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ENVIRONMENTAL ASSESSMENT

INTEGRATED RURAL DEVELOPMENT PROJECT

UPPER BONG COUNTY, LIBERIA

environment consultants, inc.

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UPPER BONG COUNTY, LIBERIA

Prepared for:

UNITED STATES DEPARTMENT OF STATE

AGENCY FOR INTERNATIONAL DEVELOPMENT

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TABLE OF CONTENTS

		Page
I.	INTRODUCTION	1
	A. PROJECT IDENTIFICATION	1
	B. REQUIREMENTS AND PURPOSE FOR THE ENVIRONMENTAL ASSESSMENT	1
	C. METHODOLOGY FOR ENVIRONMENTAL ASSESSMENT	2
	D. ACKNOWLEDGEMENTS	3
II.	PROJECT DESCRIPTION	4
	A. PURPOSE AND GOALS	4
	B. PROJECT COMPONENTS	4
	1. Farm Crop Development	4
	a. Upland Rice	4
	b. Swamp Rice	5
	c. Coffee	5
	d. Cocoa	5
	e. Dry Season Crops	5
	2. Transportation	6
	a. Improvement of Existing Roads	6
	b. Construction	6
	c. Maintenance	6
	3. Revolving Credit Fund	6
	4. Agricultural Cooperation Development	6
	a. Supervised Credit	7
	b. Input Supply	7
	c. Marketing Services	7
	5. Agricultural Extension and Credit Supervision	8
	6. Training Programs	8
	7. Agricultural Research	9
	8. Health Services	9
	9. Project Management, Coordination, and Planning	10
	a. Project Management Unit	10
	1. Administrative personnel	10
	2. Agricultural services	10
	3. Training	11
	4. Cooperative/credit	11
	5. Finance	11
	6. Roads and schistosomiasis surveillance	11

		Page
	b. Project Steering Committee	11
	c. Cooperative Sub-groups	11
	d. Project Planning and Monitoring Evaluation Unit	12
	C. IMPLEMENTATION SCHEDULE	12
	D. NON-PROJECT FINANCIAL SERVICES	12
III.	BACKGROUND OF THE REPUBLIC OF LIBERIA	13
	A. LOCATION AND GEOGRAPHY	13
	B. HISTORY	13
	C. GOVERNMENT AND POLITICAL DIVISIONS	13
	D. SOCIAL STRUCTURE	16
	E. ECONOMIC STRUCTURE	16
	F. UPPER BONG COUNTY STUDY AREA	19
IV.	EXISTING CONDITIONS IN UPPER BONG COUNTY	22
	A. PHYSICAL CHARACTERISTICS	22
	1. Physiography	22
	2. Geology	22
	3. Climate	23
	4. Soils	23
	a. General	23
	b. Agricultural Suitability	24
	5. Air Quality	25
	6. Surface Water Resources	25
	a. Rivers	25
	b. Swamps	27
	c. Surface Water Quality	27
	d. Present and Potential Use	29
	7. Groundwater Resources	29
	a. Aquifer Characteristics	29
	b. Groundwater Quality	29
	c. Present and Potential Use	29
	B. ECOLOGICAL CHARACTERISTICS	29
	1. Ecosystem Descriptions	29
	a. Natural Forest	29
	b. Secondary Vegetation	30
	c. Swamp and Marsh	30
	d. Aquatic Habitats	30

		Page
2.	Unique and Sensitive Natural Areas	30
3.	Threatened or Endangered Species	31
4.	Commercially Important Species	31
5.	Vectors	32
C.	CULTURAL CHARACTERUSTUCS	32
1.	Land Use	32
2.	Land Ownership	32
3.	Social Structure	32
a.	Tribes	32
b.	Villages	33
c.	Population	33
d.	Education	33
e.	Living Condition and Housing	33
4.	Economic and Institutional Structure	34
a.	Local Government	34
b.	Average Income	34
c.	Financial Institutions	34
5.	Public Facilities and Services	35
a.	Utilities	35
b.	Law Enforcement	35
D.	AGRICULTURE	35
1.	Crop Types and Characteristics	35
a.	Upland Rice	36
b.	Swamp Rice	36
c.	Cassava	36
d.	Sugar Cane	36
e.	Coffee	36
f.	Cocoa	36
g.	Rubber	36
h.	Oil Palm	36
i.	Other	37
2.	Crop Production Practices	37
a.	Land Availability and Usage	37
b.	Water Considerations	37
c.	Available Labor	37
d.	Capital and Financing	38
e.	Equipment and Technology	38
f.	Fertilizer Usage	38
g.	Pest Control	38
3.	Crop Marketing Considerations	39
a.	Level of Subsistence Agriculture	39
b.	Liberian Food Production/Consumption	39
c.	Farm to Market Transport	39
d.	Cooperatives	39
e.	Foreign Export	39

		Page
	4. Government Programs	40
E.	PUBLIC HEALTH	40
	1. Nutrition	40
	2. Domestic Water Supply and Sewage Disposal Systems	40
	3. Indigenous Diseases	41
	4. Health Care	41
V.	PROBABLE EFFECTS OF THE PROJECT	44
A.	PHYSICAL IMPACTS	46
	1. Soils	46
	a. Erosion Potential	46
	b. Nutrients	46
	2. Water Quality	48
	a. Fertilizers	48
	b. Pesticides	50
	c. Sediment Load	53
	3. Water and Water Supply	53
	a. Ground Water Wells	53
	b. Irrigation Systems	54
	c. Flood Control	54
	4. Air Quality	55
	a. Construction Related Pollutants	55
	b. Smoke	55
	c. Dust	55
B.	ECOLOGICAL IMPACTS	56
	1. Alteration of the Ecosystem	56
	a. Swamp and Marsh	56
	b. Abandoned Fields, Fallow Land and Secondary Forest	57
	c. High Forest	58
	d. Rivers and Streams	58
	2. Impact Upon Significant Species	59
	3. Vector Impacts	59
	a. Water borne	59
	b. Insect	59
	c. Rodent	60
C.	CULTURAL IMPACTS	60
	1. Land Ownership	60
	2. Land Use	60
	3. Social Structure	61
	a. Effect on Tribal Structure	61
	b. Changes in Education	61
	4. Economic and Institutional Structures	62
	a. Employment Opportunities	62
	b. Farm Family Income	63
	c. Revolving Credit Fund	63
	d. Cooperatives	64

Page

5. Changes in Public Facilities and Services 64
   a. Development of Central Agricultural Experiment Station (CAES) 64
   b. other 65

D. TRANSPORTATION CHANGES 65
   1. Highway Improvements 65
   2. Farm to Market Road Construction 66
   3. Effects of Improved Accessibility 66
      a. Commerce 66
      b. Agriculture 66
      c. Living Conditions 67
      d. Education 67
      e. Health Care 67
      f. Employment and Income 67

E. AGRICULTURAL CHANGES 68
   1. Effect of New Technology 68
   2. Crop Production and Yields 73
   3. Effect on Labor/Yield Ratio 75
   4. Impact of Cooperative Development 78

F. EFFECT ON PUBLIC HEALTH 78
   1. Food Supply 80
   2. Water Supply and Sanitation 80
   3. Exposure to Agricultural Chemicals 81
   4. Nature and Prevalence of Farm Accidents 81
   5. Incidence and Prevalence of Indigenous Diseases 81
      a. Schistosomiasis 82
      b. Malaria 82
      c. Trypanosomiasis 82
      d. Pneumoconiosis 82
      e. Lhasa Fever 83
   6. Health Care 83

VI. PROPOSED MITIGATION 84

A. AIR QUALITY 84
   1. Burning Controls 84
   2. Treatment of Roads 84
   3. Agricultural Applications Training 84
   4. Construction Controls 85

B. WATER QUALITY AND SUPPLY 85

C. CHEMICAL EXPOSURE 86

D. PUBLIC HEALTH 86

		Page
	E. SOILS	88
	1. Cultivation Training Programs	88
	2. Cultivation Techniques and Practices	88
	3. Soil-Enriching Cover Crops	89
	F. CULTURAL	89
	1. Housing Program for Population Redistribution	89
	2. Education and Training Programs	89
VII.	UNAVOIDABLE ADVERSE IMPACTS	91
VIII.	ALTERNATIVES TO PROPOSED ACTION	93
	A. NO ACTION	93
	B. IMPLEMENTATION OF PORTIONS OF THE PROPOSED PROJECT	93
	1. Direct Subsidization with Training Programs Only	93
	2. Annual Credit from International Sources	94
	3. Transportation Improvements Only	94
	4. Health Care and Public Education Programs Only	94
	5. Provide Extension Service to Assist with Agricultural and Marketing Management	95
	6. Summary	95
	C. CONCEPTUAL ALTERNATIVES TO THE PROPOSED PROJECT	95
	1. Non-subsidized Private Enterprise System	95
	2. Completely Subsidized Government Farming Operation Employing Local Labor	96
	3. Mechanized Farming Operation	97
	4. Cash Crops Only	97
	D. SUMMARY	97
IX.	THE RELATIONSHIP BETWEEN LOCAL SHORT TERM USES OF MAN'S ENVIRONMENT AND THE MAINTENANCE AND ENHANCEMENT OF LONG TERM PRODUCTIVITY	98
X.	IRREVERSIBLE/IRREVOCABLE COMMITMENT OF RESOURCES	99
	A. FOREST	99
	B. NATURAL SWAMP	99
	C. FUEL	99
	D. BUILDING MATERIALS	99

		Page
	E. CAPITAL	100
	F. AGRICULTURAL MATERIAL	100
	G. LABOR	100
XI.	SUMMARY AND CONCLUSIONS	101
	A. SUMMARY	101
	1. Project Components	101
	2. Environmental Effects	102
	B. CONCLUSIONS	102
APPENDIX		
BIBLIOGRAPHY		

LIST OF FIGURES

Figure		Page
1	Liberia in Relation to Other West African Countries	14
2	General Map of Liberia	15
3	Major Political Subdivisions, Liberia	17
4	Major Tribes and Tribal Boundaries	18
5	Upper Bong County, Liberia	20
6	Chiefdoms and Clans of Upper Bong County (Boundaries Approximate)	21

LIST OF TABLES

Table		Page
1	Soil Characteristics and Production Potential	26
2	Description of Water Quality Sampling Locations	28
3	Indigenous Disease Incidence, January-September 1976	42
4	Projection of Upper Bong County Acreage in Cultivation After Five Years with and without Project	47
5	Rice Seed Requirements (X 1000 lb.)	70
6	Dry Season Crops and Anticipated Yields	74
7	Estimate of Increased Rice Production During Project	76
8	Yield of Farm Models Assuming Ultimate Crop Yield	77
9	Labor/Yield Comparisons for 1.5 Hectare Farm Holdings	79

I. INTRODUCTION

A. PROJECT IDENTIFICATION

As an integral part of a comprehensive developmental program, the Government of Liberia formulated a national development plan emphasizing balanced improvements in agriculture, health, education and training by means of a series of rural development projects. The implementation of this plan began with feasibility studies of projects in Lofa and Bong Counties. Based upon the recommendations thus developed, the Government of Liberia (GOL), US Agency for International Development (AID) and the International Bank for Reconstruction and Development (IBRD) agreed to finance the $17 million Lofa County Project as the first endeavor in the rural development program. Financing was arranged in August of 1975, and the project is now in its first year.

The Upper Bong County Intergrated Rural Development Project is the subject of this Environmental Assessment. The project was first recommended in an AID draft Project Review Paper in December, 1975 and was studied in May, 1976 by a joint AID/IBRD appraisal mission in Liberia. A preliminary project paper was prepared by IBRD in August, 1976. Recommendations from the IBRD report were incorporated into AID's final Project Review Paper which was distributed in November, 1976 and provides the fundamental details of the Bong Project upon which this Environmental Assessment is based.

B. REQUIREMENTS AND PURPOSE FOR THE ENVIRONMENTAL ASSESSMENT

It is the policy of AID to conform with the spirit, intent and objectives of the National Environmental Policy Act of 1969 (NEPA) to "promote efforts which will prevent damage to the environment and biosphere, and stimulate the health and welfare of man".

It must be recognized that the relationship between AID and a prospective foreign borrower (or grantee) is different from agencies participating in an intra-US governmental project. The proposed foreign development project is not a US project, and the final decisions concerning it are not properly the responsibility of the United States but of the government of the host country.

Coordination with the participating country and its agencies is necessary to insure that project analysis, planning design and implementations reflect consideration of environmental factors and alternatives. There is no intent to impose US standards, priorities or solutions upon a foreign government through this procedure. Rather, it is intended to fulfill the objectives of the NEPA while affording recognition of the bilateral nature of the decision-making process. Missions are encouraged, therefore, to promote environmentally sound development through:

Assuring that assessment of environmental impact are undertaken early in project identification and formation so that consideration of environmental impact becomes an integral part of the project development, planning and design;

assuring that information relating to environmental impact and potential consequences of project development is received, understood and considered by the borrower/grantee country;

assuring that there is mutual agreement between the borrower/grantee country and AID on environmental considerations and safeguards to be included in the development project; and

assuring that the project minimizes adverse environmental impacts and beneficial results exceed those of similar projects where environmental consequences were not considered.

C. METHODOLOGY FOR ENVIRONMENTAL ASSESSMENT

An interdisciplinary approach was utilized to investigate the potential effects of the Upper Bong County Integrated Rural Development Project. The base team was composed of a civil engineer, public health specialist, ecologist/limnologist, water resources engineer, aquatic biologist and botanist/agronomist. This base team was supported by an anthropologist, pollution control/chemist, sociologist/economist, tropical ecologist/biologist and required sub-professional personnel.

The initial effort of the team involved a literature investigation and familiarization with project documents and plans. Many libraries, including those of the US State Department, US Congressional AID Mission Liberia and the University of Liberia, and all Liberian Ministry offices were researched for pertinent background material.

A site inspection was conducted by the field team between February 25 and March 20, 1977. During this period, interviews were conducted with AID, Liberian and World Bank personnel familiar with the project. Field observations of plants and wildlife and ecosystem mapping were conducted. Water samples were collected for chemical and biological analysis to be done in the field and in the USA. Coordination meetings were held with the American Public Health Association (APHA) team. Most importantly, the characteristics, capabilities and customs of the officials and rural farmers who must implement this project were studied.

Following the field inspection, a series of analyses and evaluations were made prior to preparation of the final report. Water quality samples were processed, and ecological field notes were used to derive quantitative estimates of ecosystem characteristics. Models of fertilizer and pesticide degradation and transport were used to evaluate water quality impacts. A series of interdisciplinary meetings were conducted to assess the probable direct and secondary impacts of the project under various assumed

scenarios. Results were assembled and are presented in this Environmental Assessment.

D. ACKNOWLEDGEMENTS

Appreciation is extended to all organizations and individuals who aided in the acquisition of information for this assessment.

Numerous officials of the Liberian Government took their valuable time to assist team members. Among them were the Honorable Louis A. Ross, Minister of Agriculture and his fine staff; the Honorable Z. Moulai B. Reeves, Assistant Minister of Planning, and Mrs. Sara Sherman, Ministry of Planning and Economic Affairs. Dean Agnes Dennis of the University of Liberia was extremely helpful in assisting with local educational and ecological information.

Special note should be made of the cooperation and splendid support of W. Dale Davies, Juan Cabrero, David Dibble, Albert Printz, Dr. Edward Cross, Cheryl Palesh, Palmer Stearns and Gary Adams of USAID/Washington and Stanley Siegel, C. Blair Allen, James Lawson and Howard Guiot of USAID/Liberia.

During field trips in Lofa and Bong Counties, a number of people assisted members of the field team and provided important information. Special thanks are extended to Mr. Luther Geiger of the Suakoko Agricultural Extension Center. The assistance of Mr. Thomas Lawson and Mr. Michael McFadden from the Peace Corps was much appreciated.

II. PROJECT DESCRIPTION

A. PURPOSE AND GOALS

Although the immediate purpose of the Upper Bong County Rural Development Project is to increase and maintain agricultural productivity and income of small farmers in the area, the ultimate goal is to improve the welfare of the rural population. The income to the inhabitants of this rural area will be increased by improving crop production and increasing the amount and number of crops the farmer can grow, by improving transportation routes so that input for agricultural production is facilitated and delivery of agricultural produce is improved, and by providing employment through the clearing and development of agricultural land. This increase in income can then be translated into improved living conditions, education, health and nutrition. The taxing capability of the Government of Liberia is somewhat limited, and many of the social programs which could benefit the Bong County area cannot be funded by the government at the present time. This project will result in increased tax base as well as increased income to the area so the inhabitants can contribute to their own social programs.

B. PROJECT COMPONENTS

1. Farm Crop Development

The traditional production pattern in the project area is multi-crop and subsistence oriented. This project will provide technological innovations which will complement these traditional patterns by increasing yields, reclaiming lands and providing technical assistance. Credit will be provided for farm inputs including hired labor, tools, equipment, seeds, fertilizer and chemicals. The growing of traditional crops will be stressed, however improved seeds will be used where possible. The crops presently grown in the area include upland rice, swamp rice, cocoa, coffee, and dry season crops such as cassava, maize, etc. The improvement for each of these crops is discussed in the following paragraphs.*

a. Upland Rice

Upland rice farming has traditionally been accomplished by shifting cultivation based on slash and burn cleaning of the land. For demographic, social, and technical reasons, this procedure must be accepted for some time. Productivity of the land which is utilized can be increased by using improved seeds, fertilizer, and better farm management practices (disease control, rodent control, pest control, etc.). Major soil conservation and water management techniques are not possible at the present time and therefore, will not be considered for the first five years of this project. Yields on farms using only improved seeds are expected to increase from 1000 kg per hectare to 1300 kg/ha, and yields on farms using improved seeds with fertilizer are expected to increase to 1800 kg/ha.

* Data from US Agency for International Development (1976)

b. Swamp Rice

There are presently 1500 hectares (3705 acres) of traditional and 200 hectares (494 acres) of improved swamp in the project area. By clearing and leveling swamp plots and constructing water control structures, agricultural properties of greatly increased value can be developed. Improved seeding, chemical weed control, and irrigation structures should increase the yield from 1400 kg/ha to 3000 kg/ha. The project would reclaim 1650 hectares (4075 acres) of swamp and improve about 400 hectares (988 acres) of existing swamp paddy. Approximately 300 hectares (741 acres) would be developed as pilot schemes for double cropping of rice. Clearing of swampland would be done with hand labor while flood protection and water control would be achieved by water impoundment, peripheral drains and leveling.

c. Coffee

The Robusta variety of coffee would be grown, planted on land 2 to 4 years after it has been cleared for upland rice cultivation. This would economize land clearance costs and provide some low shade for coffee seedlings. Fertilizers will be applied in the first 3 years of establishment, beginning with rock phosphate and ammonium sulphate. Periodically, insecticide treatments will be applied to protect seedlings from termites and borers. Labor requirements for development of 1 hectare of plantation are estimated to be 164 man-days for the first year and 89 and 115 man-days for the second and third years, respectively. Yield levels will rise from 300 kg/ha dry cherry in the fourth year to 1000 kg/ha beginning in the sixth year when the plantation will be fully productive.

d. Cocoa

The type of land, spacing, weeding and shade management would be the same for cocoa as for coffee. Fertilizer applications are also the same, although more intensive use of insecticides would be required. The type of cocoa is the Upper Amazon Hybrid. The project will promote the innovation of fermentation of cocoa beans to increase quality. The yield level is expected to rise from 200 kg/ha of dry bean in the fifth year to 800 kg/ha in the eighth year.

e. Dry Season Crops

Most swamp rice fields will not have sufficient soil moisture during dry seasons to grow a second rice crop. Thus, alternative crop programs can be designed. These may include maize, peanuts, sweet potatoes, cow peas, okra, etc., which would be established after rice harvest. Fertilizer (urea and hyperphosphate) would be applied during sowing.

2. Transportation

a. Improvement of Existing Roads

Approximately 45 percent of the population reside within one mile of a road, and there is one kilometer (0.62 miles) of road for every 13 square kilometers (5.02 square miles) of area. The desirable density of a road network in the project area cannot be exactly determined, but successful implementation of this project will require construction of new farm to market feeder roads and proper maintenance of existing highways. The existing 130 kilometers (80.6 miles) of farm to market roads require widening and rehabilitation of drainage structures and surface. Proposed improvements would make them serviceable throughout all seasons of the year.

b. Construction

The project envisages construction of approximately 170 kilometers (105 miles) of new farm to market roads, thereby extending the existing network by about 131 percent. The alignment for these new roads will be determined in detail during the project implementation phase. No detailed engineering survey or design work would be made. Farm to market roads would generally follow existing trails with the finished product as all-weather "jeep roads".

c. Maintenance

After the first year of new construction and upgrading, maintenance operations will be conducted on a scheduled basis for about 180 kilometers (111.6 miles) of farm to market roads.

3. Revolving Credit Fund

No formal system exists capable of supplying credit in sufficient quantity to small scale farmers in the project area. For project implementation, an organized system must be administered as a long term permanent operation. A revolving credit fund will be established and administered by the Project Management Unit Coop/Credit Division. In keeping with sound financial practices, monies not being used from the credit fund will be on deposit at banks earning interest at commercial rates. Eventually, it is expected that the Liberian Bank for Development and Investment will open a branch office in the project area or, as an alternative, another banking institution will be selected.

4. Agricultural Cooperative Development

To ensure a continuing developmental process, institutions must be initiated to render essential services such as marketing, credit, input supply, etc., to farmers. The institution best suited to serve the interest of the farmers in the study area is an agricultural cooperative. Formation

of cooperatives will be initiated by the farmers although a great deal of support will come from the project staff until the farmers have sufficient experience and expertise to manage a cooperative alone. The type best suited for the project area is a multi-purpose service cooperative with primary functions of granting credit, supplying farm inputs and marketing agricultural produce.

a. Supervised Credit

As previously discussed, the existing credit system will require replacement by an organized system capable of serving the needs of both the farmers and the project. All direct disbursements will originate with the lending agency and be provided to the project management unit (PMU) for disbursement in the project area. Initially, the PMU will have responsibility for credit allocation, but as the cooperatives become organized and viable, they will be assigned this responsibility. A system will be set up permitting individual credit requests to be compiled by village-level societies, with repayment following the same pattern. Disbursements will be made for fertilizer, insecticides, seeds and seedlings, and hired labor. Loan terms will vary to allow for differences in seasonal, maintenance, long term or development needs. To insure financial viability, a minimum of 6 percent interest will be granted to the cooperatives and an additional 4 percent will be capitalized in the Revolving Loan Fund.

b. Input Supply

Fertilizers and other chemicals will be obtained from overseas supply, and seedlings from nurseries already established in Liberia. Rice seed may be obtained from the Seed Multiplication Scheme, which is part of the Lofa County Integrated Rural Development Project. Inputs will be stored in Gbarnga and adequate storage facilities will be made available. Some short term storage facilities may be required to take up excess demand but rental space appears to be readily available. As the project develops, the cooperatives will arrange for temporary storage facilities at central points within the cooperative areas. At village levels, storage facilities will be provided by individual farmers. The Liberian Produce Marketing Cooperative (LPMC) will be responsible for delivering input to warehouses in Gbarnga. From that location, the distribution will be made in two steps (1) from Gbarnga to the cooperative's central points and (2) from the cooperative's central points to the villages. The LPMC will mark up the cost of imported inputs by 10 percent to cover its cost and the cooperatives will add an additional 5 percent to cover the administrative cost of input supply. Transportation costs will be included in the delivered price.

c. Marketing Services

Improvements under the project must increase producer price by decreasing the present margin between the fixed LPMC prices and prices obtained by the farmers. This can be achieved by: (1) establishing collection points where farmers are paid the full LPMC prices; (2) more efficient means of

farm to market transport; (3) quality improvement incentives and controls; and (4) better market information for the farmers.

A number of components are involved. The LPMC out-station in Gbarnga will become a focal point and backbone of all marketing operations in the area. It will accept all relevant products, not just paddy products as is the case now. The pattern of cooperation between LPMC and the project will depend in the early stages on the phasing of the cooperative structure. During the initial phase of the project, all transportation operations will work through the proposed transportation unit of the PMU. This will consist of several tractors and trailers which transport produce from the farms to the warehouses and to the LPMC out-station. While a comprehensive system of grading quality control cannot be set up within a short time, there should be an attempt at the cooperative level to enforce existing regulations concerning the quality of the produce grown. There should be a price differential between fermented and sun-dried cocoa, for example. Prices should be fixed for cherry and clean coffee in such a way that the farmers are encouraged to deliver their coffee in the form which can be processed in the LPMC mills. By fixing one stable price for each product for a whole buying season, farmers can be made more price conscious.

5. Agricultural Extension and Credit Supervision

At the present time, the extension service in the project area is understaffed, lacks transportation facilities and lacks practical on-the-job training. As part of this project, it is proposed that the area be divided into six development zones, each staffed by an extension officer and a varied number of extension aides. Assistance and supervision will be provided by the PMU headquarters in Suakoko. Initially, the extension ratio of one aide to 50 farmers will be required for the first year, decreasing to 1:100 and 1:150 in the third and fourth development years, respectively. This will require as many as 73 extension aides. A maximum of 30 (five per cooperative) will be required after the fifth year, thus maintaining a 1:300 ratio for the 9,000 farmers. These extension aides will be trained on the job by their immediate supervisor and specialist officers. Specialized in-service training courses will be provided at the training center at Suakoko. Some initial training in tree crop development for cocoa and coffee production is necessary. Additionally, all cooperatives will have two credit supervisors initially financed by the project. They will provide the required expertise in the management of the revolving credit program.

6. Training Programs

For this project to reach fulfillment, training programs will have to be provided for extension aides, cooperative staffs and to the farmers themselves. Extension aides will be trained on the job by their immediate supervisors and the PMU's specialist officers while short specialized in-service training courses will be given at the training center at Suakoko by personnel from PMU and Central Agricultural Experiment Station. Because of the lack of expertise in coffee and cocoa development, a number of extension staff will be sent for a 2-3 month course at the SATMACI Training Center at Divo and Gagnona in the Ivory Coast.

Programs for the cooperative staff will consist of the short formal courses interspersed with practical field training. The curriculum will focus on imparting the technical knowledge to this staff and upon the development of motivation and dedication by the staff.

The project will organize training for farm families on village demonstration farms, at farmer training centers, through farm visits and through village/group discussion using audio-visual aids. This training will facilitate farmer response, participation in project activities and dissemination of new technology.

7. Agricultural Research

While there are four major institutions involved in research activities in Liberia, the main research center of the Ministry of Agriculture is the Central Agricultural Experiment Station (CAES) located in Suakoko in the center of the project area. CAES has been involved in applied rice research since the late 1950's; however, significant results were obtained only after a rice agronomist was stationed in Suakoko in 1970. Research at this institution indicates that LAC 23 variety of rice is the most suitable for the upland conditions. Future improvement work for inland valley swamp conditions should emphasize screening for disease resistance and tolerance to iron toxicity. Some additional research has been done on rubber growing, tree planting, and other crops, but it is of a limited nature.

Priority will be given to the establishment and research program on such crops as coffee, cocoa, oil palm and coconut. Research programs will be undertaken by CAES for testing different varieties, determining fertilizer requirements, evaluating pests and diseases, etc.

It is intended that this project will provide funding for some of Liberia's immediate research needs such as improvement of rice research, initiating research activities for cocoa and coffee and an overall improvement in the physical facility at CAES. Funds will be provided for two consultant man-months for an in-depth analysis of the present physical status of research, required organizational changes, establishment of research priorities and most effective operational practices.

8. Health Services

The production of swamp rice in irrigated fields may alter the present schistosomiasis problem. An increase of water suitable for breeding of the vector snails and the increased number of individuals working in irrigated fields will enhance contact between man and the snail. As a consequence, a rise in the infection and increase in the mortality caused by schistosomiasis could occur. It is therefore essential that constant and careful vigilance be maintained during project implementation. The Schistosomiasis Surveillance Unit of the Lofa County IRD will, therefore, be expanded to monitor the incidence of schistosomiasis infection in Upper Bong County. In coordination with the Public Health Service, disease treatment facilities will be made available. No single ideal method for the control of the disease or infection is yet available. Hopefully, the

proposed surveillance unit will be able to collect required baseline data and develop specific recommendation for control measures for the government.

Additional health hazards result from the widespread incidence of water-borne disease in rural and semiurban areas. The government of Liberia desires establishment of rural water supply and sewage systems as a component of overall rural development programs. Well drilling programs have been initiated, and negotiations are continuing for effective implementation of this program. A rural water supply program of significant scale is beyond the scope of this project, but the PMU will encourage local inhabitants to improve water supply through wells constructed on a self-help basis. Additionally, transportation improvements indigenous to the project will provide access to villages hitherto inaccessible to well-drilling equipment.

9. Project Management, Coordination and Planning

a. Project Management Unit

The project as planned is complex, and the organization requires measures which are innovative and cope with that complexity. As a result, it is proposed to entrust the implementation to a special project administration within the Liberian Ministry of Agriculture to be called the Bong Project Management Unit (BPMU) with headquarters at Suakoko. This unit will be responsible for a number of farm support measures in the project area and in turn will be responsible to the Project Steering Committee, the chairman of which will be the Minister of Agriculture. Furthermore, the PMU will be largely an independent organization within the government section. It will have three functions: (1) organization and coordination with farm support measures; (2) planning and evaluating project activities; and (3) guiding and strengthening of rural institutions (cooperatives). It will supervise the organization of all the measures for which there are no sufficient institutions available. If such institutions are available, the PMU will coordinate the activities, including road construction and maintenance, input supply, produce marketing, cooperative distribution and experimentation.

1. Administrative personnel

The project manager would be head of the unit and would be assisted by deputy project managers. There will be five divisions within the organization; Administration and Personnel, Agricultural Services, Cooperative and Credit Services, Training, and Finance.

2. Agricultural services

The Agricultural Services Division will have three sections; Extension and Experimentation, Land Development, and Survey and Registration. The Extension and Experimentation Section will be responsible for technical advice on tree and field crop production, seed multiplication, seedling production, and field experimentation. The Land Development Section will

be responsible for land clearing, farm equipment, hire service, swamp development, irrigation and water control. Responsibilities of the Survey and Registration Section include topographic and soil surveys, land use planning, demarcation and measurement of farms, and assistance in land registration.

3. Training

The Training Division will be responsible for scheduling and conducting training programs for extension aides, cooperative staff, and the farmers themselves. These will be conducted at various institutions and locations as appropriate.

4. Cooperative/credit

The Cooperative and Credit Services Division will have the responsibility for organizing the delivery system for farm inputs and credit. It will have three Sections: Cooperatives, Credit, and Commercial Services. The Cooperative Section will be responsible for development, guidance, and strengthening of cooperatives. Distribution and recovery of small holder credit will be the responsibility of the Credit Section, while procurement and distribution inputs and marketing assistance will be provided by the Commercial Services Section.

5. Finance

The Finance Division will be responsible for the handling of all financial transactions, audits, budgeting, etc.

6. Roads and schistosomiasis surveillance

The roads program and the schistosomiasis surveillance will be implemented through the Feeder Road Unit and Schistosomiasis Unit to be established within the Ministries of Public Works and Health, respectively.

b. Project Steering Committee

The Project Management Unit will be responsible to the Project Steering Committee which will permit the necessary integration of the project into the overall institutional system. The Project Steering Committee has been established and is directed by the Minister of Agriculture to provide policy guidance to both the Lofa County and Bong County IRD projects.

c. Cooperative Sub-groups

As previously discussed, six cooperative societies will be organized within the project area. Administrative and extension staff support will be provided by the project, and these cooperatives will provide technical assistance, supervised credit, input supply, limited machinery and produce marketing services through their farmer members.

d. Project Planning and Monitoring Evaluation Unit

The project inputs and outputs will be monitored by the respective PMU divisions in accordance with their functions. The evaluation of project success at the purpose and sector goal level will be administered by a special Monitoring Evaluation Unit attached to the PMU. As monitoring and evaluation of rural development projects such as this can be costly, it is proposed that the monitoring and evaluation of both Lofa and Bong be handled as one operation. The Unit will be directly responsible to the Minister of Agriculture, and will work in close liason with the Economic Planning and Evaluation Division of the Ministry. This operation will have the responsibility of identifying and measuring project results and formulating specific recommendations in project approach.

C. IMPLEMENTATION SCHEDULE

Under this project it is proposed that the International Bank for Reconstruction and Development provide all donor financing of building construction, internationally recruited staff, and project vehicles. Inputs from the Agency for International Development would be limited to agricultural inputs, construction equipment and materials, and limited local cost support for road construction and cooperative development. Vehicles, equipment and other items (financed by the International Development Association) valued at more than $25,000 (and an estimated cumulative value of $1,000,000) would be procured through international competitive bidding. Items valued between $5,000 and $25,000 would be obtained on the basis of local competitive bidding procedures, (with an overall limit of $300,000). Contracts for the construction of buildings, houses and the purchase of construction materials and furnishings valued at $500,000 would be awarded on the basis of competitive bidding, advertised locally, in accordance with standard procedures.

Procurement will be conducted by the Government of Liberia, acting through an authorized procurement services agent appointed by the government and subject to AID approval. The Liberian Produce Marketing Corporation would probably be designated as the procurement agent of agricultural inputs. Procurement would be in conformance with AID Regulation 1, Section 201.23. The schedule for the project begins in 1977 and proceeds through 1982. Final evaluation is scheduled for the first of December 1982.

D. NON-PROJECT FINANCIAL SERVICES

In coordination with the Ministry of Education, seven community schools offering rural orientation education to children and literacy and community development training to adults will be constructed and operated in the project area. The specific objectives of the community schools are to provide education which is relevant to the needs of rural development, and to serve as a basis for rural community development activities. Introduction of these schools in Liberia is part of the nationwide program of the government. Such schools will be established and operated under the responsibility of the Ministry of Education. It is anticipated that funds will be provided under the Second Educational Loan to be negotiated with the International Bank for Reconstruction and Development.

III. BACKGROUND OF THE REPUBLIC OF LIBERIA*

A. LOCATION AND GEOGRAPHY

The Republic of Liberia occupies a unique position on the western coast of Africa. Bordered by Sierra Leone, Guinea and the Ivory Coast, Liberia is situated on the southern edge of Africa's great western bulge (see Fig. 1). It is situated in a prominent position both strategically and commercially since a circle with a radius of 806 kilometers (500 miles), centered at Voinjama in northern Liberia, would touch or include ten West African countries. Liberia is within 806 kilometers (500 miles) of the Greenwich Meridian and 484 kilometers (300 miles) of the equator.

The official language is English and Liberia encompasses approximately 98,420 square kilometers (38,000 square miles), completely within the tropics. It has the general form of a trapezoid, the longest side of which is its Atlantic coastline extending some 565 kilometers (350 miles) in a northwesterly direction from the Cavally River near Cape Palmas to the mouth of the Marro River (see Fig. 2). Its width varies between 177 and 274 kilometers (110 and 170 miles). The Marro and Makona Rivers form the northwestern boundary with Sierra Leone and a series of river segments and drainage divides separate Liberia from the inland portions of Guinea to the north and the Ivory Coast to the northeast and east.

The four major physiographic zones, which form distinctive belts of elevation and relief, extending from the coastline inland are; the coastal plain, the belt of rolling hills, the belt of mountain ranges and plateaus, and the Northern Highlands. The study area, Upper Bong County, is within the zone of mountain ranges and plateaus.

B. HISTORY

The general history of Liberia is composed of three major periods. The first period began with the arrival of the original inhabitants from the savannas of Western Sudan, possibly as early as the third century A.D. This period was primarily one of isolationism. The second period was one of expansion and export starting with the immigration of Americans of African descent, who returned to establish free colonies in Africa in 1822. The last half century of this period was characterized by economic stagnation during which Liberia experienced severe financial problems with its foreign trade. The third period began in the 1930's and has been accompanied by economic expansion to the point where, presently, Liberia has a favorable foreign trade balance and an expanding export economy.

C. GOVERNMENT AND POLITICAL DIVISIONS

Liberia is Africa's oldest independent republic, governed under a Constitution which dates to 1847. The government is headed by a President (presently

* A more detailed discussion of the topics covered below can be found in Appendix .

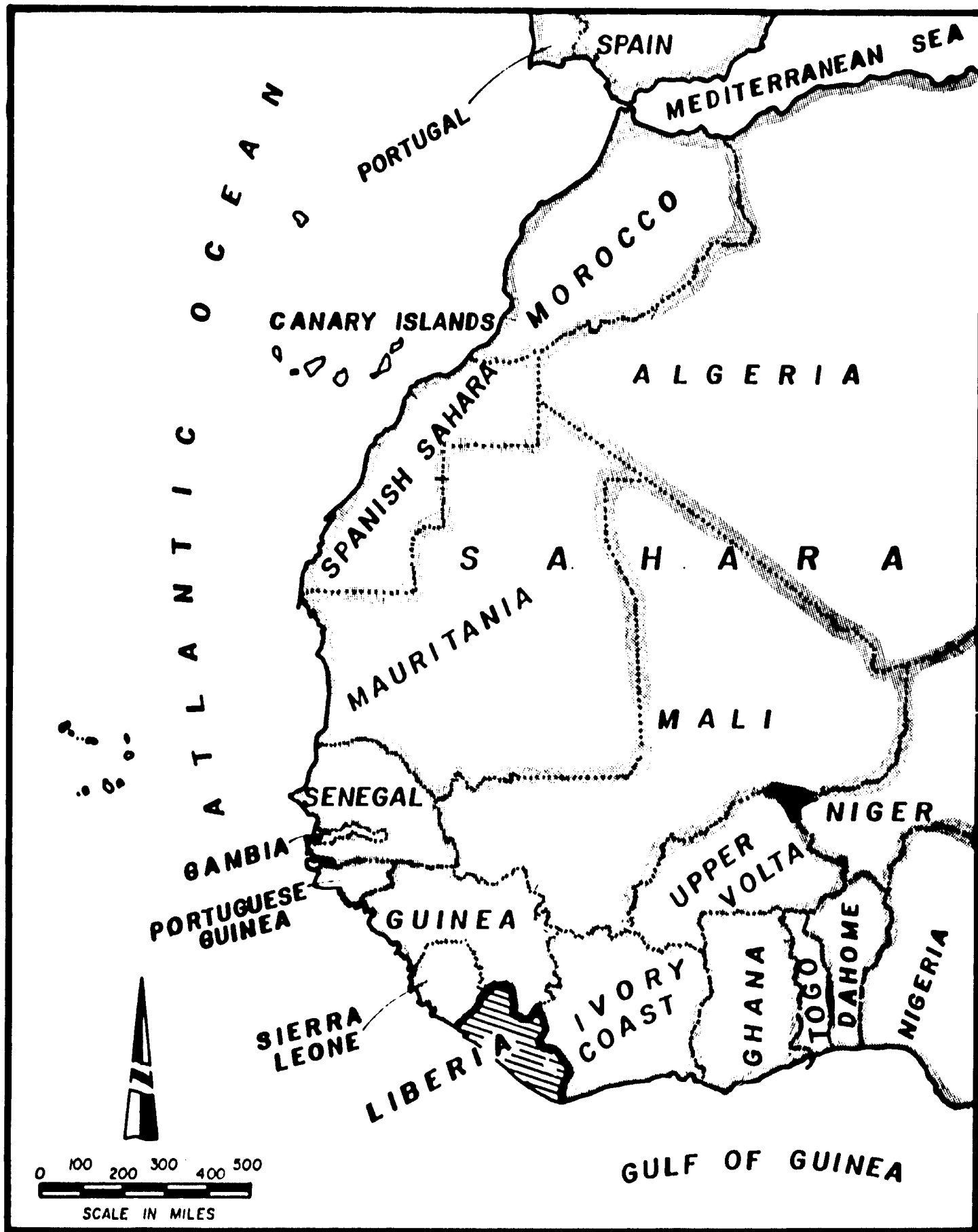


Figure 1. Liberia in Relation to Other West African Countries

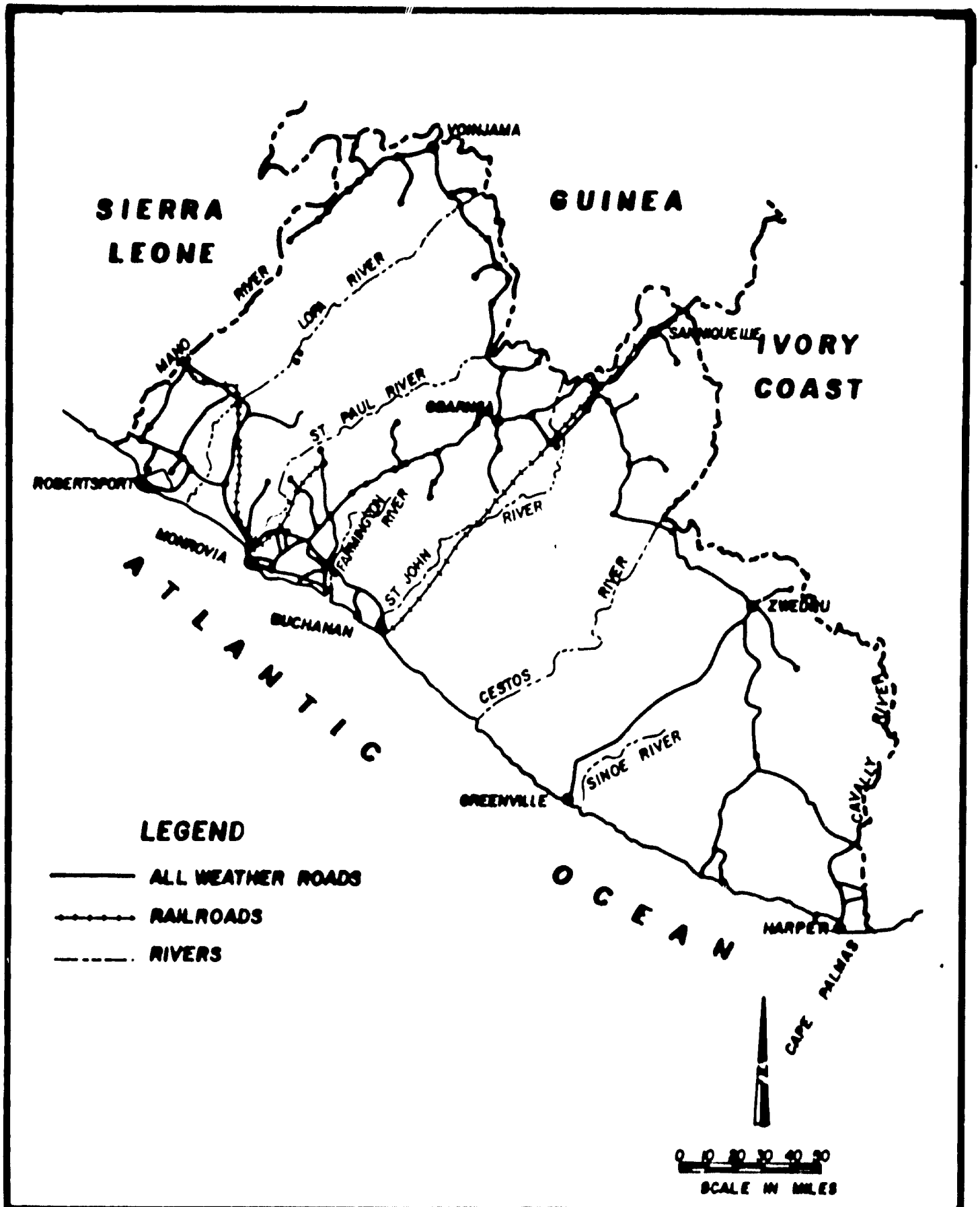


Figure 2. General Map of Liberia

William R. Tolbert) and the legislative body is a bicameral Congress (Senate and House of Representatives). The Cabinet organizations are each headed by a Minister.

The country is divided into nine counties, shown in Fig. 3, and within the counties there are political subdivisions; territories, districts, and subdistricts. In addition to the administrative system of the county-territory-district, there is the traditional leadership based on tribal lineages. The approximate territorial boundaries of each major tribe are shown in Fig. 4.

D. SOCIAL STRUCTURE

Liberia has primarily a rural society. The 1974 census classified 71 percent of the population as rural; however, if characteristics of economic activity and availability of social and physical infrastructure are considered, this proportion would be even higher. The majority of the rural population is engaged in subsistence agriculture although vegetables and tree crops are sometimes grown for cash purposes. The social structure of the rural society generally begins with tribes or chiefdoms and economic, political and other social activities are strongly influenced by family relationships.

There was a noticeable shift of population from rural to urban, evident in all counties, between 1962 and 1974. The largest urban area in Liberia is the capital, Monrovia, with a 1974 urban area population of 204,213. Other major urban areas include Buchanan (24,735), Harper 11,715), and Greenville (8,474). All of these lie along the coast. The general trend of migration occurs from the rural areas and villages to the larger settlements and then from these settlements to Monrovia which is the real focus of urban growth.

E. ECONOMIC STRUCTURE

Liberia's economic development can be divided into two principle phases. The first phase lasted from 1882 to the end of World War II and showed relatively slow progress. The second phase started with the inauguration of President Tubman and made Liberia the fastest developing nation in the world after Japan. Today, the economy of Liberia is dominated by the production of rubber and iron ore for export, mainly by foreign-owned enterprises. These enterprises are the main source of export earnings and wage employment and contribute a sizeable share of governmental revenues. Traditional agriculture, at the other extreme, has minimal interaction with the monetized economy, but continues to support the majority of the population at very low levels of productivity and income. The main products of traditional agriculture are rice, cassava, palm produce and sugar cane. Other relatively large sections, in terms of output and employment, are trade, government, transport and communications.

Liberia is an important supplier of minerals and other raw materials such as iron ore, rubber, coffee, cocoa, diamonds, palm kernels and timber to foreign nations. These materials constitute the principle export commodities but Liberia is also an important buyer of machinery, foodstuffs, fuel and other items, which form the main import goods of the country.

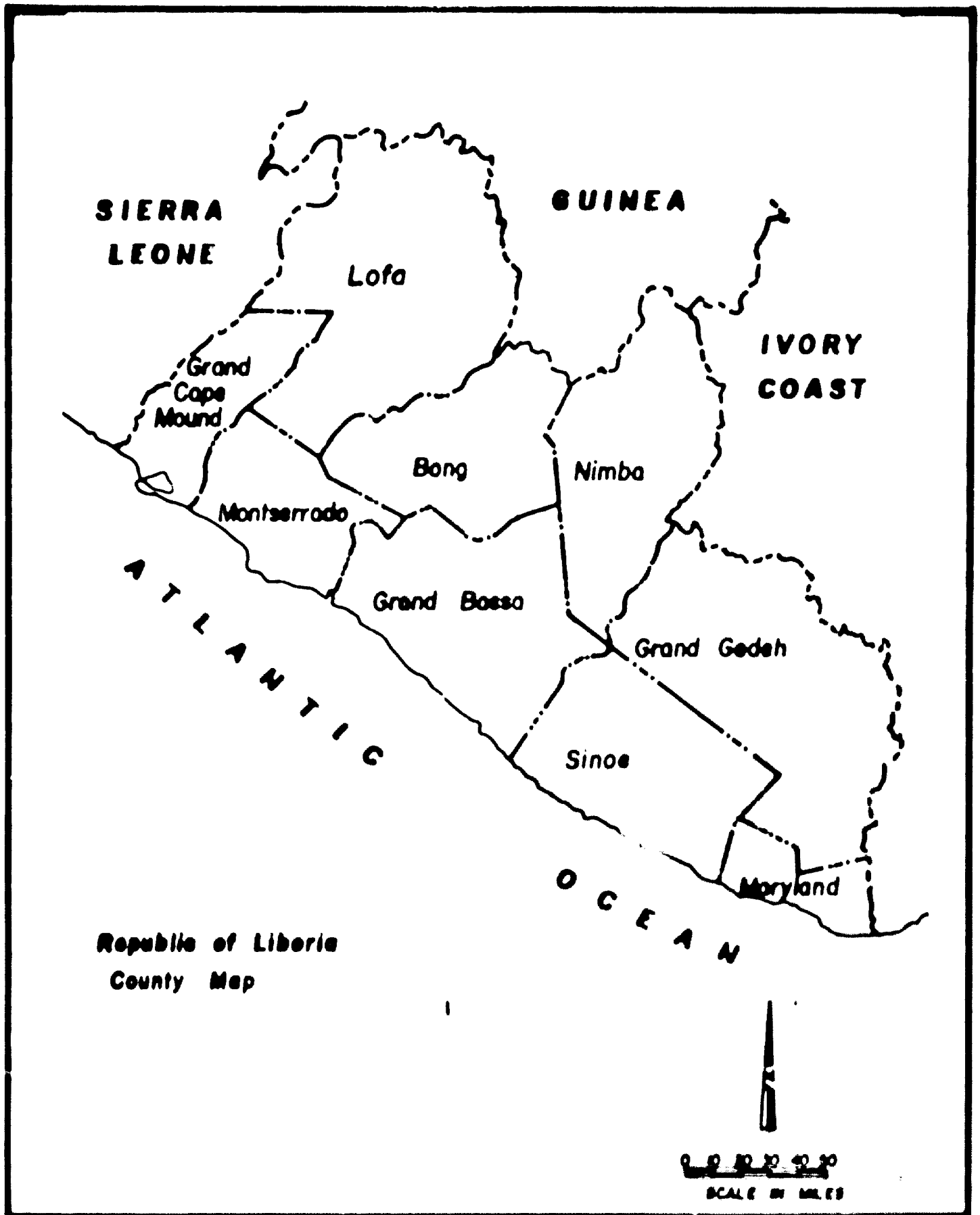


Figure 3. Major Political Subdivisions, Liberia

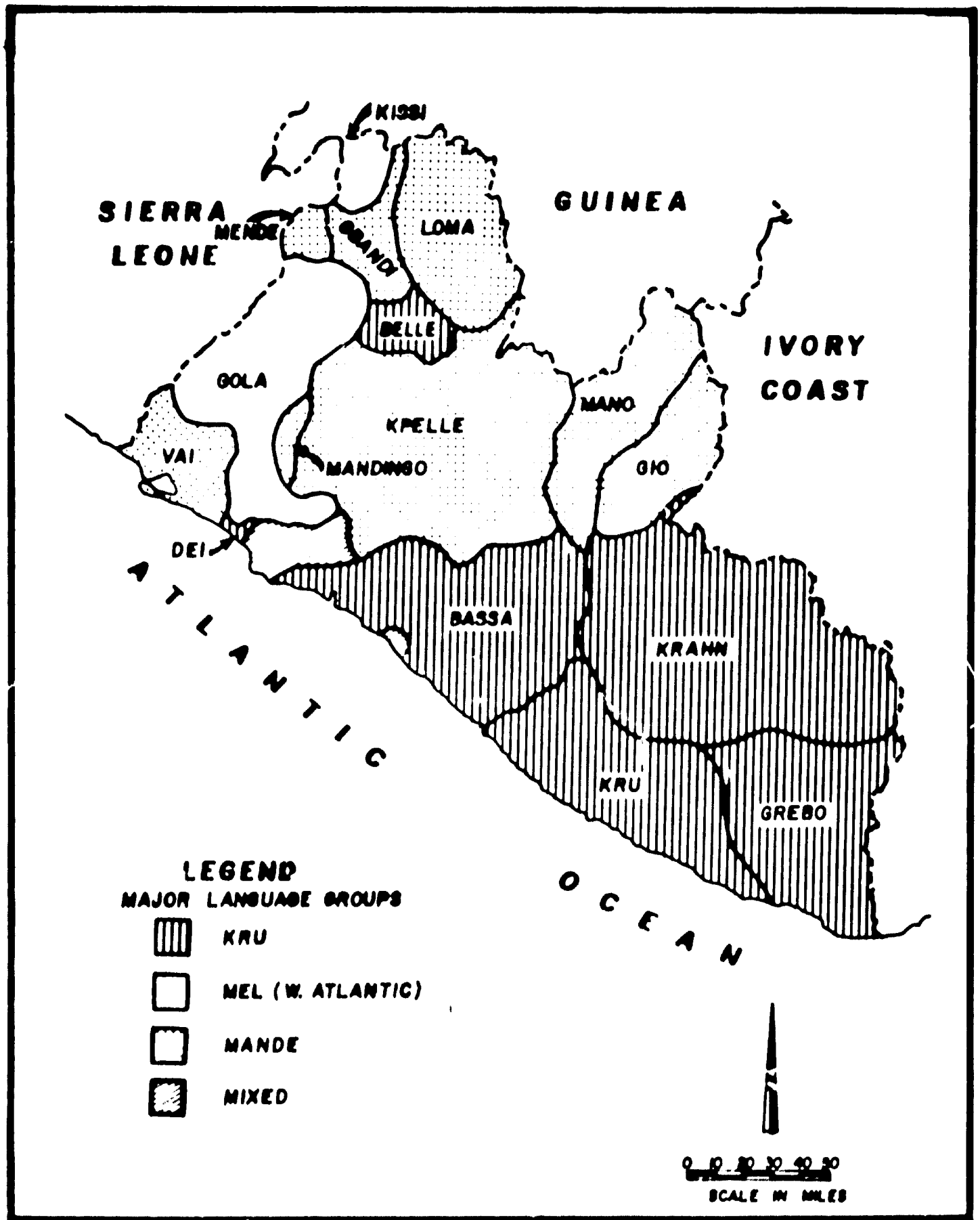


Figure 4. Major Tribes and Tribal Boundaries

Liberia enjoyed a relatively high rate of economic growth over the last decade. The average annual growth of Gross Domestic Product was 5.7 percent in real terms and 8.7 percent in current prices, from 1964 to 1974. Value-added by concession activities grew faster than average, reflecting the opening of new mines, investment in iron ore pelletizing facilities, the beginning of the commercial exploitation of the country's rich tropical forests, and expansion of diamond mining. The manufacturing industry (because of the opening of an oil refinery) and commercial agriculture (excluding rubber production by foreign concessions) also grew much faster than average. Although the output of the traditional economy grew more slowly than the average for the entire economy, it is nonetheless estimated to have grown significantly faster than the rural population. This growth probably reflects increased labor input, expansion of the cultivated area, and shifting in the crop mixture towards higher-value, marketable crops.

F. UPPER BONG COUNTY STUDY AREA

Bong County lies in the central part of Liberia as shown in Figure 3. Two of the major trunk roads of the country run through the area and connect it with the northern and southern parts of the country as well as the coast.

From Gbarnga, the county seat, it is 202 kilometers (125 miles) to the capital and main part of Monrovia. The study area is the upper portion of Bong County, and contains approximately 6,493 square kilometers (2,507 square miles), 69 percent of the county's land area.

The County Superintendent is in charge of local administration, and is the district representative of the President of Liberia. Bong is divided into five districts: Gbarnga, Kokoyah, Salala, Sanoyie and Gibi. At the district level the County Superintendent is represented by a district commissioner. In addition to the county administration, there is the traditional tribal system. Bong county is inhabited by members of the Kpelle tribe subdivided into chiefdoms and clans. Within the Upper Bong County study area, there are three districts, six chiefdoms and 28 clans (Fig. 5 and Fig. 6). The districts provide the administrative liason with the national government, while the chiefdom/clan provides the traditional leadership.

In this rural area, the family is the basic unit. Farmers do not normally move an extensive distance from their original homes and spend most of their time in subsistence farming. The farm family accomplishes most of the work, with the men clearing and burning the land, and the planting/harvesting accomplished by the women. Above the family, the clans and chiefdoms form the major social structure.

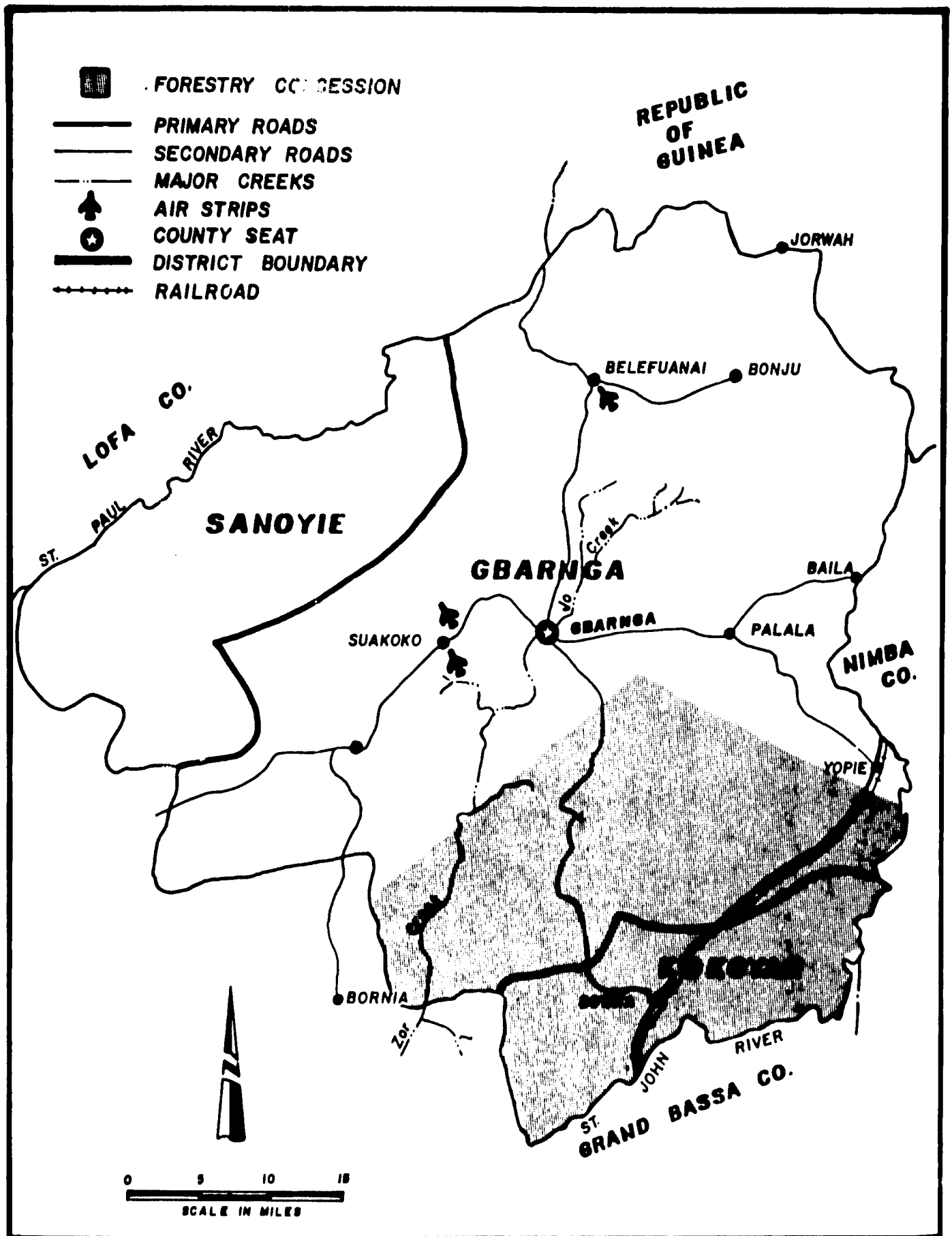


Figure 5. Upper Bong County, Liberia

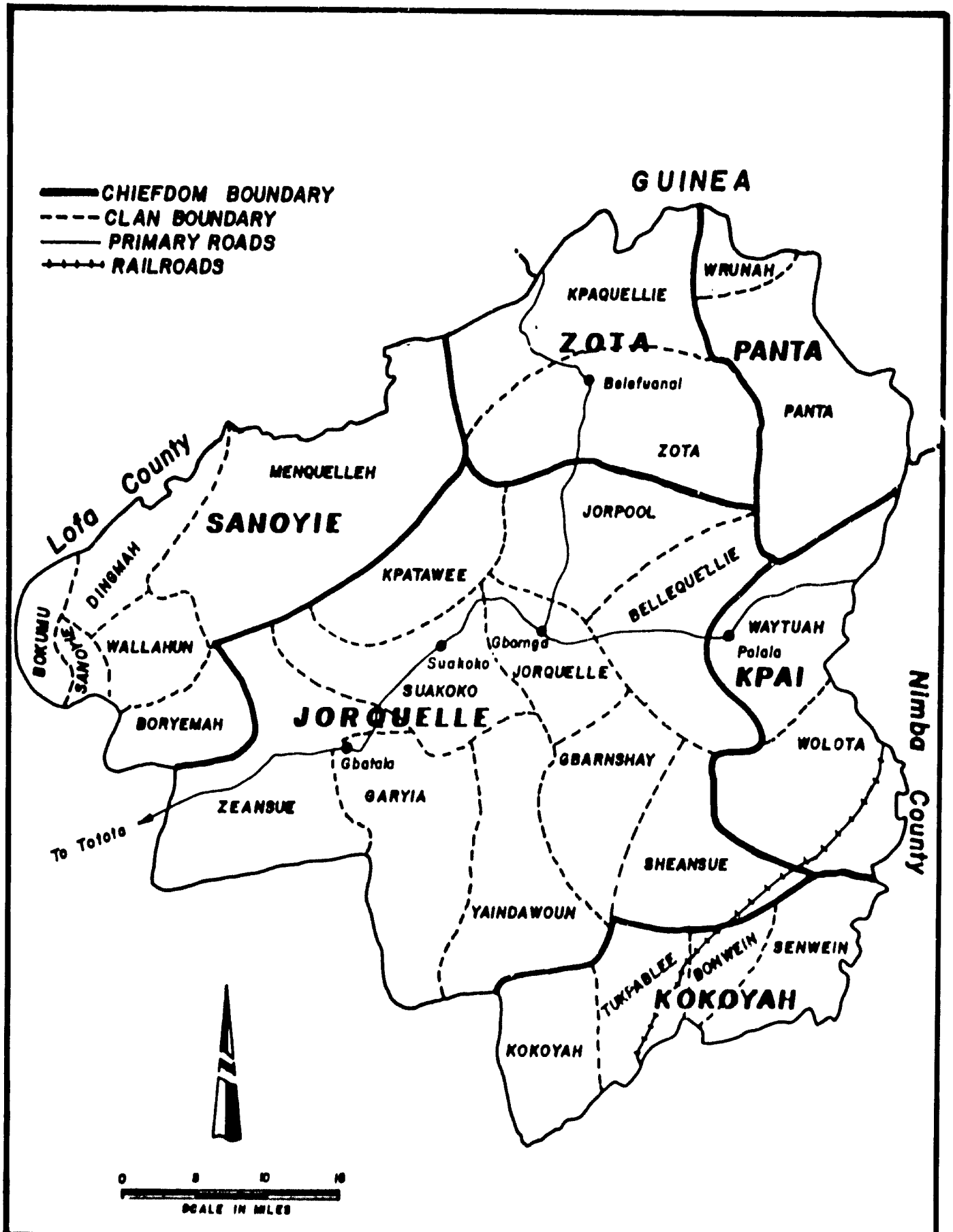


Figure 6. Chiefdoms and Clans of Upper Bong County
(Boundaries Approximate)

IV. EXISTING CONDITIONS IN UPPER BONG COUNTY*

A. PHYSICAL CHARACTERISTICS

1. Physiography

Bong County is located in the central part of the interior of Liberia beginning about 65 kilometers (40 miles) northeast of Monrovia and extending to the Guinea border. The St. Paul and St. John Rivers form the northwest and southeast borders, respectively. The study area is the northeaster or upper portion of Bong County consisting of the districts of Gbarnga, Kokoyah and Sanoyie, which are administrative sub-units of Bong County (see Figure 5). The total area of the three districts is about 6,475 square kilometers (2,500 square miles). The area is approximately bisected by the major trunk highway extending from Monrovia on the sea coast to Gbarnga and the Guinea border. Upper Bong County is inhabited by approximately 140,000 people, of whom 80 percent are engaged primarily in agriculture, occupying about 18,000 individual farm holdings.

The greater part of Bong County consists of rolling uplands traversed by river valleys. Small areas are occupied by isolated high hills or low mountains, examples of which are the Gu Mountains near Gamu. In the northern half of the project area, there are very steeply dissected hilly regions especially around Toto Mountain. Characteristic landforms of the area are narrow, poorly drained valley bottoms in a densely distributed dendritic pattern with intervening hills generally about 30 meters (100 feet) above sea level near the Guinea border. Schulze (1973) describes this area as the upland and dissected plateau portion of the central block of the nation. The northern part of the area shows a very distinct northeast, southwest alignment of ridges and valleys. This pattern is less well developed in the southern part of the study area.

2. Geology

The geology of Liberia is not complex. Of the four principal geologic eras, the Precambrian (the oldest) and Cenozoic (the most recent) comprise the majority of geologic formations in Liberia. Most of Liberia consists of ancient Precambrian igneous and metamorphic rocks, such as gneiss and granite. During the 600 million years these rocks have been above sea level, the original fold mountains have been continually eroded, resulting in the present southwest-northeast ranges of residual mountains. The Cenozoic era consisted of both arid and humid climatic conditions. During this period, the lateritic soils were formed. Somewhat later, the coast was periodically inundated by the Atlantic Ocean, depositing loose sand which extends as much as 16 kilometers (10 miles) inland. Coastal platforms were cut into the shore which, through local uplift, form the present raised beaches. More recent deposits, compose the clays, sands and gravels found in river beds or terraces. These sometimes contain alluvial gold or diamonds.

* A more detailed discussion of the topics covered below can be found in Appendix .

The specific project area is underlain by metamorphic and igneous crystalline rocks of Precambrian age, predominately granites and granitic gneisses. The predominate structural trend appears to be associated with folding, and these folds generally occur in a northwest-southeast direction. Other than some road and construction material, there are no mineral resources currently exploited in the study area. There are tentative plans for alluvial gold mining in the southern part of the area. Iron ore mining occurs in the Bong Range, southwest of the area, and the Nimba Range, northeast of Bong County.

3. Climate

The tropical climate of the project area is characterized by moderately high temperatures, a high relative humidity, a rainy season from March through November and a dry season, during which rain may occur in small quantities. Records of temperature and rainfall are scarce and often incomplete. It appears that the project area is somewhat drier than areas in the north (Ganta Mission) and south(Cibi Estate). If climatological information from Suakoko is used, the climate of the area can be classified, according to Koppen's classification, as Awi, a periodically dry, isotherm savanna climate.

The temperature in and around the project area is remarkably constant. Available data from Suakoko indicate that the mean monthly temperature varies only slightly. For 17 years of record at Suakoko, the mean monthly temperature ranged from 24 to 26°C (76 to 79°F), with a maximum of 29°C (84°F) and a minimum of 19°C (67°F).

The only records of rainfall in the project area are those at Suakoko CAES for the period of 1951 to 1971. It appears that a large part of the project area may have a considerably lower rainfall than the areas to the north and south. The mean annual rainfall at Suakoko is 162 centimeters (64 inches) while areas to the north (Ganta Mission) and to the south (Gibbi Estate) receive 231 and 251 centimeters (91 and 99 inches) respectively.

4. Soils

a. General

One of the major factors associated with an agricultural improvement project is the potential of the soil to be utilized for crop production. In this regard, various reports were reviewed and analyzed by previous studies of the project area (Agrar-Und Hydrotechnik, 1975). Soil tests were conducted and an analysis made of the potential land uses.

The climate in the project area is characterized by high temperatures, a long rainy season and a shorter dry season. The combination of this climate and parent material of Precambrian crystalline rock (mostly granite) has resulted in the formation of deep lateritic soils. (Laterite is irreversibly hardened plinthite, a highly weathered mixture of sesquioxides, clay, quartz

and various other materials, poor in humus.) Vegetation protects the topsoil from excessive drying, protects the soil from erosion, produces organic material and promotes biological activity in the soil. The factor of time reflects itself in the different soil conditions in the uplands and the valley bottoms. The former are older and more deprived of nutritional elements.

Based on a variety of criteria (see Appendix I) soils can be divided into various groups. Fanfaut (1972) grouped the soils of Liberia into soil families which were used as a basis for the description of soils in the study area. Six soil families in the study area are important in relation to the project. These various soil families occur in different topographic and geomorphologic positions, and in certain sequence, depending on the landscape. The relation between soil families and landscapes is as follows:

(1) Dalia, Ngisakonja and Makona soils are characteristic of valley bottoms. Makona soils occupy alluvial terraces; Dalia and Ngisakonja soils occur in alluvial overflow plains.

(2) Foya soils occupy the convex sideslopes of the dome-shaped ridges and also the more or less extensive, almost level parts of flattopped ridges and their convex side slopes.

(3) Konjo soils occupy small top areas of somewhat higher and steeper ridges.

(4) Weledu soils are characteristic of steep hills. The small and gentle concave slopes (toeslopes) of the undulating to strongly rolling uplands have soils very much like the Weledu soils of the steep hills, but without strongly weathered parent rock or rock fragments and with plinthite. They are included under the Weledu soils.

b. Agricultural Suitability

As a result of the soils investigation, an analysis was made of the suitability of the soils for agriculture use.

Locally, the Dalia soils are used for swamp rice which is the crop for which they are most suited. However, the high acidity and high iron content of the soil may be toxic to some crops and thus restrict usefulness of some of the land.

The Ngisakonja soils occupy poorly drained parts of alluvial overflow bottomland. The natural vegetation of these soils consists of ferns, grasses, sedges, low trees and shrubby palms. Within the study area, these soils are currently being used for the cultivation of swamp rice and are somewhat better for this crop than the Dalia soils.

Makona soils occur on the alluvial terraces of the larger streams. The vegetation of the Makona soils is determined by their drainage condition. The imperfectly drained soils have a vegetation which is very like the vegetation of the Ngisakonja soils, while the better drained Makona soils have a vegetation very similar to the uplands. Makona soils are used for a variety of crops: rubber, sugar cane and all crops common in shifting cultivation. The soils have a high potential for crop production, especially rice.

The Foya soils comprise most of the rolling hilly areas of Upper Bong County. They occupy the upper slopes and hillsides with gradients of 2 to 20 percent. The upper soil is generally a sandy clay loam with underlying lateritic gravel and iron nodules. These soils are very acid and of low fertility. They can be used for citrus, cashew and rubber crops with some of the most gravel-free areas suitable for coffee and oil palm.

Konja soils occupy somewhat steeper slopes and have a higher gravel content than Foya soils. Fertility is similar to that of the Foya soil, but the higher gravel content renders Konjo soils poor for root development and thus of low agricultural potential.

Weledu soils are similar to Foya soils without gravel but do contain fragments of decomposing rock. The fertility is generally a little better than that of Foya soils, and agricultural potential is similar.

Table 1 summarizes some characteristics and the agricultural potential of these soils.

5. Air Quality

The air quality of the study area ranges from good to poor depending upon the climatic conditions and time of year. During the rainy season, the air is relatively pure. During the dry seasons, when little mixing takes place in the atmosphere, the air quality is poor. The chief contributors of air pollution throughout the study area are smoke and lateritic dust.

6. Surface Water Resources

a. Rivers

The project area is part of the watersheds of two major rivers (St. John River and St. Paul River) which flow in a southwesterly direction. Both watersheds are intersected by numerous perennial and ephemeral streams of varying sizes. The St. Paul River flows along the northwestern boundary of Bong County and drains approximately 21, 911 square kilometers (8,460 square miles), of which 12, 950 (5,000) lie in Liberia. The St. John River flows along the southeastern boundary, draining much of the study area. Zo Creek, the major stream in Upper Bong County, is one of its tributaries. The St. John River has a drainage area of about 17,224 square

TABLE 1. SOIL CHARACTERISITCS AND PRODUCTION POTENTIAL

Characteristic	Soil Family					
	Konjo	Weledu	Dalia	Ngisakonja	Makona	Foya
Drainage	somewhat excessive	good to somewhat excessive	very poor	poor	good to imperfect	good to somewhat excessive
Erodability	moderate	low to high	none	none	none	low to moderate
Water holding capacity	low to moderate	high	high	high	high	low to moderate
Fertility	low	moderate to low	low	moderate to low	moderate to low	low
Potential for Production						
Annual crops	poor	good	none	none	good	moderate
Irrigated rice	none	none	moderate	good	good	none
Cocoa	poor	good	none	none	none	poor
Coffee	moderate	good	none	none	poor	moderate
Rubber	good	good	none	none	moderate	good

kilometers (6,650 square miles), 86 percent (14,763 square kilometers) of which lie in Liberia. The rivers strongly erode the V-shaped valleys in the upper courses, while accumulating sand and gravel in the lower courses (Schulze, 1973). During the rainy season, the sandbanks shift almost daily, particularly after heavy rainfalls. Both the St. John and St. Paul contain numerous rapids, rocks, and waterfalls.

b. Swamps

The distinction between basins on smaller perennial and ephemeral streams and swamps on the major rivers is somewhat vague. In Liberia, the term "swamp" is usually applied to all bottomland of valleys, whether this is permanently waterlogged or not. In the project area, three types of swamp could be distinguished: swamps which are permanently waterlogged, swamps which dry up during the dry season, and swamps which are generally dry but which may occasionally become saturated during the rainy season. The permanently saturated swamps usually have a predominantly grassy vegetation, with tree density increasing as saturation decreases. Since the amount and distribution of rainfall is virtually equal in any one area, the decisive factors determining formation of a swamp are its topography, drainage conditions and soils plus the vegetation of its drainage basin. The three categories of swamp total about 12 percent of the study area.

c. Surface Water Quality

Due to the lack of historical water quality data, a limited sampling program was initiated to characterize the major water resources which could receive impact from implementation of the project. Five grab samples were collected from the major rivers, lakes and swamps within Bong County and one sample from Nimba County near Yekapa. A description of the sampling stations is shown in Table 2. Samples were analyzed for dissolved and suspended solids and salts, nutrients, metals and pesticide content.

From the initial limited sampling of project area surface waters, generalization about the overall water quality may be made. However, an extensive sampling program would be required to thoroughly quantify water quality and locate the areas and cause of excessively poor quality. In making generalizations from the data of site Nos. 01 through 06, it must be realized that site No. 02 (experimental paddy) does not reflect natural conditions that may exist in other similar water resources due to the experimental nature of the system and chemical usage within the area. Concentrations of most chemical parameters analyzed were moderately low and within US EPA standards for human consumption and aquatic life propagation. Chemical parameters which possibly could present problems for human consumption or aquatic life are total suspended solids, iron and pH. Moderately high values of suspended solids and iron, as well as slightly low pH values, reflect directly on the area soil conditions and may be considered as natural background levels, contributed to in some degree by the cropping techniques of the area. Manmade pollution results primarily from sewage disposal inadequacies and land use.

TABLE 2. DESCRIPTION OF WATER QUALITY SAMPLING LOCATIONS

Sample #	Type of Water Resource	Location
1	Tubman Water Supply Lake	Agriculture Research Station at Suakoko, Bong Co.
2	Experimental Paddy	Agriculture Research Station at Suakoko, Bong Co.
3	St. Paul River backwater	West end of Bong Co. near Bong Mine
4	Swamp	Headwaters of St. Paul River near Belefani
5	Branch of St. John Headwaters	Near Yekepa, Nimba Co.
6	St. John River	Eastern end of Bong Co. near Mela

d. Present and Potential Use

Little use is presently being made of the major rivers and creeks, except for subsistence fishing and water supply by the population of villages located near the streams. No major towns in the study area are located on the St. Paul or St. John Rivers; however, Gbarnga is located on Jo Creek. A hydroelectric plant is located at Mt. Coffee, near the mouth of the St. Paul and outside the study area. Mining operations, also outside the study area, use water for various purposes. In the study area, use of surface water is primarily domestic, and the potential uses are somewhat limited. Shifting sandbars, waterfalls and rapids make commercial navigation impracticable. Some hydroelectric power potential is available on the St. John because of the steep descent of the stream; however, it is distant from areas of significant consumption.

7. Groundwater Resources

a. Aquifer Characteristics

The prevailing bedrock throughout the study area is crystalline igneous metamorphic rock, with almost no inherent permeability. Therefore, most of the effective bulk permeability of the subsurface is due to the presence of fractures and crevices. The yield of a well drilled at any point depends on the number and size of the fractures intercepted. In addition, there are no sizeable deposits of gravel or sand in the river valleys which might serve as alluvial aquifers and provide a dependable yield of groundwater.

b. Groundwater Quality

No specific information exists on the quality of groundwater. When wells are dug for domestic use, however, they frequently become contaminated because of location, misuse, etc.

c. Present and Potential Use

Current groundwater usage is almost exclusively for domestic purposes, usually from wells dug near villages. A review of the sparse data available indicates that groundwater cannot be considered as a major source of water supply for larger towns. The best groundwater potential appears to be increased domestic use from wells drilled near small villages.

B. ECOLOGICAL CHARACTERISTICS

1. Ecosystem Descriptions

a. Natural Forest

The original vegetation of much of West Africa consisted of a dense tropical forest. Nielsen (1965) refers to this forest as "moist lowland

forest" which covers a broad zone along the West African coast from Sierra Leone to Ghana and from Nigeria to the Cameroons. All of Liberia, except relatively small areas of mangrove swamp forest and mountain vegetation, was covered with this moist lowland forest.

Voorheve (1965) divided the forests of Liberia into two major zones; the evergreen forest zone, and the moist deciduous zone. In both zones, edaphic (soil) factors lead to smaller units of forest; mangrove forest, swamp forest, and river border forest. The original vegetation of Upper Bong County was moist semi-deciduous forest, river border forest, and swamp forest. Mangrove forest is not found since it is strictly coastal.

b. Secondary Vegetation

Little or none of the high forest of Upper Bong County can be classified as primary or virgin forest. Most of the forest is secondary and in various successional stages from abandoned field to mature secondary forest. During the last four centuries, the primary forest has been cleared by shifting cultivation. In this type of cultivation, the land is abandoned after short term use and begins to return to forest. The types of secondary vegetation, which form a more or less continuous series from newly disturbed land to mature high forest, are cultivated land, abandoned fields and secondary forest.

c. Swamp and Marsh

The swamps and marshes covering much of Upper Bong County are in the early stages of successional development. The treeless marsh, so often encountered, is not a natural ecosystem, but the result of cutting down a swamp forest. Most of these swamps or marshes show little development of successional stages towards the original vegetation, such as occurs in the drier areas.

d. Aquatic Habitats

Ponds, streams, rivers and swamp abound in the project area, particularly during the rainy season. These are found mostly in the shallow valleys common to Liberia and are often part of the previously discussed marshes. Some of these habitats, particularly the upper part of the St. Paul River, are heavily polluted by mining processes and other sources.

2. Unique and Sensitive Natural Areas

Very little natural or undistrubed vegetation remains in the project area. In other areas of Liberia such as the adjacent Nimba and Lofa counties, all types of ecosystems are less disturbed and more representative. Due to this disturbed nature of Upper Bong County, there are no particular areas that could be classified as unique or sensitive.

3. Threatened or Endangered Species

A small number of animals found in Liberia are considered endangered. The Endangered and Threatened Wildlife and Plants" (U.S. Department of Interior, 1976), Federal Register Vol. 41, No. 208 lists six species whose ranges extend into Liberia. Some of these may occur in the project area. Chimpanzees (Pan troglodytes) are frequently killed for food by villagers and young chimps captured for pets. It is doubtful if any chimpanzees occur in Upper Bong County, as they are nowadays found in high forest to the north of Bong County. The leopard (Panthera pardus) may still occur in Bong County, but it is killed and eaten by the villagers. It is more likely to occur in the high forest of Nimba and Lofa counties. The other species on the list are likewise unlikely to be found in the project area, and none of the six species is endemic to Liberia.

4. Commercially Important Species

The crops most important to the villagers of Upper Bong County are rice, cassava, bananas, yams and oil palms. With the exception of the oil palm, these are subsistence crops and little or no surplus is produced. Most of the cash crops produced in Upper Bong County and in Liberia as a whole are from trees grown in plantations. These may be under individual or village ownership, but most cash crops are produced on plantations belonging to the government or to foreign concessionaires.

The following are the major commercial species grown in Upper Bong County:

(1) Rubber; The Brazilian rubber tree (Hevea brasiliensis) is the most important cash crop. It is the major agricultural export of Liberia and, before the advent of heavy mining of iron ore, was the most important segment of the Liberian economy.

(2) Oil Palm; This palm tree (Elaeis guineesis) is grown for its fruits which are important for export as well as for the villagers' diet.

(3) Coffee; The coffee tree (Coffea liberica) is grown in many parts of Liberia, but ranks far behind rubber in importance. Liberia grows less than 1 percent of the world's output.

(4) Cocoa; The cacao tree (Theobroma cacao) is grown for the beans contained in pods affixed to the trunk. Liberia produces less than 1 percent of the world's output.

(5) Timber; The harvesting of timber is a major factor in Liberia's economy, but is a limited resource, as there is relatively little suitable high forest remaining. Lumbering is of little importance in Bong County due to insufficient area of high forest.

5. Vectors

There are a number of serious vector-transmitted parasitic diseases in Liberia. A vector organism serves as an intermediate host of the life cycle of the parasite and as the agent of transmission from one primary host to another. The parasite has a complex life cycle with part of its development in the intermediate host and part in the primary host. Since the occurrence of the disease is directly related to the abundance of the vector, the impact of this project on vectors is an important consideration. The most important vectors (the diseases transmitted are in parentheses) in Liberia are mosquitoes (malaria and filariasis), the blackfly (onchocerciasis), the tsetse (trypanosomiosis), snails (schistosomiasis) and rodents (Lhasa fever).

C. CULTURAL CHARACTERISTICS

1. Land Use

The project area totals 600,000 hectares (1,482,000 acres) in Upper Bong County. Approximately 528,000 hectares (88 percent) of the project area is secondary forest (less the 12,000 hectares is primary, uncut forest) and about 60,000 hectares (10 percent) is cultivated land. About 90 percent of the secondary forest land has been formed in the last 10 years. Of the 60,000 hectares in cultivation, about 42,000 hectares (70 percent) are in tree crops (mostly rubber) while 18,000 hectares (30 percent) are in annual crops (primarily rice and cassava). Urban areas are few, small, and comprise less than 1 percent of land use.

Future land use in the project area is expected to change only slightly from existing conditions. A possible exception is the planned timber concession in the southern part of Bong County which would convert 80,972 hectares (14 percent) of the project area from secondary forest to timber concession.

2. Land Ownership

The ultimate land owner in Liberia is the national government. There are, however, two systems for land tenure; tribal land tenure and private land ownership. The government thus recognizes the traditionally based control excercised by the tribes, yet provides a means for purchasing land from the state.

3. Social Structure

a. Tribes

The largest ethnic group (or tribe) in Liberia is the Kpelle and the six chiefdoms located in the project area belong to the Kpelle tribe. These chiefdoms are subdivided into 28 clans (Figure 6). The tribal system provides most of the traditional administration and leadership in the area, and most of the land utilized by the farmer is occupied under tribal tenure

rather t'. ; private ownership. The chiefs generally deal with the government, settle disputes, administer tribal justice, etc. While individuals usually associate themselves permanently with a specific clan, they sometimes shift allegiance because of intermarriage.

b. Villages

There are no towns in the project area with a population exceeding 10,000, and only one exceeding 5,000 (8,474). Smaller towns, exact population unknown, include Suakoko, Belefuanai and Palala. Thus, most of the population lives on farms, in half-towns or in farm villages. Half-towns are the smallest rural settlement, consisting of two to ten huts which are often periodically relocated to accomodate shifting agricultural patterns.

c. Population

The 1974 population of the project area totaled 135,000. The annual growth rate from 1962 to 1974 was 2.2 percent. Using this annual growth rate, the population at the end of 1976 would be approximately 141,000. Generall migration of the Kpelle tribe is about 0.4 to 0.6 percent per year. Therefore, adjusting for out-migration, the population of the study area at the end of 1976 was estimated to be 140,000. This represents almost 70 percent of the population of Bong County and 9 percent of the total population of Liberia. The population density of 22 persons per square kilometer (56 persons per square mile) is considerably greater than the whole of Liberia (1976 estimate of less than 16 persons per square kilometer).

d. Education

Liberian school system can be divided into three categories; elementary education (pre-primary grades and grades 1 through 6); secondary education, (Junior High Schools, grades 7 through 9 and Senior High Schools, grades 10 through 12); and higher education, consisting of 4 to 5 year courses at universities. All three classifications of schools exist in the project area.

e. Living Conditions and Housing

The living conditions and housing in most of the project area are very poor. Utilities (water, sewage treatment, electricity, etc.) are nonexistent except in Gbarnga and Jorwah where some electricity is provided. Houses va., in shape from circular to rectangular, generally made of sticks plastered with clay or mud with a thatch roof, although corrugated roofing was observed on many dwellings near roads. The family huts are usually 6 to 9 meters (20 to 30 feet) in diameter and have a clay floor. Houses are usually located near a water supply (stream, spring, etc.) with very primitive sanitary facilities.

Medical facilities within the study area are limited to the Phebe Hospital and a few government clinics. The government of Liberia has insti-

tuted a number of programs to improve medical facilities, health education, and immunization programs; however, these programs have been inhibited by a lack of trained personnel, lack of health data, inadequate transportation facilities, etc. Other social services are lacking in the project area.

4. Economic and Institutional Structure

a. Local Government

As previously discussed, there are two systems of administration in the project area, governmental and traditional. The seat of the governmental administration is located in Gbarnga and the county falls under the responsibility of a Superintendent, who is in charge of local administration. The main function of the Superintendent is the maintenance of law and order, for which he has his own small staff. At district level, the Superintendent is represented by a District Commissioner. The county administration also consists of personnel representing the various Government of Liberia Ministries.

In addition to the modern type of county administration, there is the traditional tribal organization. The whole of Bong County is inhabited by members of the Kpelle tribe and within the project area the tribe is subdivided into six chiefdoms; Jorquelle, Panta, Kpai, Zota, Kokoyah and Sanoyie, which are broken down into 28 chans (Figure 6). Each chiefdom is headed by a Paramount Chief, who has under him a hierarchy of clan and town chiefs. Their duties consist mainly of the adjudication of tribal disputes, the collection of taxes and maintenance of law and order within their respective areas.

b. Average Income

Real per capita income has increased about 2.4 percent per year since the mid 1960's. A study in 1974 indicated the estimated average annual farm family income in Upper Bong County was $263, consisting of $222 farm income and $41 off-farm income. Considering the estimated rate of increase, the average in 1976 would be $280-$300 per farm family per year. The number of members of a farm family within the study area is estimated at 5.3 individuals.

c. Financial Institutions

There is no organized agricultural banking and credit system in Liberia to fill the needs of small farmers. The commerical banks concentrate on the large coastal towns and the concessions. No banking facilities exist in the rural areas.

5. Public Facilities and Services

a. Utilities

A public power station provides electricity to Gbarnga and areas along the Gbarnga-Suakoko road. The plant was built in 1966 and has two operational diesel generators with a total capacity of 1,040 kw. A new unit which would provide an additional 1,065 kw is expected to be built in 1979 (Agrar- Und Hydrotechnik, 1975). A power generator was provided to Jorwah (1974 population 800) under the special impact program devised and implemented by the Ministry of Action for Development and Progress. Several small, privately owned generators exist in the area. As a long range program, the Government of Liberia is planning to connect Gbarnga and Robertsport with the Monrovia electrical system.

Except for Gbarnga, water in the project area is obtained directly from surface water or shallow wells which are unreliable and susceptible to pollution. A loan was approved in 1974 by the West German Government to finance construction of public water supply projects in Gbarnga, Voinjama and Sanniquellie. These projects are scheduled for completion in 1978.

b. Law Enforcement

Law enforcement is provided by the Liberian National Police Force. Each county has a police post headed by a deputy inspector with varying numbers of policemen assigned. The county units enjoy a considerable degree of autonomy, but the ultimate authority of the Central Headquarters is unquestioned. As with administration, there are two parallel judicial systems, the formal government judicial system and the tribal court system. The latter has broad jurisdiction in matters of civil and customary law, but its criminal jurisdiction is limited to misdemeanors and minor offenses.

D. AGRICULTURE

The total estimated agricultural population of Liberia was estimated at 813,000 in 1975, with 5.4 persons per household. The agricultural population of the study area is estimated at 100,000. There are 19,000 agricultural households in the study area, with 53 percent female and 47 percent male. Of the agricultural population, 51 percent is under 20 years of age. The average Upper Bong County farmer cultivates less than 1 hectare (2.3 acres). In the following discussions, the figures used for the project area have been extrapolated on a linear basis from data obtained during a previous study of a smaller area.

1. Crop Types and Characteristics

The major source of food in Liberia is rice with an estimated 134,400 households involved in rice farming in 1975, comprising 90 percent of the agricultural households (Republic of Liberia, Ministry of Agriculture, 1976).

a. Upland Rice

In 1975, total upland rice production in the study area involved 11,285 hectares (27,875 acres) yielding 12,750 metric tons; an average of 1.13 metric tons per hectare.

b. Swamp Rice

Swamp rice production in the study area in 1975 was 2,750 metric tons grown on approximately 2,142 hectares (5,290 acres).

c. Cassava

Approximately 18,200 households (69 percent of the total agricultural households) were involved in growing cassava in Bong County in 1975. A total area of 5,142 hectares (12,700 acres) of cassava were grown in Bong County in 1975, an average of 0.3 hectares (0.7 acres) per household.

d. Sugar Cane

Bong County has the largest number of sugar cane producers in Liberia; 7,000 households in 1974; 5,800 in 1975. Approximately 7 percent of the farmers in the project area grew sugar cane in 1971 on a total of 680 hectares (1,680 acres).

e. Coffee

In Bong County in 1975, 3,700 households actively produced coffee. In the project area in 1975, approximately 860 hectares (2,125 acres) were planted in coffee with only 745 hectares (1,840 acres) actually producing. Approximately 237.5 metric tons of clean coffee were harvested.

f. Cocoa

There were 5,000 Bong County households producing cocoa in 1975. About 1,376 hectares (3,400 acres) of cocoa were planted in the project area in 1975, of which 1,255 were in production. Total production in the project area in 1975 was approximately 400 metric tons of dry beans.

g. Rubber

A total 37,652 hectares of rubber trees were located in the study area in 1971 with only about 11,893 hectares actively producing.

h. Oil Palm

Approximately 60 percent (15,900) of the Bong County farm households were involved in palm oil making in 1975; of these 11,400 had palm oil to sell. The wild oil palm *Elaeis guineensis* occurs in Upper Bong County at a density of about 20 trees per acre.

i. Other

Other important tree crops are the (piassova) palm (Raphia vinifera), bananas, and coconuts. Tree crops of minor importance include;(avacado), grapefruit, guava, kola nut, lime, mango, orange, papaya, plantain, and tangerine (Republic of Liberia, Ministry of Agriculture, 1976a).

Almost all upland rice fields are interpersed with minor produce crops. These crops include; beans, sesame, bitter balls, collard greens, corn, cucumber, eddoe, eggplant, peanuts, guinea corn, okra, palaver souse, pepper, pumpkins, sweet potato, and tomato (Republic of Liberia, Ministry of Agriculture, 1976a).

2. Crop Production Practices

a. Land Availability and Usage

Farm holdings in the study area range from less than one to greater than 202 hectares (50 acres). Some 87 percent of all farm families cultivate less than 2 hectares (5 acres). As many as 40 percent of rural households in Upper Bong County cultivate holdings less than 0.5 hectare (1.25 acres), which is considered to be below subsistence level. The average area farm size is only about one hectare (2.3 acres). At the present rate of usage within the study area, and assuming a fallow period of 15 years, a minimum of 206,000 hectares (509,000 acres) or approximately 15 times the present annual crop land use would be available for cultivation in any given year. However, lack of accessibility is a major barrier to more effective land utilization.

b. Water Considerations

At present, no water from major rivers or creeks or from underground supplies is being used for irrigation purposes. Some small streams are utilized, but the vast majority of irrigation is through natural processes.

c. Available Labor

Of the 140,000 residents in the study area, approximately 100,000 people live on an estimated 19,000 small farm holdings. The average size of a farm family is thus about 5.2 persons. Based on an analysis of agricultural workers to total agricultural population it has been determined that the average farm family has the potential for 2.6 labor equivalents per year. When this value is adjusted for seasonal availability largely determined by social customs, about 600 man days per year are available for each farm holding.

Presently, an average of 102 man days are spent cultivating the family's holding each year while about 204 man days are spent as hired labor, mostly in nearby rubber plantations. Therefore, each farmer family has 294 man days not productively utilized. For the total study area this equals 5,586 man days per year.

d. Capital and Financing

One of the major problems facing Liberian farmers today is the lack of sufficient capital to finance the land, seed, labor and other inputs necessary to produce a high yielding crop (Blanchard, 1967). The major demand for capital usually occurs in the planting season when a farmer's resources are lowest, after the non-revenue producing dry season.

No formal system of credit supply now exists in the project area of small-scale farmers. Approximately 84 percent of this type financing comes through family or other traditional sources. While some credit for agricultural programs has been extended recently by the Liberian Bank for Development and Investment, present institutional organizations limit credit availability to a few large scale projects. A nominal amount of credit has been extended to farmers in the project area by the Cooperative Credit and Marketing Division of the Ministry of Agriculture.

e. Equipment and Technology

The use of modern agricultural equipment and advanced technology is almost unknown among the small scale farmers of the project area. Most farming is performed by the farmer and his family or by work cooperatives. The most important equipment available to the farmer is a machete for bushing or defoliating trees, the hoe for loosening the soil and cassava planting and a sickle or knife for harvesting rice. No mechanical equipment is available to the farmers due to economic constraints and no beasts of burden can be utilized effectively because of their susceptability to trypanosomiasis, a disease spread by the tsetse.

f. Fertilizer Usage

Probably the most serious problem associated with traditional agriculture in Liberia is low soil fertility but the use of fertilizer is almost unknown in Liberia. The Ministry of Agriculture (1976a.) reports that only 1 percent of Liberian farmers use fertilizer as a rice production practice. Bong County has the highest rate of fertilizer usage in Liberia with 3 percent. It is hypothesized, however, that the large number of experimental farming operations in the county is at least partially responsible for this factor.

g. Pest Control

The presence of agricultural pests reduces the productivity of Liberian farms, however, the incidence of pest damage is not as high in this type agriculture, where various vegetables are intercropped with rice, as in a monocultural agriculture. The most serious pest problems confronting Liberian rice farmers are caused by groundhogs (Thryonomys sevinderianus) and Weaver birds (Ploceus cucullatus). Control measures (mechanical) for these pests have only a limited effect. Insect damage to various crops occurs sporadically and no steps are currently being taken to prevent damage. Some crops, including rice, are attached by fungi. The fungicide Dithane M-45 is the only control means presently being utilized.

3. Crop Marketing Considerations

a. Level of Subsistence Agriculture

The availability of crops to market is severely restricted by the nature of the Upper Bong County traditional farm which is predominately subsistence oriented. As previously mentioned, the average farm size in Upper Bong County is about 1 hectare (2.3 acres). This low figure is attributable to the 15 percent of farms which are less than 0.2 hectare. It can be assumed that production on farms of less than 0.5 hectare (1.25 acres) is below subsistence level. This is about 40 percent of the farms in the study area. Statistics acquired from National Rice Production Estimates (Republic of Liberia, Ministry of Agriculture, 1976a) state that 68 percent of Bong County households growing rice produce enough rice for the members of the household.

b. Liberian Food Production/Consumption

Approximately 230,000 metric tons (505 million pounds) of rice was produced in Liberia in 1975 (86% of the total consumed). In addition to this, 31,000 metric tons (67.5 million pounds) were imported accounting for 39.9 percent of all food imports (Republic of Liberia, Ministry of Planning and Economic Affairs, 1976). No significant amount of rice is exported from Liberia. With respect to foods other than rice, exports and imports appear to be more balanced, although no accurate figures are available. The 1975 Liberian production of non-rice foods was about 88 percent of total consumption.

c. Farm to Market Transport

The lack of an adequate farm to market transportation system has long been a problem to Liberia in general and to Upper Bong County in particular. Presently there are only 129 kilometers (80 miles) of farm to market roads in the study area; conditions on these roads are generally poor with average running width of only 3 meters (10 feet). Under present conditions, 45 precent of the farmers in the study area live over 1.6 kilometers (1 mile) from a road, forcing them to carry their produce over long distances by head on foot. The situation does not encourage increased production and severely limits cash crop production.

d. Cooperatives

The first cooperative societies were formed in Liberia in 1971 under an act passed in 1936 and seem to be gaining in popularity; the societies were appointed as buying agents for the Liberian Produce Marketing Corporation. In the project area, however, the cooperative movement has been less than totally successful. Cooperatives exist at Gbatala, Palala, and Kpatawee, but none have achieved effective operation at this writing.

e. Foreign Export

Exports have long been an important part of the Liberian economy. After iron ore and diamonds, which in 1975 accounted for 79.1 percent of total

exports, agricultural products (especially rubber) constitute the major portion of exports (Republic of Liberia, Ministry of Planning and Economic Affairs, 1976).

4. Government Programs

The administrative agency responsible for agricultural development in Liberia is the Ministry of Agriculture (MOA). The long term goals of this ministry include diversification of agricultural economy, increased modernization of agricultural production, increased real income of farmers, maximization of material income, and provisions for a more nutritive diet for the entire population. Programs with which the MOA is associated include; The Expanded Rice Program, The Special Rice Project (Kpatawee Clan, Bong County), Rice Cultivation Project, Chinese Agricultural Mission, Liberian Agricultural Extension Service, The Agricultural Mechanization Company (Agrimeco) and the Central Agricultural Experimentation Station (Suakoko, Bong County).

E. PUBLIC HEALTH

The baseline health conditions of a rural African population such as the one in Upper Bong County, Liberia is a function of many factors. Some factors which must be taken into consideration are; the dietary structure of the population, the indigenous diseases associated with that population, customs, and various other external factors that might exert some influence.

1. Nutrition

Most studies provide strong indications that the nutritional condition of the Liberian is quite poor. Children, in particular, are suffering from high levels of chronic malnutrition and various dietary deficiency problems. The health baseline of the population, as associated with nutrition, must be categorized as extremely poor and since nutritional deficiency tends to be physically and intellectually debilitating, this has a profound impact on the productivity of the populace.

2. Domestic Water Supply and Sewage Disposal Systems

It can be generally stated that water supplies and sanitation systems in the study area are at a primitive level. Through custom, people tend to collect their water from any available source, and since they are indiscriminate, it is not uncommon for water to be obtained from a contaminated source. There are no public water or sewage systems in the rural area, although a public water supply project at Gbarnga is scheduled for completion in 1978. The report made by the Ministry of Planning and Economic Affairs to the second session of the Legislature of Liberia in 1976, contains no mention of other water or sewer construction in the study area.

Sanitary sewage disposal and treatment is unknown throughout most of the Upper Bong County. This in itself does not constitute a significant health hazard unless there is cross contamination between the disposal sites and the water supplies. Because of the customs of the natives, cross contamination happens quite frequently and tends to increase the incidence of a number of vector borne diseases such as schistosomiasis.

3. Indigenous Diseases

Indigenous diseases tend to be prevalent among populations that have poor health practices and nutritional conditions. The list of diseases found in the study area is extremely long and includes the following: schistosomiasis; onchocerciasis; malaria; trypanosomiasis; Lhasa fever; filariasis; pneumoconiosis; leprosy and tuberculosis. Several such as schistosomiasis, onchocerciasis, malaria and trypanosomiasis, are of greater significance than others.

It is particularly difficult to establish a baseline with respect to the levels of indigenous disease in Upper Bong County. In general, data are virtually nonexistent since there have been very few studies performed in the project area. In general, the levels of disease are high with variability from tribe to tribe and from village to village. However, on the average, the entire population is quite heavily infested. Schistosomiasis and malaria are very prevalent and many other diseases are common. It is not unusual to see patients with singular, double and triple helminthic infestations. It is likely that anyone living in this particular area will have at least one of the various parasites.

A list of indigenous diseases and their prevalence as updated by the Ministry of Health and Social Welfare (MHSW) for a 9-month period from January 1 to September 30, 1976, is found in Table 3. Data obtained from Phebe Hospital and G. B. Dunbar Clinic indicate a definite under-reporting of endemic diseases to the MHSW.

4. Health Care

Health care in Liberia is characterized by an extremely limited number of medical/health care facilities and an extensive reliance of the rural population on tribal medical practices. In the rural Liberian tribe, rarely is modern medicine practiced and it is often difficult to encourage use of facilities even when they are available. Tribal medicine utilizes a number of herbs and drugs combined with various rituals and religious practices. Certain secret societies in this area are responsible for the passing of medical secrets from one generation to another and there are severe punishments for violations of the rules of these societies.

A major problem of providing health care for the rural population is the absence of an adequate number of clinics. Within Bong County, the National Public Health Service has a county hospital at Gbarnga (one is maintained at each county seat) and Phebe Hospital (church operated) is located at Suakoko. A comparison of the number of facilities to

TABLE 3. INDIGENOUS DISEASE INCIDENCE, JANUARY-SEPTEMBER, 1976

	Liberia		Bong County	
Disease	Cases	Deaths	Cases	Deaths
Malaria	42,023	70	3,465	2
Schistosomiasis	1,077	-	191	-
Pneumonia	3,149	151	87	3
Measles	1,420	55	46	1
Dysentery	3,425	-	28	-
Cholera	508	8	-	-
Diarrhea	15,379	75	1,513	2
Leprosy	2,303	-	455	-
Tetanus	446	49	2	1
Pulmonary tuberculosis	726	22	5	-
Pertussis	1,161	1	1	-
Onchocerciasis	1,082	-	2	-
Infectious hepatitis	226	-	1	0
Total	72,934	431	5,796	9

population indicates a large number of people per facility. The distribution of facilities is poor since most are located in urbanized areas. As a consequence, the rural population has little access to more than one facility and to reach it may require considerable and difficult travel. As a further complication, the occupancy rate in existing facilities is relatively high.

V. PROBABLE EFFECTS OF THE PROJECT

Implementation of the Upper Bong County Rural Development Project will have the immediate benefit of providing improved transportation facilities, new educational programs, jobs derived from project construction and financing for the purchase of better seed, fertilizer and pesticides. In the short term, the project will increase both the crop yields per hectare and the dollar yield per man day of effort for the small farmer, creating immediate improvement to his family's diet and health. In the long term, by the twelfthyear from project startup, the monetary benefits derived from better marketing through project cooperatives and production of cash crops introduced by the project will add substantially to the quality of life of about half the rural population in the project area.

The project will cause only a few significant adverse impacts. Although air and water quality will be affected, the degree of change is minimal. By encouraging greater production, more acreage will be converted to agricultural use thereby impacting the natural ecosystems of the area. This impact is most significant with regard to swamps and marshes which will be subject to conversion to paddies. Land improvements encouraged by the project will likely stimulate a present trend away from tribal land tenure to individual land ownership thereby modifying cultural customs. Although project improvements, particularly paddies, may provide increased habitat for carriers of malaria and schistosomiasis, improved health care and surveillance programs should mitigate any adverse effect to the regional population.

The following sections of this chapter document the analysis and conclusions of the impact assessment. To the greatest extent possible, changes produced by the project have been quantified; however, the projections of project effects and the success of the project are based on the following assumptions:

> That village societies and village leadership encourage equity in the distribution of farm inputs and credit;
>
> that existing land tenure rights are sufficient, or new ones can be adopted, which will provide the necessary incentives for acceptance of technology without generating social resentment or economic inequality;
>
> that the Republic of Liberia provides effective political and administrative support for the project;
>
> that the benefits from increased production will be passed on to the small farmers through a price structure which will cover the costs of the new inputs and risks;

that the introduction of new technology will not have an adverse effect on the ecology of the project area;

that world market prices for crops produced in the project area will remain at constant levels or increase over time;

that crop farm-gate prices will be maintained or improved;

that the LPMC will participate in the project and give it their full support, including administrative capability as well as handling, storage, and transportation facilities for the expected increase in production;

that project innovations will provide adequate adoption incentives;

that labor is not a constraint;

that there will be a substantial expansion of the farm to market road network in the project area and that it will be adequately maintained;

that effective training programs can be developed by the PMU with support and assistance from the CAES and other government training organizations;

that technology being introduced will result in the estimated yields;

that Liberian extension agents can be motivated to work effectively with farmers and that the necessary number of extension staff can be found;

that farmers understand and are willing to accept group responsibilities for credit repayment and that cooperative savings programs can be established with greater farmer commitment to the savings and loan institution and increased financial capital for further agricultural development lending;

that farmer resistance to swamp rice does not constitute a serious constraint;

that the LPMC will play a prominent role in the timely delivery of inputs to the cooperatives; and

that the Ministry of Public Works will comply with agreements to build and maintain roads.

A. PHYSICAL IMPACTS

1. Soils

a. Erosion Potential

The effects of project implementation on soil erosion will be primarily dependent on the extent of increased acreage exposed to erosion and the soil management techniques utilized. Table 28 shows the projected distribution of farm sizes in the project area with and without the project. Additional annual cultivation will be 7,642 hectares (18,876 acres) which represents a 13 percent increase in exposed soil attributable to project farm improvements. This increase provides a reasonable approximation of the potential for greater agricultural erosion.

Road construction activities and increased road surface area associated with implementation of the project will also add to erosion potential. The amount of increased erosion due to construction and operation of new roads will be proportional to the amount of new surface area exposed. The present road system consists of approximately 147 kilometers (91 miles) of primary roads (paved), 205 kilometers (127 miles) of secondary roads (lateritic surface), and 129 kilometers (80 miles) of farm to market roads. Secondary and farm to market roads are subject to erosion since they are unpaved. In the project area, 313 kilometers (194 miles) of unpaved roads presently exist and implementation of the project will add approximately 161 kilometers (100 miles) of new unpaved farm to market roads, thus, increasing potential erosion from roads by about 50 percent.

The proposed design specifications for new farm to market roads call for a 6 meter (20 foot) roadbed and a 24 meter (80 foot) right-of-way. It can be calculated that a total surface area of 161 kilometers x 24 meters (100 miles x 80 feet) might be exposed or disturbed during construction and an area of 161 kilometers x 6 meters (100 miles x 20 feet) would be exposed during operation of the new proposed farm to market roads. From the above data 392 hectares (950 acres) of land will be subject to temporary erosion during construction activities and 98 hectares (240 acres) will be subject to some degree of permanent erosion, depending on the quality and maintenance of the road. It is important to note that the increased erosion potential from proposed construction and operation of new farm to market roads is small in comparison to the erosion potential posed by increased area of agricultural production.

b. Nutrients

Soils of Upper Bong County are characteristically low in both nutrients and organic matter due to parent material, high annual precipitation and the tropical climate of the area. The insufficiency of nutrients and organic matter in regional soils limits agricultural productivity and

TABLE 4. PROJECTION OF UPPER BONG COUNTY ACREAGE IN CULTIVATION AFTER FIVE YEARS WITH AND WITHOUT PROJECT

Size Groups (hectares)	Number of Holdings		Total Acreage (hectares)	
	Without	With	Without	With
0 - 0.19	2962	1420	293.9	140.5
0.20 - 0.50	4730	2267	1187.4	798.4
0.51 - 0.99	5343	2561	4044.9	1938.9
1.00 - 1.99	4250	11037	6443.7	16734.4
2.00 - 3.99	1191	1191	3614.2	3614.2
4.00 - 10.00	346	346	2450.6	2450.6
10.10 - 20.10	227	227	3445.7	3445.7
20.20 - 50.50	665	665	23556.3	23556.3
50.60 - 101.10	131	131	9944.1	9944.1
101.20 - 202.40	22	22	3340.1	3340.1
Total	19867	19867	58320.9	65963.2

necessitates shifting agriculture and rotating cropping techniques to permit the replenishment of soil nutrients.

Low Soil fertility in the uplands is caused, to some degree, by phosphorus fixation while iron toxicity presents problems in swamp cultivation. Increased productivity in the uplands and swamps is predicated on the increased use of fertilizers, as well as improved seed and cropping techniques. The long term nutrient effect of fertilizer application on an increased area under cultivation is not well documented. The limiting factors determining the ultimate productivity in Upper Bong County may be related to soil organic matter, phosphorus availability, pH, and iron toxicity and not on the nutrient content of the soil per se. The impact of project implementation on soil nutrients will depend on how the project influences factors controlling the nutrient input-output relationship. It is expected that some degree of net nutrient depletion may occur over the project life despite the input of chemical fertilizers due to the physiochemical properties of area soils, a high rate of nutrient assimilation and photosynthetic production by plants, and high volumes and heavy intensity of annual precipitation.

2. Water Quality

a. Fertilizers

The project area comprises 600,000 hectares (1,482,000 acres) within Upper Bong County. The majority of the project area drains to the south into the St. John River via Zo Creek and tributaries. A small portion of the project area drains to the north and east to numerous streams along the northern and northeastern boundary of Bong County.

The discussion of water quality effects will be limited mainly to the Zo Creek subbasin and the St. John River since these watercourses receive 90 percent of the runoff from the project area. Flow data are unavailable for watercourses within the Zo Creek subbasin and are available only at Baila on the St. John River. Because of the lack of flow data for the Zo Creek subbasin, runoff data were extrapolated to estimate flow in Zo Creek near the mouth.

Runoff data for Suakoko and Gihi Estate are 538 mm/yr and 1173 mm/yr respectively (Agrar- Und Hydrotechnik, 1975). The above data are an average of annual means for 11 years. Precipitation and runoff data for Suakoko are significantly less than areas to the north and south. To be conservative, the annual runoff from the Zo Creek subbasin was assumed to be equal to the value calculated at Suakoko, 538 mm/yr.

The exact drainage area of the Zo Creek subbasin is not known but was estimated from topographic maps to be 70 percent of the entire project area. Drainage area (420,000 hectares: assumed size of Zo Creek subbasin) times the annual runoff (538 mm/yr) yields an annual flow of 2528 cfs in Zo Creek near the mouth. This calculated annual mean flow

compares reasonably well with the annual mean flow of 5,000 cfs on the St. John River at Baila (Agrar- Und Hydrotechnik, 1975).

To predict the impact of fertilizer application on area water quality, the amounts and chemical composition of fertilizers to be utilized were evaluated. The table below gives fertilizer types and estimated inputs by project year.

Fertilizer	Input (tons/year)				
	Y1	Y2	Y3	Y4	Y5
Ammoniun Sulfate (20% N)	37.8	196	580	1048	1209
Rock Phosphate (17% P O)	114	306	440	580	--
Triple Superphosphate (35% P O)	53	195	403	687	714
Urea (45% N)	37	136	276	463	480
Total Fertilizer Input	241.8	833	1699	2778	2403

Many factors influence nutrient export from fertilized land, including the following; topography, contour, precipitation characteristics, soil properties, vegetative cover, farming practices, and animal populations. Many of the factors mentioned above would be favorable to increased nutrient export for Upper Bong County agricultural lands (if fertilizers are added).

Nutrient input-output research on agricultural lands has shown that surface runoff of total-N is generally 5 percent or less of the total annual nitrogen application but that subsurface drainage or seepage of total nitrogen may be as high as 50 percent of the total applied. Generally deep seepage loss of nitrogen is the major export pathway from agricultural land, caused to some degree by the mobility of nitrate and ammonium ions in soils. (Uttormark et. al., 1974).

Phosphorus, unlike nitrogen, is not particularly mobile within soils and, consequently, does not leach easily from soils. The major export pathways of phosphorus from soils is crop uptake and soil erosion. Phosphorus export from agricultural lands by surface or subsurface drainage is much lower than nitrogen export and generally less than 1 percent of the total amount applied.

Using the above average loss figures for nitrogen and phosphorus, the fraction of annual fertilizer applications which may enter area watercourses can be computed. Combining the annual amounts of ammonium sulfate

and urea nitrogen applications, a total annual nitrogen application of 22,664 kilograms (25 tons) would be applied to the project area during the first year of implementation. Assuming a 5 percent surface runoff loss of applied nitrogen, a total annual surface nitrogen loss of 1,133 kilograms may occur. Combining this figure with the total annual runoff (3.25 x $10^9 m^3$) from the entire project area indicates the most probable average increase in nitrogen concentration which could result from fertilizer application is .0004 ppm.

Continuing these calculations, and assuming 50 percent nitrogen loss (worst case: all nitrogen loss, surface and subsurface, entered area watercourses) the first year projected increase of total nitrogen in area watercourses would be .004 ppm. The following table shows the estimated nitrogen and phosphorus increase for each year of project implementation.

	y1	y2	y3	y4	y5	yx
Total Nitrogen, Avg. increase (ppm)	.0004	.0014	.0034	.0059	.0064	.0064
Total Nitrogen, Worst case increase (ppm)	.004	.014	.034	.059	.064	.064
Phosphorus, Avg. increase (ppm)	.0001	.0004	.0006	.0010	.0007	.0007

These calculations attempt to quantify the maximum degradation of area watercourses due to increased fertilizer usage during project implementation. No attempt can be made to predict the effect of fertilizer usage on individual streams due to a lack of specific information concerning the location of fertilized lands and the existing water quality of nearby streams.

Degradation of area water quality from fertilizer nitrogen and phosphorus compounds, for project year No. 5 and all subsequent years would be slight (maximum increases of .064 ppm for nitrogen and .0007 ppm for phosphorus) due to high runoff water volumes and the relatively small percentage of total project area receiving fertilizer. Localized areas within Upper Bong County may experience temporary water quality degradation much greater than the projected increases outlined above. These areas would include stagnant or impounded waters during periods of decreased precipitation.

b. Pesticides

An integral part of the planned increase in rural agricultural productivity of Upper Bong County includes the selective use of insecticides, herbicides and fungicides. Insecticide and fungicide chemicals will be utilized for increased cocoa and coffee production while herbicide and insecticide chemicals will be used for swamp rice.

The route of pesticides into the environment is very complex and the eventual effects and fate of a pesticide are determined by many factors, including; chemical and physical characteristics of the pesticide, type and efficiency of application, soil characteristics, and climatic conditions. Pesticides enter the aquatic environment by direct application, water runoff and soil erosion. All of the above pathways lead mainly to surface water contamination while groundwater receives little impact since pesticide molecules tend to attach to soil particles. Most pesticides have a low solubility to water and are transported in surface runoff as films, emulsions or attached to particulate matter.

The major method by which pesticides enter the aquatic environment is in association with suspended sediments (Lichtenstein et al, 1966). This conclusion is supported by the fact that relatively larger concentrations of pesticides are found in the bottom sediments of watercourses than in the overlying water. The concentration of pesticide pollution in water courses is therefore, largely related to soil erosion. The amount of pesticides which enters the aquatic food chain is dependent on many complex physiochemical properties of the soil, water and pesticide.

In order to determine the impact of pesticide application to area water quality, a worst-case approach must be used. This approach requires a series of assumptions to arrive at an estimate and the inclusion of a "safety factor" to allow for variations and to ensure a truly worst-case. The assumptions necessary are that; all pesticides applied will remain within the upper 3 inches of soil (USEPA, 1972), no other losses of pesticides will occur during application, application of the yearly quantity of pesticides and yearly erosion will take place at one point in time instead of throughout the year, and the pesticides entering the water will remain suspended and undegraded. Using the Universal Soil Loss Equation (USDA, 1961) it can be calculated that as much as 0.1 inch/year of soil might erode from each acre of land in the study area. Since the pesticide remains in the upper 3 inches of soil, this means that about 3.3 percent of the pesticide would be removed through erosion. Since many factors influence erosion (such as the slope-length-steepness factor) and since a worst-case "safety factor" must be included, the amount removed by eorsion, in this case, has been assumed to be 10 percent. The maximum increase in area pesticide content can be calculated using these applications.

During the first year of project implementation approximately 300 kilograms of combined pesticides will be utilized. Assuming 10 percent of this amount (30 kilograms) will enter area waters and become diluted by the total projected annual runoff ($3.25 \times 10^9 m^3$), a maximum average annual increase of .009 μg/l of pesticide in area waters is projected and for project year No. 5 and subsequent years the maximum increase is .6 μg/l. These values are below detectable analytical limits.

Actually, the increase of pesticides in area waters would probably be undetectable during project implementation due to removal mechanisms not taken into account in the above calculations. Most pesticides are degraded within a period of weeks or months depending on biological and chemical conditions. Only a small group of organochlorine pesticides are stable

for periods of years in the environment and many of these pesticides are either banned from use or production, or have strict limitations placed on their usage. Also, degradation of these pesticides is much faster in tropical climates. Thus, no adverse impact due to the limited pesticide applications is projected.

The Environmental Impact Statement on the AID Pest Management Program (USAID, 1977) thoroughly discusses AID's pest management policies and strategies. AID's policies take into consideration important factors, restrictions and field problems related to: pesticide selection and procurement; pesticide transport, storage and distribution; pesticide application; and postapplication activities and events.

AID recognizes that pesticides by themselves will provide only limited, short-term solutions to less developed countries' crop protection, health and other pest problems. If and where pesticides are provided by AID, their selection will be determined, on a case-by-case basis, according to the policies and guidelines as described in the AID Pest Management Program (USAID, 1977). In attempting to develop long-term solutions, future AID programs will include support for:

1. Establishment and operation, or improvement of integrated pest management systems.

2. Establishment and operation, or improvement of schemes for the regulation of pesticide usage (encouraging adoption of internationally developed model licensing, approval and labeling schemes, and of international pesticide residue tolerances).

3. Adoption of pesticide quality standards (such as the "FAO specifications for plant protection products"), and establishment or improvement of facilities and procedures to monitor and enforce them.

4. Strengthening of national health and agricultural programs ("agromedical approach"), with particular emphasis on training and technical assistance.

5. Strengthening of less developed countries' capabilities to apply sound environmental planning and monitoring as an integral part of their crop production and public health systems and policies.

6. Monitoring of the human and environmental health effects of pesticides.

7. Collection of efficacy and safety data on pesticides.

In Africa, pesticides may be approved for crop protection or for health programs. Pesticides presently anticipated to be used for crop protection programs include BHC, endolsulfan and trichlorfon. Those to be used in health programs are DDT, Malathion and Abate. Where feasible, AID is committed to the use of organophosphate or carbamate pesticides as opposed

to the more stable, long-lasting chlorinated hydrocarbon pesticides. In tropical countries, all pesticides tend to degrade more quickly than in temperate climates. This fact makes the case-by-case approach used by AID, even more necessary.

c. Sediment Load

Increased sediment load in area watercourses, due to project implementation, is the direct result of increased erosion from project related activities. The same factors which influence soil erosion potential also influence suspended sediments in area waters. The two primary factors are increased clearing of land for agricultural production and road construction and usage activities. The amount of increased sediment load in major area streams due to project activities will be less than the amount of eroded soil because some suspended solids will settle out during transit to major watercourses. Solids that remain suspended for an extended period of time are generally 50 percent or less of the total amount of soil eroded. The amount of increase in suspended sediments in area waters will be a function of the percentage increase in cleared land necessitated by project implementation. From previous data it has been calculated that an increase of 10 to 15 percent in cleared lands will result from the project activities. It can therefore be assumed the maximum increase in suspended sediments in area waters will be of the same magnitude (10 to 15 percent). With proper mitigation procedures employed, this figure may well be reduced to 5 percent or less. Total suspended solids measured in the St. John River were only 2.0 ppm, thus, this impact on water quality (increasing suspended solids by about 0.2 ppm) is projected to be insignificant.

3. Water and Water Supply

a. Ground Water Wells

The drilling of wells for rural communities is not within the scope of this project, however, the Government of Liberia wishes to establish rural water supply as a component of its overall rural development programs. Through assistance from the Federal Republic of Germany, investigations planning and feasibility studies were completed in six county towns for the supply of treated, piped water and bids have been invited from contractors for implementing three such programs, one of which will be at Gbarnga. Other well-drilling programs have been conducted in rural areas.

The Project Management Unit will appraise the situation in the project area regarding rural water supplies and encourage local improvements through wells constructed on a self-help basis. In accomplishing this, the PMU will work closely with the Project Advisory Committee and local health authorities and, where necessary, supply materials and other assistance for well construction. If the PMU is successful in increasing the number of wells which the villages can utilize, it will have a positive effect by increasing the supply of water, which is not as contaminated as that currently obtained from surface sources. The well drilling program must be conducted in conjunction with a program to educate the vil-

lagers on the necessity to locate the wells in an area which would reduce the probability of contamination. Project construction of farm to market roads will facilitate access by drilling equipment.

Other than improvement programs no impact upon ground water is anticipated through project implementation.

b. Irrigation Systems

Water from the major streams in the area is not presently used for irrigation because most farmland is not near streams. Additionally, the smaller streams frequently are dry during the rice growing season. Experience with reclaimed swamp has led to the conclusion that it is usually impossible to grow a second crop of rice because of lack of water during January and February unless irrigation water is provided.

The project will allow (on a pilot basis) a small number of farmers to double crop rice after the construction of small weirs and catchment basins to make stable and dependable irrigation possible. The Land Development Unit will be required to assist in the development of each swamp earmarked for possible double rice cropping during the first two years. Development loan funds will be made available for the implementation of irrigation structures. The construction of such catchment basins and irrigation systems will be a part of the flood control program as discussed in the following section.

c. Flood Control

Flood water control in the valleys of the project area is one of the key factors for successful swamp cultivation. Experience indicates effective water control is possible using a low level, labor intensive technology. Decisive factors for determining swamp development are catchment topography and soils. After the first year of crop growing, during which necessary data will be obtained by the Land Development Unit, flood control structures will be constructed upstream from paddies. These measures will consist of a central floodway channel and an upstream flood protection dike to prevent uncontrolled catchment in the fields. Peripheral distribution and secondary drainage to secure more controlled supply and outlet of water will be developed. The result of construction of such flood control structures will be to allow the farmers greater certainty in rice production because excessive water will be kept from inundating the paddy. The amount of water which is contained in these catchment basins should have a negligible effect upon the major streams of the area because water will be contained during the rainy season. It will have a slight beneficial flood control impact downstream but because of the relatively small size of the flood control works, the impact will be small. A secondary effect is that the water held in these catchment basins could be utilized to irrigate swamps during the dry season, permitting double cropping of rice. Health impacts are discussed in the appropriate health section.

4. Air Quality

a. Construction Related Pollutants

Most of the construction associated with the proposed projects will relate to the clearing and cultivation of land and to the construction of the farm to market roads. Dust produced during the clearing and road construction operations will be annoying and have some short-term effect on the surrounding area; however, no significant health hazards will be created. Pollution from the exhaust fumes of construction equipment will be short term and localized. These factors will cause a temporary increase in the levels of particulate matter and carbon monoxide in the atmosphere adjacent to the construction or clearing site.

b. Smoke

The present method for clearing land in the project area is by cutting and burning. During the dry season, this results in a smoky haze over the study area and much of the country. High natural humidity and stagnant air contribute to this effect. Because of few alternative methods to dispose of the cleared vegetation, and because of the traditional social and governmental acceptability of burning vegetation, it is expected that vegetation cleared from the proposed agricultural land will also be burned. This will add additional pollutants and will cause increased temporary discomfort to individuals in the area. The increased contribution of smoke due to the project will be proportional to the increased agricultural land use (approximately 13 percent).

c. Dust

The primary road construction material in Liberia is laterite, a soil principally composed of aluminum iron ore oxide. While it is an excellent road construction material, it is also a pollutant during the dry season. In tropical countries where laterite is used for road construction, the residual red dust is visible for considerable distances along the sides of roads. The amount of dust created depends on traffic volume and speed, road maintenance quality, climatic conditions, etc. The anticipated increase in road mileage and traffic due to the project will increase the amount of dust in the air during the dry season. The number of people exposed to this pollution will be minimal, however, because of the sparsely populated areas through which most of the new roads will be constructed. Air pollution also will be minimized due to the heavy rainfall during most of the year.

Air along road corridors will be polluted by the exhaust fumes from vehicles. The older passenger vehicles burn excessive oil, while most trucks and buses use low quality diesel fuel or kerosene, emitting clouds of of black dense smoke which linger in the humid air. Most of the travel by this type of vehicle already occurs on the major roads and the only increase will be due to that traffic increase caused by the project. The farm to market roads will normally be utilized by farm type and small 4-wheel drive vehicles.

B. ECOLOGICAL IMPACTS

1. Alteration of the Ecosystem

The Upper Bong County Rural Development Project contains a number of programs which are potentially harmful to the environment. Many of the harmful impacts can be mitigated by careful planning and implementation of the project. The potential impacts to various parts of the ecosystem are discussed below. However, it must be remembered that the different parts of the ecosystem interact, and an effect to one part may also be felt by another.

a. Swamp and Marsh

The project call for the clearing and improvement of about 2,050 hectares (5,060 acres) of swamp in addition to those already in use. This additional land represents an increase of 120 percent over the present 1,700 hectares (4,200 acres) but is only 3 percent of all swamp land and only 0.33 percent of the total land area. Consequently, any impact to swamps must be considered minor in the context of the total project area although the impacts on a particular swamp are quite severe.

Clearing and improving a swamp for rice production requires the cutting of all trees and brush and the in situ burning of such vegetation. During this process, adverse impacts will result from the use of power saws (noise pollution and petrochemical spills) and fromburning vegetation (smoke). The removal of vegetation (e.g. trees such as Alstonia boonei, Gilbertodendron splendium, Nauclea pobeguini, Raphia sp.; and other plants such as the sedge Rhynchospora corymbosa, and eddos Colocasia sp.) has a very severe impact. Not only are the plants themselves destroyed, but this disrupts the habitat used by various insects, birds, reptiles, amphibians and small mammals. In addition to outright destruction, the swamp ecosystem would be adversely affected by the alterations in flow rate and mechanics caused by clearing and other improvements. The severity of these impacts (as related to the total project area) is reduced because the amount of swamp land distrubed in any one spot is very small (only a few hectares), and these areas of disturbance are scattered over the project area.

Growing swamp rice calls for the use of herbicides and insecticides. These chemicals will cause additional damage to the swamp and its effluent. The pesticides to be used are primarily organophosphates and carbamates with some chlorinated hydrocarbons. The chlorinated hydrocarbons are the most stable and present the most severe, long-term impacts. However, careful consideration and use of pesticides can reduce the impact considerably. Their localized use in many small areas spread over the total project area further decreases the severity of total impact. Assuming that 10 percent of the total pesticides applied will enter the area waters, the annual increase in concentrations at the end of 5 years (project length) will be much less than 0.1ppm (part per million). The assumption of 10 percent entering area waters is extremely generous since degradation mechanisms (both physical and biologocal) will reduce the amount of residual pesticides very rapidly. In addition, this figure is total pesticides which

means that the concentration and impact of any given pesticide will be much less since pesiticides affect various organisms differently. The impact of pesticides used in the project will be not only undetectable but probably insignificant.

b. Abandoned Fields, Fallow Land and Secondary Forest

The project calls for increasing the acreage of upland rice fields and tree crops by about 5,750 hectares (14,200 acres). This land would be taken from abandoned fields and secondary forests and represents an increase of 58 percent over the acreage (9,919 hectares) presently cultivated in upland rice. This increase, however, represents only 1 percent of presently uncultivated land (0.9 percent of the total project area). Thus, impacts to this land, while severe, also must be viewed as minor impacts to the total project area.

Clearing the land will require cutting all trees (e.g. Amphimas pterocarpodies, Fagara tessmannii, Ceiba pentandra, Uapaca guineensis, etc.) as well as shrubs, bushes and other vegetation. After cutting, the vegetation is burned in situ. The cutting and burning will cause pollution by smoke, noise and possibly petrochemical spills. These impacts will be very short-term and will be concentrated in a small area. Consequently, they must be considered minor impacts. Clearing the land will result in complete destruction of habitat used by various invertebrates, birds, amphibians, reptiles and small animals. This habitat will be lost, and the organisms will be killed outright, or migrate to nearby areas. This impact, while locally severe, will be minor in the context of the total project area.

Additional impacts to abandoned field and secondary forest will result from the construction of 170 kilometers (105 miles) of new roads and the rehabilitation of 130 kilometers (80 miles) of existing roads. In addition, a maintenance system is planned. Road construction will remove less than 405 hectares (1,000 acres) of land from the ecosystem; this represents less than 0.1 percent of the total project area. This impact is minor.

The only major adverse impacts result from construction, rehabilitation, maintenance and long-term use of the roads. Construction and rehabilitation will require the use of some mechanized equipment which will cause noise pollution, air pollution from exhausts and dust, and, potentially, pollution from petrochemical spills. These impacts will be short-term, and careful planning and supervision during construction can prevent the majority of them. Maintenance and long-term use of the roads will cause pollution from noise, exhaust fumes and dust. The road surface will be principally laterite (aluminim iron ore oxide) which can cause significant amounts of red dust during dry periods. The impact of this dust, while locally severe, is not major since it occurs principally in dry weather and is related to the amount of traffic. Thus, during most of the year, dust would not be a problem and even in dry periods, the increased traffic will not cause a truly severe dust problem.

c. High Forest

Less than 8 percent of the project area could be considered as true forest land. Although originally covering much of the project area, high forest has been largely replaced by secondary forest, abandoned fields and fallow land. No aspect of the project would have an impact on any of the remaining high forest.

d. Rivers and Streams

The major impacts to rivers and streams result from fertilizer and pesticide runoff and from road construction. The project calls for fertilization and the use of pesticides in upland rice fields and tree crop areas. Application of fertilizer would have its most severe impact by increasing the levels of nitrogen and phosphorus in the area waters due to runoff. By using projected application rates and assuming that 50 percent of the nitrogen and 1 percent of the phosphorus (both figures are well above the expected amounts) would enter the area waters, the impact to water quality can be calculated. Under these conditions, the annual increase at the end of 5 years would be 0.064ppm for nitrogen and .0007ppm for phosphorus. These figures indicate only a minor impact to the project area although localized impacts may be far greater. However, since the assumptions about the amounts entering area waters are generous and since most farms are some distance from any stream or river, the impacts from fertilizer runoff would be minimal.

Conclusions concerning pollution by pesticides are similar. Assuming that 10 percent of the total pesticides applied will enter the area waters, the annual increase in concentration at the end of 5 years is much less than 0.1ppm. This assumption does not truly reflect the degradation by physical and biological factors but represents the "worst possible" case. In addition, the figure is a composite for several pesticides, and since pesticides affect organisms differently, the actual impact of any given pesticide will be much less severe.

Construction impacts arise primarily from physical disruption of the stream or river and from siltation. Additional impacts could result from bridges or culverts used to cross streams and would be most evident during peak flow periods. All of these impacts can be kept to a minimum by proper construction methods and careful advanced planning. Construction during the dry season, when streams and rivers have minimum flow, would show the least impact from disruption and siltation.

The impact to any given stream or river cannot be determined at this time. However, it is clear that because of the relatively small amounts of chemicals applied, the widely scattered points of application, and the limited construction, the water quality of the rivers and streams in the project area will not be significantly altered. In fact, except very close to the points of application, fertilizers and pesticides will probably be virtually undetectable in the rivers and streams. The impact on the biological communities will be nonexistent except very close to the point of application. At these points, some organisms (mostly invertebrates) may be killed or harmed. However, many streams and small rivers in the area are dry except during

the rainy season and the biological communities must re-establish themselves each year. Thus the overall impact on the water quality and biological community of the project area will be minimal.

2. Impact Upon Significant Species

The project, as proposed, will have no foreseeable negative impact on any significant species. Two species on the list, "Endangered and Threatened Wildlife and Plants" (US Department of Interior, Federal Register, Vol. 41, No. 208) have ranges which include the project area. These are the chimpanzee (Pan troglodytes) and the leopard (Panthera pardus). Both species are basically associated with high forests and no negative impact to these species can be expected. No other significant species have ranges in the project area.

3. Vector Impacts

a. Water borne

The swamp rice program will increase the habitat for the vectors of schistosomiasis (snails). In addition, tending the swamp paddies will increase the frequency of contact between the vectors and humans. These adverse effects are recognized and the project contains programs to deal with them. The Schistosomiasis Surveillance Unit is responsible for monitoring Schistosomiasis in the area and control measures will be instituted where necessary. These control programs may be chemical, environmental, genetic or biological or may be a combination of these types (integrated). Integrated programs have shown significant effects (from 75 to 90 percent reduction of vectors) in Iran, the Phillipines and Puerto Rico (Schad and Roseboom, 1976). Various control programs are discussed more thoroughly below (see Chapter XI).

Chemical control measures such as the use of molluscicides would have a severe negative impact on aquatic organisms associated with the swamps. The molluscicides may kill a variety of non-target organisms and significantly affect the biological community. However, in view of the limited areas of application and the necessity to control the vectors, these impacts, although locally severe, must be considered acceptable. Impacts would be further mitigated by the implementation of regional health programs under formulation by AID/GOL.

b. Insect

The two major diseases with insect vectors are malaria and filariasis. The vectors for both are mosquitoes, and the swamp rice program will increase the available habitat for the aquatic larvae. Increasing vector populations and frequency of contact between humans and vectors are potential impacts of the project. Vectors may be controlled by insecticides, but the use of insecticides will cause severe negative impacts by affecting non-target organisms as well. This impact, while severe locally, must be viewed as acceptable. Additional regional control programs are being negotiated with GOL and other nations.

The impacts from both mosquito and snail control measures are further

lessened since the major sites will be swamp paddies. The biological community will be temporary since paddies are dry for part of the year. Thus, an established, continuous community will not be disturbed.

c. Rodent

The vectors of Lhasa fever are various rodents. Increased rice production and especially rice storage, may serve to increase the rodent population. The most severe problem will exist near and in villages at storage sites. Partial control can be accomplished by careful methods of harvesting and storage, while additional control can be achieved by chemical means. Thus, if vector populations are controlled, the project should have little impact on the incidence of Lhasa fever, and the control methods should have no significant effect on the ecosystem.

C. CULTURAL IMPACTS

1. Land Ownership

Approximately one-half of the cultivated portion of the project area is in private ownership; however, only one-fifth of the farmers are reported to have private title deeds. Presently, most of the land in private ownership consists of rubber plantations. Farmland is primarily utilized under tribal tenure procedures. Tribal land rights appear to provide sufficient security for the farmers with present agricultural methodologies. It is unlikely that this system will still suffice when farmers are required to make substantial capital improvements to develop the land and when yields and income from lands increase. The desire to obtain private title deeds on land has been increasing in the project area during recent years. Farmers apparently feel that land will become more scarce in the future. Tribal members who are temporarily absent while working in other areas also appear to desire to consolidate traditional rights by obtaining private title deeds. Thus, it may be expected that as the land is improved and the farmers obtain more income from their farms, land ownership will change from tribal rights to private ownership. If this desire for private title deeds becomes apparent under project conditions, some necessary procedures would be required within the framework of the project. Included would be such things as surveying, preparation of sketches and maps, facilitating procedures for acquisition of deeds, and preventing transfer of land for speculative purposes.

2. Land Use

Project implementation will increase the amount of land in the study area used for roads and farming. Most of the additional land will be taken from secondary forest which presently covers 80 percent of the project area. The rest of the area is composed of swamps (12 percent) and high forest (8 percent). The project would have absolutely no impact on high forest. At the end of Project Year 5, about 7,600 hectares (18,800 acres) more than without the project will be cultivated (Table 28). In addition, new construction of farm to market roads will take about 400 hectares (1,000 acres) of land primarily from secondary forest. The combined total (8,000 hectares) is only 1.4 percent of the total project area and since land is

an abundant resource in Upper Bong County this represents a minor impact.

The major effect of the project will be to increase the per farm acreage of farms under 2 hectares (Table 28). The major impact will be on holdings of between 1.00 and 1.99 hectares which will increase from 4,250 to 11,037 farms. This will represent an increase of about 10,000 hectares but the number of smaller farms will decrease, thus making the increase in total acreage cultivated only 7,600 hectares. Associated with the increase in the number of farms between 1.00 and 1.99 hectares will be a change in crops grown. The project will cause an increase in the acreage of swamp rice grown and will increase production of cash crops, especially coffee and cocoa.

The long term impact of the project on land use is difficult to assess due to uncertainties regarding local farmer acceptance of instituted practices after 5-year project period. It is certain that after year 6 the 9,000 project farmholders will continue to clear additional acreages of upland rice each year; however, this use is included in projecting the additional 7,642.3 hectares per year. If the project is successful in encouraging the 10,000 farmholders not included in the initial project to improve methodologies and increase yields, then more project land will be converted to agricultural use each year. It does not appear, however, that this conversion would be more than 8,097 hectares (20,000 acres) annually in addition to the projected 7,642.3 hectares.

3. Social Structure

a. Effect on Tribal Structure

Experience in Liberia has shown that it is advantageous to form cooperatives along the tribal structure. The Town Chiefs and Clan Chiefs are well trusted by the inhabitants of the project area and apparently have skill in handling tribal matters. Since the project encompasses the continuing utilization of tribal structure and traditional institutions, there should be no significant effect on the tribal structure in general. The project will make tribal members more aware of the institutions of the Government of Liberia because of the necessary monitoring and evaluation that must take place. However, any adverse reaction toward becoming more dependent upon the government should be minimized by working through the tribal structure.

b. Changes in Education

Intrinsic to the project is 70 weeks of extension aide training, 23 weeks of co-op staff training, and 140 weeks of farmer training. To accomplish these educational goals, a farmer training center and dormitory will be constructed at CAES, Suakoko. In addition to providing necessary project training, this educational program should provide the impetus for peripheral educational programing.

As previously discussed, the educational system in Liberia suffers from a lack of relevance to the educational needs of the rural areas. In this regard, the idea of community schools has developed. The purpose of the

community school program is to improve primary education in rural areas, provide more relevant education to rural children and prepare them for a life in rural society. In view of the special objectives of this program, the Upper Bong County Rural Development Project is extremely well suited to foster this type of program. The project will create conditions under which farmers need the knowledge and skills that will be taught in the new schools. According to information received from the Ministry of Education during the previous studies, the Upper Bong area will eventually obtain 4 to 6 additional community schools under existing plans. While school construction funding is not part of this rural development project, the increased technology, increased business activities, required credit program, etc., will necessitate an increased educational attainment for those individuals who become involved in the program. Increased financial rewards will be obvious, and regional economic stimulation will justify GOL education investment. Therefore, a major change in education will occur from the requirement of personnel with specialized knowledge in the area who could assist in project operations and management. This will result in the realization by the inhabitants that additional education is desirable. A demand for more and better educational facilities will probably result.

4. Economic and Institutional Structures

a. Employment Opportunities

It is estimated that the project will provide at least 800,000 man days of job opportunity, primarily for road construction and swamp reclamation. There will be a demand for 120 permanent hired laborers per year for road construction, or 180,000 man days for the five year project investment period. Swamp reclamation activities are expected to create an additional seasonal labor demand of over 650,000 man days. To assure that labor requirements will be reached, the project will pay $1.30 per day, or $.50 per day more than the present wage for rubber tappers on local plantations (US Agency for International Development, 1976). These employment opportunities will generate cash earnings which may be utilized for productive investment in the modern agricultural practices which would be introduced. By working the maximum of 20 days in project financed employment, a farmer could earn enough cash to finance improved crop technologies. Thus, the construction will provide local inhabitants with a means of obtaining the necessary funds to partially finance the improved technology envisioned by the project. In addition, it will teach some peripheral skills in road building and reclamation projects, permitting an increase in wage-earning capabilities by participants.

Because of the complexities in such a development project, successful implementation requires a project staff with high levels of managerial efficiency, technical competence, innovation and commitment to the small farmers. Realistically viewing the situation, it appears that a number of senior key positions will have to be filled through international recruitment. This would include the project manager, managers of finance, agricultural services training, and cooperative/credit services divisions, a swamp development officer and land use planning officer. Thus, many of the senior project staff members may not be Liberians unless qualified Liberian

personnel could be found and induced to work on the project. Many employment opportunities for Liberians will exist in the field services staffs. A Senior Extension Officer will be in charge of the extension service and directly responsible to the Chief Agricultural Officer. He will direct a field force of three to four Field Supervisors and approximately 120 Extension Aides. Some Aides are presently working in the area (approximately 30) and should be taken into the project. The general education level of these Aides is low, but a comprehensive training program would improve their technical skills. Thus the program will provide training to a number of graduates from the Booker T. Washington Institute and from other areas which would supply Field Extension Aides. Additionally, individuals to work with the Cooperatives must be recruited and trained, including bookkeepers, managers, office staff, etc. This may put a severe stress on the number of trained personnel presently available in the country and those being trained. However, the fact that such positions exist will prove to be an incentive to individuals to participate in educational and/or vocational training programs.

An analysis of the potential labor force indicates that the only labor constraint on farms will occur in the initial phases of the proposed swamp development. The force required for the construction of water control devices and initial land leveling will exceed local farm labor capacity; however, hired labor will be obtained to fill this need. After the initial phase, the annual cultivation work will be carried out by family labor in the traditional manner, and no stress impact is anticipated although an increase in effort per farm family over existing conditions will be required.

The project will obviously result in a number of induced jobs, i.e. jobs created as a result of the project but not directly related to it. Such jobs include those related to the transportation and handling of inputs and the transportation and processing of the harvested crops. As the income of the families increase, they will purchase more goods, resulting in increased commerce. The new technology will result in a demand for more education and training. Eventually, as a result of the educational program, more health and sanitary facilities will be required. Thus, the initial development project would ultimately lead to an improved standard of living, with the concomitant requirement for individuals to provide the necessary goods and services.

b. Farm Family Income

The present average annual income of farm families in the project area is less than $300 (US Agency for International Development, 1976). This is expected to increase by 140 percent (to $720) within 13 years after project implementation. This income will provide more than just subsistence, and should significantly improve the standard of living.

c. Revolving Credit Fund

At present, there is no formal system capable of supplying credit in sufficient quantity to small-scale farmers in the project area. Present borrowing occurs through family or other traditional structures. Loans

are generally small, bear no fixed interest rate and are used mostly for non-agricultural purposes. This present credit supply will require supplementation by an organized system administered as a long-term, permanent operation, since credit is essential for the major improvements of the project. A Revolving Credit Fund will be established during initial stages, with the PMU having the responsibility of allocating credit. This will later be processed through the cooperatives. While the idea of loans and credit is not entirely new to the farmers, the formalized procedure proposed by the project is different. Farmers must understand and be willing to accept group responsibilities for credit repayment as well as the reason for credit and its long-term implications. The farmer must agree to more controls over what and how he produces, where he sells his produce, and must accept the responsibility for credit obligations of other primary group members if they default on loans. Thus, the major impacts from the credit plan will be to provide the farmer an opportunity to increase his income and improve his farm, but at the cost of losing some of this independence to produce, buy and sell what and where he pleases. The latter is not as great an impact as it might initially appear. Because most farming is now subsistence oriented, the crops grown are essentially dictated by food requirements. Presently, any surplus cash crop is relatively small and sold locally, so the farmer, in effect, has little choice of where to sell.

d. Cooperatives

Six cooperatives are proposed, based on traditional lineages; i.e., the six clans. The idea is not new to the area, as unofficial temporary cooperatives (Kau's) have functioned for a number of years. Additionally, small cooperatives have been formed within some of the clans. Thus, there will be little sociological impact from the formation of such units. The major impacts will result from the benefits gained through the operation of these organizations. The type envisioned is the multipurpose service cooperative which eventually, will assume the responsibility for granting credit, supplying inputs and marketing produce. This will provide an opportunity for volume buying and selling, resulting in larger profits. The co-ops can also purchase equipment which could be utilized by the members, and which is beyond the financial capability of individuals; i.e., tractors, processing equipment, loading equipment, trucks, etc. Co-ops can sponsor training programs, demonstration plots,etc., to provide new ideas and technology. In some areas of Liberia, the Liberian Produce Marketing Corporation has appointed cooperatives as their buying agents, and the societies have earned considerable revenue in the form of commissions. The net impact of program related cooperatives, therefore, would be economic and social enhancement of its members.

5. Changes in Public Facilities and Services

a. Development of Central Agricultural Experiment Station (CAES)

The CAES, the main research center for the Ministry of Agriculture in the country, is located at Suakoko in the center of the project area. Since the 1950's, the facility has been involved in rice research. An

analysis of present CAES operations indicates that it is poorly staffed, has limited physical facilities, is inadequately financed, and lacks the administrative and financial power to organize effective research (US Agency for International Development, 1976). This project will provide finances for some of Liberia's immediate research needs; specifically continuity of the rice research efforts started under an earlier IBRD loan, initiating research activities in the field of cocoa and coffee, and overall improvement of the physical facilities at CAES, particularly laboratory facilities for the agronomy and soils section. In addition, funds will be provided for two consultant man-months for an in-depth analysis of the present status of research and the development of required organizational changes and research priorities. This effort will have a positive impact on the whole of Liberia's agricultural program. Improved crops and greater yields should result as improved varieties of rice, cocoa and coffee are tested and proven. Types and amounts of fertilizer, herbicides and pesticides will be tested and recommended. Soils analysis will be performed to determine soil deficiencies. The impacts of a properly funded and administered research program will be extremely beneficial. Facilities at CAES will be used for training programs required by this project. In this regard, a farmer training center and a 15-bed capacity dormitory will be constructed.

b. Other

Changes will also occur in the areas of education, health and water supply, the impacts of which are discussed in other sections. The Community Schools which will be constructed by the Government of Liberia (GOL) will make education more relevant to the farmers. A schistosomiasis laboratory will be established and the incidence of that disease monitored to develop data for control recommendations. Although not funded by this program, the GOL is expected to construct or assist in the construction of 300 wells during the project life, improving the water supply to the villages.

D. TRANSPORTATION CHANGES

1. Highway Improvements

For a rural development project of this type and magnitude to be successful, an adequate transportation network must be available. The only applicable means of transportation in the study area is the highway network, consisting of primary and secondary highways and farm to market roads. Improvements to primary and secondary highways are not an intrinsic portion of this project, however, they are important to the success of this project. A study of the existing primary and secondary highways indicates that they are poorly maintained, often do not meet present standards for such highways, are poorly drained, and the structural integrity of many timber bridges and culverts is poor. This project will have a definite impact on such roads. Primary and secondary roads are fed by the farm to market roads, and the products and inputs for the rural development project must travel over the regional highway network. If existing highways are not properly maintained, it will have the effect of reducing project benefits. The Government of Liberia has received a highway loan from the

International Bank for Reconstruction and Development, and it is planned that under the programs developed from these loans reconditioning and regular maintenance of primary and secondary roads in the study area will occur. Therefore, it is expected that all such roads will be brought up to standards during the early stages of the project. Traffic resulting from the operation of the project components will result in increased use of primary and secondary roads, and will probably increase maintenance requirements. However, the revenue generated from the rural development project should be adequate to more than compensate for the cost of additional requirements.

2. Farm to Market Road Construction

The farm to market roads which will be constructed as part of the program (approximately 160 to 170 kilometers) will have a number of impacts on the Upper Bong County area. It is expected that population centers will develop near the farm to market roads (and/or the primary and secondary roads). Most new farms, particularly those involved in the redevelopment project, will probably locate as close to the new roads as possible. As part of the project consists of maintenance of these farm to market roads, it can be anticipated that the inhabitants of the area will give more consideration to improved means of transportation, particularly as their income increases. This could be anything from bicycles to trucks. New farm to market roads will provide access for a variety of services, including health care and monitoring to villages previously unreachable. There will be no requirement to relocate people within the corridors of the new highway construction. Acquisition of right-of-way is provided for under Liberian law and compensation is based on fair land values.

3. Effects of Improved Accessibility

a. Commerce

As the transportation network within the project area is improved, it will be possible for more diverse products to be transported throughout the area. Additionally, the increase in income to farmers will provide them with funds to purchase additional goods. As a natural consequence, it can be expected that additional commercial establishments will locate in the project area, particularly in the larger towns. Therefore, commerce should increase, particularly in goods and products which would be utilized by rural farming communities.

b. Agriculture

The improved transportation network will make it possible for more rapid transportation of agricultural inputs and products. Because of the cooperative movement, it may be possible for the farmers to jointly purchase various types of machinery that could be transported between farms or villages via these roads. It will facilitate the visits of technical experts to inspect crops and thereby minimize the loss due to disease or other problems. Farmers not involved in the development project will have better accessibility to view the farms of those individuals who are involved in

the project and thus be made aware of the techniques and technology being utilized. The overall impact to agriculture should be very beneficial.

c. Living Conditions

The living conditions of the farmers should be improved both directly and indirectly as a result of the improved and expanded transportation network. It will be easier for representatives of various social agencies to visit the villages and the farms and to teach the villagers health sanitation, cooking, cleanliness, etc. (See also, Section e. Health Care). Additionally, the farm to market roads will provide well drilling equipment with adequate access to rural areas and the water supply of the villagers should be immeasurably improved. Indirectly, the improved transportation network will assist in providing higher incomes to the farmers, permitting them to purchase or invest in various items or services to improve their living conditions.

d. Education

It is important that the farmers in the area become trained in the proper methods of fertilizing, seeding, cultivating and harvesting the crops to produce the maximum yields. The road network will provide a more rapid and convenient means for the farmers to receive training, either from extension courses or by traveling to training centers. The roads will also provide a better method of transportation for students enrolled in either the traditional schools or the new community school program.

e. Health Care

One of the major problems of making health care available has been lack of accessibility to and from the villages. The improved transportation network will make it easier for inhabitants of the area to travel to health care centers and will also make it easier for health care specialists to visit the various villages and farms. In conjunction with the improved living conditions and education, a greater awareness of the need for and availability of health care should result. This greater awareness in conjunction with the improved transportation network should lead to better health conditions in the project area. The improved transportation network will also make it possible for the Schistosomiasis Surveillance Unit to cover a greater area in a given period of time. When it is considered that the only present access to areas that will be serviced by new farm to market roads is trails, the great beneficial impact to all health facets becomes readily evident.

f. Employment and Income

Improved transportation will not only make it possible for the farmers to transport significant inputs and produce, thus increasing their income, but will also make it easier for inhabitants of the area to travel to various locations to seek employment at locations other than their homes. For example, during the construction phase, inhabitants could travel greater distances to work. Additionally, many of the inhabitants of the area work on rubber plantations. Construction of the highway network will

reduce the time required for them to travel to these plantations or allow them to travel greater distances in a given amount of time than at present. Thus, the improved network will increase employment income not only to the farmers employed on their own farms, but to various other individuals who travel to or from their place of residence to work in other areas.

E. AGRICULTURAL CHANGES

1. Effect of New Technology

A number of new strategies will be employed under the project, aimed at improved utilization of available land and labor, resulting in improved agricultural production. By increasing average farm sizes, increasing the relative averages of the more highly productive crops, and the wider adaptation of modern practices and material inputs it is anticipated that such goals can be achieved.

The use of power farm equipment is very expensive and is cost effective only when labor is a major constraint. This expense, coupled with the necessity for thorough clearing operations before machinery can be used, dictates a cost which cannot normally be recovered given the relatively short time that a piece of land is in use under the traditional shifting cultivation system. Machinery suggested for use in the project area therefore include only two-wheeled tractors (powertillers) and motor-driven rice threshers.

Environmental problems associated with the use of this equipment includes slight increases in air pollution due to emissions and increased danger of erosion which could cause soil loss as well as raising turbidity levels in associated waterways.

The use of powertillers is feasible for the cultivation of larger swamp areas because cultivation is not shifted in these areas and preparatory clearing costs must only be incurred once. The use of powertillers becomes more practical as the size of the cultivated swamp increases. Studies indicate that the use of powertillers is not feasible for the production of a 0.2 hectare swamp, however; farmers producing larger areas may be able to increase their incomes by using powertillers.

The other major capital investment in equipment being considered by the project is for motor-driven rice threshers. Indications are that the purchase of 30 mobile units would significantly reduce the major labor constriction now experienced at harvest time.

Other equipment necessary for project success include hand carried pesticide and fertilizer applicators, portable weeding, mulching and pruning tools, and a variety of marketing tools such as scales and transportation equipment.

The use of pesticides is necessary for the production of high yield crops. Environmental damage caused by pesticide usage, especially if incorrectly

applied, include: water pollution, vegetation destruction, and low level poisoning of aquatic organisms, wildlife and man. An analysis of pesticides on water quality indicates that applications will be sufficiently small to preclude any adverse impact to the aquatic ecosystem. To prevent negative effects to humans and wildlife, the pesticide will not be applied by farmers but by project aides trained in its use.

The use of improved seeds is an important component of any agricultural development project designed to improve yields. The Central Agricultural Experiment Station (CAES) at Suakoko has been responsible for production of improved seeds and supports an annual production of about 15 tons of foundation seed. However, the development project will probably obtain seed from Upper Lofa Rural Development Project in which a seed multiplication scheme has been incorporated, including a small processing unit for drying, cleaning, grading and dressing.

Table 30 gives the rice seed requirements for the project. Gissi 27 seed will be used for swamp rice in the first four years of the project in newly developed swamps to alleviate problems of temporary iron toxicity prevalent in this type swamp. The higher yielding variety IR5 will be used in subsequent years and in previously developed swamps. LAC 23 will be recommended for use on all upland rice fields. Seeds for annual crops other than rice will be obtained from CAES when available or from international sources. Seedlings for tree crops such as coffee and cocoa will continue to be supplied by LPMC. Seeds will be selected for use in this project in the basis of high yield, environmental tolerance, and disease and pest resistance. The major anticipated effect of the better seeds is significantly improved yields.

Agricultural research is needed as a supplement to existing knowledge of farming methodologies to satisfy the goal of increased agricultural production in Upper Bong County. The Central Agricultural Experiment Station at Suakoko will operate an adaptive research program designed to test new seed varieties and agricultural practices. The following project research objectives, taken from the Ministry of Agriculture Project Feasibility Study were designed to impact positively, the agriculture production in the study area.

Annual Crops

- rice varietal improvement through the introduction and testing of new stock. Particular emphasis on high yield potential and disease resistance (Blast);

- economic ways to maintain and improve soil fertility, particularly substitution of artificial fertilizers by manure;

- development of suitable crop rotations with upland and swamp rice;

- feasible means of mechanizing development and recurrent operations of swamp rice cultivation; the organization of machinery services;

TABLE 5. RICE SEED REQUIREMENTS (X1000 lb.)

Variety	Application Rate	Project Years 1	2	3	4	5	6	7	8	9	10
Gissi 27	60 lb/acre[1]	24.0	66.0	90.0	120.0	-	-	-	-	-	-
IR 5	60 lb/acre[2]	-	-	-	24.0	66.0	90.0	120.0	24.0	66.0	90.0
LAC 23	40 lb/acre[3]	40.8	109.2	160.0	212.0	40.8	109.2	160.0	212.0	40.8	109.2
Total rice seed requirements		64.8	175.2	250.0	356.0	106.8	199.2	280.0	236.0	106.8	199.2
Value at 0.15 $/lb (X1000)		9.7	26.3	37.5	53.4	16.0	29.9	42.0	35.4	16.0	29.9

1 For swamp rice years 1-3.

2 For swamp rice years after year 4.

3 For upland rice.

- improvement of grain storage facilities adaptable to peasant farm conditions;

- simple ways to identify suitable soils for tree crop plantations, which can easily be managed by the extension personnel;

Tree Crops

- varietal improvement of tree crops, establishment of seed and bud-wood gardens and importation and testing of foreign types and varieties;

- suitable practices of tree crop cultivation, such as land preparation, pruning, shade management and fertilization;

- identification of pests and diseases affecting tree crops, and development of economic methods of control, adaptable to peasant farm conditions;

- suitable methods of collecting and processing tree crop products.

In addition to the above mentioned research objectives, CAES is studying economic methods of fish production which can be used by peasant farmers to improve their protein supply.

The success of CAES in meeting these objectives could lead to significant improvements in production in the agricultural sector with a number of beneficial secondary impacts relative to improved living conditions.

Increased use of irrigation in swamp rice production is envisioned as one of the more important ways of increasing rice production in the project area. Swamp reclamation on a small scale basis is recommended for the project because of the simple techniques involved. The main problem associated with the small scale development is that logistic problems are created by the spatial distribution of reclaimable swamps.

The methodology involved in swamp reclamation includes flood control measures, irrigation facilities to secure a controllable supply of water, drainage facilities to evacuate excess water, removal of the existing vegetation, and levelling and bunding of farm plots. It is imperative that clearing operations be kept to a minimum in the swamp drainage area to assure a more reliable source of high quality irrigation water.

The first project year will be primarily devoted to hydrological and topographical surveys to determine the reclaimability of swamp. Actual developmental construction will not begin until the second year, in most cases. The following schedule gives projected rates of swamp reclamation following project implementation.

Work Item	Project Years					
	1	2	3	4	5	6
Site selection, survey design construction supervision	*	*	*	*	*	*
			(hectares)			
1st development year areas,	162	445	607	810		
2nd development year areas,		162	445	607	810	
3rd development year areas,			162	445	607	810
Reclaimed swamps fully developed,			162	607	1,215	2,050

Approximately 304 hectares (750 acres) of this land will be developed as pilot schemes for double cropping.

No water from large streams is now being used for irrigation. Project development plans also call for retention of irrigation water from catchment of localized swamp drainage basins. The water requirements for this development are quite high.

The irrigation requirements for rainy season rice are initially high (about 2.60 l/sec-hectare) to saturate the ground but rapidly fall to only about 0.50 l/sec-hectare during growth and ripening. These figures take into account the normal rainfall during the months of May to November. Toward the end of the rainy season requirements for irrigation during ripening are much higher (0.80 l/sec-hectare) than earlier in the season (0.23 l/sec-hectare). Rice grown during the dry season will require significantly more irrigation during the saturation period as well as the growing and ripening periods.

Impacts associated with the proposed irrigation projects include destruction of 2,024 hectares (5,000 acres) of natural swamp, (some of which is already under production using traditional techniques), interruption of the normal runoff regime and possible deterioration of water quality in irrigation water impoundments, especially if commerical fertilizer is used in the watershed. Additional ramifications will be found in the ecological and health sections.

2. Crop Production and Yields

The basic aim of the Upper Bong County Agricultural Development Project is to increase total agricultural production as well as yields. The main target for production increases is rice. By the end of year five, the area planted in upland rice has been scheduled to have increased by 5,750 hectares (14,000 acres), and yield is projected to increase from 1.0 ton/ha to 1.8 tons/ha. Total upland rice production associated with the project should approximate 8,225 tons in the fifth project year. These higher yields are anticipated as a result of the use of fertilizers, improved seeds and improved pest control technology. A total of 2,050 hectares (5,063 acres) will be developed by project year five for the production of swamp rice. Swamp rice yields are projected to increase from 1.4 tons/ha to 3.0 tons/ha for a total production of 5,950 MT in project year five. This production would be achieved by use of water control structures, improved seeds, fertilizer and chemical weed control.

Increases in per capita income are best achieved by increased production of cash crops, particularly coffee and cocoa. A total of 1,498 hectares (3,700 acres) of coffee plantation would be developed by the project. A density of 1,124 coffee trees/hectare would be used during the project. The use of superior seedlings, fertilizer, insecticide and weed control would increase yield from 0.38 ton/hectare in year four to 1.00 ton/hectare in year six when plantations are fully productive. A total of over 1,498 metric tons of coffee will be produced in year six as a direct result of project development.

The production of cocoa is also used to stimulate income in the project area. Almost 3,036 hectares (7,499 acres) of cocoa plantation would be developed by the project. Yields are expected to increase from 0.25 ton/hectare in year five to 0.80 ton/hectare in year eight when plantations are fully productive. Total project associated cocoa production is estimated at 2,429 metric tons of dry beans. A system of fermentation of wet beans would be promoted by the project which would significantly increase the quality of the product. LPMC is expected to introduce a system of grading and differential payment to compensate for this improved product.

Project participants who grow upland rice will be advised to continue the practice of growing cassava after a plot has been abandoned for rice production. This practice will insure a food source should the rice crop fail as well as providing an income to the farmer. No methodological improvements are recommended for cassava production because there is little marketing prospect for additional cassava production.

When insufficient soil moisture prevents the production of a second swamp rice crop, project recommendations call for the production of minor dry season crops in swamp areas. These dry season crops could supply a good source of income to the farmer as well as a secondary food supply. Table 31 provides a list of recommended crops and relative quantities to be planted on .2 hectare (one acre). This list is not exhaustive and could include many additional vegetable crops as personal preference and marketing conditions change.

TABLE 6. DRY SEASON CROPS AND ANTICIPATED YIELDS

Crop	Surface Planted (hectares)	Yield (metric tons)
Maize	0.101	0.18
Peanuts	0.069	0.09
Sweet Potatoes	0.032	0.22
Cow Peas	0.069	0.09
Soya Peas	0.069	0.10
Okra	0.032	0.07
Green Pepper	0.016	0.18
Watermelons	0.016	0.15

To illustrate the benefit which the improved yields will have on farm productivity, Table 32 shows annual potential rice harvests if the project land was farmed with and without proposed improved seed, fertilizer, etc. By project year five and for subsequent years, the project increases total productivity by 68 percent, from 22,280MT to 37,447MT.

In an effort to aggregate some of the data and further assist project appraisal, five hypothetical farm models have been proposed as follows:

FARM MODELS AND CROPPING PATTERNS

Model 1	1 Hectare Improved Upland Rice .5 Hectare Coffee
Model 2	1 Hectare Improved Upland Rice .5 Hectare Cocoa
Model 3	1 Hectare Advanced "Swamp" Rice .5 Hectare Coffee
Model 4	1 Hectare Advanced "Swamp" Rice .5 Hectare Cocoa
Model 5	.5 Hectare Improved Upland Rice .5 Hectare Advanced "Swamp" Rice .5 Hectare Coffee

These models have been built, not so much to approximate actual farmer behavior, but rather to highlight the various requirements (such as labor) and benefits (such as crop yield and return on effort) which the project will provide. Table 33 shows the productivity for each model assuming both yield improvement from the project and yields based on the existing traditional practices.

It should be stressed that the preceeding production estimates are not for the entire project area but instead only for those farmers who are actual project participants. The target number of participating farmers is 9,000 or 48 percent of the farm families in the area. In addition to the identified production increases, it is very likely that some production increase would also be realized among non-participating farmers. These increases would be attributable to the observation and imitation of project methodologies and the availability for purchase of surplus agricultural inputs.

3. Effect on Labor/Yield Ratio

It is anticipated that the application of the improved technology being introduced under this project would result in major beneficial improvements in income per hectare and per unit of labor as follows:

TABLE 7. ESTIMATE OF INCREASED RICE PRODUCTION DURING PROJECT

Crop	Year 1			Year 2			Year 3			Year 4			Year 5			5 Year Total			
	Area (ha)		Yield (Metric T)	Area (ha)		Yield (Metric T)	Area (ha)		Yield (Metric T)	Area (ha)		Yield (Metric T)	Area (ha)		Yield (Metric T)	Yield (Metric T)		Increase (MT)	%
	without[a]		with	without[a]		with	without[a]		with	without[a]		with	without[a]		with	without[a]	with		
Upland Rice																			
Improved[b]	440	440	572	1150	1150	1495	2110	2110	2743	3150	3150	4095	4250	4250	5525	11100	14430	3330	30
Advanced[c]	160	160	288	400	400	720	740	740	1332	1100	1100	1980	1500	1500	2700	3900	7020	3120	80
Total	600	600	860	1550	1550	2215	2850	2850	4075	4250	4250	6075	5750	5750	8225	15000	21450	6450	43
Swamp Rice																			
Improved[d]	100	140	250	450	630	1125	1050	1470	2625	1318	1845	3954	1750	2450	5250	6535	13204	6669	102
Advanced[e] (Irrigated)	0	---	---	0	---	---	0	---	---	232	325	1218	300	420	1575	745	2793	2048	275
Total	100	140	250	450	630	1125	1050	1470	2625	1550	2170	4513	2050	2870	5950	7280	15997	8717	120
Total of All Rice																22280	37447	15167	68

a Yields without benefit of the project were calculated from existing yields. Upland Rice, 1.0MT/ha; Swamp Rice, 1.4MT/ha.
b Improved Upland Rice yield calculated at 1.3MT/ha.
c Advanced Upland Rice yield (fertilizer and insecticides) calculated at 1.8MT/ha.
d Improved Swamp Rice yield calculated at 2.5MT/ha. for years 1-3 and 3.0MT/ha. for years 4 and 5.
e Advanced (irrigated) Swamp Rice Yield nonexistent for years 1-3 and calculated at 3.0MT/ha. for years 4 and 5, assuming an average of 1.75 crops/year.

TABLE 8. YIELD OF FARM MODELS ASSUMING ULTIMATE CROP YIELD[a]

Example	Without Project	With Project
	(Metric tons)	
Model 1		
1 ha Improved Upland Rice[b]	1.00	1.30
.5 ha Coffee[c]	0.16	0.50
Model 2		
1 ha Improved Upland Rice[b]	1.00	1.30
.5 ha Cocoa[d]	0.16	0.40
Model 3		
1 ha (Irrigated) Advanced Swamp Rice[e]	1.40	5.25
.5 ha Cocoa[c]	0.16	0.50
Model 4		
1 ha (Irrigated) Advanced Swamp Rice[e]	1.40	5.25
.5 ha Cocoa[d]	0.16	0.40
Model 5		
.5 ha Improved Upland Rice[b]	0.50	0.65
.5 ha (Irrigated) Advanced Swamp Rice[e]	0.70	2.63
.5 ha Coffee[c]	0.16	0.50

a Yields are expressed as actual metric tons produced per farm not as per hectare quantity.

b Upland rice yields are calculated on the basis of 1.00 MT/ha without the project and 1.30 MT/ha with the project.

c Coffee yields are calculated on the basis of 0.32 MT/ha without the project and 1.00 MT/ha six years after the project begins (time for full maturity).

d Cocoa yields are calculated on the basis of 0.32 MT/ha without the project and 0.80 MT/ha eight years after the project begins (time for full maturity).

e Swamp rice yields are calculated on the basis of 1.40 MT/ha without the project and 3.00 MT/ha with the project assuming an average of 1.75 crops/year.

	Traditional		Project		Increment	
	$/ha	$/manday	$/ha	$/manday	$/ha	$/manday
Cocoa	153	4.1	468	4.8	315	.7
Coffee	191	3.8	855	4.2	664	.4
Rainfed & Swamp	350	1.5	546	2.1	196	.6
Irrigated Swamp	-	-	724	1.9	-	-
Improved Upland	235	1.7	298	2.1	63	.4
Advanced Upland	235	1.7	386	1.9	151	.2

In a rural society where the average wage is about $0.80 per day, the incremental increase in income per labor of up to $0.70 per day is most significant.

Another means to evaluate the improvement to labor/yield ratios is to analyze the net return for an average farm holding. The same five models for 1.5 hectare farms described in the previous section were utilized in this analysis. Table 34 shows that the net receipts,at a point in time when the cash crop productivity has stabilized, range from $761 to $1,113 per year. This is in contrast to present average farm holding incomes of about $300 per year.

4. Impact of Cooperative Development

The services which the tribal-oriented agricultural cooperatives would provide to the small farmers have been described previously. The two services of the greatest potential benefit to the small farm holder are financial assistance and marketing capabilities. At present, no formal source for loans is available, and repayment of a loan, if obtained, may require a disproportionate percentage of the farmer's annual crop. Marketing is often done through middlemen and agencies which penalize the small farmer because of inaccurate weighing or pricing which does not reflect the true quality (grade) of his crop. Thus, the new cooperative services would immediately improve the net return which a farmer receives from his cash production. Additionally, production itself would benefit from the ability of the new cooperatives to supply the farmers with seed, fertilizer, implements, etc., particularly suited to his area.

F. EFFECT ON PUBLIC HEALTH

The proposed Upper Bong County Intergrated Rural Development Project may exert several positive and several negative impacts on the public health of the local population. In order to interpret the significance of these potential impacts, we must take into consideration the baseline health condition of the rural population. As has been stated in a previous section,

TABLE 9. LABOR/YIELD COMPARISONS FOR 1.5 HECTARE FARM HOLDINGS

	(A) Family Labor Required (Man Day)							(B) Net Return Per Man Day (Dollars, Weighted Average)						
Years	1	2	3	4	5	10	**12/30**	1	2	3	4	5	10	12/30
Model 1	315	292	255	268	258	312	**312**	1.52	1.88	2.10	1.96	3.09	2.38	2.51
Model 2	315	292	251	247	240	307	**307**	1.52	1.90	2.16	1.39	1.79	2.14	2.48
Model 3	285	308	363	440	457	484	**484**	1.51	1.63	1.56	1.39	1.66	2.22	2.30
Model 4	285	308	359	413	412	431	**431**	1.51	1.64	1.54	1.05	1.27	2.04	2.22
Model 5	301	300	309	354	371	398	**398**	1.52	1.73	1.76	1.61	1.91	2.28	2.38

	(C) Net Receipts (AxB=C) (Dollars)							(D) Non-Labor Inputs (Dollars)						
Model 1	479	549	536	505	881	743	**783**	136	217	92	109	168	110	110
Model 2	379	555	542	343	430	657	**761**	136	189	71	93	162	112	130
Model 3	430	502	566	610	759	1074	**1113**	82	413	189	522	730	672	516
Model 4	430	505	553	440	503	879	**957**	82	413	163	503	724	674	518
Model 5	453	519	544	570	719	907	**947**	109	329	133	315	399	391	313

the health condition of the population in the project area is very poor. The prevalence of disease, particularly with respect to malaria, schistosomiasis, onchocerciasis, trypanosomiasis and several others is very high. Naturally, this is going to influence the significance of many impacts. What is, for example, of great significance to a relatively healthy population may be of very little significance to a relatively unhealthy population. Also, the fact that health service facilities are quite poor and that the accessibility of project area residents to medical facilities is difficult must be considered. As a consequence, those activities that might exert a negative impact may in fact be magnified simply because there is no way to monitor and/or treat whatever problems may arise.

1. Food Supply

As has been stated in previous sections, the supply of food for rural populations is somewhat limited. There is considerable evidence that the rural population (particularly among children) is not receiving an adequate nutritional intake. Any increase in the food supply must therefore, be construed as a positive impact. For purposes of assessing potential impacts on the food supply, consideration must be given three factors; the amount of increased food production, the quality of food produced, and any potential effects this food production might exert on economic and transportation conditions.

The agriculture section discusses in some detail the types and amounts of food that would be produced in the project area. Increased yields of the basic staple food (upland rice) from 1,000kg/ha to 1,300kg/ha must be construed as having a positive impact on a population in which chronic malnutrition seems to be the rule. But, with respect to the quality of diet, the proposed agricultural production must be regarded as neutral in impact. The types of foods proposed to be grown have essentially the same nutritional deficiencies since the diet is lacking in certain elements. The proposed cropping scheme of the project with its heavy emphasis on rice and certain commercial products will not significantly affect this particular aspect.

There is a strong possibility that the production scheme would have a significant beneficial impact in terms of economic stimulation and changes in distribution patterns. For example, if some of the production were utilized for export and trade with other regions, then it is entirely possible that the study area population may be able to purchase or acquire certain types of foods that will improve the nutritional quality of their diet. If, in fact, economic benefits permit the supplementing of the present nutritional intake, then there is a good possibility for a positive impact. In addition, because of the necessity to change the distribution network in the project area and its intrinsic transportation improvements, residents will have better access, not only to new food sources, but also to health care facilities.

2. Water Supply and Sanitation

At present the rural population gets much of its water supply from whatever source happens to be available. While well-drilling is not a specific

portion of this program, the project would encourage well-drilling at the village level, and the GOL is planning a well-drilling program. The latter would be facilitated by project road construction. This is important since several indigenous diseases in the area have vectors associated with water. It is, in fact, very critical to improve the quality of water used for drinking and cooking purposes if vector borne diseases are to be controlled. The increased educational effort in the area may be utilized to provide instruction in sanitation (presently completely lacking in most of the region). If cross-contamination between sanitary waste and water supply could be avoided through training programs, the effect on health would be dramatic.

If project programs relative to water supply and sanitation are not successful, other program benefits could be comprised. Unless action is taken to exercise control over supply and sanitation and to educate study are residents with respect to basic sanitation there is a possibility that part of the project activities might well increase the incidence of disease.

3. Exposure to Agricultural Chemicals

The proposed project would utilize a number of different chemicals for purposes of increasing agricultural yields. These would include various pesticides for control of plant pests, and in some instances the control of certain vector organisms, and also the use of fertilizers and herbicides. All are normally used in more intensive levels of agriculture. However, it is extremely important that the people using the chemicals understand what the purposes are, the application methods and what risks are involved. For a rural population with virtually no exposure in the past to any form of chemicals, there is a risk that accidents may occur.

As a consequence, the use of chemicals holds the potential of adverse impacts on public health. This is magnified by the present absence of significant health care programs or monitoring facilities directed toward chemicals.

4. Nature and Prevalence of Farm Accidents

Since the agricultural structure is going to be oriented toward higher yields with inherent increased farming sophistication, more farm related accidents may occur. The manipulation of unfamiliar mechanized instruments could increase accident incidence. Considering the nature of project training program, however, it is anticipated that adverse impacts associated with accidents would not be particularly significant and they should be regarded as relatively minor.

5. Incidence and Prevalence of Indigenous Diseases

By far the most significant potential impact to public health can be found within the reservoir of indigenous disease associated with this particular rural population. Baseline health conditions have been previously discussed and significant diseases have been identified. Of these various diseases, however, only a few hold the potential for significant impact

due to project implementation. In particular, these are schistosomiasis, malaria, trypanosomiasis, pneumoconiosis and possibly Lhasa Fever.

a. Schistosomiasis

Schistosomiasis is prevalent throughout the project area. Transmission of this disease is associated with poor hygiene, cross contamination of water systems and contact with that water. Proposed project activities related to swamp rice present the opportunity for increased incidence and as a consequence, there is a possibility of a negative health impact. It will therefore be necessary to carefully monitor the activities of the project and take appropriate preventative measures. Recommendations for these purposes will be made in the mitigation section. It might be suggested that because the prevalence of the disease in the study area is so great, the project could not significantly increase the number of individuals who have this disease. However, while schistosomiasis is widespread in the area it is not all pervasive throughout the population. There is still a sizable number of individuals who have not been infected. Hence, it is necessary to consider carefully the potential impact that the project may exert upon this most serious health problem.

b. Malaria

Malaria is widely spread throughout the project area. Medical records indicate that as many as 70 percent of the population are infected. Because of the swamp rice cultivation and associated water impoundment, an increase in the potential breeding grounds for mosquitos will occur. Without proper mitigative measures, this will result in a negative impact.

c. Trypanosomiasis

There is some evidence that trypanosomiasis is indigenous to the study area. However, there is no evidence at this time to suggest that the project, as presently defined, will have a discernable impact on this disease. It is mentioned only for the purpose of suggesting a possible source of negative impact that should be monitored.

d. Pneumoconiosis

Most of the roads in the rural region are not paved. Because of the lateritic soil associated with the study area, there is a large quantity of red dust suspended in the air or close to these roads during the dry season. Residents who travel on or live close to these roads are subjected to the inhalation of small dust particles. While there is no definite evidence to suggest this inhalation of dust particles leads to lung disorders, such as pneumoconiosis, it can be assumed that the possibility exists. By increasing roads and traffic in the project area there is the possibility that incidence would increase. Should this possibility occur a negative impact would result.

e. Lhasa Fever

There has been little or no work performed in the project area with respect to Lhasa Fever. However, it has been found in other similar areas residing in the rat population of the jungle. For example, in a rural development project in Sierra Leone, there has been a significant increase in the incidence of Lhasa Fever. This has been specifically associated with the change in vector patterns between the rat, man and the grain storage facilities of the project. It appears that increasing centralized grain storage facilities play a central role in this particular disorder. While no evidence exists to indicate that Lhasa Fever will increase within the confines of the Bong Project, it can be assumed, by comparison with similar projects, that the possibility exists. If Lhasa Fever does occur in this particular project area, it would exert a sizable negative impact simply because it is an extremely dangerous disease, not easily treated even in the most modern facilities.

To summarize, there are several diseases indigenous to the area which may be aggravated by the project as described. Mitigative measures are discussed in the mitigation section.

6. Health Care

As has been previously stated, the health care facilities in Liberia are highly limited in staff, funding, and support and many health problems are related to institutional monitoring and health care. In terms of determining the significance of potential impacts three factors merit consideration: (1) the case load of the various health facilities, (2) accessibility to the various medical facilities, and (3) the surveillance programs available. Should negative impacts take place, the case load would increase. This would further dissipate the already thinly spread labors of the health care attendants and as a consequence, reduce the overall health care available to the general population. This is a significant negative impact. The project will, on the other hand, increase the accessibility of health care facilities to the rural population by opening up new roads, permitting monitoring and other health measures. Increased income and educational accessibility to hitherto unreachable areas will also present a positive effect. The surveillance program inherent in the project will have a significant impact on health care. A good, efficient surveillance will enable the health care facilities to have a better understanding of the types and extent of disease and will provide lead time to prepare for potential problems.

VI. PROPOSED MITIGATION

A. AIR QUALITY

1. Burning Controls

The slash and burn land clearing technique presently utilized in the project area creates low to moderate levels of air pollution as a result of smoke created during burning. The harmful effects to the population are minimized because of the relatively short period of burning, the wide dispersal of the small farms on which it occurs and the spatial relationship between the centers of population. This project proposes to maintain the same type of land clearing and in the short run, the level of existing air pollution should not change. The mitigation of any increased pollution caused by clearing larger areas can be accomplished by scheduling the burning to limit the amount occurring at one particular time. In addition, burning can be scheduled to take into account climatological and meterological conditions. If properly done, this will further induce the adverse impacts.

2. Treatment of Roads

Most of the roads in the area are surfaced with lateritic soils. During the dry season, vegetation, buildings, etc. are covered with the reddish dust. While the best mitigation would be to pave the roads, this is not feasible because of existing economic conditions. It is more important at this time to provide access to the areas rather than to pave the roads which exist. Additionally, there are long expanses of the roads which do not pass near residences or villages. It was noted, however, that the Ministry of Public Works has an ongoing paving plan for primary highways. One form of mitigation would be to pave roads in the vicinity of inhabited areas first, paving between such areas as funds become available. Another means of mitigation would be to wet the road in the vicinity of villages and towns. In view of the lack of equipment and water in the area, this is not a valid alternative and could be accomplished only in a few areas. The use of chemical dust retardants (e.g., calcium chloride), at least near heavily populated areas, should be explored. Used crankcase oil should be applied to roads near maintenance areas and wherever else possible during the dry season.

3. Agricultural Applications Training

Air pollution also will result from application of pesticides, herbicides, and fertilizers. While there is no way to eliminate air pollution during these applications, any pollution can be minimized by applying these materials correctly. They should be applied only during periods when there are no high winds, and when the other climatological and meteorological conditions are such that the dispersion into the air is limited.

The farmers will need education and training in the application of these materials, as discussed in Section C, Chemical Exposure. As part of AID's

future pest management policies and strategies (USAID, 1977) AID is committed to consider a variety of factors which affect pesticide application. These factors include such considerations as; necessity for control, whether pesticides are the best control method, appropriate time and rate of application, etc. AID's policies and strategies revolve around an integrated approach which includes training and monitoring programs.

AID's future policies also restrict the use of pesticides related to suspended or cancelled chemicals. Where feasible, compounds other than chlorinated hydrocarbons are preferred but this must be decided on a case-by-case basis. Although the AID Pest Management Program (USAID, 1977) did not specifically mention Liberia, compounds anticipated for use in Africa include BHC, endosulfan and trichlorfon.

4. Construction Controls

During construction, heavy equipment will generate smoke, fumes, and dust along the rights-of-way. The amount of smoke and exhaust fumes can be minimized by ensuring that all equipment is well maintained and properly operated. The work teams should be required to use dust abatement procedures, such as water sprinkling, during work periods. Proper work scheduling to minimize the amount of construction occurring at any one time also will reduce pollution from construction equipment.

B. WATER QUALITY AND SUPPLY

The principal problem of water quality and supply in the project area is the cross contamination that frequently occurs between human wastes and the drinking water supplies. At the present time the local population is unaware of the problems thus created. The development of acceptable water quality in the study area requires the development of good potable water supplies that are readily accessible to the general population, the development of controlled waste disposal sites, and educational/monitoring teams. The continuation of the Government of Liberia well-drilling programs and project-related well-digging stimulation are necessary to increase the availability of potable water. At present no programs exist to develop sewage disposal systems in rural areas. Sewage disposal systems should be developed and implemented for smaller urban areas when feasible. This could best be accomplished by coordination between this project and existing Government of Liberia programs. Education in this field will be dispensed through the various project educational programs and expanding community schools. The Schistosomiasis Control Teams could be utilized to monitor water quality and to note and correct obvious pollution problems. Project management must ensure that proper sanitation measures are taken during the construction and operational phases in order to both educate the personnel involved and to avoid new pollution problems.

Other areas of concern about water quality arise from the use of fertilizers and pesticides and from construction activities. Inexperienced and untrained individuals will be tempted to apply agricultural chemicals at too high rates and to dispose of excess chemicals incorrectly. The result

will be increased pollution of the water supply. Mitigation measures consist of extensive, proper training and monitoring by the extension aides. Construction related water pollution can be mitigated by proper scheduling and by following standard techniques to reduce siltation and runoff.

C. CHEMICAL EXPOSURE

A considerable likelihood exists that the rural population will be exposed to several potentially toxic chemical elements. These are primarily pesticides and herbicides used in the agricultural acitivity. The pesticides include BHC, endosulfan and trichlorfon while the herbicides include alachlor, atrazine, cyanazine and linuron. Exposure to these chemicals can occur on food, in the air, in drinking water and by direct contact during application. Mitigative measures will involve two basic activities: training of the rural farmer in the dangers and uses of these substances (e.g., results of misuse, proper quantities, and methods of application); and inspection and monitoring to ensure compliance.

Training and technical assistance activities are important elements in AID's pest management assistance. AID assists countries in training and educating the people in the proper use of pesticides, and assists in devising and implementing ecologically and economically sound integrated pest management systems for the control of disease vectors and agricultural pests. Training and assisting the people will help avoid many of the problems associated with the improper use of pesticides by farmers relatively uninformed regarding pesticide use techniques. At the same time it will lead toward maximizing the benefits that can be obtained from the proper use of pest management techniques. Water supplies would be monitored for toxic elements during normal monitoring processes and immediate corrective action taken in the unlikely event of evidence of chemical pollution. All appropriate CEQ Guidelines would be followed.

D. PUBLIC HEALTH

If people do not understand some of the causes of health problems, they will not be able to protect themselves against the dangers. At present, the rural inhabitants in the study area lack sufficient understanding and the project has the potential for a severe negative impact on public health. Health education, as well as monitoring and control programs, will be instituted as part of the project to combat the adverse impacts. These programs can be accomplished with proper implementation of the project educational programs and coordination with other governmental programs and health teams (especially the Schistosomiasis Surveillance Team). The improvement over current conditions can be dramatic.

With respect to the significant diseases found in the rural area, it is necessary to break the vector cycle for effective control of the disease. Control is best achieved through an integrated approach; controlling one of the vector elements, education of the population, treatment of the disease in the individual, and upgrading the general health of the

population. Some of the mitigation measures which can be used by the project are:

Schistosomiasis. Control of the transmission of this disease is the key to a successful rural development program. The study area has a high prevalence of schistosomiasis and the Schistosomiosis Surveillance Unit (SSU) is an integral part of this project as it has been in the nearby Lofa County Integrated Rural Development Project Surveillance is oriented toward the development of schistosomiasis health data and, to the extent possible, the control of snails. Besides snail control, chemotherapy and prevention of water contamination are important elements. Participants in the project will be educated about the vector cycle, field and laboratory techniques, prevention techniques, sanitation, and chemotherapy applications. Snail control would be accomplished primarily by the use of mollusicides.

Project programs will be coordinated with higher level Liberian schistosomiasis surveillance activities. Every effort will be made to determine whether or not the project is, in fact, having some impact on the specific project area. If a negative impact is detected, more stringent control measures will be instituted.

Lhasa Fever. While there is no indication Lhasa fever is important to this specific area, reasonable presumptive evidence suggests that it might be. Vector controls instituted in advance will probably eliminate any problem before it occurs. The Government of Liberia (GOL) is currently studying and surveying this problem. The (GOL) will continue its present efforts and increase them if necessary.

Malaria. Malaria has a very high prevalence in the project area as it does in tropical regions throughout the world. This project, by itself, cannot contain programs to effectively combat malaria since it is a regional problem. However, AID has, since 1957, been a part of the Worldwide Antimalaria Program spearheaded by the World Health Organization. This program for malaria erradication is an integrated approach with control based on chemical, environmental, biological and genetic measures. Chemical control relies heavily on the use of DDT although three nonorganochlorine insecticides (malathion, fenitrothion, and propoxur) have been recommended for use. Environmental measures include any physical transformations of the environment that will result in the presention, elimination or reduction of malaria. Biological methods are based on larvivorous fish and the use of insect pathogens while genetic control relies on

the sterile male technique. Any mitigative measures as part of this Rural Development project would necessarily be part of a multi-national regional approach and possibly a GOL/AID/WHO joint effort.

Trypanosomiasis. There is some indication that a residual amount of trypanosomiasis is indigenous to the population of this area. At this time, it does not appear to be a significant problem, but a surveillance program could be established to monitor the situation.

Onchocerciasis. The prevalence of onchocerciasis in the project area is high; however, this problem is confined to areas involving running water. The few areas where the project creates or increases existing flow rates would be closely monitored. Should any negative impact be noted, appropriate control measures could be taken in coordination with the Ministry of Public Health.

E. SOILS

1. Cultivation Training Programs

The agricultural pattern traditional to the Upper Bong County farmers reduces soil erosion by allowing the soil to return to natural vegetation after approximately two years of cropping. Agricultural practices which are part of the proposed project will decrease the amount of shifting from field to field, thus increasing the potential for erosion. As part of the training program, the farmers will be instructed on the need for proper conservation practices and techniques. Such techniques will include the use of cover crops to reduce erosion potential, site selection and use, rainy season protection, and other soil conservation techniques. Experience in projects in other parts of tropical Africa has shown that soil erosion can be minimized by proper training and conservation practices.

2. Cultivation Techniques and Practices

In lieu of the natural vegetation which prevents soil erosion, this project proposes to introduce tree crops in the second crop year. Both coffee and cocoa will be planted with 10-foot spacing in each direction, and shading plants such as banana and cassava will be planted between the coffee and cocoa. This system of planting has been widely utilized throughout tropical regions without causing adverse erosion and no increased erosion is expected in the upland areas. A study was conducted on the hydrological effects of a change in land use from rain forest to tree plantations in Kenya (Blackie, 1972). The study showed that the drastic change from protective forest to the cover of a tree crop is possible without permanent deterioration of water resources in either quantity or behavior. The study area was cleared and planted as a tea estate which proved to be a hydrologically effective substitute for the natural forest. However, to obtain such results, full implementation of conservation techniques must be utilized. Therefore, the cultivation

techniques and practices which are used in this project will determine, to a large extent, the impact on erosion. On slopes of any significant degree, all cultivation will be performed in a manner to slow run-off as much as possible, and plantings will occur at such time that sufficient ground cover will be available before the rainy season. The selection of areas for incorporation into this program will be carefully made to insure that farming does not occur in areas where excessive slopes or highly erodible soils are present.

3. Soil-Enriching Cover Crops

The purpose of this project is to improve the agricultural yields of the farmers in Upper Bong County, thus increasing their income and eventually improving their standard of living. There is no provision made in the proposal to plant crops specifically for the purpose of enriching the soils. However, if areas which are initially cleared for farming are abandoned for any reason, consideration should be given to planting legumes to provide ground cover and soil enrichment.

F. CULTURAL

1. Housing Program for Population Redistribution

It is expected that the rural development project will decrease population migration because of the improved yields and increased income to the farmers. Population within the project area will become more aware of the increased need for services associated with farming and may generate toward the natural community centers where the inputs and produce are processed. It is unlikely that there will be any major population shift, or any significant redistribution. While some farmers will move to new locations to participate in the program, there is no new housing program planned. The procedure for building houses in the project area is simple, inexpensive, and is commonly carried out by the individual families. Therefore, the impact of any population redistribution is minor, and the impact as far as housing the individual farmers is negligible. Excepting those programs indicated under public health, no mitigation measures are required.

2. Education and Training Programs

Most of the training programs will educate the inhabitants of the project area about procedures required to participate in the redevelopment program. Among the items to be explained are improved cultivation and harvesting procedures, the purpose for cooperatives, etc. Some training programs will be established to train staff members, however, these programs will be very specific in subject matter and will be taken by a low percentage of the inhabitants of the area. Included in this category are extension aides, cooperative staff members, and others. The impact of these training programs will be to provide the individuals taking part in this program with information to upgrade their agricultural practices. From a cultural standpoint, the program will probably

result in a desire by farmers not included in the project to receive similar training in order to improve the yields on their own farms. Therefore, it is likely that the rural redevelopment project will result in a demand for improved training, more inputs for agricultural areas, and better marketing procedures throughout the areas surrounding the Upper Bong County project.

As the training increases, the participants in the program are going to be made more aware of the necessity of educating themselves and their family in various other aspects. Seven community schools are planned for the project area, and the information and training received in these project schools will be more relevant to the conditions which exist than the previous formal schooling. Therefore, it is likely that the training and educational programs will make the rural population more aware of the possibilities and potentials for increased agricultural production, increased income, and improved standard of living. Health care and social programs will become more accessible, and the demand for such programs should increase. The educational and training programs should also assist in making the inhabitants of the area aware of the necessity of improved sanitation and improved water supplies.

VII. UNAVOIDABLE ADVERSE IMPACTS

The implementation of a plan for agricultural development in an underdeveloped country will necessarily have certain unavoidable adverse impacts. These are impacts which cannot be prevented by mitigatory action.

The most obvious impact of the project is the alteration of the natural or existing ecosystem because of the amount of land to be cleared annually by the "slash and burn" agricultural technology. This natural habitat destruction will not be appreciably more than under existing traditional practices. The size of the project area is 6,493 square kilometers (2,507 square miles), of this 5,750 hectares (14,200 acres) will be cleared for upland rice production by the fifth project year. The cleared land will be primarily secondary upland forest. About 1,291 hectares (3,190 acres) of this land will be abandoned after one year of upland rice production and one year of cassava production and allowed to return to natural sucession. The remaining acreage will be permanently converted to tree crop plantation, 3,000 hectares (7,410 acres) of cocoa and 1,462 hectares (3,610 acres) of coffee. The construction of 169 kilometers (105 miles) of farm to market road within a 24 meter (80 foot) right-of-way will permanently alter another 413 hectares (1,020 acres) of land, mostly upland forest. Natural habitat is partially mitigated by virtue of lack of wildlife in the study area. Most larger species have disappeared through years of hunting and shifting cultivation practices.

In addition to the destruction of upland forest, 1,650 hectares (4,080 acres) of swamp will be cleared, leveled and farmed for swamp rice production, while another 400 hectares (1,000 acres) of swamp, which is currently in swamp rice production, would be improved to provide for the use of modern technologies. The loss of natural swamp land is somewhat mitigated by the natural tendency of swamps to become arid during the dry season.

Several components of this project will lead to some degradation in air quality, especially on a localized basis. The "slash and burn" technology currently utilized in the area will continue after project implementation. Air quality degradation caused by smoke from these operations will continue, even though burn scheduling can reduce the acuteness of this situation. Road construction also will lead to some air pollution on a short term basis, but road watering can sharply reduce the amount of fugitive dust. Another source of air pollution is hydrocarbon emissions from machinery such as road and agricultural equipment used in project development.

The quality of water in the project area will be adversely impacted by project implementation, although the degree of this impact is largely dependent upon prior mitigation efforts. Runoff from road construction sites will lead to increased turbidity levels in associated waterways, however; careful planning and the use of silt traps can keep turbidity levels from becoming detrimental to aquatic life. Impacts from road construction are short term.

The runoff from agricultural fields will be more deleterious to water quality since it will be long-term and will contain pesticides and fertilizers. Pesticides used in the project area will be incorporated into the waterways but the level of concentration will depend on the persistence of the particular pesticide, the environmental conditions and the methods of application. Pesticide concentrations are expected to be very low and should cause no significant environmental damage unless the pesticides are improperly applied or disposed of. Runoff from agricultural land on which fertilizers have been used usually contains high levels of nutrients, especially phosphates and nitrates. These nutrients generally lead to eutrophic conditions in impounded water such as might be found in irrigation water supplies. Eutrophication caused by agricultural runoff will not be of sufficient magnitude to cause significant environmental damage, however, unless incorrect applications or unusual environmental conditions are encountered.

The adverse impacts associated with the Upper Bong County Rural Development Project are relatively small and proper mitigation procedures will further reduce the impacts. Thus, the project may be considered to have minor adverse impacts.

VIII. ALTERNATIVES TO PROPOSED ACTION

A. NO ACTION

The first alternative to be considered with relation to any project is that of no action, or in this case, no development. For the purpose of analysis, no action is defined as providing no assistence to the agriculture of Upper Bong County except that which is ongoing. This would include some assistence from extension agents, but no significant training, productivity or marketing assistence, transportation improvements, or credit. Some transportation improvements will occur in the area as a result of the highway program presently underway by the Government of Liberia; however, improvements are essentially confined to the primary and secondary roads and not to the farm to market road system.

This alternative would force the farmers of Upper Bong County to continue at the present subsistence level of farming. The average income of the farm family has been estimated at from $280 to $300 per year, and it is unlikely that, without assistence, this amount would increase. If there is no program to provide technology and fertilizer to the farmers and to provide programs which would allow him to increase the productivity of his farm, the traditional "slash and burn" cultivation will continue. There would probably be no increase in the production of cash crops because of insufficient knowledge, financing, and because of problems associated with the various insects and diseases which attack those types of crops. In essence then, the majority of the farmers in the study area would be doomed to a continued existence of subsistence agriculture with little means of improving their standard of living, improving health, improving sanitation facilities, etc. From a national standpoint, there would be no improvement to the tax base, and no means for the inhabitants of the area to participate in any self-help projects because of lack of knowledge, finances and access.

B. IMPLEMENTATION OF PORTIONS OF THE PROPOSED PROJECT

1. Direct Subsidization with Training Programs Only

This alternative may be defined as a program of providing money directly to the farmers and instituting a series of training programs. Subsidizing the farmer, that is providing him with a previously determined amount of money, and instituting training programs could be a partial solution. However, given the present knowledge and education of the farmers in the area, it is unlikely that the money provided to them would be expended in an efficient manner without at least a moderate degree of supervision. Additionally, the training programs would probably be ineffective without some means established for the farmers to receive the proper inputs and means of marketing. The development of an improved transportation system, absent from this alternative, is of primary importance in any development program. It is, therefore, unlikely that any significant improvement to the income and standard of living of the farmer would result with this alternative.

2. Annual Credit from International Sources

This alternative would provide a means of providing money to the farmers in the study area to obtain loans. Presently, most loans are obtained through family sources, and are very small. This alternative would provide a means whereby farmers could obtain loans for agricultural improvement. While the farmer would be provided with a source of money for agricultural improvements, consideration must be given to the repayment of these loans. Without training, extension assistance, assistance in obtaining inputs and marketing the end products, it is unlikely that the farmer would substantially increase his yields over the existing amounts. The farmer would not have an economically sound means of obtaining fertilizers, herbicides and other required inputs or a cost effective method of selling his produce. Essentially the credit program would result in an annual subsidization program unless some means were established to enable and require the farmer to repay the loans If penalties were set for defaulting on the loans, it is likely that the farmer would default on such loans, and any assets the farmer had would be forfeited. The farmer probably would move to another area and resume his traditional "slash and burn" cultivation and realizing the penalty for non-payment of credit, refuse to participate in such a program. The end result would be the same as no action in most cases.

3. Transportation Improvements Only

This alternative would encompass the construction of approximately 169 kilometers (105 miles) of new farm to market roads, the improvement of all roads to effective all-weather status and the paving of all primary roads in the study area. Improvement of transportation would have some beneficial effect in providing for improved means of visits by agricultural extension agents, health personnel, etc. It would provide for better communications in the study area, but only minor benefits to the farm families would result. Even with assistance from extension agents or aides, there would be little increase in agricultural yields because essentially the traditional agricultural practices would continue. The farmer would have no means of obtaining credit to purchase the fertilizer, pesticides, etc. that the improved transportation facilities would make available to him. Additionally, without the means to improve his marketing abilities, any increase in cash crops which resulted would probably yield only slight increases in income. The primary beneficial impacts of the proposed transportation improvements would be in the social sector, and there would be little beneficial impact to the life of the farmer. There would be only small, if any, increases in income and, therefore, little incentive for him to abandon his traditional system of agriculture. While the success of the rural development project is most dependent upon adequate transportation facilities, they must be combined with other facets to achieve project goals.

4. Health Care and Public Education Programs Only

There is obviously a requirement for improved health care and improved education in the entire country of Liberia. The Upper Bong County study area is no different. The general health conditions of the inhabitants

are poor, and health facilities are limited. Education is also restricted. Very few of the children even reach the fourth grade, and illiteracy rates are extremely high (approximately 90 percent). Therefore, improving health care and improving the public education programs are laudable goals; however, they must be viewed in the context of reality. The tax base of the Government of Liberia is severely limited and health and education programs are limited by the amount of funds available to be placed in those programs. To afford improved health and education programs, revenues must be increased. In the study area, the major source of additional revenue is improved agricultural productivity. Additionally, many of the programs require some assistance from the inhabitants of the area, and the resources of those inhabitants is also severely limited. Transportation is poor, and it is difficult for children to travel to and from school, and for health personnel to reach the isolated farms and villages. Establishment of health and educational programs are a necessary requirement to improve the standard of living in Upper Bong County. However, without an increased income to the farmers, training programs, and improved transportation facilities, the probability of these programs becoming even moderately successful is severely limited.

5. Provide Extension Service to Assist with Agricultural and Marketing Management

This alternative would provide agricultural specialists to assist the farmers in improving their agricultural practices and improving the marketing operations of their agricultural produce. Undoubtedly this would provide some benefit to the farmers of the project area, but these benefits would be only minor. While the extension agents could provide information to the farmers on improved seeds, improved agricultural practices, fertilizers, pesticides, etc., the present income of the farmers is such that he would be unable to purchase these materials. Even if by some means he were able to purchase the materials, he would have no continuous training to provide him with information necessary to successfully and safely utilize them. Additionally, without the establishment of farmer cooperatives, completion of improved transportation system, and establishment of credit, the beneficial impact of extension service can only be considered as minor.

6. Summary

The alternatives considered under this section have all been subsystems of the program which has been recommended. As can be seen from a review of these subsystems, each would have some beneficial impact to the Upper Bong County area. However, the benefit which would result from each is minor when compared to the overall beneficial impacts which would result from the complete program.

C. CONCEPTUAL ALTERNATIVES TO THE PROPOSED PROJECT

1. Non-subsidized Private Enterprise System

This alternative envisions the establishment of a large agricultural producing center by a private enterprise. In this concept, a large agricultural entity would provide the funds to clear the land, fertilize the soil, provide

pesticides and herbicides, improved seeds, improved harvesting equipment and establish its own marketing system. This would be somewhat analogous to the type of operation conducted at the Firestone Rubber plantation, except that it would be an agricultural crop system. It is unlikely that any major private entrepreneur would desire to invest an extensive sum of money in so large a farming enterprise in this area. Because of the secondary forest and poor natural fertility, extensive clearing and fertilization would be required. Additionally, the yield that would result from rice growing is not sufficient to induce private investment, and the tendency would be to concentrate investments in cash crops providing a greater return, such as coffee and cocoa. If the type investment required was to be provided by a private entity, it would endeavor to minimize cost while maximizing benefits. Cost minimization would require an extensive mechanization to produce long term low cost. Introducing some mechanization to an area where labor is an excess commodity would be counter-productive and would not provide overall regional benefits. There are presently no private organizations or companies in Liberia with the resources and inclination to conduct this type of operation, therefore, a foreign concessionaire would be the most probable entrepreneur. To attract such an investment, favorable tax concessions would be required. Therefore, any profits would probably be accrued outside of Liberia, and the benefit to the Government of Liberia would be minimal. In summary, a major agricultural development project conducted by a private company would probably involve machine intensive, high yield crops and would result in income increases to only a minimum number of inhabitants. It would provide no training which could be transmitted to other farmers of the area or to other regions of Liberia. It would confine transportation, health and educational berefits to areas within the corporate sphere of influence thereby preventing such benefits from extending to the more remote portions of the project area.

2. Completely Subsidized Government Farming Operations Employing Local Labor

Because of the constricted financial capability of the Government of Liberia, and the extensive number of programs which are required to upgrade the country as a whole (education, transportation, health, etc.) it is unlikely that the Government of Liberia would establish a large agricultural operation employing local labor. The inhabitants of this area, at the present time, are more oriented toward the tribe than to the programs of Liberia. They tend to be more interested in being independent farmers than working on any of the rubber plantations. Because of the existing agrarian culture, it is likely that the local inhabitants would work on the Government farming operations, but at the same time desire to maintain their own subsistence farm plots. Some social and cultural problems would occur as a result of the government taking extensive amounts of land belonging to the Kpelle Tribe, even though all the land theoretically belongs to the Government of Liberia. If the Government of Liberia acquired land in the amount projected to be used for this project, it would likely infringe upon the tribal rights of the farmers presently in the area. This could create resentment against the government. In summary, this alternative would not serve to increase the education, productivity and agricultural expertise of the farmers in the project area. It would not form a means of increasing the tax base nor permit the self-help programs required in the study area.

3. Mechanized Farming Operation

This concept envisions farming operations which would be primarily mechanized, utilizing only a small amount of local labor. Commodity and cash subsidization would be provided to local inhabitants. This would have a number of adverse impacts discussed under Concepts 1 and 2 above. While the yield from the crops might be increased by use of mechanization, an extensive capital outlay would be required for clearing, fertilizing, planting, cultivation and havesting. Very little of these funds would be provided to the inhabitants of the local area. If commodities and cash subsidies were provided, it would tend to make the inhabitants more dependent on the Government of Liberia, reduce the willingness of the local inhabitants to participate in independent projects, and increase the dependency of the local inhabitants on community welfare. It would result in a condition where, as the welfare from the government increases, the amount of dependency on the government increases and the productivity of the individuals decreases.

4. Cash Crops Only

This concept envisions the growing of cash crops such as coffee, cocoa and rubber, at the cost of decreasing subsistence crops such as rice. While coffee, cocoa and rubber are higher yield crops, it also takes from three to six years for coffee and cocoa to produce. There would be an initial period where the farmers would grow few subsistence type crops with most of their labor being placed on the cash crops. This is an unlikely situation and would require subsidization from other sources. In the reverse situation, where only subsistence crops were grown, the farmers would have insufficient funds to purchase inputs for increasing yields. Thus, a mixture of cash and subsistence crops obviously is the best alternative.

D. SUMMARY

None of the alternatives considered provides the benefits of the proposed project. The No-Action alternative would continue conditions at their present level with no improvement to productivity, accessibility, income or living standards. Although worthy of consideration for financial reasons, none of the subsystem alternatives furnish sufficient advantages to satisfy project purposes or to warrant the expenditure of the funds required. Of the conceptual alternatives, the private enterprise and government subsidization plans would both essentially fulfill physical project goals. Both, however, have serious financial and social drawbacks. If a private commercial entity could be enticed to participate it would have to be profit oriented thereby destroying most farmer income/ownership benefits. Governmental subsidies would place undue stress upon Liberian financial resources and deprive other worthwhile projects of funding. Any attempt to develop funds through some type of agricultural nationalization program would be extremely tenuous and detrimental to the total Liberian economy. Intrinsic social problems are even worse than those of the private enterprise system since traditional tribal values would be destroyed.

IX. THE RELATIONSHIP BETWEEN LOCAL SHORT TERM USES OF MAN'S ENVIRONMENT AND THE MAINTENANCE AND ENHANCEMENT OF LONG TERM PRODUCTIVITY

The major short term commitments of resources associated with this project are the capital investment of about $20 million over a five year period, the labor required to clear and farm the land, and the additional land itself. Because both land and labor are surplus commodities in Upper Bong County, only the monetary investment can be construed as a major short term commitment with viable alternate uses.

The result of this local short term use of labor, land and capital is the major enhancement of long term agricultural and economic productivity of the study area. Within 12 years of project initiation, 50 percent of the farm population of the region will have doubled their productivity. Existing average farm family incomes of $300 per year will have reached $750 or more per year. The financial and marketing infrastructure developed by the project should be self-perpetuating so that the rest of the study area farmers can receive similar production benefits in future years.

If long term productivity in this agricultural society is measured by increased harvests, then, during the five project years, annual rice production will be more than doubled. Without project improvements, the 9,000 farm families would harvest an estimated 20,080 tons of rice from the 5,750 hectares of upland and 2,050 hectares of reclaimed swamp. However, with project improvements this cumulative yield will be 37,447 tons. Another important aspect of increased productivity related to the project is crop diversification. Due to the introduction of cash crops such as cocoa and coffee, the small farmer will have money to improve his standard of living.

X. IRREVERSIBLE/IRREVOCABLE COMMITMENT OF RESOURCES

A. FOREST

By the fifth year of the project, approximately 5,750 hectares (14,200 acres) of secondary upland forest will be cleared for upland rice production. Of this amount, about 1,291 hectares (3,190 acres) will be abandoned in about two years and allowed to return to natural succession. Construction of approximately 169 kilometers (105 miles) of farm to market roads will permanently alter another 413 hectares (1,020 acres) of upland forest. Thus, the long term impact will be approximately 4,874 hectares (12,040 acres), or only about 0.75 percent of the study area. It is questionable whether this would be an irreversible commitment of resources, since most of the forest is presently secondary, and if the farms were abandoned, the vegetation would rapidly revert to secondary growth.

B. NATURAL SWAMP

As previously discussed, about 12 percent (77,935 hectares) of the study area is classified as swamp. For this project, approximately 1,650 hectares (4,075 acres) of swamp will be cleared and farmed for swamp rice production. This represents only 0.25 percent of the swamp land in the project area. It would not revert to its former condition as easily as forests because of drainage and soil modifications which would occur during its agricultural use.

C. FUEL

Fuel is considered to include petroleum products such as oil, diesel fuel, gas, lubricants, etc. which would be utilized during road construction and maintenance, land clearing and swamp reclamation. Additionally, some increase in traffic can be expected with improved farming practices because of the transportation of inputs and outputs. Aggregate fuel usage should be relatively minor. The farm to market roads are neither wide nor paved, thus construction would be relatively simple and much of it would be labor intensive. After the land has been cleared (again by labor intensive methods, but using some chain saws), little mechanization will be used. Traffic on new farm to market roads and project associated use of existing roads would be light and primarily seasonal. Thus, fuel consumption for the project would be of minor significance.

D. BUILDING MATERIALS

Building materials will be used in roadway construction, culverts and bridges, catchment basins, and storage facilities. The roads will be constructed of laterite, a naturally occurring material which is abundant in the project area. Culverts and bridges will be formed by small earth filled or concrete dams with concrete spillways and wooden stop-

logs. Storage facilities for agricultural inputs and outputs will be required at the village level, and ultimately at the cooperative level. These will probably be of wood and tin, although the use of wood should be minimized. Thus, little building material will be required, and most of that will be of native material, such as laterite and timber. Cement, sand, gravel and tin will be used for some minor construction. Farmers who relocate to be closer to transportation routes, distribution points, etc., will build new homes, but these will be of traditional materials and the relocation process conforms to present shifting agriculture practices.

E. CAPITAL

The estimated cost of this project is $20,256,000. While this will be an irreversible commitment of resources from one viewpoint, the projected internal rate of return is 21 percent. Thus, there will be a short term commitment of capital resources, but, economically, those resources are neither irrevocable nor irreversible in the long term. More simply stated, the capital which is invested will eventually be returned through repayment of loans, increased taxes and better balance of payments. Such resources could be put to other uses during this period, however, and may, therefore, be considered an irrevocable commitment, particularly if unforeseen natural or economic events should alter the projected rate of return.

F. AGRICULTURAL MATERIAL

Agricultural material includes seeds, seedlings, fertilizer, pesticides and herbicides. Seeds and seedlings should not be considered an irreversible commitment of resources as they could be utilized to produce additional seeds. Further, they are produced for the specific purpose of planting. Fertilizer, pesticides and herbicides are created from other resources and their commitment is irreversible and irrevocable. Many are based on petroleum derivatives and, thus, use a limited resource. These materials will not be recoverable.

G. LABOR

It is estimated that 800,000 man days of paid labor will be required, in addition to the unpaid family farm labor. The labor thus utilized cannot be used for any other purpose; however, since there is often a labor surplus in the area, this commitment is justifiable.

XI. SUMMARY AND CONCLUSIONS

A. SUMMARY

The immediate purpose of the Upper Bong County Integrated Rural Development Project is to increase the agricultural productivity and income of small farmers in the project area. The ultimate goal, partially achieved by the immediate project purpose, is to improve the general welfare of the rural population. The project spans 5 years from the time of implementation to completion and will achieve the project goal through a combination of agricultural, social, economic and health components.

1. Project Components

Agricultural components include crop development, development of cooperatives, agricultural extension services and research programs. Crop development will concentrate on improvements in rice cultivation. These improvements will include use of improved rice strains and better farm management practices to upland rice and improved seeds and double cropping for swamp rice. In addition, planting of cash crops (coffee and cocoa) and dry season crops (such as maize, sweet potatoes, peanuts, cow peas, okra, etc.) will be encouraged. The crop development programs include the use of fertilizers (urea and hyperphosphate) and pesticides (possibly BHC, endosulfan or trichlorfon). Cooperatives will be developed to render essential services such as marketing, credit, input supply, etc. to the area farmers. Information and assistance with new or unfamiliar agricultural practices will be provided by agricultural extension aides. An important component in this project is agricultural research. Priority in research programs will be given to crops such as coffee, cocoa, oil palm and coconut (all potential cash crops). When taken together, these components will contribute heavily toward reaching the goal of improving the general welfare of the rural population.

Social components include improvements to transportation and training programs. Transportation improvements will consist of upgrading existing farm to market roads and increasing the present network by about 130 percent with the construction of 170 kilometers of new farm to market roads. Training will be provided for extension aides and cooperative staffs. This training will be necessary to familiarize the individuals with their duties and functions. Once trained, the aides and staffs will then provide training to individual farmers.

The economic component will consist of a revolving credit fund to provide credit to small scale farmers in the project area. This credit fund will be established as a long term permanent operation.

The health services component will concentrate on the schistosomiasis problem and will include both a Schistosomiasis Surveillance Unit and a snail control program. Also, in coordination with the Public Health Service, disease treatment facilities will be made available. Transportation improvements will provide access to medical facilities for farmers and access to rural areas by health teams.

2. Environmental Effects

Adverse impacts to the environment will occur as a result of project implementation and will affect the natural ecosystem, air and water quality. However, these impacts will be of minor significance.

Impacts to the natural ecosystem include the destruction of upland forest as part of the upland rice program and swamp destruction associated with the clearing of swamp for rice production. Also, road construction will destroy some natural lands. Air quality degradation will be primarily on a localized basis due to the "slash and burn" method of clearing farm land and from road construction. Short-term water quality degradation will occur as a result of increased turbidity due to runoff from construction sites. Long-term runoff from agricultural land will decrease water quality because of fertilizer and pesticide residues. Proper mitigation measures would lessen these impacts.

B. CONCLUSIONS

This Environmental Assessment has considered the consequences of implementing the Integrated Rural Development Project as well as nine alternatives to that project. The alternatives include the No Action (no development plan), five plans which are parts of the proposed project and three conceptual alternatives.

The No Action plan would provide none of the benefits of the proposed project but would result in some negative environmental effects. These impacts are primarily loss of the natural ecosystem because of continued use of shifting agriculture. The five plans which are part of the proposed project do provide some benefits to the project area. However, none of the plans provide all of the benefits of the proposed project and all plans have some detrimental environmental aspects. The same can be said of the three conceptual alternatives; some benefits accrue, but less than from the proposed project, and adverse environmental impacts will occur with each.

Thus, none of the alternative plans provide the full benefits which will result from the proposed Integrated Rural Development Project. All of the alternatives and the proposed project will cause similar but unequal environmental damage. As discussed in the Assessment, the environmental impacts of the proposed project will be primarily short-term and/or of minor importance. In view of the full range of benefits provided and the minor adverse environmental impacts, it is the conclusion of this Environmental Assessment that The Upper Bong County Integrated Rural Development Project should be implemented in the manner and to the degree proposed.

APPENDIX

TABLE OF CONTENTS

		Page
I.	BACKGROUND OF THE REPUBLIC OF LIBERIA	1
	A. LOCATION AND GEOGRAPHY	1
	B. HISTORY	4
	C. GOVERNMENT AND POLITICAL DIVISIONS	5
	1. Federal	5
	2. Local	7
	a. County	7
	b. Tribal	7
	D. SOCIAL STRUCTURE	7
	1. Rural Population	7
	2. Urban Population	10
	3. Population Characteristics	11
	E. ECONOMIC STRUCTURE	11
	1. Economic Development and Status	11
	a. Period of Political Consolidation (1882-1847)	11
	b. Period of Temporary Economic Consolidation (1847-1871)	11
	c. Period of Permanent Economic Crisis (1871-1934)	12
	d. Rubber Period (1934-1950)	12
	e. Iron Ore Period (1951 to Present)	12
	f. Present Conditions	13
	2. Traditional Economy	13
	3. Modern Concession Economy	13
	a. Iron Ore Mining	13
	b. Rubber Production	15
	c. Other Activities	15
	4. Other Sectors of the Modern Economy	15
	a. Commercial Agriculture	15
	b. Manufacturing	16
	c. Other Components	16
	5. International Trade	16
	6. Economic Growth	17
	F. TRANSPORTATION	18
	1. Roads	18
	2. Rail	18
	3. Water	21
	4. Air	21
	5. Sea	21

	Page
G. COMMUNICATIONS	21
1. Telecommunications	21
2. Broadcasting	22
H. UPPER BONG COUNTY STUDY AREA	22
I. EXISTING CONDITIONS IN UPPER BONG COUNTY	25
A. PHYSICAL CHARACTERISTICS	25
1. Physiography	25
2. Geology	25
3. Climate	27
a. Climate Classification	27
b. Temperature	27
c. Precipitation	28
d. Weather Patterns and Storms	29
e. Mixing and Circulation	29
4. Soils	29
a. General	29
b. Soil Types and Properties	30
c. Erosion Potential and Stability	34
d. Agricultural Suitability	34
5. Air Quality	35
a. Dust	35
b. Smoke	35
c. Other Pollutants	35
d. Summary	37
6. Surface Water Resources	37
a. Hydrologic Characteristics of Rivers	37
b. Hydrologic Characteristics of Swamps	39
c. Surface Water Quality	40
d. Present and Potential Use	45
7. Groundwater Resources	46
a. Aquifer Characteristics	46
b. Groundwater Quality	46
c. Present and Potential Use	46
B. ECOLOGICAL CHARACTERISTICS	46
1. Ecosystem Descriptions	46
a. Natural Forest	46
b. Secondary Vegetation	49
c. Swamp and Marsh	51
d. Aquatic Habitats	54
2. Unique and Sensitive Natural Areas	54
3. Threatened or Endangered Species	55
4. Commercially Important Species	56
5. Vectors	57
a. Molluscan Vectors	57
b. Insect Vectors	57
c. Rodent Vectors	58

	Page
C. CULTURAL CHARACTERISTICS	58
1. Land Use	58
2. Land Ownership	59
a. Tribal Land Tenure	59
b. Private Ownership	60
c. Land Ownership in the Study Area	61
3. Social Structure	61
a. Tribes	61
b. Villages	64
c. Population	64
d. Education	66
e. Living Condition and Housing	68
4. Economic and Institutional Structure	69
a. Local Government	69
b. Employment	70
c. Average Income	71
d. Financial Institutions	71
5. Public Facilities and Services	73
a. Communications	73
b. Utilities	73
c. Law Enforcement	74
D. TRANSPORTATION FACILITIES	74
1. Roads	74
2. Railroads	75
3. Airfields	75
4. Water	75
E. AGRICULTURE	76
1. Crop Types and Characteristics	76
a. Upland Rice	76
b. Swamp Rice	77
c. Cassava	77
d. Sugar Cane	79
e. Coffee	79
f. Cocoa	80
g. Rubber	81
h. Oil Palm	81
i. Piassava Palm	82
j. Bananas	82
k. Coconuts	82
l. Other	82
2. Crop Production Practices	83
a. Land Availability and Usage	83
b. Water Considerations	83
c. Available Labor	85
d. Capital and Financing	87
e. Equipment and Technology	87
f. Fertilizer Usage	88
g. Pest Control	88

	Page
3. Crop Marketing Considerations	89
a. Level of Subsistence Agriculture	89
b. Liberian Food Production/Consumption	90
c. Farm to Market Transport	90
d. Cooperatives and Commodity Dealers	92
e. Foreign Export	92
4. Government Programs	93
5. Forestry Concession	95
F. PUBLIC HEALTH	96
1. Nutrition	97
a. Principal Foods and Consumption	99
b. Customs Affecting the Diet	103
c. Nutritional Deficiencies	105
2. Domestic Water Supply and Sewage Disposal Systems	105
3. Indigenous Diseases	110
a. Schistosomiasis	110
b. Malaria	114
c. Onchocerciasis	114
d. Trypanosomiasis	114
e. Other	114
4. Health Care	115

LIST OF FIGURES

Figure		Page
1	Liberia in Relation to other West African Countries	2
2	General Map of Liberia	3
3	Major Political Subdivisions, Liberia	6
4	Major Tribes and Tribal Boundaries	9
5	Upper Bong County, Liberia	24
6	Location of Water Quality Sampling Stations	41
7	Field Cleared and Prepared for Upland Rice; CAES, Suakoko	50
8	Multi-layered Tropical Forest Canopy Northeast of Gbarnga	52
9	Swamp Near Belefuanai	53
10	Chiefdoms and Clans of Upper Bong County (Boundaries Approximate)	63
11	Swamp Rice Cultivation; CAES, Suakoko	78
12	Birth Rates by Literacy Status of Mother	98

LIST OF TABLES

Table		Page
1	County Data, Liberia	8
2	Structure and Growth of GDP at Constant (1971) Factor Cost, 1964-74	14
3	Road Design Standards, Liberia	19
4	Road Network Composition (in miles)	20
5	The Geologic History of the Earth in Relation to Liberia's Geology	26
6	Soil Characteristics and Production Potential	36
7	Mean Monthly Discharge Rates in Cubic Feet/Second St. Paul and St. John Rivers	38
8	Description of Water Quality Sampling Locations	42
9	Water Quality Sampling Data	43
10	Estimated Population per Clan, Project Area	62
11	Labor Balance of Project Area	72
12	Livestock: Number of Agricultural Households Raising Livestock and Poultry and Number of Head on Hand, Liberia, 1975	84
13	Agricultural Calendar and Crop Labor Requirements per Acre, Bong County	86
14	Production and Consumption of Rice in Liberia	91
15	Volume, Value and Unit [illegible] of Major Exports, 1970-75	94
16	Daily Food Intake	100
17	Nutritional Content of 100g Edible Portion of Representative Liberian Foods	101
18	Percentage of FAO Recommendations for a 2-4 Year Old Child in one serving of Selected Liberian Food	102
19	Hemoglobin Values of Mothers and Children	104
20	Nutrient Intake of Hypothetical Children	106

LIST OF TABLES (cont'd)

Table		Page
21	Prevalence of Signs of Nutritional Deficiency by Tribe (both sexes)	108
22	Prevalence of Signs of Nutritional Deficiency by Area (both sexes)	109
23	Incidence of Helminthic Infestation in School Children	111
24	Precentages of Helminthic Infestations in School Children According to their Residence	111
25	Single and Multiple Intestinal and Urinary Infestations	112
26	Helminthic Infestations According to Tribes	112
27	Indigenous Disease Incidence, January-September 1976	113

I. BACKGROUND OF THE REPUBLIC OF LIBERIA

A. LOCATION AND GEOGRAPHY

Bordered by Sierra Leone, Guinea and the Ivory Coast, the Republic of Liberia is situated on the southern edge of Africa's great western bulge (see Fig. 1.). It occupies a prominent position both strategically and commercially since a circle with a radius of 806 kilometers (500 miles), centered at Voinjama in northern Liberia, would touch or include ten West African countries. Liberia is within 806 kilometers (500 miles) of the Greenwich Meridian and 484 kilometers (300 miles) of the equator. This English speaking country encompasses approximately 98,420 square kilometers (38,000 square miles), completely within the tropics. Liberia has the general form of a trapezoid, the longest side of which is its Atlantic coastline extending some 565 kilometers (350 miles) in a northwesterly direction from the Cavally River near Cape Palmas to the mouth of the Mano River (see Fig. 2.). Its width varies between 274 and 177 kilometers (170 and 110 miles). The Mano and Makona Rivers form the northwestern boundary with Sierra Leone and a series of river segments and drainage divides separate Liberia from the inland portions of Guinea to the north and the Ivory Coast to the northeast and east. The four major physiographic zones which form distinctive belts of elevation and relief extending from the coastline inland are; the coastal plain, the belt of rolling hills, the belt of mountain ranges and plateaus and the Northern Highlands.

Averaging 40 kilometers (25 miles) in depth, the coastal plain attains an elevation of between 9 and 30 meters (30 and 100 feet) above sea level. Its surface is flat or very gently rolling with a few isolated hills rising over 46 meters (150 feet). Major rivers cross the plain in broad meanders which become wider near the shoreline and merge with coastal lagoons and mangrove swamps. The Liberian coast is characterized by the effects of a powerful surf which has produced an even coastline along which active sand beaches separate coastal lagoons from the sea and surf-formed bars occur at the mouths of rivers. A few points along the shoreline such as Cape Mount, Cape Mesurado and Cape Palmas have palisades directly fronting the ocean.

The belt of rolling hills begins at the inner margin of the coastal plain and is marked by a definite transition to a more rugged terrain with a general elevation of 61 to 152 meters (200 to 500 feet).

Abrupt elevation changes and waterfalls along major streams signify the beginning of a belt of mountain ranges and plateaus, as much as 129 kilometers (80 miles) in width. The general aspect of this belt is that of a dissected plateau having an elevation of 183 to 305 meters (600 to 800 feet) above the surrounding terrain. Hillsides normally have a convex form with streams occupying V-shaped valleys characterized by small level areas between the hills. The dendritic drainage pattern is quite intricate with closely spaced streams and valleys. Upper Bong County is within this plateau zone.

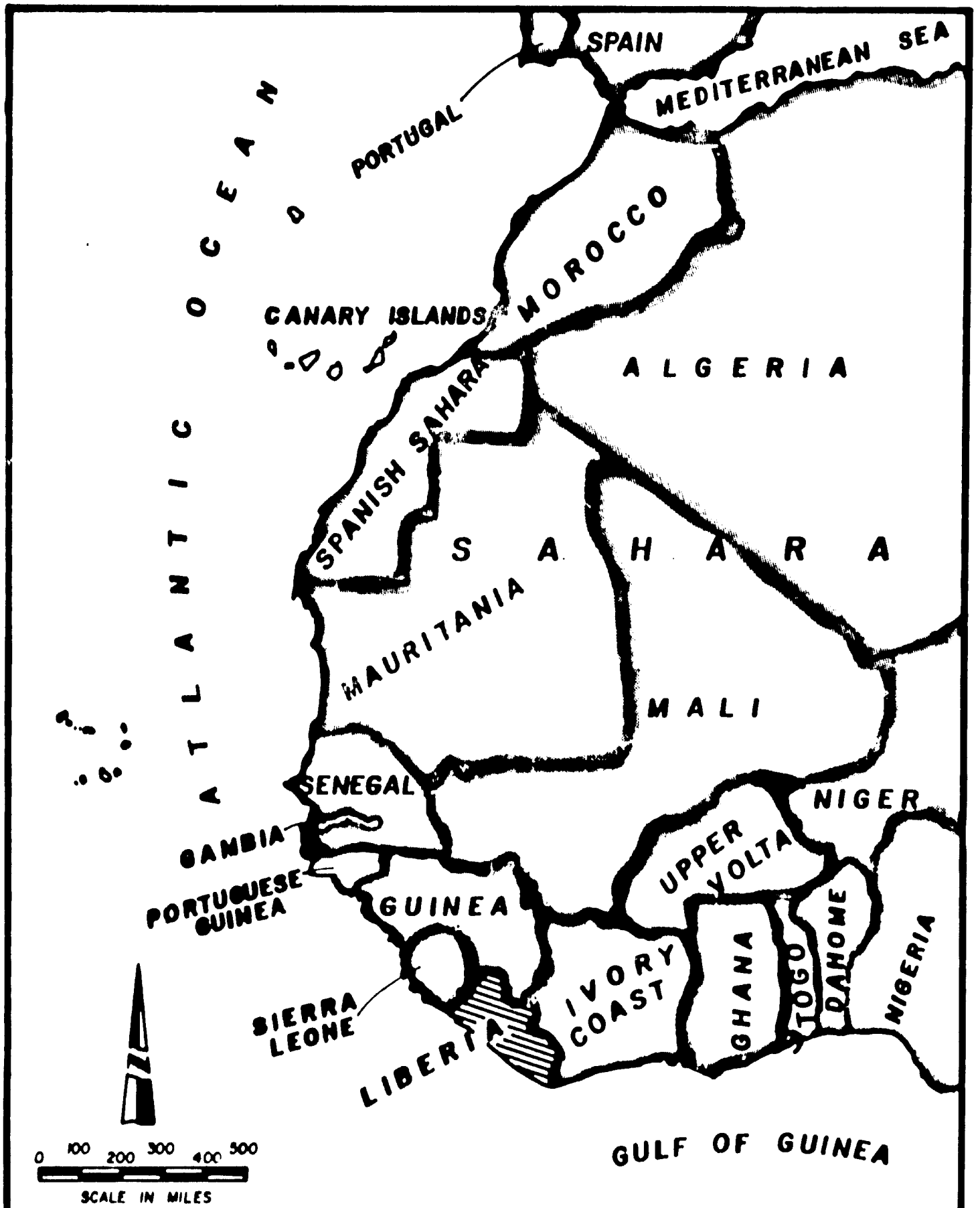


Figure 1. Liberia in Relation to Other West African Countries

112

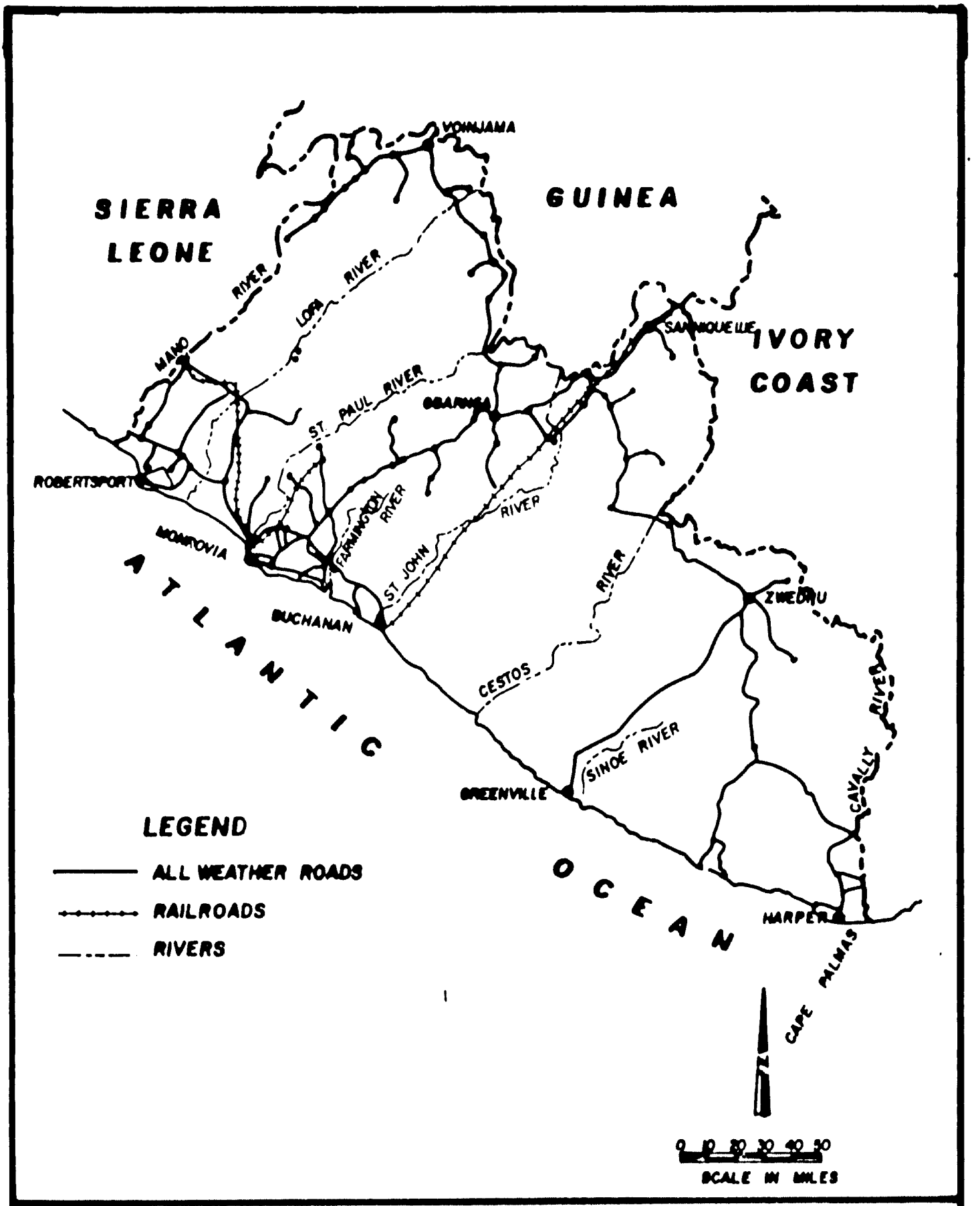


Figure 2. General Map of Liberia

The Northern Highlands are found in the northern parts of Lofa and Nimba Counties and form part of the Guinea Highlands which are also known as the Futa Jallon Mountains. The characteristic topography of this region is a series of long ridges with dome shaped summits. The Wologisi Range in Lofa County is about 65 kilometers (40 miles) long with a maximum elevation of 1,356 meters (4,450 feet). The Nimba Range reaches an elevation of over 1,829 meters (6,000 feet) in Guinea and over 1,372 meters (4,500 feet) in Liberia.

In summary, the Republic of Liberia is a nation occupying a unique position on the western coast of Africa. It is a nation of coastal plains, rolling hills and low mountains with a tropical climate and a number of major rivers. It is strategically located for commerce within the West African States; Monrovia is its capital city, with a free port status.

B. HISTORY

The general history of Liberia is composed of three major periods. Traditions and linguistic evidence suggest that the original inhabitants of Liberia migrated south from the savannas of the Western Sudan, possibly as early as the third century A.D. Subsequent movements characterized by a general drift towards the coast continued and accelerated in response to Arab invasions of Northern Africa between the 8th and 11th Centuries. The nearly impenetrable high forest belt south of the moist savanna regions offered not only security, but more unoccupied farmland as a refuge from the nomadic invaders of the Sahara.

For the next several hundred years, migration consisted of the continued movement of peoples from the interior towards the coast with coastal diversification by seafaring tribes. By the beginning of the 19th Century, Liberia contained several tribes with distinctive linguistic characteristics. Peoples along the coastline and the lower parts of the major rivers had some contact with European traders who had been visiting the region since the 15th Century. There was also considerable disruption of coastal cultures by slave-taking activities during this period.

A second major period in Liberian history began in 1822 when the first of a migration of Americans of African descent returned to establish free colonies in Africa. Although numerically a small minority, these settlers from the United States introduced a more sophisticated agricultural economy to the immediate coastal area. During the mid-part of the 19th Century significant amounts of palm kernels, coffee, sugar cane, ginger and natural dyes were exported and extensive commerce in tropical agricultural products was carried on in Liberian owned merchant shipping with Europe and North America. By the 1870's, however, there was increasing competition from the produce of colonial areas which had the benefit of capital subsidization from the mother country and protected trade relationships. Liberia, having no direct colonial ties, lost much of her commerce and there followed nearly a half century of economic stagnation, during which the nation experienced severe financial problems with its foreign trade.

A new period of agricultural and marketing opportunities began in the 1930's when the Firestone Rubber Company established extensive rubber plantations in Liberia as an alternative to the high fixed price of rubber from the colonial possessions of European powers. Production of Liberian rubber was just getting well established when World War II caused an influx of American military aid, chiefly for construction of an airbase, vital to the South Atlantic-Trans African suppy route to support the war in the Middle East. During this period the large airport, now known as Roberts Field, was constructed. A significant increase in both the quality and quantity of Liberian roads was made and the initiation of a sizeable American presence in Liberia took place.

Following World War II, rubber production increased as additional plantations, both foreign and Liberian, were developed. Beginning about 1950, the extensive deposits of high grade iron ore, which had been discovered in Liberia, were exploited by foreign concessions from Europe and the United States. This has increased steadily until the present time. Today, Liberia annually exports more than 25 million tons of iron ore with a value of more than 65 million dollars. As a result, the nation as a whole has a favorable foreign trade balance and expanding export economy. This, despite the fact that most of the population still exists in a basic subsistence agriculture society. During the latter half of the modern period of export oriented economy, a cultural change began taking place. For the first time, the indigenous African tribal population is being integrated into the culture. Although most economic and political power is still vested in the descendents of the American immigrants, the benefits of modern development are being gradually extended throughout the country.

C. GOVERNMENT AND POLITICAL DIVISIONS

1. Federal

Liberia is Africa's oldest independent republic, governed under a Constitution which dates to 1847. The governemnt is headed by a president (presently William R. Tolbert), who is initially elected for an eight year term, and can be re-elected for an indefinite number of four year terms. The legislative body is a bicameral Congress, consisting of a Senate (two from each county or 18 members) and a House of Representatives (52 members). Senators are elected for six year terms and Representatives for four years. The Cabinet organizations are each headed by a Minister.

Since 1904-1912, a dual system of administration for the interior has existed; the interior service officers (provincial commissioners, district commissioners, etc.) and the paramount chiefs, clan chiefs, town chiefs and quarter chiefs who are responsible for the collection of revenues and the administration of customary justice. By 1920, the country consisted of four counties along the coast (extending 65 kilometers inland) and five hinterland provinces. Various changes were made to the composition of territories, counties, provinces, etc. until 1963, when a law converted the hinterland provinces into counties. This resulted in the present nine counties as shown in Fig. 3.

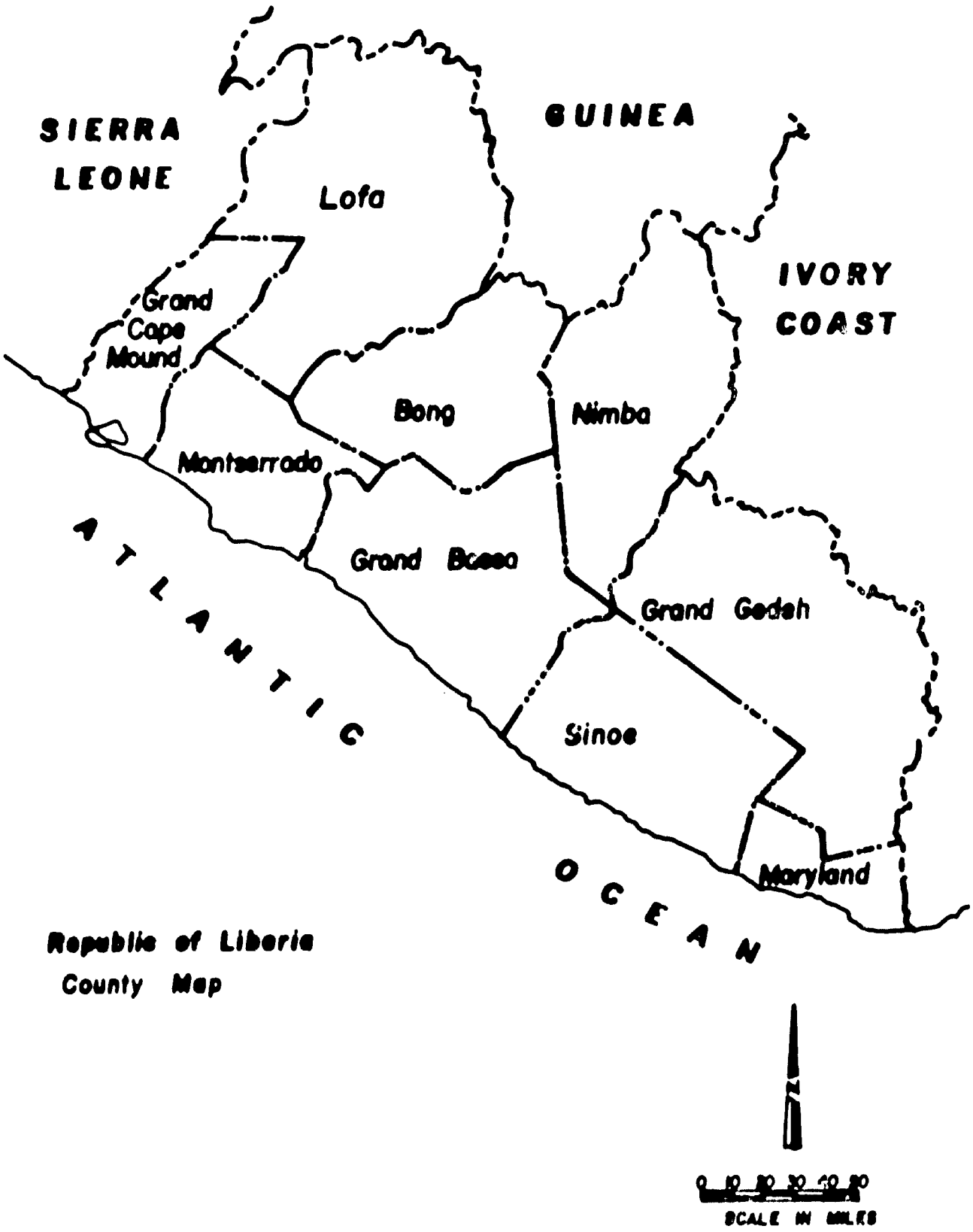


Figure 3. Major Political Subdivisions, Liberia

2. Local

a. County

The size, population and population density of the counties vary greatly as indicated in Table 1. Since the early 1960's, Liberia has had one of the fastest growing populations in Africa, with an annual rate of 3.3 percent. In the counties, however, the growth rate varies from 1.1 to 4.8 percent. The populations of Grand Cape Mount, Montserrado and Nimba counties grew significantly faster than average, while the growth rate was well below average in Grand Bassa, Grand Gedeh and Sinoe counties.

Within the counties, there are political subdivisions; territories, districts and subdistricts. Only Grand Bassa, Maryland, Montserrado and Sinoe have territories with Montserrado having two and the others one each. The next smallest subdivision is the district which is further subdivided into clans or townships. The township is more a political subdivision of the Liberian Government, while clans are based on hereditary custom. As of 1974, there were 54 districts and 46 townships in the country.

b. Tribal

In addition to the administrative system of the county-territory-district, there is the traditional leadership based on tribal lineages. The approximate territorial boundaries of each major tribe are shown in Figure 4. Included in the tribal system are the paramount, clan, town and quarter chiefs. When the first national census was taken in 1962, there were 124 paramount chiefdoms and 336 clan chiefdoms in the country. The 1973 census indicated there were 369 clans in the country. The area of each chiefdom varies greatly, the largest being the old Kongba Chiefdom. Lying between the Morro and Lofa Rivers, its 3,217 square kilometers (1,242 square miles) extend into the Gola National Forest.

Chiefdoms are subdivided into clans, each headed by a Clan Chief, who is, in turn, superior to a number of Town Chiefs. Tribal leaders are elected by the people every four years, a system which apparently makes sure that the formal leadership is in accordance with the informal authority stucture.

A town, (or minor settlement, which is also normally called a town) is a social system in intself. It may consist of different numbers of families. The elected Town Chief can nominate his assistant, the Quarter Chief. In addition, there may be other dignitaries, such as town elders, church leaders and medicinemen. The Town Chiefs are responsible for tax collection and all matters concerning government affairs.

D. SOCIAL STRUCTURE

1. Rural Population

The 1974 census classified about 71 percent of the population as rural; however, if characteristics of economic activity and availability of social and physical infrastructure are considered, this proportion would be even higher.

TABLE 1. COUNTY DATA, LIBERIA*

County	Area (sq miles)	County Seat	Population 1962	Population 1974	Annual Growth 1972-74 (%)	Share of Population 1974 (%)	Density 1974 (persons/ sq mi)
Bong	3,650	Gbarnga	131,528	194,191	3.3	12.9	53.2
Grand Bassa	5,650	Buchanan	131,840	150,926	1.1	10.0	29.7
Grand Cape Mount	2,250	Robertsport	32,190	56,604	4.8	3.8	25.2
Grand Gedeh	6,575	Zwedru	59,275	71,825	1.7	4.8	10.9
Lofa	7,475	Voinjama	123,165	180,737	3.2	12.0	24.2
Maryland	1,675	Harper	62,786	91,619	3.2	6.1	54.7
Montserrado	2,550	Monrovia	258,821	439,997	4.5	29.3	172.5
Nimba	4,650	Sanokole	160,743	249,702	3.8	16.6	53.7
Sinoe	4,350	Greenville	56,095	67,599	1.6	4.5	15.5
Total	38,250		1,016,443	1,503,200	3.3	100.0	39.3

* Republic of Liberia, National Planning Council, National Socio-Economic Development Plan, July 1976-June 1980, March 1976.

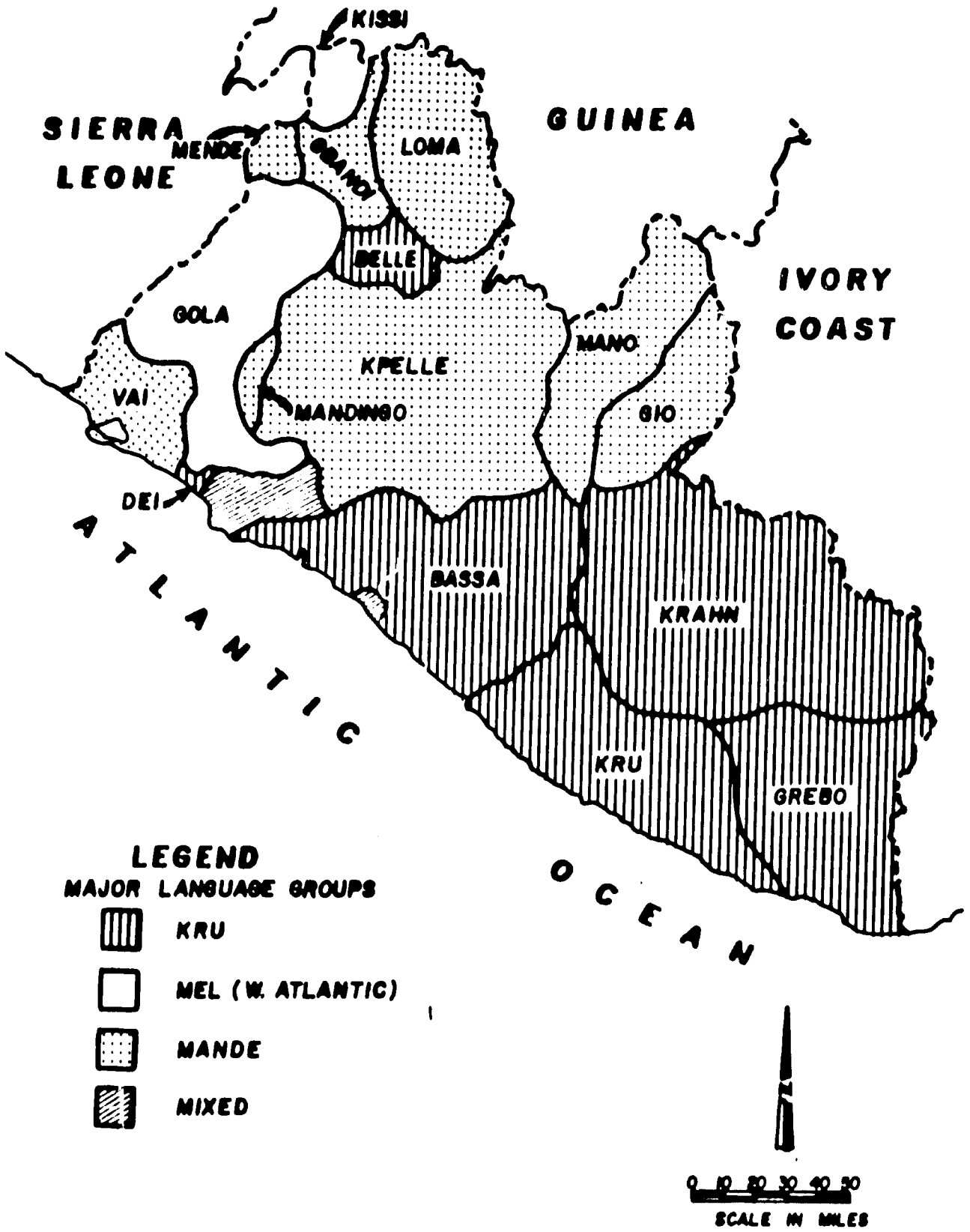


Figure 4. Major Tribes and Tribal Boundaries

119

The majority of the rural population is engaged in subsistence agriculture, although vegetables and tree crops are sometimes cultivated for cash purposes. Family incomes are low and services and utilities are extremely limited. The structure of the rural society generally begins with tribes or chiefdoms headed by a Paramount Chief. While the division of clans is based on lineages, town leadership is based on geographical divisions.

Economic, political and other social activities are strongly influenced by family relationships but the impact varies in form and implications for the working of other institutions. The rural household is the prime user of the two principle production factors, land and labor. Although the federal government is officially the ultimate owner of all land in Liberia, tradition based control, exercised by the various tribes under the chiefs, is recognized. This same tribal control rules the family's access to the land. A recognized member of a traditional group may occupy and use any piece of land not occupied by anyone else. Because of the system of shifting cultivation, strict rules are observed regarding land clearing. It is generally accepted, however, that a man has priority of choice over a piece of land which has already been cultivated by him or his neighbor, or which is adjacent to his present field.

2. Urban Population

Between 1962 and 1974 there was a noticeable shift of population from rural to urban. This was evident in all counties, whether or not the population growth rate exceeded the national average. Grand Bassa County had one of the lowest average growth rates (1.1 percent), but about two-thirds of the absolute increase in population was reportedly concentrated in the town of Buchanan where the population doubled over a twelve-year period. Similarly, in Montserrado County, with one of the highest growth rates (4.5 percent), about two-thirds of the additional population lived in Monrovia, the nation's capital, which experienced a phenomenal growth of about 8 percent per year. As a result of this pronounced migration into the towns, the proportion of the population living in urban areas (communities of 2,000 or more persons) increased from 20 percent in 1962 to 29 percent in 1974.

The largest urban area in Liberia is its capital, Monrovia, with a 1974 urban area population of 204,213. Other major urban areas included Buchanan (24,375), Harper (11,715), and Greenville (8,474). All of these lie along the coast. Excluding Monrovia, the annual growth rate of all urban areas was about 6 percent. This refelcts the general trend of migration, which occurs in two phases, from the rural areas and villages to the larger settlements and then from those settlements to Monrovia - the real focus of urban growth and attendant problems.

The rapid growth of the capital city resulted in spontaneous development. There was no land use planning, ineffective zoning, little enforcement of building codes and slow expansion of water supply, sewage facilities, telephones and power. The most serious problem is inadequate housing. Land is scarce and financing is lacking. The lawful owner of vacant land is often difficult to ascertain because of conflicting titles. Similar problems exist in the other large cities, but not to the same degree. The smaller settlements are considered urban, but are more rural in attitude and development.

3. Population Characteristics

Available statistics indicate the average size of a household ranges from 4.1 in the urban areas to 4.9 in the rural portions of the country (Republic of Liberia, Ministry of Agriculture, 1976b.). At birth, the average life expectancy of a Liberian is only about 45 years. Because of the predominately rural isolated existence of the inhabitants, the illiteracy rate is estimated to be 90 percent. Average family income is approximately $300 per year.

E. ECONOMIC STRUCTURE

1. Economic Development and Status

Liberia's economic development can be divided into two principal phases. The first phase lasted from 1882 to the end of World War II and showed relatively slow progress for two reasons. First, the sites selected for the new settlements were most unhealthy and unfavorable to man in general and especially to unadapted and unprepared settlers; and secondly, the newcomers had to spend most of their energy struggling against internal and external political difficulties that threatened the unity and independence of the state. The second phase started with the inauguration of President Tubman and made Liberia the fastest developing country in the world after Japan. In the two principal phases, five different periods have been identified.

a. Period of Political Consolidation (1822-1847)

Until the declaration of Liberia's independence in 1847, a well-regulated economic life was impossible because of political problems while tropical disease and internal wars constantly reduced the number of settlers. Nevertheless, according to the census of 1843, 1,410 hectares (3,482 acres) of land were owned and cultivated by the farmers of the colony; 21,200 coffee trees had been planted, and sugar cane, rice, Indian corn, potatoes, tobacco, cotton and cassava were grown at many places, generally on a market-garden scale. Production, however, did not suffice to feed all 2,400 immigrants and the other inhabitants of the colony, and exports of coffee, ivory, palm oil and canwood for dyeing purposes were small.

b. Period of Temporary Economic Consolidation (1847-1871)

After 1847, the political situation became more stable, the last slaver's factory on the Cestos River was destroyed in 1849 (3,500 slaves were freed). Treaties of "amity, commerce and navigation" were concluded with Great Britain, France, Germany and many other European powers, shipyards were established at Monrovia and other places and agriculture was extended.

In 1850, at the instigation of Samuel S. Herring of Buchanan, Liberia initiated African export of palm kernels. In that year, some 2,024 hectares (5,000 acres) of sugar cane, coffeee, ginger, etc., were under cultivation along the St. Paul's River. By 1885, some thirty sailing vessels built in the country for Liberian shipowners, showed the Liberian flag in many

European and American ports. In 1858, the first exhibition was held in Monrovia in which prizes were awarded for agricultural products, domestic animals and agricultural implements manufactured in the country.

By 1860, hundreds of tons of palm oil were exported whereas twenty years before there was scarcely one drum, and camwood (Baphia nitida) sold for fifty to eighty dollars per ton in the United States. During the same period, rice was abundant, and exports of coffee, ginger, pepper and sugar were considerable.

c. Period of Permanent Economic Crisis (1871-1934)

Liberia's early economic expansion was followed by a period of permanent economic crisis. It lasted from 1871 when the first financial loan was taken under unfavorable conditions and ended in 1934 when the Firestone plantations came into production.

During this period the economic situation was characterized by the disappearance of Liberian ships from the sea, by the decline in prices of coffee, palm oil and sugar, by renewed tribal fighting in the interior, by the granting of monopolistic concessions of wild rubber and minerals to foreign companies, by constant boundary troubles, by the interruption of German trade during World War I, by another series of loans in 1906, 1912 and 1926, by the effects of the world economic depression in 1929, and by the discrimination against Liberia precipitated by the League of Nations investigations of 1930.

d. Rubber Period (1934-1950)

The expansion of world trade after the 1929-30 depression coincided with the beginning of steadily increasing rubber exports from the Firestone plantations at Harbel and on the Cavally River which determined Liberia's economic position for about sixteen years. Tax revenues rose from 320,000 dollars to nearly four million dollars in 1950 of which about twenty-five percent were export and import duties, land rent, hut and other taxes from Firestone. The success of the Firestone experiment encouraged more and more Liberian farmers to start private plantations so that by 1950, about four hundred and sixty independent rubber farms existed. The increasing income from rubber exports stimulated development in all branches of public life: the road system was extended, the number of motor vehicles grew from under one hundred to over eight hundred and the budget for education was increased.

e. Iron Ore Period (1951 to Present)

Between 1951 and 1965, four iron ore mines came into production and provided thousands of people with improved incomes. The mines caused a marked economic boom which reached its climax between 1959 and 1961. A five-year plan for the improvement of the infrastructure and the economic structure in general was started in 1951 and was followed by another five-year plan in 1963. Concurrently, technical co-operation with the USA and other countries was intensified, and hundreds of millions of dollars of private capital were attracted by the Open Door Policy which President

Tubman announced when he came into office in 1944. The results of this policy can be recognized through all the following chapters, whether in the growth of the educational and public health budgets or in other sectors of the national economy.

f. Present Conditions

Today, Liberia's economy is dominated by the production of rubber and iron ore for export, mainly by foreign-owned enterprises. These entities, using modern technology and enjoying the associated high productivity, are the main source of export earnings and wage employment, and contribute a sizable share of governmental revenues. Traditional agriculture, at the other extreme, has minimal interaction with the monetized economy, but continues to support the majority of the population--perhaps as much as 70 percent--at very low levels of productivity and income. The main products of traditional agriculture are rice, cassava, palm produce and sugar cane. Other relatively large sectors, in terms of output and employment, are trade, government, transport and communications. The structure and growth of the Gross Domestic Product (GDP) of Liberia is shown on Table 2.

2. Traditional Economy

The traditional economy provides about 14 percent of the country's GDP. The majority of the country's population depends on agriculture and related activities for its livelihoood. Preliminary estimates from the 1974 Population Census indicate that about 70 percent of the population live in rural areas, i.e. settlements of under 2,000 persons. The majority of these people are primarily engaged in agriculture. Traditional holdings are typically less than 4 hectares (10 acres) and are farmed by thousands of small land-holders practicing shifting cultivation of rice and cassava. Rice, the staple food in the Liberian diet, is the largest single product of the traditional economy, accounting for about one-third of value-added in the sector. Most of the rice is produced and consumed on a subsistence basis. Cash crops, (e.g. cocoa, coffee, palm oil, sugar cane, vegetables) and the raising of goats, pigs and poultry are becoming increasingly popular but have not produced a major economic impact.

3. Modern Concession Economy

The modern sectors of the economy generate most of the domestic income. Concession activities, encompassing mining and agricultural production developed within the framework of specific concession agreements between government and private investors, directly account for almost one-half of Gross Domestic Product (GDP) of the modern economy (Table 2.).

a. Iron Ore Mining

Iron ore mining is by far the largest single activity in this sector, accounting for three-quarters of value-added by concessions and 28 percent of the GDP. Since 1965, when the last of four companies started operations, production increased from 15.5 million metric tons to 24.5 million tons in

TABLE 2. STRUCTURE AND GROWTH OF GDP AT CONSTANT (1971) FACTOR COST, 1964-1974

	Average 1964-66		Average 1972-74		Annual growth 1964-74 (percent)
	$million	Per-cent	$million	Per-cent	
Modern Economy	231	83	368	86	6.0
Concession Sector	98	35	159	37	6.2
Rubber	13	5	20	4	5.5
Forestry	1	-	8	2	29.8
Iron-ore Mining	80	29	120	28	5.2
Other Mining	4	1	11	3	13.5
Other Modern Sectors	133	48	209	49	5.8
Commercial Agriculture	7	3	16	4	10.9
(Rubber)	(2)	(1)	(5)	(1)	(12.1)
Manufacturing	8	3	20	5	12.1
Construction	13	5	14	3	0.9
Government	18	6	25	6	4.2
Other	87	31	134	31	5.6
Traditional Economy	46	17	61	14	3.6
of which, Rice	(15)	(5)	(21)	(5)	(4.3)
Total Economy	277	100	429	100	5.7

1974. Liberia is now the fifth largest exporter of iron ore in the world. Production in 1974 included about 4 million tons of high value pellets, an item first produced, on a significant scale, in 1968. Iron ore has only a small direct linkage with the rest of the economy. The main direct contribution to the economy is in the form of payments (profit sharing, royalties) to government, which averaged 7.4 percent of export sales in 1971-73 but only 5.3 percent in 1974. The production process is typically capital-intensive, and capital equipment as well as other material inputs are largely imported. Further, as much as 10 percent of the labor force, including many of the higher paid technical and managerial staff, are expatriates. The mining companies are predominately foreign-owned, although the Liberian Government now holds 50 percent equity in one company, 37.5 in another, and there exists a small private Liberian shareholding. Employment of about 11,000 is less than 10 percent of the wage-labor force, and wage payments absorb only about 15 percent of the gross earnings of the iron ore mining companies.

b. Rubber Production

Seven foreign-owned concessions, of which the Firestone Company is the oldest and largest, accounted for about two-thirds of rubber production in 1974. The concessions purchase the output of Liberian growers for processing and export. In response to falling world market prices, rubber output fell from an average of about 95 million pounds at the end of the 1950's to 88 million pounds in 1962. Although prices remain rather low, output subsequently increased annually, reaching some 189 million pounds in 1973-74. With the growth of other activities, particularly iron ore mining, the share of rubber production in GDP and in export earnings declined. However, exclusive of subsistence agriculture, rubber is still the most important source of employment and income for Liberians. A relatively large share of income generated in rubber production, probably 40-45 percent, accrues as national income to Liberia. This mainly results from the large number of laborers needed for tapping rubber.

c. Other Activities

Although iron ore mining and rubber production account for the majority of concession activity, other mining and agricultural concessions have been granted and/or are being negotiated. Included in this category are diamond and gold mines and forestry concessions (used to grow trees for pulp wood). These concessions currently contribute about 5 percent of the annual GDP.

4. Other Sectors of the Modern Economy

a. Commercial Agriculture

Liberian-owned commercial farms are primarily engaged in rubber production, but also include significant acreages of cocoa, coffee, palm oil and vegetables, and some poultry and livestock raising. The establishment of these farms, which range in size from 2 to 405 hectares (5 to 1,000 acres) was stimulated from the 1930's by the operation of the Firestone rubber

concession, and the availability of considerable labor and cheap land. The management of these farms, except for the larger ones, is generally inefficient. Rubber production of Liberian farmers, which was negligible in 1950, contributed about 18 percent of total output in the early 1960's and increased further to around one-third in 1973-74. Permanent wage-employment in rubber production is approximately 42,000 persons, or one-third of the wage-labor force. The total contribution of commercial agriculture to the GDP is 4 percent.

b. Manufacturing

The manufacturing industry is a small part of the Liberian economy, accounting for less than 5 percent of GDP in recent years. The sector has a dual structure, consisting of a large number of small shops engaged in tailoring, concrete blocks and furniture making, and a relatively few modern establishments of modest size. Little data are available about the small scale sector. Food and chemicals are the main branches of manufacturing activity, accounting for 35 percent and 40 percent of value-added, respectively. The major products of the food category are bread, beer and soft drinks; while petroleum products account for most of the value-added of the chemicals and related industries.

c. Other Components

Various services, such as commerce, transport, utilities, financial and personal services, account for the bulk of value-added in the rest of the modern economy (about 31 percent of GDP). The contribution of government services is also fairly important, reflecting the fact that government is the largest single employer in the country. Value-added in construction activity is fairly small and is mainly determined by investments in the concession sector of the economy.

5. International Trade

Liberia is an important supplier to foreign nations of minerals and other raw materials such as iron ore, rubber, coffee, cocoa, diamonds, palm kernels and timber. These constitute the principal export commodities. Liberia is also an important buyer of machinery, foodstuffs, fuel and other items which form the main import goods of the country. Liberia's economy is very open. Small countries typically have a narrow, highly skewed resource base and limited domestic markets, so that they necessarily export a large share of domestic output (usually a small number of primary commodities) and import a wide range of consumer and producer goods. The importance of foreign trade and capital flows has been further enhanced by the Government's deliberate "open door" policy. In Liberia imports have accounted for around 30 percent of total supplies since the mid 1960's, while the share of exports in the disposition of resources rose from 38 percent in the 1960's to 40 percent in the early 1970's. This reflects the dominate role of iron ore--all of which is exported--in the growth of output. In the period 1971-74, iron ore accounted for almost two-thirds of exports, rubber for 13 percent, diamonds for 11 percent, and timber for about 4 percent.

6. Economic Growth

Liberia enjoyed a relatively high rate of economic growth over the last decade. The average annual growth of GDP is 5.7 percent in real terms and 8.7 percent in current prices from 1964 to 1974. Value-added by concession activities grew faster than average, reflecting the opening of new mines, investment in iron ore pelletizing facilities, the beginning of the commercial exploitation of the country's rich tropical forests, and expansion of diamond mining. Manufacturing industry and commercial agriculture (excluding rubber production by foreign concessions) also grew much faster than average. In the case of manufacturing, this mainly resulted from the opening of an oil refinery. Although output of the traditional economy grew more slowly than the average for the entire economy, it is nonetheless estimated to have grown significantly faster than the rural population. This probably reflects increased labor input, expansion of the cultivated area, and shifting in the crop mixture towards higher-value, marketable crops.

Real per capita GDP in Liberia is much higher than in most other West African countries. Real per capital income (valued at 1971 prices) increased at about 2.4 percent per year since the mid 1960's and is estimated to have reached about $300 in 1974. However, because of the great differences in productivity between the concession and traditional sectors, the bulk of the population still has relatively low incomes.

On April 2, 1975, the National Planning Council (NPC) authorized the Ministry of Planning and Economic Affairs to prepare a comprehensive National Socio-Economic Development Plan covering the first four years of the New Administration to be inaugurated in 1976. This Plan was published on March 9, 1976.

The basic objectives of this development strategy are:

Diversification of production;

dispersion of sustainable socio-economic activities throughout the country.

total involvement of the entire population in the developmental efforts; and

equitable distribution of the benefits of economic growth, development, and diversification to ensure an acceptable standard of living to all Liberians.

The cornerstone of the diversification strategy is integrated rural development. This involves the design and implementation of comprehensive programs for raising agricultural productivity, improving associated rural economic activities, such as marketing, and providing a social and physical infrastructure to enhance the quality of life in the villages where most Liberians live. The improvement of agricultural incomes via increased productivity is absolutely essential for self-sustaining transformation of economic conditions in the rural areas of Liberia.

F. TRANSPORTATION

1. Roads

Roads are the basis of Liberia's internal transportation system, and are the principal means of moving both passengers and goods. Most roads, however, are not paved, and the unpaved all-weather facilities have a lateritic surface.

Before World War II, there were approximately 161 kilometers (100 miles) of roads passable to motor vehicles in Liberia. Most of this mileage was in the vicinity of Monrovia. Limited improvements in transportation facilities occurred during World War II as a result of the war effort of the United States, and by the end of the war, the general pattern of major highways was formed. Even then, the country had only 355 kilometers (220 miles) of roads, mostly unsurfaced.

In 1953, the Liberian Government began an intensive program of road construction. The emphasis of this program was to develop primary roads to provide year-round highway access to remote regions of the country. Between 1953 and 1960, nearly 435 kilometers (270 miles) of primary roads were constructed and over 113 kilometers (70 miles) of roads improved. By 1964, roads of lesser quality also had been built to improve access. Use was also made of roads constructed by private corporations.

Continued construction closed several of the gaps in the network until the system developed into that shown in Figure 2. As can be seen, there are several areas not yet connected by all-weather roads. The Liberian government classifies highways into primary, secondary and farm-to-market roads. Primary and secondary road classifications are based on design standards set forth in Table 3, with primary roads further divided into classes A and B as shown. Primary roads are the most important national/international roads connecting the major population centers and secondary roads provide access to the primary roads for small communities. Farm-to-market roads give farmers access to primary or secondary roads but do not meet design standards. They are, most often, built along existing trails and only suitable for 4-wheel drive vehicles but provide access to smaller population centers. Thus, classification of roads based on design standards must frequently be a goal rather than a reality. The highway network of Liberia was surveyed for the Liberian Department of Public Works in 1972 and the composition of highways is shown in Table 4.

A study completed in 1974 indicated the total road network of Liberia comprised 5,061 kilometers (3,318 miles) of roads. This would mean that there are approximately 2,737 kilometers (1,687 miles) of farm-to-market roads in the country. While some upgrading and new construction has occurred since the study was made, these figures provide a good indication of the type and status of roads.

2. Rail

Liberia has no national railroad, utilizing most of the transportation budget for road construction. Several railroad lines do exist, however,

TABLE 3. ROAD DESIGN STANDARDS, LIBERIA

Road system	Class	Design speed MPH	Radius ft. (min.)	Maximum grade	Width		Pavement construction
					Right-of-way	Running surface	
Primary (A)	Paved	45	1,200	7	150-200	24-26	1.5"-3" bituminous pavement of 16"-18" base
Primary (B)	Improved unmetalled road (lateritic)	45	1,200	7	150-200	24-26	6"-12" laterite pavement
Secondary	Improved unmetalled road (lateritic)		500	8	100	18-20	4"-10" laterite pavement

Source: LIBERIA, Republic of, Department of Public Works/Sauti Overseas: Highway Organization and Maintenance Study, Final Report. N. P. 1971.

TABLE 4. ROAD NETWORK COMPOSITION (IN MILES)

County	Primary		Secondary	Total
	Paved	Lateritic	(Lateritic)	
Montserrado	127	94.5	112.0	333.5
Grand Cape Mount	-	70.0	43.0	113.0
Bong	27	102.0	131.0	260.0
Grand Bassa	49	-	82.0	131.0
Lofa	-	154.0	44.0	198.0
Nimba	-	177.5	68.5	246.0
Grand Gedeh	-	206.0	6.5	212.5
Sinoe	-	87.0	-	87.0
Maryland	-	50.0	-	50.0
Total	203	941.0	487.0	1,631.0

having been constructed by various mining companies. The location of these lines is shown on Figure 2. Approximately 145 kilometers (90 miles) of railroad are narrow gauge, and 35 kilometers (22 miles) are standard gauge. Thus, connecting these lines to form any type of system is unlikely. Tonnage moved on these lines exceeds that moved by any other means, and is primarily iron ore.

3. Water

The rivers were important means of transportation even before settlement by the immigrants. During the period of settlement, the downstream portions of the larger rivers between the fall zone and the ocean were the major arteries of travel. It is interesting to note that no interior settlements were established above the fall zone, or where navigation terminated. Thus, after 1822, settlement was generally restricted to a narrow coastal strip about 32 kilometers (20 miles) wide. Major rivers which were utilized for transportation include the St. Paul, St. John, Cestos, Sinoe and Cavally. While use of these streams has declined, the Lofa and Farmington Rivers, little used during the early years, have become important routes for transporting rubber.

4. Air

During World War II, Roberts Field was constructed near Harbel under an agreement between the United States and Liberian governments. This airfield eventually developed into the Liberian international airport. National airfields exist near Monrovia, Kolahan, Samiguellia, Buchanan, Tchien, Greenville and Harper. Additionally, a number of landing strips exist throughout the country. Scheduled passenger service to principal settlements is provided by the Liberian National Airways. Several air taxi companies also operate throughout the country.

5. Sea

A deepwater port facility was opened at Monrovia in 1948, ushering in a new era of economic growth for Liberia. Iron ore and petroleum, as well as general cargo, are shipped from this port. Buchanan's deepwater port was opened in 1963 and is extensively used for iron ore shipments. Port development also occurred at Greenville and Harper, although most of the berthing at Harper has been shallow draft coastal steamers. The two ports compete for the same export products, and the port of Greenville has better facilities for deepwater draft vessels. Although Liberia has these ports in operation, and ranks first in world shipping, it has a relatively small merchant fleet. Most of the ships flying the Liberian flag are foreign-owned.

G. COMMUNICATIONS

1. Telecommunications

Public telecommunication facilities for domestic and international telephone, telex and telegraph service is provided by the Liberia Telecommunications Corporation (LTC), which has functioned as an autonomous commercial

enterprise since 1972. Several private systems were installed in the past because of the lack of public facilities. French Cables established Liberia's first international telecommunications service in 1910, and now operates an independent telegraph service. That service terminates at LTC's switchboard, as LTC controls the routing of all telephone and telex traffic.

A rudimentary telephone system was developed in the early 1960's to serve the basic requirements of the Government of Liberia. A major expansion was completed in 1965, consisting of the following components:

> A local network consisting of automatic exchanges and associated outside plants in Central Monrovia (2,000 lines) and Senkar (1,000 lines) and small capacity automatic exchanges at 9 other settlements;
>
> a national long distance trunk line network of a medium/low capacity tube type multichannel microwave/VHF system connecting Monrovia with local telephone exchanges and public telephones located in some towns along the trunk network; and
>
> high frequency international radio circuits for telephone, telegraph and telex service.

The exchange capacity in Monrovia was fully utilized within one year and there is a substantial waiting list for telephone installation. Long delays are frequently experienced due to heavy use, and the reliability of the service has been adversely affected by lack of routine maintenance. Problems occur because of lack of funds and shortage of trained personnel.

2. Broadcasting

The Liberian Broadcasting Company (ELBC) was established in 1949 by a private non-Liberian company. Only a radio station was operated until 1964 when a television service was added. The same year (1964) the Government of Liberia purchased the company. Service is limited and often unreliable, as the physical plant is modest and technically obsolete. The television transmitter serves only the Monrovia area and equipment failures are common.

H. UPPER BONG COUNTY STUDY AREA

Bong County lies in the central part of Liberia as shown in Figure 2. Two of the major trunk roads of the country run through the area and connect it with the northern and southern parts of the country as well as the coast. From Gbarnga, the county seat, it is 202 kilometers (125 miles) to the capital and main part of Monrovia. The study area is the upper portion of Bong County, and contains approximately 6,493 square kilometers (2,507 square miles), or 69 percent of the county's land area.

The County Superintendent is in charge of local administration, and is the district representative of the President of Liberia. Bong is divided into five districts: Gbarnga, Kokoyah, Salala, Sanoyie and Gibi. At the district

level the County Superintendent is represented by a district commissioner. In addition to the county administration, there is the traditional tribal system. Bong county is inhabited by members of the Kpelle tribe subdivided into chiefdoms and clans. Within the Upper Bong County study area, there are three districts, six chiefdoms and 28 clans (Fig. 5). The districts provide the administrative liason with the national government, while the chiefdom/clan provides the traditional leadership.

In this rural area, the family is the basic unit. Farmers do not normally move an extensive distance from their original homes and spend most of their time in subsistence farming. The farm family accomplishes most of the work, with the men clearing and burning the land and the planting/harvesting accomplished by the women. Above the family, the clans and chiefdoms form the major social structure.

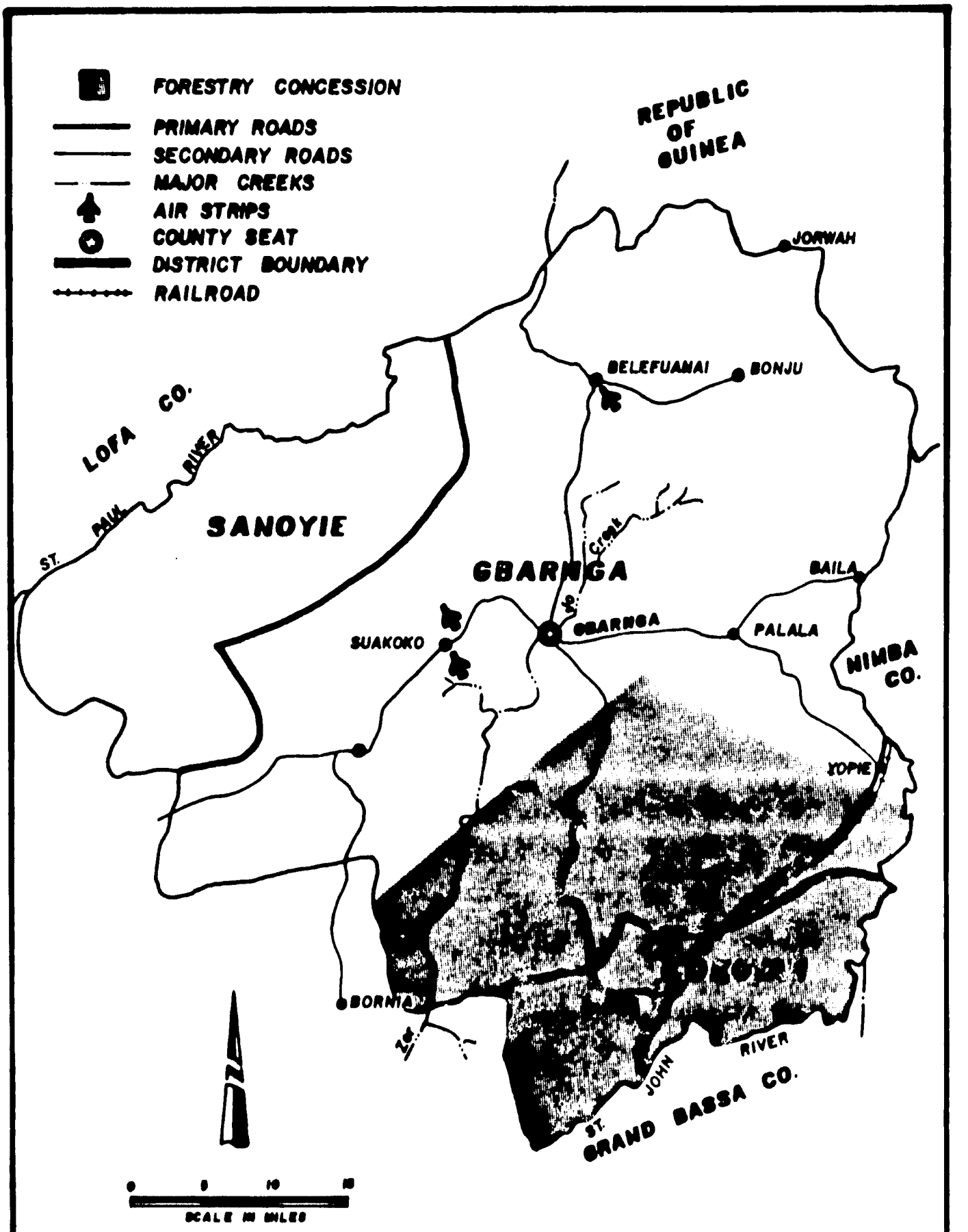


Figure 5. Upper Bong County, Liberia

II. EXISTING CONDITIONS IN UPPER BONG COUNTY

A. PHYSICAL CHARACTERISTICS

1. Physiography

Bong County along with Nimba County was created from the former Central Province. It is located in the central part of the interior of Liberia beginning about 65 kilometers (40 miles) northeast of Monrovia and extending to the Guinea border. The St. Paul and St. John Rivers form the northwest and southeast borders, respectively. The study area is the northeastern or upper portion of Bong County consisting of the districts of Gbarnga, Kokoyah and Sanoyie, which are administrative sub-units of Bong County (see Figure 5). The total area of the three districts is about 6,475 square kilometers (2,500 square miles). The area is approximately bisected by the major trunk highway extending from Monrovia on the sea coast of Gbarnga and the Guinea border. Upper Bong County is inhabited by approximately 140,000 people, of whom 80 percent are engaged primarily in agriculture, occupying about 18,000 individual farm holdings.

The greater part of Bong County consists of rolling uplands traversed by river valleys. Small areas are occupied by isolated high hills or low mountains, examples of which are the Gu Mountains near Gamu. In the northern half of the project area, there are very steeply dissected hilly regions especially around Toto Mountain. Characteristic landforms of the area are narrow, poorly drained valley bottoms in a densely distributed dendritic pattern with intervening hills generally about 30 meters (100 feet) above sea level near the Guinea border. Schulze (1973) describes this area as the upland and dissected plateau portion of the central or bleetro-nimba block of the nation. The northern part of the area shows a very distinct northeast, southwest alignment of ridges and valleys. This pattern is less well developed in the southern part of the study area.

2. Geology

The geology of Liberia is not complex, but it is rather unique. Of the four principal geologic eras (Table 5), the Precambrian (the oldest) and Cenezoic (the most recent) comprise the majority of geologic formations in Liberia. Most of Liberia consists of ancient Precambrian igneous and metamorphic rocks, such as gneiss and granite. During the 600 million years these rocks have been above sea level, the original fold mountains have been continually eroded, resulting in the present southwest-northeast ranges of residual mountains. Further denudation resulted in the formation of gentle erosional surfaces found in many parts of the country, especially along the coast. The mountain ranges and hills rising over these plains consist of resistant portions of hard diabase interspersed with iron ore.

During the Paleozoic era, volcanic activity resulted in magma (molten rock) filling cracks and faults in the earth's surface, dikes and veins. Some of this material is kimberlite, a rock formation containing diamonds.

TABLE 5. THE GEOLOGIC HISTORY OF THE EARTH IN RELATION TO LIBERIA'S GEOLOGY *

Era	Age (millions of years)	Duration (millions of years)	Characteristic Rocks and Minerals	Representation In Liberia
Cenozoic	Present 70	70	Sand, Loam, Gravel, Peat, Clay, Lignite	Lagoonal and coastal sands, River deposits, mangrove swamps, Diabase sills and dikes, Lateritic soils
Mesozoic	70 225	150	Chalk, Limestone, Red Sandstone	Diabase dikes, Kimberlite dikes?
Paleozoic	225 600	375	Diabase, Sandstone, Hardcoal, Slate	Volcanic intrusions, Diabase dikes, Kimberlite dikes? Diamonds
Precambrian	600 4600	4,000	Gneiss, Granite schists	Gneiss, granite schists, iron ore, (itabirite), gold

* From Schulze, 1973

Also formed during volcanic activity were intrusions of a coarsely crystalline rock known as pegmatite and other minerals forming veins and dikes of quartz which provide material for glass production. During the Mesozoic era, Liberia remained above the sea. Thus rocks, minerals, and associated products of economic importance dating from this period; i.e. salt, limestone and petroleum, are not present.

The Cenozoic era consisted of both arid and humid climatic conditions. During this period, the lateritic soils were formed. Somewhat later, the coast was periodically inundated by the Atlantic Ocean, depositing loose sand which extends as much as 16 kilometers (10 miles) inland. Coastal platforms were cut into the shore which, through local uplift, form the present raised beaches. More recent deposits, compose the clays, sands and gravels found in river beds or terraces. These sometimes contain alluvial gold or diamonds.

The specific project area is underlain by metamorphic and igneous crystalline rocks of Precambrian age, predominately granites and granitic gneisses. The predominate structural trend appears to be associated with folding, and these folds generally occur in a northwest-southeast direction. Other than some road and construction material, there are no mineral resources currently exploited in the study area. There are tentative plans for alluvial gold mining in the southern part of the area. Iron ore mining occurs in the Bong Range, southwest of the area, and the Nimba Range, northeast of Bong County.

3. Climate

a. Climate Classification

The tropical climate of the project area is characterized by moderately high temperatures, a high relative humidity, a rainy season from March through November and a dry season, during which rain may occur in small quantities. Records of temperature and rainfall are scarce and often imcomplete. It appears that the project area is somewhat drier than areas to the north (Ganta Mission) and south (Gibi Estate). If climatological information from Suakoko is used, the climate of the area can be classified, according to Koppen's classification, as Awi, a periodically dry, isotherm savanna climate. If data is used from the Gibi Estate, approximately 35 kilometers (22 miles) south of the study area, the climate can be classified as Ami, a hot, isotherm monsoon climate.

b. Temperature

The temperature in and around the project area is remarkably constant. Available data from Suakoko, Ganta Mission, Gibi Estate and Zorzor were analyzed (in many instances, only partial data were available). The mean monthly temperature varied only slightly. For 17 years of record at

Suakoko, the mean monthly temperature varied from 24 to 26 °C (76 to 79 °F), with a maximum recorded temperature of 29 °C (84 °F) and a minimum of 19 °C (67 °F). At Gibi Estate (13 years of records), the mean monthly temperatures ranged from 24 to 27 °C (76 to 81 °F), with a maximum and minimum recorded temperature of 28 °C (82 °F) and 23 °C (74 °F), respectively. Other data indicated similar variations, although temperatures at Zorzor were slightly lower because of the higher elevation of that town.

c. Precipitation

The only records of rainfall in the project area are those at Suakoko CAES for the period of 1951 to 1971. For 47 months of this period, records are not available, but for eight years a complete 12 month period was recorded.

To supplement these data, rainfall records of stations outside, but peripheral to the project area have been used. These stations are Ganta Mission, Zorzor and Gibi Estate. At Ganta Mission, the record period extends from 1951 to 1974, but for 28 months of this period no records are available, and a complete record exists for only 15 years. At Zorzor, records for a very short period (1954-1961) are available. For 27 months during this period, no data are given, while a complete 12 month record exists for only three years. At Gibi Estate, rainfall record from 1961 to 1974 are complete except for two months at the start of the series.

The mean annual rainfall at Suakoko, Ganta Mission and Zorzor has been estimated by adding the mean monthly rainfall figures. For Gibi Estate, the mean of 14 annual rainfall figures has been taken. The mean annual rainfall figures thus derived for Suakoko, Ganta Mission, Zorzor and Gibi Estate are 162, 231, 211 and 251 centimeters (64, 91, 83 and 99 inches) respectively.

It appears that a large part of the project area may have a considerably lower rainfall than the areas to the north and to the south. The possibility that the lower rainfall figure at Suakoko may have been caused by a systematic error due to the equipment utilized is not likely as the number of rainy days is also considerably lower at Suakoko than at Gibi Estate. Also, the project area has the appearance of drier conditions than in the areas to the north and south.

Because of missing data for the stations of Suakoko, Ganta Mission and Zorzor, the general trend of the annual rainfall at these stations cannot be determined accurately. However, from the records at Gibi Estate, it becomes clear that the past five or six years have had 15 to 20 percent less rainfall than the years in the early 1960's.

d. Weather Patterns and Storms

Between the Tropics of Cancer and Capricorn, a belt of clouds and rain called the Intertropical Convergence Zone (ITCZ) moves north and south with an annual rhythm following the latitude of the sub solar point with a time lag of about six weeks. This rain-producing feature is a broad belt within which ascending currents of air lead to the formation of clouds and rain. The moisture in the belt is supplied by southerly moisture bearing winds from the Atlantic Ocean (monsoon). From the northeast, dry winds blow toward this belt (harmattan). These winds are cold during the winter (in the north) and warm in the summer. In the monsoon part of the belt however, temperatures are more stable.

e. Mixing and Circulation

During the dry season, the atmosphere is extremely stable with very little vertical mixing. Haze is prevalent, especially when smoke from land burning is confined within the lower few feet of the atmosphere. Vertical mixing associated with rain squalls increases the atmospheric mixing activity during the rainy season.

4. Soils

a. General

One of the major factors associated with an agricultural improvement project is the potential of the soil to be utilized for crop production. In this regard, various reports were reviewed and analyzed by previous studies of the project area (Agrar-Und Hydrotechnik, 1975). Soil tests were conducted and an analysis made of the potential land uses. To understand the soil types and classification, it is necessary to review the specific factors which led to the formation of the soils in the study area; climate, parent material, vegetation, physiography and time.

The climate is characterized by high temperatures, a long rainy season and a shorter dry season. The combination of this climate and parent material of Precambrian crystalline rock (mostly granite) has resulted in the formation of deep lateritic soils. (Laterite is irreversibly hardened plinthite, a highly weathered mixture of sesquioxides, clay, quartz and various other materials, poor in humus.) Vegetation protects the top-soil from excessive drying, protects the soil from erosion, produces organic material and promotes biological activity in the soil. The factor of time reflects itself in the different soil conditions in the uplands and the valley bottoms. The former are older and more deprived of nutritional elements.

The physiography of the area plays an important role in soil formation. The formation of plinthite requires not only a warm climate, but also a fluctuating groundwater table. All topographic situations that favor

such a fluctuation will also promote plinthite formation. With regard to the project area, the following land forms can be distinguished:

(i) Valley bottoms; A dense dendritic pattern of valley bottoms dissects the land, and most contain narrow alluvial overflow plains with very high groundwater table throughout the year. Generally, they do not have plinthite. The wider valleys consist of narrow alluvial overflow plains and low terraces. These terraces are characterized by a strong fluctuation of groundwater table. In many soils of these terraces, plinthite occurs.

(ii) Dissected uplands; The undulating to strongly rolling topography has been caused by a continuous erosion of the old Precambrian base complex. The dense dendritic drainage pattern has led to an irregular and dissected topography. The combination of high precipitation and forest vegetation have probably affected the formation of a series of convex slopes which facilitates run-off.

The convex forms are characterized by very deep soils with thick layers of very hard, knobbly laterite gravel, with some plinthite below it. The concave slopes at the foot of the convex forms have gravel-free soils with plinthite in the deeper soil horizons.

(iii) High hills; Hill ranges and isolated hills ("Inselbergs") occur frequently and have steep to very steep slopes. Generally, the soils are free of gravel and plinthite and may have many weathered rock fragments.

b. Soil Types and Properties

Soil formation has led to the presence of an oxic horizon, plinthite and laterite (irreversibly hardened plinthite) in most upland soils of Upper Bong County. According to the USDA system of soil classification, these features can be defined as follows:

(i) Oxic Horizon; A subsurface horizon that, among other characteristics, is at least 30 centimeters (12 inches); has only traces of primary abiminosilicates such as feluspars, micas, glaso and ferromagnesian minerals; has only traces of water-dispersable clay in some subhorizons; has texture of sandy loam or finer in the fine-earth fraction and more than 15 percent clay; and has less than 5 percent by volume that shows rock structure.

(ii) Plinthite; A highly weathered mixture of sesquioxides, clay, quartz and various other minerals, poor in humus. It occurs as red mottles, usually in platy, polygonal and reticulate patterns, and hardens upon exposure to the air after repeated wetting and drying.

(iii) Laterite; Irreversibly hardened plinthite.

The soil forming process that leads to the formation of an oxic horizon is called laterization, ferrallitixation or, more recently, desilication. It includes the partial removal of silica and removal of nearly all the alkali and alkaline earth metals, showing the destruction of the primary minerals. Weathering is so extreme that virtually the only remaining minerals are quartz, zircon and similar highly insoluble primary minerals, hydrated iron and aluminum oxides, and the most resistant silicate clay minerals.

The soil forming process that leads to the formation of plinthite is called plinthization. It is strongly dependent on the possibility of redistribution of weathering products, especially iron. The redistribution of iron is strongly favored by alternative reduction and oxidation. In its turn, this is only possible if a fluctuating groundwater level or apparent groundwater level is present. Besides this mechanism, certain recrystallization processes will be necessary to give the plinthite its firmness.

By repeated wetting and drying, plinthite undergoes a process of irreversible hardening. The end product is laterite, of which many forms exist. The laterite that characterizes most soils of Upper Bong has a discontinuous structure. It occurs as concretionary or fine gravel horizons. The indurate elements are dark brown or black, very hard, generally 1 to 2 centimeters (0.4 to 0.8 inches) and have a knobbly form.

Utilizing the presence (or absence) of an oxic horizon, plinthite and laterite as criteria, soils can be divided into various groups. Of course, thickness of each, the presence of various minerals, etc., result in subclassifications or families. Fanfant (1972) grouped the soils of Liberia into soil families which were used as a base for the description of applicable soils in the study area. Valley bottom soils include the Dalia, Ngisakonja and Makona. Included in the upland soils are the Faya, Konjo, Weledu, Conrasadu and Sheloe.

Dalia soils are the most poorly drained parts of alluvial overflow bottoms. Generally, the soils occur in narrow, almost level valley bottom swamps with a water table at or near the surface throughout the year and are ponded during and some time after the rainy season. The soils are characterized by a dark gray muddy surface layer, consisting of a mixture of sandy clay loam and decomposing organic matter. However, the absolute percentage of the latter is relatively low. At somewhat greater depth, usually between 30 to 51 centimeters (12 to 20 inches), the dark muddy surface layer changes into light gray fine sandy loam or fine loamy sand followed by light gray or white loamy sand. Some soils show prominent yellow or olive brown mottling at moderate depth. Some Dalia soils have

a thick layer of partly decomposed organic matter, generally 64 to 102 centimeters (25 to 40 inches) thick, above a very sandy subsoil. The transition from organic material to sandy sub-soil is sharp. If cultivated, these soils may have or may develop a mineral topsoil with a high humus content. The Dalia soils support a vegetation which consists predominately of ferns, sedges and grasses in association with low trees and shrubby palms. Those valley bottoms where real organic soils prevail are mainly covered by ferns, sedges and grasses.

The Ngisakonja soils occupy poorly drained alluvial overflow bottoms. They receive a considerable amount of water as seepage and runoff from adjacent hills and have very slow external drainage. Consequently, the soils have a very high water table throughout the year and may be ponded during considerable periods of the rainy season. The predominating texture of this soil family is sandy clay loam, but loam and sandy loam were also found. At greater depth, the subsoil may become more sandy. The silt content of the soils occur on the alluvial terraces of the larger streams and have very different drainage conditions caused by considerable variations in the depth of the groundwater table. Hence, drainage conditions vary from well drained to imperfectly drained. In the peak of the rainy season, water logging periods occur. Generally, the soils have a uniform sandy clay loam or sandy clay texture. A striking difference between Makona soils and upland soils is the relatively high silt content of Makona soils indicating a less thorough weathering. The soils are acid and of relatively low fertility, although more fertile than the upland soils.

The Foya soils comprise most of the undulating, rolling and sometimes even low hilly landforms of Upper Bong. In particular, they occupy the relatively flat upper parts and convex side slopes of ridges and low hills. The slope at which Foya soils can be found usually varies from 2 to 30 percent. All Foya soils are well but somewhat excessively drained, depending on the degree of slope at which they occur. The soils have a topsoil with texture varying from sandy loam to sandy clay, with a sandy clay most common. The clay content may increase slightly with depth. Laterite gravel contents of 60 to 80 percent by weight are not uncommon, and the common size of gravel particles varies from 1 to 2.5 centimeters (0.4 to 1 inch). At greater depth, the hard black knobbly laterite gravel grades into hard red irregular iron nodules which overlay soft red iron nodules. At some places, the laterite gravel grades into a laterite layer of conglomeratic nature and limited extent.

The Konjo soils occupy small parts of moderately steep ridges occurring at slopes varying from 2 to 40 percent. They are very well drained, and laterite gravel often occurs at the surface. The upper portions of the soil may have a clay loam or sandy clay texture changing with depth to a sandy clay or clay texture. At greater depth, below the very graveling horizons, soils may have a much lower clay content and a much higher silt content resulting in loam or clay loam textures. This confirms the condition of less weathering and ferrallitization in the deeper soil layers. The Konjo soils usually have a thicker gravel layer than the Foya soils, i.e., 1.5 to 2.5 meters (5 to 8 feet). The gravel content is extremely high, commonly 80 percent with very hard black knobbly ironstone nodules, and at greater depth red nodules also occur. Usually, the Konjo soils do not have plinthite.

Weledu soils are typical on low, somewhat rounded hills and steep, pointed hills. The slope under which they occur often exceeds 30 percent. The small concave base of many ridges of the undulating and strongly rolling uplands have soils which are very similar to the Weledu soils of the hilly areas and, therefore, are included. The texture of the top portion is predominately sandy clay loam, but sandy loam is also found. With depth, the texture may remain constant or show an increase in clay content resulting in a sandy clay texture. The Weledu soils are free of laterite gravel; however, coarse fragments in the form of strongly weathered granitic rock are found in most of the hilly areas, sometimes starting at depths of 51 to 76 centimeters (20 to 30 inches). These strongly weathered rock fragments occur in association with fresh angular quartz gravel. Usually, the soils of the small gently sloping concave parts are free of granitic rock fragments. Quartz gravel, however, was found on various occasions, often as a stone line.

Two other soil families can be found in Upper Bong: Comasadu and Sheloe soils; however, the total area covered by these soils is very small. Comasadu soils occur on summits and steep slopes of high hills. They are formed in parent rocks rich in ferro-magnesian minerals, and the most outstanding characteristic is their dark or dusty red color. The texture is predominately sandy clay loam, and the clay content of the soil usually increases with depth, resulting in a sandy clay texture at somewhat greater depth.

The Sheloe family are the shallow and moderately deep soils over decomposing granite. They mostly occur on hill crests and steep slopes of high hills. The soils have a loamy texture and a high content of granite and quartz gravel.

In summary, these various soil families occur in different topographic and geomorphologic positions, and in certain sequence, depending on the landscape. The relation between soil families and landscapes is as follows:

(1) Dalia, Ngisakonja and Makona soils are characteristic of valley bottoms. Makona soils occupy alluvial terraces; Dalia and Ngisakonja soils occur in alluvial overflow plains.

(2) Foya soils occupy the convex sideslopes of the dome-shaped ridges and also the more or less extensive, almost level parts of flattopped ridges and their convex side slopes.

(3) Konjo soils occupy small top areas of somewhat higher and steeper ridges.

(4) Weledu soils are characteristic of steep hills. The small and gentle concave slopes (toeslopes) of the undulating to strongly rolling uplands have soils very much like the

Weledu soils of the steep hills, but without strongly weathered parent rock or rock fragments and with plinthite. They are included under the Weledu soils.

(5) Sheloe soils are characteristic of steep hills where they occur in association with Weledu soils.

c. Erosion Potential and Stability

A series of tests were conducted on the soil families in the project area in 1975 (Agrar-Und Hydrotechnik, 1975). These tests provided a basis for determination of erodability. The Dalia, Ngisakonja and Makona soils had very low erosion potential, as might be expected of the valley bottom soils. The erodability of the upland soils varied from low to very high and depended upon slope as well as soils. Foya and Konjo soils were rated low to moderate while Weledu soils varied from low to high, depending upon slope. Comasadu and Sheloe soils are relatively rare and occur on steep slopes. The erodability of these two soils was high to very high.

d. Agricultural Suitability

As a result of the soils investigation, an analysis was made of the suitability of the soils for agriculture use.

Locally, the Dalia soils are used for swamp rice which is the crop for which they are most suited. However, the high acidity and high iron content of the soil may be toxic to some crops and thus restrict usefulness of some of the land. Furthermore, the organic material or humus in the soil may oxidize if the soil is intensively drained. This could cause loss of soil bulk and even extensive land subsidence.

The Ngisakonja soils occupy poorly drained parts of alluvial overflow bottomland. The natural vegetation of these soils consists of ferns, grasses, sedges, low trees and shrubby palms. Within the study area, these soils are currently being used for the cultivation of swamp rice and are somewhat better for this crop than the Dalia soils.

Makona soils occur on the alluvial terraces of the larger streams. The vegetation of the Makona soils is determined by their drainage condition. The imperfectly drained soils have a vegetation which is very like the vegetation of the Ngisakonja soils, while the better drained Makona soils have a vegetation very similar to the uplands. Makona soils are used for a variety of crops: rubber, sugar cane and all crops common in shifting cultivation. The soils have a high potential for crop production, especially rice.

The Foya soils comprise most of the rolling hilly areas of Upper Bong County. They occupy the upper slopes and hillsides with gradients of 2 to 20 percent. The upper soil is generally a sandy clay loam with underlying lateritic gravel and iron nodules. These soils are very acid and of low fertility. They can be used for citrus, cashew and rubber

crops with some of the most gravel-free areas suitable for coffee and oil palm.

Konjo soils occupy somewhat steeper slopes and have a higher gravel content than Foya soils. Fertility is similar to that of the Foya soil, but the higher gravel content renders Konjo soils poor for root development and thus of low agricultural potential.

Weledu soils are similar to Foya soils without gravel but do contain fragments of decomposing rock. The fertility is generally a little better than that of Foya soils, and agricultural potential is similar.

Table 6 summarizes the characteristics and agricultural potential of these soils.

5. Air Quality

a. Dust

As a result of land clearing and construction, many areas of bare soil have been created where little previously existed. These areas are exposed to the elements, and dust is created particularly during cultivation. This source, however, is of minor significance when compared to the large amounts of dust caused by traffic and machinery upon existing roads. Most roads in the study area are constructed of laterite and as a result, clouds of red dust are created during dry weather periods. The prevalence of a thick coating of this dust on vegetation and buildings paralleling the roads of the region bears testimony to the extent of this pollutant problem.

b. Smoke

The standard agricultural method for clearing land in the study area is slash and burn. Large volumes of smoke are produced by this practice during the dry season and can be observed throughout the region as a significant addition to the natural haze condition. Smoke produced by trash burning, cooking fires and the curing of rubber adds to this problem. The results of smoke pollution can easily be observed by flying over the study area. During the dry periods, very little mixing takes place due to the lack of wind, and as a result, smoke mixed with natural haze occurs from approximately 152 to 610 meters (500 to 2,000 feet) above ground.

c. Other Pollutants

Throughout the survey of the study area, no control was noted for the emission of motor vehicles and other internal combustion engines. Since traffic is not particularly heavy, this does not present a major problem. However, in view of the stagnant pollution occurring during the dry season, even this minor pollutant contribution can be noted.

TABLE 6. SOIL CHARACTERISTICS AND PRODUCTION POTENTIAL

Characteristic	Soil Family							
	Konjo	Weledu	Comasadu	Sheloe	Dalia	Nigisakonja	Makona	Foya
Soil depth	very deep	very deep	very deep	shallow	very deep	very deep	very deep	very deep
Drainage	somewhat excessive	good to somewhat excessive	excessive	excessive	very poor	poor	good to imperfect	good to somewhat excessive
Erodability	moderate	low to high	high	very high	none	none	none	low to moderate
Stoniness & rockiness	none	locally boulders	none	boulders and rock outcrop	none	none	none	none
Texture								
Topsoil	sandy clay loam	sandy clay loam	clay loam	sandy clay loam	sandy clay loam	sandy loam	sandy clay loam to clay	sandy clay loam
Subsoil	clay loam or clay	clay loam or sandy clay	clay loam or clay	decomposing bedrock	org. matter loamy sand	sandy loam to sandy clay	sandy clay loam to clay	sandy clay loam to sandy clay
Gravel content	high	low	none to moderate	moderate	none	none	none	high
Water holding capacity	low to moderate	high	high	high	high	high	high	low to moderate
Fertility	low	moderate to low	moderate to low	moderate to low	low	moderate to low	moderate to low	low
Potential for Production								
Annual crops	poor	good	moderate	poor	none	none	good	moderate
Irrigated rice	none	none	none	none	moderate	good	good	none
Cocoa	poor	good	good	none	none	none	none	poor
Coffee	moderate	good	good	none	none	none	poor	moderate
Rubber	good	good	good	poor	none	none	moderate	good

There is little industrial pollution in the regions since most industrial development has occurred at the mines and in the area along the coast, particularly in Monrovia. One major exception is the 7,200 ton per year rubber processing plant at Gbarnga owned by the Liberia Rubber Processing Corporation. There are no existing data as to the extent of pollution caused by this industry. However, as has been indicated, any additional pollution during the dry season is significant due to the particular climatic conditions of the area.

d. Summary

The air quality of the study area ranges from good to poor depending upon the climactic conditions and time of year. During the rainy season, the air is relatively pure. During the dry seasons, when little mixing takes place in the atmosphere, the air quality is poor. The chief contributors to air pollution throughout the study area are smoke and lateritic dust.

6. Surface Water Resources

a. Hydrologic Characteristics of Rivers

The project area is part of the watersheds of two major rivers (St. John River and St. Paul River) which flow in a southwesterly direction. Both watersheds are intersected by numerous perennial and ephemeral streams of varying sizes. No extensive flow data is available for any of these streams, so expressed data must be considered as approximate only, unless otherwise noted. The rivers strongly erode the V-shaped valleys in the upper courses, while accumulating sand and gravel in the lower courses (Schulze, 1973). During the rainy season, the sandbanks shift almost daily, particularly after heavy rainfalls. Both the St. John and St. Paul contain numerous rapids, rocks, and waterfalls.

The St. Paul River flows along the northwestern boundary of Bong County. It drains approximately 21,911 square kilometers (8,460 square miles), of which 12,950 (5,000) lies in Liberia. The discharge of the river is typical of Liberian streams, varying greatly from one season of the year to another. Records from the Mt. Coffee hydroelectric plant near the mouth of the river indicate the flow may be as low as 2,000 cfs (cubic feet per second) during the dry season, and reach 100,000 cfs at the end of the rainy season. The average monthly discharge at Mt. Coffee is shown in Table 7. Generally, flow rates increase from February to September and decrease from September to February. With a minimum recorded discharge of 2,010 cfs, the volume in the St. Paul river during dry season, is exceeded only by the Cavalla River forming the border between Liberia and The Ivory Coast, with 3,000 cfs (Schulze, 1973).

The St. John River flows along the southeastern boundary, draining much of the study area. Zo Creek, the major stream in Upper Bong County is one of its tributaries. The river has a drainage area of about 17,224 square kilometers (6,650 square miles), 86 percent (14,763 square kilometers) of which lies in Liberia. The characteristics of the river are

TABLE 7. MEAN MONTHLY DISCHARGE RATES IN CUBIC FEET/SECOND
ST. PAUL AND ST. JOHN RIVERS

Month	St. Paul River @ Mt. Coffee*	St. John River @ Balia**
January	5,600	1,900
February	3,600	1,200
March	3,800	1,300
April	4,700	1,300
May	9,750	2,400
June	15,250	4,200
July	23,500	6,200
August	35,500	9,600
September	50,000	12,000
October	37,300	11,000
November	24,800	5,600
December	12,000	3,300

* Schulze, 1973

** Agar and Hydrotechnik, 1975

similar to those of the St. Paul River; sand islands, rocks and crags, rapids and waterfalls. The falls near Bo are well known because of their size. Three waterfalls rush over a 152 meter (500 foot) diagonal bar at a height of 18 to 21 meters (60 to 70 feet). The minimum recorded flow at the falls was 828 cfs in 1961 (Schulze, 1973). Mean monthly discharge data for the St. John River at Baila, which is on the eastern boundary of the study area, were calculated from records and are shown in Table 7.

No data are available regarding flow characteristics of Zo Creek. Some preliminary data exist on Jo Creek, a tributary of Zo Creek at Gbarnga. These date indicate that the creeks begin running in June-July, and maximum discharges occur in September-October. During the dry season, the creek or portions thereof, may be dry. The flow characteristics of Zo Creek should follow a similar pattern.

b. Hydrologic Characteristics of Swamps

The distinction between basins on smaller perennial and ephemeral streams and swamps on the major rivers is somewhat vague. In Liberia, the term "swamp" is usually applied to all bottomland of valleys, whether this is permanently waterlogged or not. In the project area, three types of swamp could be distinguished: swamps which are permanently waterlogged, swamps which dry up during the dry season, and swamps which are generally dry but which may occasionally become saturated during the rainy season. The permanently saturated swamps usually have a predominantly grassy vegetation, with tree density increasing as saturation decreases. Since the amount and distribution of rainfall is virtually equal in any one area, the decisive factors determining formation of a swamp are its topography, drainage conditions and soils plus the vegetation of its drainage basin. The three categories of swamp total about 12 percent of the study area.

A portion of the swampland is presently used for the growing of rice. The water necessary for growing this rice is supplied by rain and runoff from upstream catchment areas. During the dry season, however, practically all water has to be supplied from catchment areas still containing water. Discharge from such areas may become low or cease between January and April.

The Agrar-Und Hydrotechnik report (1975) concludes that it is usually impossible to grow a dry season rice crop because of the lack of water in the early part of the year when a dry season crop is flowering and, therefore, has great need of water. Of course, it must be realized that the swamps reclaimed at this time are swamps which are rather dry, because they can be more easily prepared for rice growing than very wet swamps. However, field team observations at improved swampland with impoundment facilities in the Fava area and at Suakoko confirm that it is possible to grow dry season crops with proper swamp improvement and management.

c. Surface Water Quality

Quantification of existing surface water quality throughout the project area (Upper Bong County) is somewhat restricted because of a complete absence of historical water quality data and because of the necessarily limited number of water samples taken and analyzed for the purpose of this report.

Due to the lack of historical water quality data, a limited sampling program was initiated to characterize the major water resources which could receive impact from implementation of the project. Five grab samples were collected from the major rivers, lakes and swamps within Bong County and one sample from Nimba County near Yekapa. Figure 6 depicts the location of all sampling stations, and a description is shown in Table 8. Samples were analyzed for dissolved and suspended solids and salts, nutrients, metals and pesticide content. Results of these analyses are summarized in Table 9.

Dissolved Oxygen, pH and Temperature - These chemical and physical parameters were measured in the field due to their unstable nature. Values for dissolved oxygen (D.O.) ranged from 7.6 mg/l to 9.0 mg/l with an average of approximately 8.5 mg/l. pH values tended to be slightly acidic, in the range of 6.0 to 6.5. Water temperatures were relatively consistent between 25° C. and 30° C. The above reported values of pH, D.O. and temperature for stations 1 through 6 indicate acceptable limits of these parameters for sustaining aquatic populations and general usage, except for the slightly low pH values. The United States EPA (proposed) water quality criteria specify a pH range of 6.5 to 9.0 for freshwater aquatic life.

Suspended Solids, Dissolved Solids and Total Solids - Samples collected for general analysis (includes most physical parameters) were available for site Nos. 02, 04 and 06. General samples were not collected at site Nos. 01, 03 and 05 due to logistical and sampling difficulties. Values of total suspended solids and total solids were highest at site No. 02 (experimental paddy) with concentrations of 95 mg/l and 200 mg/l, respectively, while site No. 06 (St. John River near Mela) showed the lowest values of TSS and TS with concentrations of 2.0 mg/l and 15 mg/l, respectively. TSS and TS data for site No. 04 (swamp at St. Paul headwaters) were intermediate between the above extremes. With very limited data available, few generalizations about this factor can be made. The above data do confirm to some extent the fact that most surface waters in the area are polluted by suspended solids due to high annual precipitation, cropping techniques and soil characteristics (AID, 1976).

Specific Conductance, Turbidity and Alkalinity - Values of conductance, turbidity and alkalinity were highest at site No. 02 (experimental paddy) and approximately equal and substantially lower at the two remaining sites, Nos. 04 and 06. Values of specific conductance varied from 54 $\mu\Omega$/cm (site No. 04) to 154 $\mu\Omega$/cm (site No. 02), while turbidity values

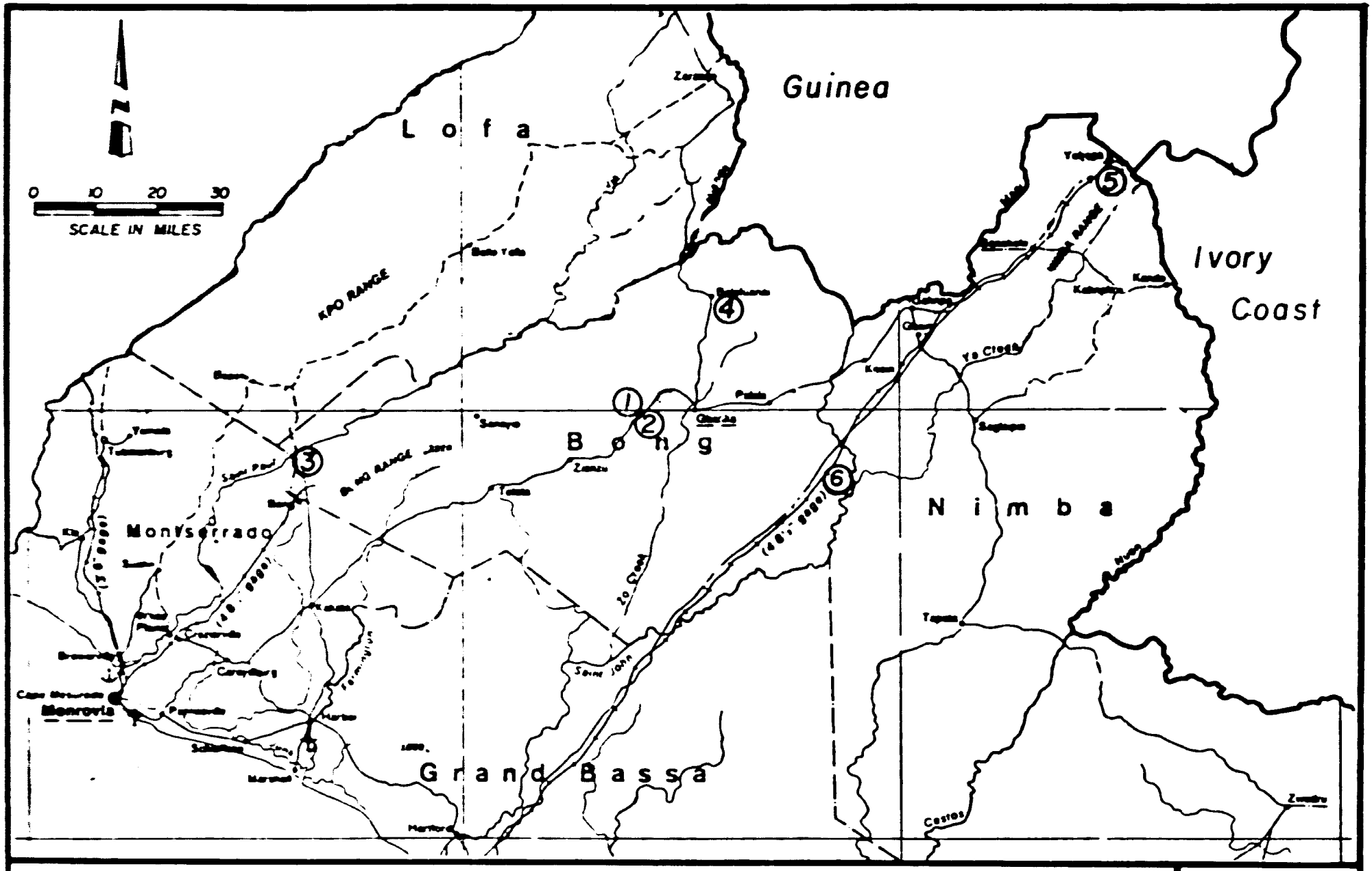


Figure 6. Location of Water Quality Sampling Stations.

TABLE 8. DESCRIPTION OF WATER QUALITY SAMPLING LOCATIONS

Sample #	Type of Water Resource	Location
1	Tubman Water Supply Lake	Agriculture Research Station at Suakoko, Bong Co.
2	Experimental Paddy	Agriculture Research Station at Suakoko, Bong Co.
3	St. Paul River backwater	West end of Bong Co. near Bong Mine
4	Swamp	Headwaters of St. Paul River near Belefani
5	Branch of St. John Headwaters	Near Yekepa, Nimba Co.
6	St. John River	Eastern end of Bong Co. near Mela

TABLE 9. WATER QUALITY SAMPLING DATA

Parameter	Units	Sample # 01	02	03	04	05	06
Alkalinity	mg/l	-	62	-	21	-	17
Chloride	mg/l	-	1.0	-	1.0	-	2.6
Diss. Oxygen	mg/l	8.5	9.0	7.8	7.6	8.8	9.8
pH		6.3	6.0	6.0	6.5	6.1	6.2
Specific Conductance	μΩ/cm	-	154	-	54	-	61
Sulfate	mg/l	-	1.3	-	0.0	-	<0.2
Total Suspended Solids	mg/l	-	95.0	-	10.0	-	2.0
Total Solids	mg/l	-	200	-	76	-	15
Turbidity	JTU*	-	32	-	15	-	28
Nitrogen, Ammonia	mg/l	0.16	9.40	<.01	0.03	<.01	<0.05
Nitrogen, Nitrate	mg/l	.244	.044	.042	.139	.302	.301
Nitrogen, Nitrite	mg/l	.008	.023	.011	.016	.002	.006
Phosphate, Total Ortho	mg/l	.016	.027	.022	.008	.005	.019
Phosphorus, Total	mg/l	.030	.141	.035	.016	.011	.030
Cadmium	mg/l	0	0	0	0	0	0
Calcium	mg/l	1.86	6.90	2.54	3.22	0.70	2.83
Chromium	mg/l	0	0	0	0	0	0
Copper	mg/l	0	0	0	0	0	0
Iron	mg/l	2.14	2.06	0.71	6.05	2.84	1.14
Magnesium	mg/l	0.80	3.66	1.45	1.65	0.85	1.95
Nickel	mg/l	0	0	0	0	0	0
Potassium	mg/l	2.01	0.71	1.79	1.23	0.67	3.02
Sodium	mg/l	2.3	4.7	3.2	3.6	0.5	3.1
Zinc	mg/l	0	0	0	0	0	0
Organochlorine Pesticides	μg/l	-	<1.0	-	<1.0	-	<1.0
Organphosphorus Pesticides	μg/l	-	<1.0	-	<1.0	-	<1.0
P-nitrophenol	μg/l	-	<0.1	-	<0.1	-	<0.1

* Jackson Turbidity Unit

ranged from 15 JTU (site No. 04) to 32 JTU (site No. 02). The above data confirm a pattern of higher than usual concentrations of most parameters at site No. 02. This can probably be explained by the agricultural nature of the site and the addition of fertilizers and other related products.

Chloride and Sulfate - Levels of chloride and sulfate ion in area waters appear to be extremely low, possibly due to the lack of widespread fertilizer usage and the chemical characteristics of area soils. Chloride levels ranged from 1.0 mg/l (site Nos. 02 and 04) to 2.6 mg/l (site No. 6), while sulfate levels ranged from less than 0.2 mg/l (site Nos. 04 and 06) to 1.3 mg/l (site No. 02).

Nutrients - Levels of nutrients for surface waters in the project area are generally low, with only nitrate exhibiting concentrations of 0.1 mg/l or greater, except at site No. 02. Site No. 02 had the highest level for four out of five nutrients tested, probably due to the liberal addition of fertilizers. Generally low levels of nutrients in area waters was anticipated due to the nutrient poor condition of soils in the region and lack of widespread fertilizer application. Concentrations of ammonia nitrogen ranged from less than 0.05 mg/l (site Nos. 03 and 06) to 9.4 mg/l (site No. 02). Site No. 01 (Tubman Water Supply Lake) contained an intermediate ammonia value of 0.16 mg/l. Concentrations of nitrate nitrogen ranged from 0.042 mg/l (site No. 03) to 0.302 mg/l (site No. 05). The average nitrate concentration was 0.179 mg/l. Nitrite nitrogen concentrations were moderately low at all stations sampled, ranging from 0.002 mg/l (site No. 05) to 0.023 mg/l (site No. 02), with an average concentration of 0.012 mg/l. Total phosphorus concentrations also were generally low except for site No. 02 which exhibited the highest value of 0.141 mg/l. Total phosphorus values for all other stations ranged from 0.011 mg/l to 0.035 mg/l. Total orthophosphate concentrations followed a pattern similar to total phosphorus concentration at approximately half the concentration (except for site No. 02 for which orthophosphate was approximately 20 percent of the total phosphorus present). Orthophosphate concentrations ranged from 0.005 mg/l to 0.027 mg/l (site No. 02) with an average value of 0.016 mg/l.

Metals - Analysis of Liberia water samples included the following metallic elements: cadmium, calcium, chromium, copper, iron, magnesium, nickel, potassium, sodium and zinc. Levels of cadmium, chromium, copper, nickel and zinc in all water samples analyzed were below the detection limits of the atomic absorption method and therefore were reported as 0 mg/l. Metallic elements showing positive values included calcium, iron, magnesium, potassium and sodium. Calcium concentrations ranged from 0.70 mg/l (site No. 05) to 6.9 mg/l (site No. 02) with an average concentration of 3.00 mg/l. The high calcium value at site No. 02 reflects the addition of fertilizers containing calcium. Concentrations of iron were moderately high and exceeded EPA proposed water quality criteria for aquatic life (1.0 mg/l). Concentrations of iron ranged from 0.71 mg/l (site No. 03)

154

to 6.05 mg/l (site No. 04) with an average value of 2.49 mg/l for all stations. These moderately high iron concentrations are chiefly a reflection of the iron-rich nature of the soils in the surrounding watersheds. Magnesium concentrations were moderately low and ranged from 0.80 mg/l to 1.95 mg/l, with an average value of 1.73 mg/l. Concentrations of sodium and potassium were in the range of 0.5 to 5 mg/l with average concentrations of 2.9 mg/l and 1.57 mg/l, respectively.

Pesticides - Pesticide samples were collected at station Nos. 02, 04 and 06, shipped to Dallas, Texas, and analyzed for three classes of compounds; organochlorine, and organophosphorus pesticides, and p-nitrophenols. Results of the analysis (contained in Table 9) showed that background levels for the above classes of compounds are less than the detection limits for the standard GC electron capture method. Organochlorine and organophosphorus concentrations were less than 1.0 μg/l while concentrations of p-nitrophenol was less than 0.1 μg/l in all samples analyzed. The lack of detection of pesticides and p-nitrophenol compounds in project area surface waters results from the low level of pesticide and chemical usage in present agricultural practice.

From the initial limited sampling of project area surface waters, generalization about the overall water quality may be made. However, an extensive sampling program would be required to thoroughly quantify water quality and locate the areas and cause of excessively poor quality. In making generalizations from the data of site Nos. 01 through 06, it must be realized that site No. 02 (experimental paddy) does not reflect natural conditions that may exist in other similar water resources due to the experimental nature of the system and chemical usage within the area. Concentrations of most chemical parameters analyzed were moderately low and within US EPA standards for human consumption and aquatic life propagation. Chemical parameters which possibly could present problems for human consumption or aquatic life are total suspended solids, iron and pH. Moderately high values of suspended solids and iron, as well as slightly low pH values, reflect directly on the area soil conditions and may be considered as natural background levels, contributed to in some degree by the cropping techniques of the area. Manmade pollution results primarily from sewage disposal inadequacies and land use.

d. Present and Potential Use

Little use is presently being made of the major rivers and creeks, except for subsistence fishing and water supply by the population of villages located near the streams. No major towns in the study area are located on the St. Paul or St. John Rivers; however, Gbarnga is located on Jo Creek. A hydroelectric plant is located at Mt. Coffee, near the mouth of the St. Paul and outside the study area. Mining operations, also outside the study area, use water for various purposes. In the study area, use of surface water is primarily domestic, and the potential uses are somewhat limited. Shifting sandbars, waterfalls and rapids make commercial navigation impracticable. Some hydroelectric power potential

is available on the St. John because of the steep descent of the stream; however, it is distant from areas of significant consumption.

The lack of appropriate topographic maps and sufficiently reliable discharge data are major difficulties in irrigation potential assessment. The absence of sufficiently detailed topographic maps prohibits the selection of irrigatable areas and of sites for intake and other structures. The lack of reliable data on river discharges throughout the year makes it impossible to determine the quantity of water available for irrigation.

7. Groundwater Resources

a. Aquifer Characteristics

The prevailing bedrock throughout the study area is crystalline igneous metamorphic rock, with almost no inherent permeability. Therefore, most of the effective bulk permeability of the subsurface is due to the presence of fractures and crevices. The yield of a well drilled at any point depends on the number and size of the fractures intercepted. In addition, there are no sizeable deposits of gravel or sand in the river valleys which might serve as alluvial aquifers and provide a dependable yield of groundwater. This lack of groundwater is substantiated by a report on the future water supply for the town of Gbarnga which concluded that even for the quantity of water required for that town, there were no adequate aquifers in the area, and groundwater catchment was impossible because of geological and hydrogeological conditions.

b. Groundwater Quality

No specific information exists on the quality of groundwater. When wells are dug for domestic use, however, they frequently become contaminated because of location, misuse, etc.

c. Present and Potential Use

Current groundwater usage is almost exclusively for domestic purposes, usually from wells dug near villages. A review of the sparse data available indicates that groundwater cannot be considered as a major source of water supply for larger towns. The best groundwater potential appears to be increased domestic use from wells drilled near small villages.

B. ECOLOGICAL CHARACTERISTICS

1. Ecosystem Descriptions

a. Natural Forest

The original vegetation of Upper Bong County and most of the rest of Liberia consisted of a dense tropical forest. Nielsen (1965) refers

to this forest as "moist lowland forest" which covers a broad zone along the West African coast from Sierra Leone to Ghana and from Nigeria to the Cameroons. All of Liberia, except relatively small areas of mangrove swamp forest and mountain vegetation, was covered with this moist lowland forest. To the north of the forest zone is a zone of "forest mosaic" which is transitional zone between the moist lowland forest and the savanna.

Voorhoeve (1965) divided the forests of Liberia into two major zones; the evergreen forest zone, and the moist deciduous zone. In both zones, edaphic (soil) factors lead to smaller units of forest; mangrove forest, swamp forest, and river border forest. There is no evergreen forest in Upper Bong County. With an annual rainfall of less than 2.54 meters (100 inches) and with a four month dry season, Bong County forests fall within the confines of Voorhoeve's moist semi-deciduous forest.

The original vegetation of Upper Bong County was moist semi-deciduous forest, river border forest, and swamp forest. Mangrove forest is not found since it is strictly coastal. Most of Upper Bong County consists of low rolling hills interspersed with shallow valleys. The soil on the hillsides is relatively well-drained, but that of the valleys is waterlogged for all or part of the year, creating differences in natural vegetation.

The difference between the moist semi-deciduous forest and the swamp forest is largely the degree and duration of differences of soil water in the two habitats. Tree species that thrive in or prefer waterlogged soil predominate the swampy valleys, and those preferring better drained soil predominate the hillsides.

The separation of these two types of forest is obviously not clear-cut, as the two extremes of soil water are connected by a continum of intermediate conditions. Also, some trees appear to be little affected by the soil water differences and are found in both habitats. The two forest types can be thought of as opposite ends of a spectrum, and divisions between the two are necessarily somewhat arbitrary.

The moist semi-deciduous forest, in its undisturbed or natural state, is composed of tall trees forming a canopy 30 to 50 meters (100 to 175 feet) high. The forest is stratified into layers from the canopy and emergent trees down to the herbaceous layer. Epiphytes and climbers are common, but ground cover is usually light, giving a characteristic open aspect to the forest. The number of tree species found in this forest is high, and includes the following important species:

Erythrophleum spp.	(Leguminosae)
Gilbertiodendron preussii	(Leguminosae)
Lophira alata	(Ochnaceae)

Parinari spp.	(Rosaceae)
Parkia bicolor	(Leguminosae)
Piptadeniastrum africanum	(Leguminosae)

A predominance of trees in the legume family can be seen in this list.

The trees of the swamp forest are not as tall as those in the moist semi-deciduous forest and are usually less than 30 meters (100 feet) high. Stratification is less obvious, and the ground cover species are usually more hydrophilic. The dominant tree species of the swamp forest include the following:

Alstonia boonei	(Apocynaceae)
Gilbertodendron splendidum	(Leguminosae)
Heritiera utilis	(Sterculiaceae)
Mitragyne ciliata	(Rubiaceae)
Nauclea pobeguini	(Rubiaceae)
Uapaca corbisieri	(Euphorbiaceae)
Raphia spp.	(Palmae)

The trees of the river borders are similar to those of the swamp forest, in that both are adapted to wet soil conditions. The river border forest is taller than swamp forest but consists of only a narrow band along the rivers and streams. It blends into the moist semi-deciduous forest a short distance from the river or stream. The more common river border trees are:

Cathormion altissimum	(Leguminosae)
Naucala pobeguini	(Rubiaceae)
Pandanus spp.	(Pandanaceae)
Pterocarpus santalinoides	(Leguminosae)
Raphia spp.	(Palmae)
Ricinodendron heudelotii	(Euphorbiaceae)

b. Secondary Vegetation

Little or none of the high forest of Upper Bong County can be classified as primary or virgin forest. Most of the forest is secondary and in various successional stages from abandoned field to mature secondary forest. During the last four centuries, the primary forest has been cleared by shifting cultivation. In this type of cultivation, the land is abandoned after short term use and begins to return to forest. The types of secondary vegetation, which form a more or less continuous series from newly disturbed land to mature high forest, are cultivated land, abandoned fields and secondary forest.

The cultivated land is used mostly for growing rice and cassava. After the forest is cleared and burned at the end of the dry season, rice is planted. An example of a recently cut field is shown in Figure 7. Only one crop of rice per year can be grown on the hillsides (upland rice), and during the second year, cassava may be grown. After the second year, the land is abandoned and new land is cleared. Cultivated land provides a habitat for many animal species that are adapted to the disturbed vegetation and crop plants. These species, such as weaver birds and various rodents, do not commonly occur in undisturbed forest, but thrive in the open fields of rice and cassava. Most of the native species of animals are eliminated from cultivated areas due to removal of their food sources and cover, or due to hunting by the villagers.

Plantation land is used for growing rubber, oil palm, cocoa and coffee. The trees are spaced at regular intervals with or without other species present. Plantations also provide a habitat for adaptable animals such as rodents and birds that may use the plantation for shelter and/or food.

When the fields are abandoned or when plantations are neglected, a series of successional changes occurs. Each change or stage becomes structurally and floristically more complex with taller vegetation. Abandoned land that is reused, often after a period of between 7 to 15 years, is classified as fallow. After initial cropping, the soil becomes deficient in minerals, but most of these minerals are restored during this fallow period when the vegetation is left undisturbed.

Secondary vegetation, when young, is often called "bush". This bush is a low forest with densely packed trees showing no layering or stratification. Heavy undergrowth provides shelter for many small animals such as rodents, snakes, mongooses, small antelopes and various small carnivores. The many small trees are species which thrive in open sunny conditions but are eventually eliminated when taller forest trees grow to shade them out.

When the "bush" becomes forest, it is called secondary forest and has various intermediate stages which are part of a continuum. The last stage is called high or mature secondary forest. High secondary forest is sometimes hard to separate from primary forest, but there are several

Figure 7. Field Cleared and Prepared for Upland Rice; CAES, Suakoko.

characteristics that serve to distinguish it:

General trees species composition;

the presence of several tree species associated with human habitation; and

the lack of well developed structure and stratification.

Secondary forest species usually require a certain amount of light for germination and early growth, and have small, readily dispersed seeds. This enables them to become established on abandoned land and other disturbed areas. Some of the common secondary forest trees are:

Amphimas pterocarpoides	(Leguminosae)
Fagara tessmannii	(Rutaceae)
Funtumia elastica	(Apocynaceae)
Ceiba pentandra	(Bombacaceae)
Terminalia superba	(Combretaceae)
Uapaca guineensis	(Euphorbiaceae)

When the forest matures, species with large, less readily dispersed seeds slowly invade the area. The seeds are able to germinate and grow on the shady forest floor, and eventually, the secondary forest species are replaced by primary forest species. At some stage of this process, mature secondary forest will be indistinguishable from primary forest. An example of mature secondary forest is shown in Figure 8.

c. Swamp and Marsh

The marshes and swamps covering much of Upper Bong County are in the early stages of successional development. The treeless marsh, so often encountered, is not a natural ecosystem, but the result of cutting down a swamp forest. Most of these marshes or swamps show little development of successional stages towards the original vegetation such as occurs in the drier areas.

The marshes are dominated by aquatic plants, grasses and sedges. The most common and dominant plant is the sedge Rhynchospora corymbosa. Also common are eddos (Colocasia sp.) which were either planted or are growing spontaneously. Pissava or white palms (Raphia spp.) are also common, probably representing a later successional stage in the development of the marsh or swamp. These palms eventually shade out much of the light-requiring ground vegetation below them. An example of disturbed marsh is shown in Figure 9.

Figure 8. Multi-layered Tropical Forest Canopy Northeast of Gbarnga.

Figure 9. Swamp Near Belefuanai.

Any undisturbed swamp forest would be found in association with primary forest but none was encountered in the reconnaissance of Upper Bong County. The marshes examined are or have been used for cultivation of swamp rice.

Animal life is rather scarce in the disturbed marsh. Because only one or several species dominate the vegetation, very little variety of food is available, while the marshy ground and lack of trees reduce the amount of cover and shelter available. The animals that can live in this habitat generally are the adaptable ones such as rodents.

d. Aquatic Habitats

Ponds, streams, rivers and swamp abound in the project area, particularly during the rainy season. These are found mostly in the shallow valleys common to Liberia and are often part of the previously discussed marshes. Some of these habitats, particularly the upper part of the St. Paul River, are heavily polluted by mining processes and other sources.

Generally, there is abundant life in the water. Many kinds of algae (e.g. Closterium, Synedra, Navicula, Gyrosigma, Achnanthes, Eunotia, Pediastrum and Scenedesmus) and aquatic vascular plants, along with decaying plants and animal matter, provide the base of the food chain. The numerous types of invertebrates (e.g. hydra, planaria, nematodes, etc.) feed on the plant material or upon each other. Higher up in the food chain are numerous species of fish (e.g. catfish, perch, carp, etc.) which provide important protein to the diet of the villagers. Larger animals such as otter and crocodiles (Crocodylus sp.) are found in aquatic habitats, but they are now uncommon or non-existent in Upper Bong County. At Yila, on the St. John River, crocodiles are occasionally shot for food by villagers.

Most important socially and economically are the invertebrates which act as intermediate hosts for parasitic organisms. Freshwater snails (Bulinus, Biomphalaria) are vectors for schistosomes. Various species of these snails inhabit moving or standing water. Mosquito larvae also are found in marshes, ponds or even puddles, and the adult female (Anopheles sp.) acts as the vector for malaria. The larva of the blackfly (Simulium sp.) lives in flowing water; the adult is the vector for onchocerciasis.

2. Unique and Sensitive Natural Areas

Very little natural or undisturbed vegetation remains in the project area. In other areas of Liberia such as the adjacent Nimba and Lofa counties, all types of ecosystems are less disturbed and more representative. Due to this disturbed nature of Upper Bong County, there are no particular areas that could be classified as unique or sensitive.

3. Threatened or Endangered Species

The number of species of wildlife found in Upper Bong County is relatively small due to the destruction of the primary forest during the last four centuries and hunting pressures. Most of the remaining wildlife in Liberia is restricted to high forest and inaccessible or undisturbed areas away from villages. Species found in the project area are mostly adaptable varieties that can survive or even thrive in the presence of man.

The total number of species of mammals recorded in Liberia is just over 100, while the number of species and subspecies of birds is over 280. There are also about 33 species of amphibians and 41 species of reptiles (Strong, 1930).

A small number of animals found in Liberia are considered endangered. The "Endangered and Threatened Wildlife and Plants" (U.S. Department of Interior, 1976), Federal Register Vol. 41, No. 208 lists the following six species whose ranges extend into Liberia:

1. White-necked rock fowl flycatcher (Picathartes gymnocephalus) found from Togo to Sierra Leone

2. Leopard (Panthera pardus) found from Africa to Asia

3. White collared mangabey (Cercocebus torquatus) found from Senegal to Ghana and Nigeria to Gabon

4. Chimpanzee (Pan troglodytes) found in West and Central Africa

5. Diana monkey (Cercopithecus diana) found in coastal West Africa

6. African dwarf crocodile (Osteolaemus terapsis terapsis) found in West Africa

Some of these may occur in the project area. Chimpanzees are frequently killed for food by villagers and young chimps captured for pets. One of the pets was observed at the village of Yila. It is doubtful if any chimpanzees occur in Upper Bong County, as they are nowadays found in high forest to the north of Bong County. The leopard may still occur in Bong County, but it is killed and eaten by the villagers. It is more likely to occur in the high forest of Nimba and Lofa counties. The other species on the list are likewise unlikely to be found in the project area, and none of the six species is endemic to Liberia.

Several other Liberian species are mentioned by the Federal Register (U.S. Department of Interior, 1977, Vol. 42, no. 35), as needing regulation in order to avoid the threat of extinction. These include the pygmy hippopotamus (which is found in Maryland County in southeast Liberia) and

the elephant. The elephant is not likely to be found in the project area, and excepting one pet, none were observed in the field reconnaissance. It is found in adjacent counties.

There are no species of plants in Liberia that have been recorded as endangered. A comprehensive study of the Liberian flora might reveal some species that could be so classified.

4. Commercially Important Species

The crops most important to the villagers of Upper Bong County are rice, cassava, bananas, yams and oil palms. With the exception of the oil palm, these are subsistence crops and little or no surplus is produced. In fact, Liberia still imports basic food such as rice just to meet its minimum requirements.

Most of the cash crops produced in Upper Bong County and in Liberia as a whole are from trees grown in plantations. These may be under individual or village ownership, but most cash crops are produced on plantations belonging to the government or to foreign concessionaires.

The following are the major commercial species grown in Upper Bong County:

(1) Rubber; The Brazilian rubber tree (*Hevea brasiliensis*) is the most important cash crop. It is the major agricultural export of Liberia, and before the advent of heavy mining of iron ore was the most important segment of the Liberian economy.

The trees are mostly grown on huge plantations in neat rows and columns on the rolling hills. The major concessionaire is Firestone, with the labor required to plant and care for the rubber trees, a major source of income for the villagers.

(2) Oil Palm; This palm tree (*Elaeis guineensis*) is grown for its fruits which are important for export as well as for the villagers' diet. The oil from the fruit is used for cooking and for making a form of butter. Two different oils are produced from the fruit. One is obtained from the husk, and the other is extracted from the kernel. These oils are exported for use in the manufacture of soaps and lubricants.

Oil palms are grown in plantations, but also occur around villages on cultivated land. They persist in secondary forest, and when the land is cleared and burned for cultivation, the oil palm trees are usually preserved.

(3) Coffee; The coffee tree (Coffea liberica) is grown in many parts of Liberia, but ranks far behind rubber in importance. Liberia grows less than 1 percent of the world's output. Unlike rubber and oil palm, coffee is not grown in monoculture but grows under other taller trees, as it does best in somewhat shaded conditions. The coffee beans are collected and sent to Monrovia for export.

(4) Cocoa; The cacao tree (Theobroma cacao) is grown from the beans contained in pods affixed to the trunk. The extent of cocoa cultivation is limited to the distribution of the specific soil types on which it thrives and Liberia produces less than 1 percent of the world's output.

(5) Timber; The harvesting of timber is a major factor in Liberia's economy, but is a limited resource, as there is relatively little suitable high forest remaining. Lumbering is of little importance in Bong County due to insufficient area of high forest. It is much more important in neighboring Lofa and Nimba counties. During lumbering, several trees such as African mahogany (Entandrophragma sp.), ironwood (Lophia alata) and African walnut (Lovoa sp.) are selectively cut in these forests, leaving much of the remaining forest relatively undisturbed, but lacking in commercial value.

5. Vectors

There are a number of indigenous vector-transmitted parasitic diseases in Liberia. A vector organism serves as an intermediate host of the life cycle of the parasite and as the agent of transmission from one primary host to another. The parasite has a complex life cycle with part of its development in the intermediate host and part in the primary host. Since the occurrence of the disease is directly related to the abundance of the vector, the impact of this project on vectors is an important consideration. The most important vector-transmitted diseases in Liberia are malaria, schistosomiasis, onchecerciasis, trypanosomiasis, filariasis, and Lhasa fever. The vectors and diseases are briefly discussed below.

a. Molluscan Vectors

Freshwater snails act as vectors for schistosomiasis and inhabit pools, ponds and sluggish streams. The snail Bullinus truncata and related species serve as vectors for Schistosoma haematobium while Biomphalaria sp. is the vector for S. mansoni. Transmission occurs when a human swims or wades in water containing infected snails.

b. Insect Vectors

The adult Anopheles mosquito is the vector for malaria and in Liberia the predominant species is A. gambiae. Malaria has the highest frequency among communicable diseases in Liberia and constitutes a severe problem.

The main type is Plasmodium falciparum malaria which is also the most clinically severe of the four which affect humans. Transmission occurs when infective stages of the parasite are injected along with saliva as the mosquito takes a blood meal. The larvae of Anopheles are found in standing water such as ponds, pools, puddles, wells and even tin cans or similar containers.

The blackfly Simulium damnosum acts as the vector of onchocerciasis which is caused by the filarial worm, Onchocerca volverlis. The blackfly larva is aquatic and found on the bottom of flowing streams. Transmission occurs during feeding by the blood-sucking adult flies.

A variety of species of the genera Culex, Anopheles, Aedes and others may serve as the vector for filariasis. This disease is also caused by a filarial worm, Wuchereria bancrofti, and is commonly called elephantiasis. The mode of transmission is similar to that of malaria.

The tsetse, Glossina palpalis, is the vector for Trypanosoma gambiense which is the causitive agent of trypanosomiasis (sleeping sickness). The tsetse does not have an aquatic larva and transmission occurs during adult feeding. While trypanosomiasis is not widespread in Liberia, the potential for a serious outbreak exists.

c. Rodent Vectors

A variety of rodent species can act as vectors for Lhasa fever. This viral disease is probably transmitted through human contact with rodent feces. This disease is often fatal and the potential for widespread incidence exists.

C. CULTURAL CHARACTERISTICS

1. Land Use

The project area comprises 600,000 hectares (1,482,000 acres) in Upper Bong County. Approximately 90 percent of the project area is broadleaf deciduous and evergreen forest. Most of this forest was previously cleared and cultivated and is now in a second growth stage. It is estimated that less than 2 percent of the study area contains primary forest which has never been cut and these parcels are small and widely disbursed. About 9 percent of the secondary forest has not been recently cut while the remaining forest has been cultivated within the past 10 years.

Of the 10 percent of land in cultivation, 70 percent is in tree crops (mostly rubber) while 30 percent is in annual crops (primarily rice and cassava). Annual crops are generally grown in a field from one to two years, and the land is then left fallow for five to ten years. This extensive shifting cultivation results in a continuous pattern of land clearing (slash and burn), land being cultivated and land being abondoned.

Urban areas are few and small and comprise less than 1 percent of land use in the study area. The largest town in the study area is Gbarnga, the county seat, which had a 1974 population of only 8,474. Most of the population resides in villages of from five to twenty families.

Future land use in the study area is expected to change only slightly from existing conditions, with one possible exception. A Swedish paper company has applied for a timber concession in the southern part of the project area. This concession would occupy 80,972 hectares (200,000 acres) as shown in Figure 5, resulting in the conversion of 14 percent of the study area from secondary forest to timber plantation. There also appears to be a growing interest by the farmers in obtaining private ownership of the land rather than tribal ownership. This probably results from an increasing awareness of population growth and the decreasing availability of land, as well as absentee farmers desiring to retain their farms.

2. Land Ownership

The ultimate land owner in Liberia is the national government. There are, however, two systems for land tenure; tribal land tenure and private land ownership. The government thus recognizes the traditionally based control excercised by the tribes, yet provides a means for purchasing land from the state.

a. Tribal Land Tenure

Under the tribal land tenure system, the family's access to the land is ruled by traditional laws and customs handed down by the tribe. A recognized member of a traditional group may occupy and exploit any piece of unoccupied land in accordance with individual tribal custom. Claims are established by marking trees or by digging holes into the ground. In a system of shifting cultivation where a new piece of land is cleared every year, strict rules are required in order to avoid argument. It is generally agreed that a man has priority of choice over a piece of land which has already been cultivated by him or his family ancestors, or which is adjacent to his present field.

Families try to avoid moving far from their present dwelling place, which is generally permanently occupied. Thus, a family will normally try to clear land in the neighborhood of its farm or village. Hence, inheritance of an area where a family's priority of choice is normally recognized is quite common. In this way, a more permanent right of occupancy is maintained than would normally be possible under an extensive system of shifting cultivation. The first priority is securing access to upland rice fields which are the most important in the common farming system.

If swamp rice is cultivated, a suitable piece of land may be cleared in or near the upland farm, or further away, depending on the availability of such sites. Decisions about cultivating natural swamps and the selection of such sites are usually made independently from upland site claims. A swamp that is chosen need not be adjoining, or even near the upland farm;

farmers do not usually move away from their present home in search of more swamp land elsewhere, as may be the case when upland rice sites are exhausted.

Permanent improvements on the land, such as tree crops, are recognized as being owned by the farmer by both tribal law and custom as well as the Liberian Land Laws. This provides a means by which farmers can secure an individual right over the land, although there is evidence that unless there is a serious land shortage, security of tenure is rarely a reason for the establishment of tree crop plantations.

Although tribal land tenure is somewhat flexible and allows for the improvement of farming practices in the near future, more secure forms of ownership will have to be introduced eventually. Farmers who can establish their land under a recognized title deed are, normally, more inclined to maintain soil fertility and to install permanent improvements on their farms. Furthermore, credit administration may be facilitated if farmers are given the opportunity to mortgage their land.

b. Private Ownership

The Public Land Law of Liberia (Section 30) provides a procedure for purchasing land from the State. This procedure is summarized as follows:

> The applicant must gain the consent of the tribal authorities to have the parcel of land deeded to him by the Government;
>
> the Paramount or Clan Chiefs issue a respective certificate to the District Commissioner;
>
> the District Commissioner must satisfy himself that the parcel of land in question is not a portion of the tribal reserve, that it is not otherwise owned or occupied, and forwards the certificate to the Land Commissioner of the county;
>
> the Land Commissioner certifies that the land in question is neither privately owned nor encumbered;
>
> a payment must then be made to the Bureau of Revenues for the value of land, at a minimum rate of $0.50 per acre;
>
> application and official receipt from the Bureau of Revenue are forwarded to the President of the Republic for approval and deed.

The "Public Land Law" does not necessarily prevent acquisition of land for speculative purposes, since the law contains no regulation to evaluate whether the application is in the best interest of the public.

The procedures of the law are too complicated for the average unsophisticated small farmer to exercise his prerogative for land ownership.

Tribal and agricultural customs are so deeply ingrained, however, that there is no evidence that land ownership would be preferred over current practice if the system were simplified.

c. Land Ownership in the Study Area

The present rudimentary system of land registration does not give a complete picture of the land tenure situation; however, a basic idea can be obtained from the results of the 1971 Agricultural Census. Four categories of ownership were registered in the Census; private ownership, tribal rights, squatter rights and tenants rights. Squatter rights are part of the tribal system and given to strangers within a tribal territory.

Utilizing these categories, land tenure in the study area can be approximated as follows:

	Cultivated Land %	Farmers %
Private ownership	49	18
Tribal land	44	62
Rented	2	6
Squatters/other	5	15
	100	100

Although nearly half of the cultivated area is in private ownership, only one fifth of the farmers are reported to have private title deeds. This shows a strong correlation between the size of farms and the ratio of private ownership. This is confirmed by comparing the tenure situation in different farm size classes. In the size class below 10 hectares (25 acres) per farm, the percentage of private ownership is only 17 percent; however, it is 64 percent of the size class above 10 hectares and 84 percent of the group of farms over 51 hectares (125 acres). As the vast majority of large farms consist of rubber plantations, this correlation is essentially the relationship between private ownership and land planted with rubber.

3. Social Structure

a. Tribes

The largest ethnic group (or tribe) in Liberia is the Kpelle and the six chiefdoms located in the project area belong to the Kpelle tribe. These chiefdoms are subdivided into 28 clans (Table 10, Figure 10). This tribal

TABLE 10. ESTIMATED POPULATION PER CLAN, PROJECT AREA[1]

Chiefdom	Clan	Population 1962[2]	Population 1974[2]
Jorquelle		52,300	66,000
	Bellequellie	1,900	2,600
	Garyia	6,400	6,500 } 3
	Tongbeyah[3]	-	1,000 }
	Gbarnshay	7,500	7,900
	Jorpool	5,200	6,600
	Jorquelle	5,000	10,700
	Kpatawee	3,200	900 } 3
	Kporyorquellie[3]	-	1,800 }
	Sheansue	4,300	6,100
	Suakoko	7,700	10,900
	Yaindawoun	2,600	3,400
	Zeansue	8,500	7,600
Kpai		11,300	16,500
	Waytuah	6,800	9,300
	Wolota	4,500	7,200
Zota		9,400	14,700
	Kpaquellie	3,600	4,800
	Zota	5,800	9,900
Panta		8,400	10,100
	Panta	7,500	6,100
	Wrunah	900	4,000
Kokoyah		7,900	11,200
	Bonwein	1,500	3,500
	Kokoyah	1,500	2,400
	Senwein	1,600	600
	Tukpablee	3,300	4,700
Sanoyie		14,000	16,500
	Bokumu	1,300	2,600
	Boryemah	1,700	1,700
	Dingmah	1,100	1,200
	Menquelloh	4,400	5,200
	Sanoyie	2,900	3,200
	Wallahun	2,600	2,600
Totals		103,300	135,000

1 The areas of chiefdoms and clans, and data based on these areas can only be considered as approximations due to intermarriages, migrations, shifting boundaries, etc.

2 Republic of Liberia. 1962 Census of Population. Monrovia, 1964.
Republic of Liberia. 1974 Census of Population. Monrovia, 1974.

3 The population figures of the Kporyorquellie clan (1,800 inhabitants) and the Tongbeyah clan (1,000 inhabitants) which registered for the first time in the 1974 census, were applied to the Kpatawee and Garyia clans respectively so that they can be compared with the data obtained in 1962.

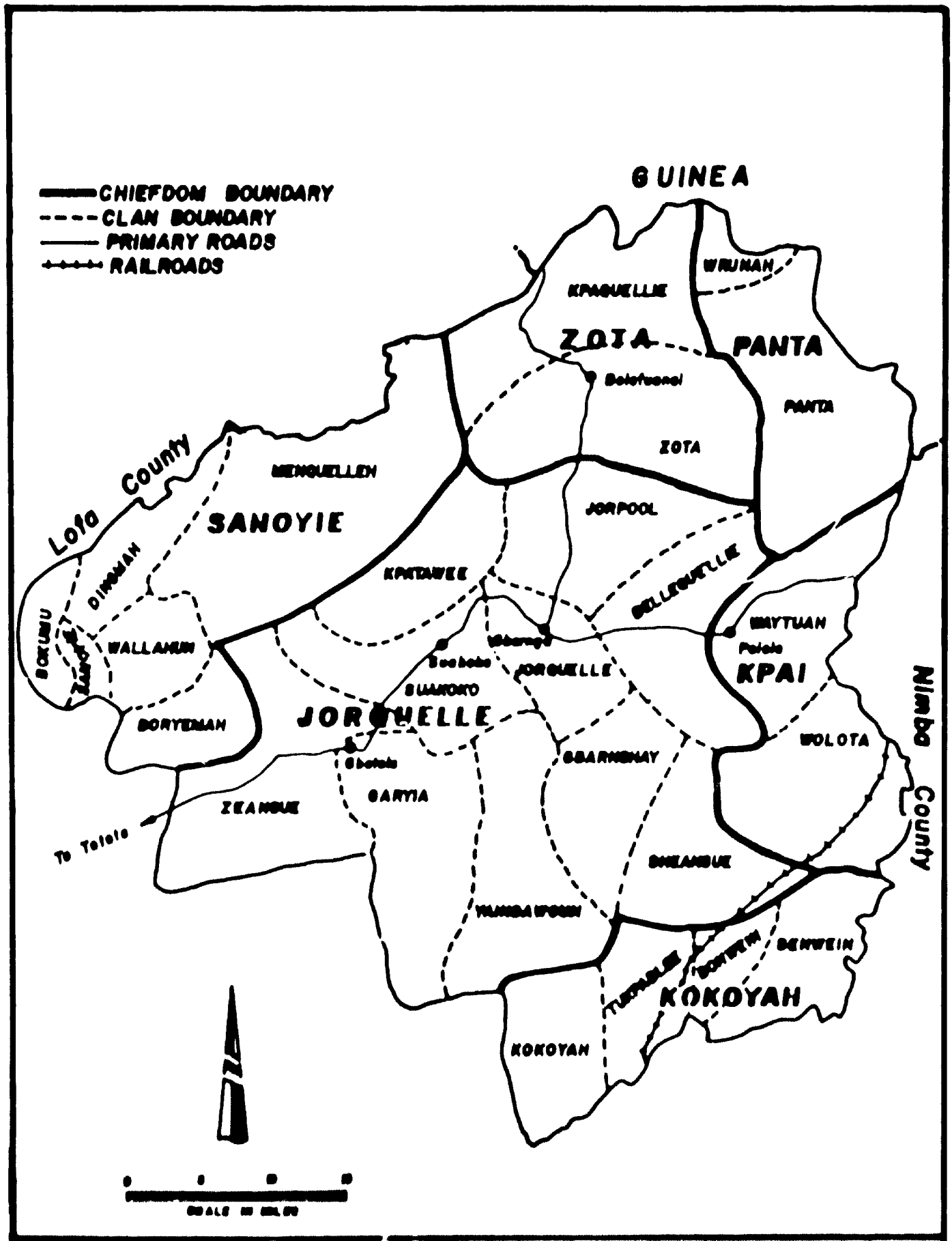


Figure 10. Chiefdoms and Clans of Upper Bong County
(Boundaries Approximate)

system provides most of the traditional administration and leadership in the area, and most of the land utilized by the farmer is occupied under tribal tenure rather than private ownership. The chiefs generally deal with the government, settle disputes, administer tribal justice, etc. While individuals usually associate themselves permanently with a specific clan, they sometimes shift allegiance because of intermarriage.

b. Villages

There are no towns in the project area with a population exceeding 10,000, and only one exceeding 5,000 (8,474). Smaller towns, exact population unknown, include Suakoko, Belefuanai and Palala. Thus, most of the population lives on farms, in half towns or in farm villages. Half towns are the smallest rural settlement, consisting of two to ten huts which are often periodically relocated to accomodate shifting agricultural patterns.

The farm village usually consists of twenty to forty houses depending on geographical location. These villages are usually connected by footpaths, if no roads exist. Criteria for the location of such villages formerly included proximity of a permanent water supply and defensibility, but the location of roads is now the primary consideration. As a result, there is a population density of as much as 100 persons per square mile along the highway between Monrovia and Gbarnga.

Thus, the farm family, the basic unit, is part of a social structure which is traditional and based lineage. The farmer is associated with a village when he trades, and with a clan/chiefdom/tribe.

c. Population

The 1974 population of the study area by clan is shown in Table 10, and totaled 135,000. This indicates the annual growth rate from 1962 to 1974 was 2.2 percent. This growth rate is calculated in accordance with methods adopted by the Liberian Ministry of Planning and Economic Affairs, utilizing the formula:

$$\text{Annual growth rate} = \frac{2}{n}\left(\frac{Pn-Po}{Pn+Po}\right)$$

where

Po - Population in 1962
Pn - Population in 1974
n - Number of years, 12

Using this annual growth rate, the population at the end of 1976 would be approximately 141,000. Generally, migration of the Kpelle tribe is about 0.4 to 0.6 percent per year. Therefore, adjusting for out-migration, the population of the study area at the end of 1976 was estimated to be 140,000. This represents almost 70 percent of the total population of Bong County and about 9 percent of the total population of Liberia.

The population density of 22 persons per square kilometer (56 persons per square mile) is considerably greater than the whole of Liberia (1976 estimate of less than 16 persons per square kilometer).

The population densities vary greatly among individual clans and chiefdoms. In the Jorquelle Clan, each square kilometer was inhabited by an average of 66 people, whereas in the sparsely populated Senwein Clan, there were only about 3 people per square kilometer. The densely populated Jorquelle and Suakoko Clans are both located along the main road, but so are the more thinly populated Bellequellie, Sheansue, Garyia and Kpaquellie Clans. Conversely, the very densely populated Bonwein Clan in the Kokoyah Chiefdom lives far from the main roads. Thus, the location of the main road does not appear to be the dominant factor in the distribution of the population in the area. No natural reasons for the population distribution can be detected within the Project Area since the area on the whole is rather homogeneous as regards its topography, its soil quality and vegetation. Therefore, the present distribution must be attributed mainly to traditional developments typical of each individual clan.

From 1962 to 1974, the population in the Project Area increased at an annual growth rate of 2.2 percent. Within the same period, the total population of Liberia increased 3.3 percent per year. Thus, the population growth in Upper Bong is essentially lower than the growth rate for the whole of Liberia; however, it is considerably higher than the population growth in the rural areas of Liberia, 1.3 percent per year.

TOWN	POPULATION 1962	POPULATION 1974	% of Growth
Gbarnga	2,810	8,474	8.4
Gbatala	660	3,760	11.7
Namata	900	4,900	11.5
Sgt. Kollie Town	860	2,290	7.6
Saini	570	2,850	11.1
Suakoko	730	1,260	4.4

The heaviest population growth has occurred in the Bonwein and Jorquelle Clans whose increase in population is attributable to the intensive development of the county capital, Gbarnga. All clans with a high growth rate are favorably situated with regard to roads. The clans with a decreasing population figure, however, are less accessible: the Senwein Clan is not touched by any road, the Garyia Clan has no road connections except in the extreme north-west of the clan area, and the Kpatawee Clan

176

has only recently had access to a road. In the towns of over 600 inhabitants, the population growth was above average. In 1962, 12 percent of the total population of Upper Bong lived in towns of over 600, whereas in 1974, this amounted to 23 percent. Thus, a strong tendency towards a concentration of the population in larger towns can be seen and the six largest towns of the Project Area showed a rapid growth from 1962 to 1974 (see Table above).

Migration is not a primary factor in the study area, as evidence indicates that the mobility of the members of the Kpelle tribe is not as high as that of most of the other tribes. For example, in the three iron-ore mines outside of Bong County, the percentage of the workers from the Kpelle tribe is relatively small.

Assuming the growth rate in the study area over the next 20 years averages 3.25 percent which is approaching the National mean, the population of the project area would increase from 140,000 in 1976 to 265,300 in 1996. As the percentage of inhabitants in the urban areas (settlements over 2,000) increased from 20 percent to 29 percent between 1962 and 1974, an increased migration to urban centers can be projected particularly to Monrovia. Therefore, the percentage of the inhabitants of the project area engaged in agriculture may decline, although the total number of farmers will obviously increase.

d. Education

The Liberian school system can be divided into three categories; elementary education (pre-primary grades and grades 1 through 6); secondary education, (Junior High Schools, grades 7 through 9 and Senior High Schools, grades 10 through 12); and higher education, consisting of 4 to 5 year courses at universities. All three classifications of schools exist in the Project Area.

There are 45 elementary schools in Upper Bong, 29 located in the Gbarnga District, 5 in the Kokoyah District, and 7 in the Sanoyie District. Six elementary schools are situated in Gbarnga with the remainder dispersed throughout the area. Studies conducted by the Ministry of Education indicate that the majority of children do not complete elementary school. Nationwide, only about one-third of the students who started first grade reach grade 4, normally considered as the minimum formal education for permanent literacy. In the study area, the percentage is even less, between 10 and 15 percent. The teacher-student ratio was 1:47 in 1974, exceeding the desired 1:40 ratio set forth by the Ministry of Education.

There are 14 Junior High Schools in the Project Area. Not only grades 7, 8, and 9 are taught in these schools but also grades 1 through 6. Because of this there is no way to distinguish clearly between the teachers who taught grades 1 through 6 and those who taught the upper grades. According to the following figures (1974) the number of enrollments in grades 7, 8, and 9 are also declining with advancement:

Grade 7 (14 Junior High Schools) 346 enrollments;

Grade 8 (11 Junior High Schools) 250 enrollments; and

Grade 9 (9 Junior High Schools) 176 enrollments.

The schools teaching up to grades 7, 8, and 9 achieved the average teaching staff-student ratio of 1:40 desired by the Ministry. However, in order to make this proportion apply to all Junior High Schools, 19 extra teachers would have to be employed. The class attendance in the Junior High School grades 7 through 9 averaged 18 students per class. At the Senior High School in Gbarnga, where (in addition to grades 8 and 9) grades 10, 11 and 12 are offered, the following enrollments were registered in 1974:

Grade 10	62 enrollments;
Grade 11	72 enrollments; and
Grade 12	39 enrollments.

The staff-student ratio in grades 10 through 12 was registered at 1:28 with a class average of 34 students.

One of the two universities in the country, situated in the study area near Suakoko is Cuttington College (administered by the Episcopal Church). In 1974, 300 students were enrolled at this college, amounting to 18 percent of all students in the third educational level in Liberia. A total of 50 teachers of various nationalities teach the following subjects; Biology, Business Administration, Chemistry, Economics, Education, General Sciences, Languages/Literature, Political Sciences, and Theology. Remarkably, agriculture is no longer a part of the curriculum.

Statistically, children of school-age (between the ages of 6 and 16) make up 25 percent of the total population of Liberia. If it is assumed that the age structure of the Upper Bong population is identical to that of Liberia as a whole, then 29,000 people of school age reside in this area (1974). Thus, it can be seen from this figure, and the enrollment number, that not more than 29 percent of the school age population in Upper Bong County actually attend school. The 1971 Agricultural Census gives information concerning education among the farm population in the Project Area. According to its statistics, 89 percent of the farm population had absolutely no schooling, 10 percent had been in one or more grades between 1 and 8, and 1 percent had been educated above the 9th grade.

These figures clearly indicate the shortcomings of the present school system within the Project Area, in terms of quantity. There are also fundamental problems in the quality of education. As in other developing countries the education system in Liberia suffers from a lack of relevance to the needs of the environment in rural areas. The knowledge which the children receive is not only of little use for the environment

in which they live, but also tends to make them discontented with rural life and work.

Recognizing these educational deficiencies, and in order to reorientate its primary school system towards the requirements of rural development, the Government of Liberia (GOL) launched a program in 1971 known as the "Community Schools Program". The purpose of this program is to improve primary education in rural areas, to provide more relevant education to rural children and to prepare them for life in a rural society. Furthermore, school facilities will be made available for adult education and community development activities so that they can become the nucleus for development acitivities in rural communities.

In the present Community School Program,GOL is planning to establish 200 Community Schools throughout Liberia. At the end of 1974, 115 schools had been improved or were in the process of improvement. Of these, 15 are in the Project Area, situated in the following locations; Gbarnga, Wenshu, Gbatala, Namata, Suakiko, Gbondoi, Blamiyie, Gbalatuai, Palala, Saini, Gbandela, Samay, Gbekohn, Fokole, and Jorway. It is anticipated that in the whole of Liberia, at least 20 additional schools will be built or improved in 1977. According to the Ministry of Education the majority of these schools are likely to be in counties which do not yet have their quota of Community Schools.

e. Living Conditions and Housing

The living conditions and housing in most of the project area are very poor. Utilities (water, sewage treatment, electricity, etc.) are nonexistent except in Gbarnga and Jorwah where some electricity is provided. Houses vary in shape from circular to rectangular, generally made of sticks plastered with clay or mud with a thatch roof, although corrugated roofing was observed on many dwellings near roads. The family huts are usually 6 to 9 meters (20 to 30 feet) in diameter and have a clay floor. Houses are usually located near a water supply (stream, spring, etc.) with very primitive sanitary facilities.

Medical facilities within the study area are limited to the Phebe Hospital and a few government clinics. The government of Liberia has instituted a number of programs to improve medical facilities, health education, and immunization programs; however, these programs have been inhibited by a lack of trained personnel, lack of health data, inadequate transportation facilities, etc. Other social services are lacking in the Project Area.

The Ministry of Action for Development and Progress (ADP), created in 1972, has devised and implemented a special impact program in selected rural areas. The first pilot program was initiated in 1972 in the Panta Chiefdom, which lies within the study area. The pilot program area is approximately 311 square kilometers (120 square miles), with a 1974 population of 9,900 living in 28 dispersed villages. Jorwah (1974 population 800) was chosen as the focal point. A school, health clinic, ten

low-cost houses, market and power generator have been provided in Jorwah. Other facets of the program include a seed multiplication project; demonstration plot for swamp rice, cassava and vegetables; tree crop nursery; and some farm-to-market road construction.

4. Economic and Institutional Structure

a. Local Government

As previously discussed, there are two systems of administration in the project area, governmental and traditional. The seat of the governmental administration is located in Gbarnga and the county falls under the responsibility of a Superintendent, who is in charge of local administration. He is appointed by the President of the Republic and is his direct representative, although he operates under the administration of the Ministry of Local Government, Rural Development and Urban Reconstruction. The main function of the Superintendent is the maintenance of law and order, for which he has his own small staff. At district level, the Superintendent is represented by a District Commissioner. The county administration also consists of personnel representing the various Government of Liberia Ministries. They report directly to their main offices in Monrovia and the Superintendent excercises only non-technical supervision over them.

The county administration has no source of independent revenue and, therefore, no budget of its own. The hut tax which is collected at county level is transferred in full to the central government. Funds are channelled back to the counties through the budgets of the various Ministries. The Superintendent's office receives an additional lump sum of $10,000 per year for administrative purposes.

A slight improvement has been brought about by the creation of the so-called "Rally Fund" which is fed from non-budgetary sources every two years. According to the regulations pertaining to this "Rally Fund", 50 percent of the funds collected in a particular county have to be spent on projects within that county. Most funds which have thus been allocated to Bong County have been spent on the acquisition of road construction equipment for the county administration. The equipment has been used to construct some of the farm to market roads which now exist in the project area.

In addition to the modern type of county administration, there is the traditional tribal organization. The whole of Bong County is inhabited by members of the Kpelle tribe and within the project area the tribe is subdivided into six chiefdoms: Jorquelle, Panta, Kpai, Zota, Kokoyah and Sanoyie. The six chiefdoms are broken down into 28 clans. (Table 10, Figure 10)

Each chiefdom is headed by a Paramount Chief, who has under him a hierarchy of clan and town chiefs. Their duties consist mainly of the adjudication of tribal disputes, the collection of taxes and maintenance of law and order within their respective areas. Following a change in

1974, the chiefs now receive a salary from the government and are subject to elections every four years.

b. Employment

A large proportion of the labor force is self-employed on small and medium-sized farm holdings. The extent of labor utilization on these small holdings is low, particularly during the slack season and the employment capacity actually utilized averages only 16 percent of the overall annual potential. The rubber farms in the project area, the Firestone plantations in Harbel and the Bong Mine (the latter both lying outside the project area) offer a number of jobs for hired labor. The majority of hired laborers working on the large plantations and in the mine outside the project area are employed there throughout the year and have generally given up agriculture. The low labor turnover on the Firestone plantations and in Bong Mine confirms this fact.

Most of the laborers who find employment on the medium-sized and small plantations inside the project area continue to manage their own farms and work away from the farms only temporarily. When there is much work to be done on the farms or during social events (festivals, etc.) they abandon their jobs on the rubber plantations. The high turnover rates on the smaller and medium-sized plantations in the project area are symptomatic of this condition.

The following table provides an estimate of the dominance of agricultural life and employment in the project area.

TOTAL POPULATION	140,000
Total Farm Population	100,000
Total number of gainful workers	67,000
Number of these primarily working in agriculture	58,500
Number in non-agricultural occupations	8,500

Approximately 6,000 of the 58,500 working in agriculture are employed permanently or temporarily as hired labor on rubber plantations within the project area and another 4,500 are employed outside the project area on the larger rubber plantations.

There is no statistical information available on the number of unemployed persons nor on the potential of hireable labor in the project area. In order to gather some information on the available potential in hireable labor, investigations were made into the employment situation on the large rubber plantations and in the Bong Mining Company (Agrar- Und Hydrotechnik, 1975). The results of the inquiries indicated that it is relatively easy to find additional workers during the months of June,

July, August, September and October. It is difficult, however, during the months of December, January, February and March. The companies were asked how difficult it would be to recruit 50, 100 or 500 workers. It was agreed that from June to October there would be no problem in obtaining an additional 50 to 100 workers. The Firestone plantation went so far as to declare that 500 workers could easily be recruited during these months. On the other hand, the companies made clear the difficulty of finding even as few as 50 workers between December and March. The recruitment of 100 or 500 workers during this period was considered most difficult, if not impossible.

The period during which hired labor is easily obtained does not coincide with the farm holdings' slack season. April, May, June, October and November are the months in which the farmers have the most work on their own farms. Rather, it appears that a more accurate explanation of the abundance of hireable labor between June and October is that the time immediately before the harvest is the so-called hungry season, and it becomes necessary for the farmers to seek additional income. However, between October and February, when rice, cocoa and coffee are harvested, the small holders receive a large share of their annual income; so there is little necessity for them to seek off-farm employment. Another factor which should be taken into account is that it is traditional between December and March to fulfill social obligations and to take part in the festivities.

Statistics indicate that the available labor for each small farm holding in the project area slightly exceeds 2.6 labor equivalents or 600 man days per year. Table 11 shows a projected labor balance for the project area based on the 1976 estimate of 19,000 farm holdings in the study area. At present, only 102 man days are spent each year tending individual farm holdings. The majority of expended effort is used as hired labor on rubber plantations. Even then, 294 man days of labor capacity per farm holding are not utilized each year.

c. Average Income

Real per capita income has increased about 2.4 percent per year since the mid 1960's. A study in 1974 indicated the estimated average annual farm family income in Upper Bong County was $263, consisting of $222 farm income and $41 off-farm income. Considering the estimated rate of increase, the average in 1976 would be $280-$300 per farm family per year. The number of members of a farm family within the study area is estimated at 5.3 individuals.

d. Financial Institutions

There is no organized agricultural banking and credit system in Liberia to fill the needs of small farmers. The commercial banks concentrate on the large coastal towns and the concessions. No banking facilities exist in the rural areas.

TABLE 11. LABOR BALANCE OF PROJECT AREA[1]

Crop	Total man days per year[2]
Upland rice	70
Cassava	8
Swamp rice	15
Maize	4
Sugar cane	3
Cocoa	1.5
Coffee	1
Subtotal	102.5
Rubber	203.5
Total	306
Availability at 2.6 labor equivalents per holding[3]	600
Non-utilized labor capacity per holding	294
Non-utilized labor capacity (19,000 holdings)	5,586,000

1 Assumed for 1976 without project activities.

2 Labor requirements for average of all holdings.

3 Assumed rate of labor use: 40 percent for January-March and 80 percent for April-December.

An attempt to institutionalize agricultural credit was made in 1957 with the creation of an Agricultural Credit Corporation. It failed, and in 1964 the Corporation ceased to operate. The Liberian Bank for Development and Investment (LBDI) has recently undertaken to extend credit to the agricultural sector. With its present organization, however, the bank is in a position only to finance a limited number of large-scale projects. In the project area, the Cooperative, Credit and Marketing Division (CCMD) of the Ministry of Agriculture has extended a few loans to farmers. The government is aware of the present unsatisfactory situation, and there are plans to set up an institution for agricultural credit to fill the existing gap in credit to the ordinary small-scale farmer.

5. Public Facilities and Services

a. Communications

The project area does not possess its own public communications system. Communications between the area and other parts of Liberia are provided by the government radio station in Gbarnga and by a telephone line between Gbarnga and Monrovia. An expansion of telephone services completed in 1965 included construction of a small capacity automatic exchange in Gbarnga, equipped for 100 subscribers. All existing communications equipment is unrealiable and outdated. The Government of Liberia has proposed programs, between 1977 and 1980, to add 430 lines to the exchange at Gbarnga and provide for a 5 kilowatt medium wave radio transmitter (GOL, 1976).

b. Utilities

A public power station provides electricity to Gbarnga and areas along the Gbarnga-Suakoko road. The plant was built in 1966 and has two operational diesel generators with a total capacity of 1,040 kw. A new unit which would provide an additional 1,065 kw is expected to be built in 1979 (Agrar- Und Hydrotechnik, 1975). A power generator was provided to Jorwah (1974 population 800) under the special impact program devised and implemented by the Ministry of Action for Development and Progress. Several small, privately owned generators exist in the area. As a long range program, the Government of Liberia is planning to connect Gbarnga and Robertsport with the Monrovia electrical system.

Except for Gbarnga, water in the project area is obtained directly from surface water or shallow wells which are unreliable and susceptible to pollution. A loan was approved in 1974 by the West German Government to finance construction of public water supply projects in Gbarnga, Voinjama and Sanniquellie. These projects are scheduled for completion in 1978.

Monrovia is the only city in Liberia with a sewage treatment system. The system covers most of Monrovia from Sinkoe to New Kru Town. There are no existing plans to provide sewage treatment systems to any of the towns in the project area.

c. Law Enforcement

Law enforcement is provided by the Liberian National Police Force. Each county has a police post headed by a deputy inspector with varying numbers of policemen assigned. The county units enjoy a considerable degree of autonomy, but the ultimate authority of the Central Headquarters is unquestioned. Incomplete records indicate petty larceny and simple assault are the most prevalent offenses[8]. As with administration, there are two parallel judicial systems, the formal government judicial system and the tribal court system. The latter has broad jurisdiction in matters of civil and customary law, but its criminal jurisdiction is limited to misdemeanors and minor offenses. The legal authority for tribal courts was repealed in 1963, but changes were to take place slowly to protect the interests of the tribal people. Application of the Penal Law of the Government of Liberia continues to increase as the influence of tribal law is reduced.

D. TRANSPORTATION FACILITIES

1. Roads

Economic development in the project area is difficult because of the lack of adequate transportation facilities. Although the capital of Bong County, Gbarnga is only 202 kilometers (125 miles) from the port of Monrovia, 45 percent of the rural population does not live within 1.61 kilometers (one mile) of a road. Because the project has been somewhat expanded since the initial 1975 study, mileage figures are approximate. A total of about 481 kilometers (298 miles) of public roads comprised of 147 kilometers (91 miles) of primary, 205 kilometers (127 miles) of secondary and 129 kilometers (80 miles) of farm-to-market roads exists within the study area.

Inspection of the primary roads indicated the vertical grades are close to design standards, but road and right-of-way widths are frequently below standard, varying from 4.3 to 7.0 meters (14 to 23 feet) and from 15 to 24 meters (50 to 80 feet) respectively. For secondary roads vertical grades are eight percent in many cases, and frequently exceeded twelve percent with below standard widths varying from 2.7 to 4 meters (9 to 13 feet). Basic dimensions of the farm-to-market roads average 3 meters (10 feet) wearing surface width, and 6 meters (2 feet) between ditches. On both secondary and farm-to-market roads, horizontal sight distances are often low and vertical sight distances are bad.

The major highway in the study area is Route No. 1026, which originates in Monrovia and runs northeast through Careysburg, Kakata and Totota into the study area. Within the project area, it connects Zeanue, Gbatala, Suakoko, Gbarnga, and Palala, then crosses the St. John River and continues northeast. It is lateritic from Totota north, varying significantly in width and quality. An improvement program is currently in progress. Another primary road (Route 1166), originates at Gbarnga and goes northwest through Belefuanai, crossing the St. Paul River and

eventually reaching Voinjama. It is also constructed of laterite, with a 4.3 to 5.2 meters (14 to 17 foot) wearing surface.

Secondary roads extend from Palalo southeast to connect Yopie on the Buchanan - Sanokole Route, from Gbarnga southeast to Botata, southeast from Gbatala to near Bornia and from Belefuanai northwest to Bonju (See Figure 5).

The government's development priorities include rehabilitation and improvement of primary roads, upgrading of secondary roads to primary standards where justified, planning and construction of a network of feeder and secondary roads, improvement of major roads in Monrovia, establishment of an efficient road maintenance system, and development of a comprehensive set of transport regulations. As an initial part of this program, the GOL has allocated a total of $138 million for road investment between 1977-1980.

2. Railroads

One railroad traverses the southeastern portion of the project area. The 4'8½" gage facility was constructed in 1963 by the Liberian American-Swedish Minerals Company (LAMCO), and extends 269 kilometers (167 miles) from the port at Buchana northeast to Yekepa in the Nimba range. The railroad was constructed to haul iron ore, although lo and rubber are transported in limited quantities.

3. Airfields

No major airfields exist in the study area, although there are some airstrips. Such facilities are located near Suakoko, Cuttington College, and Belefuanai. The conditions of these strips vary; and none are paved or lighted. They are not utilized by any scheduled airlines and support only light general aviation traffic. There are no heliports in the study area, and at this time, no helicopters, public or private, exist in Liberia.

The Government of Liberia considers the immediate needs for domestic air transport are rehabilitation of airfields where road access is difficult and establishment of effective regulations. Approximately $400,000 is proposed to improve ground facilities at Greenville, Belefuanai and Voinjama. Construction of a new terminal (estimated cost, $4.1 million) at Robertsfield was initiated in 1975 and is scheduled for completion in 1977.

4. Water

There are two major rivers which border the project area, the St. John and the St. Paul. A major tributary of the St. John, Zo Creek, flows south-southwest from near Gbarnga. Because of the falls and rapids in the rivers, they are insignificant as transportation facilities, supporting only canoe traffic in some locations.

E. AGRICULTURE

The total estimated agricultural population of Liberia was estimated at 313,000 in 1975, with 5.4 persons per household. The agricultural population of the study area is estimated at 100,000. There are 19,000 agricultural households in the study area, with 53 percent female and 47 percent male. Of the agricultural population, 51 percent is under 20 years of age. The average Upper Bong County farmer cultivates less than 1 hectare (2.3 acres). In the following discussions, the figures used for the project area have been extrapolated on a linear basis from data obtained during a previous study of a smaller area.

1. Crop Types and Characteristics

The major source of food in Liberia is rice with an estimated 134,400 households involved in rice farming in 1975, comprising 90 percent of the agricultural households (Republic of Liberia, Ministry of Agriculture, 1976). About 35,223 (87,000 acres) of rice were harvested in Bong County in 1975, yielding an average of 1.29 metric tons per hectare (1,150 pounds per acre) for a total production of 45,438 metric tons (100 million pounds).

a. Upland Rice

Of the 229,000 metric tons of rice produced in Liberia in 1975, 209,400 metric tons were produced as upland rice, an average of 1.16 metric tons per hectare (1,030 pounds per acre) (Republic of Liberia, Ministry of Agriculture, 1976). In 1975, total upland rice production in the study area involved 11,285 hectares (27,875 acres) yielding 12,750 metric tons; an average of 1.13 metric tons per hectare.

In Liberia, a land rotation or bush fallowing method is used for the production of rice. This method of farming requires extensive land to allow a fallow period of sufficient length to restore the productive potential of the soil.

Upon selection of a suitable farm site, undergrowth is cut or "slashed" from the site in January followed by the cutting of the large trees. After cutting is complete, the trees are burned with unburned branches removed by hand. The burning process adds potash to the soil. Planting of upland rice is done by hand with 99 percent of the Bong County farmers using the broadcast method (Schulze, 1973). The rice crop must be weeded and protected from "rice birds" (Weavers, Family Ploceidae). This is usually done by women using a system of strings with shiney objects attached which is moved about to frighten the birds. The rice matures from October to December and is harvested using a knife or sickle (Blanchard, 1967).

The processing of rice in Liberia is very wasteful. After harvesting, the rice is brought to the village and dried on the ground, where large amounts are either lost or eaten by birds, rodents, insects, and domestic animals. Rice is threshed by stomping with the feet or by beating and is finally beaten with a pestle in a mortar. This breaks the rice into

small pieces causing additional loss. The rice is fanned to remove impurities and then bagged. Amachree (1970) estimated that 15 to 20 percent of the harvest is lost during processing. The loss is significant since only 68 percent of Bong County farmers have sufficient rice production to feed their households. The 1.29 metric tons per hectare (1,150 pounds per acre) yield of rice in Bong County in 1975 was the highest yield for any county in Liberia, and is attributable to the slightly more advanced practices employed. Bong County farmers used 57.3 kilograms of seeds per hectare (51 pounds per acre) with 3 percent of the farmers using improved seeds and fertilizer. Another indication of the relative success of Bong County rice farmers is that 35 percent have rice for sale with 39 percent forced to buy rice. The Liberian average in 1975 was 24 percent selling and 51 percent buying rice.

b. Swamp Rice

Swamp rice production in Liberia for 1975 was 19,700 metric tons or 8.6 percent of the total rice harvest. The per hectare yields for swamp rice, however, were considerably higher than for upland rice. The yield for rainfed swamp rice was 1.73 metric tons per hectare (1,540 pounds per acre) and for irrigated swamp rice 2.81 metric tons (2,500 pounds). Yields in excess of 4.49 metric tons per hectare (4,000 pounds per acre) have been obtained under the direction of specialists from Taiwan. Swamp rice production in the study area in 1975 was 2,750 metric tons grown on approximately 2,142 hectares (5,290 acres).

Swamp rice is planted in beds adjacent to swamps and transplanted into the swamp when the plants are about 30 centimeters (12 inches) tall or seeds are broadcast directly into cleared swamps. Techniques for tending, harvesting and processing swamp rice are identical to those for upland rice. When adequate water is available (e.g., by irrigation) two crops of rice can be harvested annually. Reasons for the small area (10,121 hectares in 1975) of swamp rice production in Liberia include high labor intensity, objectionable working conditions, and the traditional view that swamp rice production is "woman's work". Figure 11 shows swamp rice cultivation near Suakoko.

c. Cassava

The second most important food crop in Liberia is cassava. In 1975, 90,400 households harvested cassava growing on 30,769 hectares (76,000 acres). This annual crop is grown for its nutritious root stalk and is often planted together with rice. However, the most common method is to plant abandoned upland rice fields in cassava the second year. The crop ripens between January and March, but many times is left standing for over a year as insurance against a poor rice harvest. The sweet species of cassava, Manihot palmata is more commonly grown in Liberia than the bitter species, Manihot utilissima (Schulze, 1973).

A total of 103,000 metric tons of cassava were harvested in Liberia in 1975 for an average yield of 3.37 metric tons per hectare (3,000 pounds

Figure 11. Swamp Rice Cultivation; CAES, Suakoko.

per acre). Approximately 18,200 households (69 percent of the total agricultural households) were involved in growing cassava in Bong County in 1975. The pure stand area of cassava in Bong County was 2,429 hectares (6,000 acres) and the equivalent area mixed with rice was 2,713 hectares (6,700 acres). (The equivalent area figure is the area of a farm with a mixture of cassava and rice converted into the equivalent of cassava grown in a pure stand). Thus, a total area of 5,142 hectares (12,700 acres) of cassava were grown in Bong County in 1975, an average of 0.3 hectares (0.7 acres) per household.

d. Sugar Cane

Major cash crops in Liberia are coffee, cocoa, and sugar cane. The largest physical production came from sugar cane with 82,000 metric tons produced in Liberia in 1975. There were 24,800 households producing sugar cane on 7,287 hectares (18,000 acres) in 1975, with an average of 11.23 metric tons per hectare (10,000 pounds per acre). Bong County has the largest number of sugar cane producers in Liberia; 7,000 households in 1974; 5,800 in 1975. Approximately 7 percent of the farmers in the project area grew sugar cane in 1971 on a total of 680 hectares (1,680 acres).

Experimental sugar cane planting at the Shedin Rice project in Nimba County had an average yield of 75.11 metric tons per hectare (66,900 pounds per acre). Similar results were obtained at the Talhert farm in Bong County (Schulze, 1973). However, traditional farming methods normally employed with small plots, not using fertilizer, irrigation or high-yield varieties, produce a much lower yield. The mature product is cut by hand and crushed in a mill. Of the 2,375 mills in Liberia, 81.8 percent are hand mills. Traditional emphasis has been on the production of syrup and molasses, however, the principle product today is gin or rum.

e. Coffee

The second most important export cash crop in Liberia is coffee. Three species of coffee can be grown in Liberia, Coffea arabia, C. robusta and C. liberica. Coffea robusta has replaced C. liberica as the most advantageous species with respect to yield and price and is now the most commonly grown species (Buchanan et. al., 1975). Coffee seedlings are generally planted in the beginning of the rainy season, after being grown in a nursery for about one year. Upland rice fields, abondoned for 2 to 3 years, are often selected for planting sites since these abandoned fields provide a low bush shade cover for the young coffee seedlings. Coffee plants do not usually provide a significant yield until the third year after planting. To insure maximum production, the plants must be weeded and periodically pruned, practices that are often ignored.

In 1975, 37,500 households were involved in coffee production in Liberia. Of the 22,267 (55,000 acres) planted in coffee, only 14,413 actually pro-

duced. Average yield, according to the Ministry of Agriculture (1976a) was 292 kilograms per hectare (260 pounds per acre) with total production of 4,200 metric tons in 1975. A coffee mill located near Voinjama is capable of hulling up to 7,000 pounds of dry coffee per day. About 90 percent of Liberia's total coffee production comes from farms of 0.4 to 1.2 hectares (one to three acres). In Bong County in 1975, 3,700 households actively produced coffee. In the project area in 1975, approximately 860 hectares (2,125 acres) were planted in coffee with only 745 hectares (1,840 acres) actually producing. Approximately 237.5 metric tons of clean coffee were harvested. In 1975, 5,432 long tons of coffee were exported from the Free Port of Liberia according to the Ministry of Planning and Economic Affairs (1976). Exports of coffee amounted to $4.5 million and accounted for 1.1 percent of Liberia's total export (Republic of Liberia, Ministry of Planning and Economic Affairs, 1976). The total coffee export from Liberia was 4.14 million kilograms (9.1 million pounds) in 1975, however, this figure probably includes some coffee from Sierra Leone. Recent price escalations could prove coffee production to be considerably more significant to the GNP in the future.

f. Cocoa

The production of cocoa in Liberia has been on the increase recently and almost equaled coffee production in 1975. Cocoa is produced by essentially the same methodology as coffee. Upper Amazon Hybrid is the type most suited for Liberian production. Presently there are no large cocoa plantations in the country, and all cocoa produced comes from rather small individually owned plots. The primary hinderance to cocoa production historically has been the lack of permanent moisture and fresh soil necessary in the first five years of growth, until the plants can produce sufficient humus themselves (Schulze, 1973).

A total of 32,500 households produced cocoa in Liberia during 1975 from 20,649 hectares (51,000 acres). According to the Minister of Agriculture (1976a.) less than half the planted area (9,514 hectares) actually produced to yield an average of 336.6 kilograms per hectare (300 pounds per acre) and a total production of 3,200 metric tons. There were 5,000 Bong County households producing cocoa in 1975. About 1,376 hectares (3,400 acres) of cocoa were planted in the project area in 1975, of which 1,255 were in production. Total production in the project area in 1975 was approximately 400 metric tons of dry beans.

The Free Port of Liberia exported 2,113 long tons of cocoa in 1975 out of a total Liberian export of 3,182 metric tons (7 million pounds) (Republic of Liberia, Ministry of Planning and Economic Affairs, 1976). The value of cocoa exports, which has been on the increase for several years was $4.4 million in 1975, accounting for 1.1 percent of Liberian exports. The average unit price of cocoa was 1.38 dollars per kilogram (62.9 cents per pound) in 1975 (Republic of Liberia, Ministry of Planning and Economic Affairs, 1976), but the price of wholesale cocoa has sharply escalated recently and should become a more profitable crop in the near future.

g. Rubber

Historically rubber has been the most important crop grown in Liberia. Rubber was the most valuable export product of Liberia until 1962, when it was replaced by iron ore. Rubber plantations are started in Liberia in one of two ways; by transplanting young rubber trees obtained from nurseries, or by green budding, a process by which branches from high yield species are grafted to plants grown from seed. Normally rubber trees are tapped for latex beginning with the seventh year. There are six rubber concessions in Liberia at this time with 57,368 hectares (141,700 acres) of rubber plantation of which 40,364 are producing. The average yield from concessions is 1.39 metric tons per hectare (1,240 pounds per acre) for a total production of 58,106 metric tons in 1975. There are 8,800 privately owned Liberian rubber farms with 62,955 hectares of which 38,057 are producing. The average yield from these farms is 637 kilograms per hectare (568 pounds per acre) for a total production of only 24,222 metric tons in 1975 (Schulze, 1973). A total 37,652 hectares of rubber trees were located in the study area in 1971 with only about 11,893 hectares actively producing. According to Schulze (1973), reasons for low yields on privately owned farms include insufficient recruitment of labor and lack of marketing capability, with transportation being a major problem.

In 1975, a total of $46.2 million worth of rubber was exported from Liberia, this ranked second among exports and accounted for 11.7 percent of all exports. Average price received for the 81 million kilograms (178.3 million pounds) of exported rubber was 57 cents per kilogram (25.9 cents per pound). Exports are in three forms; liquid latex, dried sheets of crepe, and crumb. Recent worldwide petroleum shortages may limit the amount of petroleum available for production of synthetic rubber, a condition that enhances the present and future outlook of the natural rubber industry.

h. Oil Palm

The oil palm is the most important of the various tree products which play a role in the Liberian economy. In addition to being exported, palm oil is a principal item in the Liberian diet.

Palm nuts are harvested during the dry season each year. The nuts are cooked and pounded in special pits followed by separation of the outer portion (pericap) from the inner stoney portion (endocarp which contains the kernel). The endocarp is then dried and separated from the kernel which is subsequently roasted and creamed into nut oil or marketed as kernels. Experiments with the Angola oil palm have shown this species to be a superior producer. Oil palms have extensive root systems, going down fifty feet or more and probably are better suited to Liberian soil conditions than rubber trees (Schulze, 1973). There are three commercial palm oil plantations producing in Liberia on 4,049 hectares (10,000 acres) and 67,500 households producing on the equivalent of

34,000 hectares (84,000 acres). Average yields from the operation in 1975 were 591.3 kilograms of palm oil per hectare, 363.5 kilograms of palm kernels, 162.7 kilograms of palm kernel oil and 166 kilograms of oil seed. Commercial plantation yields are about twice as high as traditional producers. Total production in 1975 included 22,500 metric tons of palm oil, 13,800 metric tons of palm kernels, 6,200 metric tons of palm kernel oil and 6,300 metric tons of oil seed cabs (Minister of Agriculture, 1976). There were $3.2 million of palm products reported in 1975 constituting 8 percent of total exports. Palm kernel oil accounted for $2.3 million in exports. Approximately 60 percent (15,900) of the Bong County farm households were involved in palm oil making in 1975; of these 11,400 had palm oil to sell. The wild oil palm Elaesis guineensis occurs in Upper Bong County at a density of about 20 trees per acre.

i. Piassava Palm

Another tree crop of historic importance is the piassava palm, Raphia vinifera, harvested for fronds from which piassava fibres are obtained and used in the manufacture of palm wine, thatching of huts and manufacturing of mats and baskets. However, the production of synthetic fibres has caused intense price competition and threatens to remove piassava from the list of exports.

j. Bananas

Bananas are grown in Liberia with 69 percent of all agricultural households involved in production and most are consumed locally. In 1955, the promising banana industry was halted by the appearance of "Panama disease" which still is not controlled.

k. Coconuts

Coconuts are only grown by 24 percent of agricultural households in Liberia, (Schulze, 1973), but appear to be a potentially important export crop in the future. Coco-palms seem extremely well suited to the Liberian climate.

l. Other

In addition to the crops previously mentioned, other minor tree crops and the percentages of agricultural household growing them include: avacado, 21; grapefruit, 17; guava, 4; kola nut, 48; lime, 14; mango, 22; orange, 37; papaya, 36; plantain, 67; and tangerine, 12 (Republic of Liberia, Ministry of Agriculture, 1976a.).

Almost all upland rice fields are interpersed with minor produce crops. These crops and the percentages of agricultural households growing them include: beans, 29; sesame, 31; bitter balls, 63; collard greens, 9; corn, 80; cucumber, 30; eddoe, 46; eggplant, 36; peanuts, 12; guinea corn, 8; okra, 68; palaver souse, 33; pepper, 72; pumpkins, 48; sweet

potato, 25; and tomato, 43 (Republic of Liberia, Ministry of Agriculture, 1976a.).

The presence of the tsetse and the lack of a sufficient quantity of nutritionally balanced feed has long hindered the development of the livestock industry in Liberia. In recent years, however, progress has been made especially with regards to poultry and goat production. This development is essential to meeting basic nutritional goals for the Liberian populus. Table 12, taken from National Rice Production Estimate (Republic of Liberia, Ministry of Agriculture, 1976a.) summarizes livestock production in Liberia for 1975.

2. Crop Production Practices

a. Land Availability and Usage

A complete discussion of land usage and ownership was provided earlier in this report. Only about 18 percent of the farmers in the study area have private title deeds to their farms. The majority of the remaining 82 percent farm under existing tribal land customs.

The prevailing form of land use in the project area is shifting cultivation, which entails the felling of trees, and the clearing and burning of secondary bush. The slash and burn process is followed by the period of cultivation and succeeded by a return to bush fallow for a period of five to fifteen years. This system, by its nature, is a very intensive type of land usage, however, population pressure in the project area has not been sufficiently high to make land availability a problem. At the present rate of usage within the study area, and assuming a fallow period of 15 years, a minimum of 206,000 hectares (509,000 acres) or approximately 15 times the present annual crop land use would be available for cultivation in any given year. However, lack of accessibility is a major barrier to more effective land utilization.

Farm holdings in the study area range from less than one to greater than 202 hectares (50 acres). Some 87 percent of all farm families cultivate less than 2 hectares (5 acres). As many as 40 percent of rural households in Upper Bong County cultivate holdings less than 0.5 hectare (1.25 acres), which is considered to be below subsistence level. The average area farm size is only about one hectare (2.3 acres).

b. Water Considerations

At present, no water from major rivers or creeks or from underground supplies is being used for irrigation purposes. Some small streams are utilized, but the vast majority of irrigation is through natural processes.

Estimates of the Agricultural Extension Service of Bong County indicate that about 810 hectares (2,000 acres) of swampland in the project area

TABLE 12. LIVESTOCK: NUMBER OF AGRICULTURAL HOUSEHOLDS RAISING LIVESTOCK AND POULTRY AND NUMBER OF HEAD ON HAND, LIBERIA, 1975

Species	Households		Number of Head	
	Number	Percent of All Households	Number	Average Per Household
Cattle	7,500	5	19,900	2.6
Sheep	13,500	9	48,300	3.6
Goats	32,200	21	133,300	4.1
Pigs	6,700	4	32,800	4.9
Chickens	99,000	66	906,800	9.2
Ducks	8,800	6	33,800	3.8
Guinea Fowl	6,900	5	25,000	3.6

are being cultivated for swamp rice, using traditional techniques. Under the decision of the "Expanded Rice Development Project" an additional 202 hectares (500 acres) of swampland has been developed in the project area with irrigation and drainage facilities to assist in water-flow control.

Under present traditional levels of technology and available equipment a second rice crop is usually impossible. Experience in the project area has indicated that during January and February, the middle of the dry season, the critical flowering period of the rice crop occurs and there is a lack of sufficient water to produce the crop. It should be pointed out, however, that due to ease of preparation only the relatively dry swamps are now under cultivation.

Another problem in traditional swamp rice production is the marginal ability of the watershed to pre-saturate the paddies in early May, before run-off is produced in a significant quantity. This saturation is a prerequisite to the establishment of a productive rice crop. Flooding causes further problems for traditional swamp rice production methodologies. Inundation of swamp with several feet of water occurs quite regularly. The destruction associated with this flooding is dependent upon the stage of development of the rice crop. If water levels reach the panicles during flowering or after the seed has set, the entire crop is in jeopardy. In earlier stages of development, inundation will have less impact but considerable yield reduction can be expected.

Experimentation at Fava and Suakoko indicates that multiple swamp rice crops are indeed possible with proper irrigation facilities and management.

c. Available Labor

Of the 140,000 residents in the study area, approximately 100,000 people live on an estimated 19,000 small farm holdings. The average size of a farm family is thus about 5.2 persons. Based on an analysis of agricultural workers to total agricultural population it has been determined that the average farm family has the potential for 2.6 labor equivalents per year. When this value is adjusted for seasonal availability largely determined by social customs, about 600 man days per year are available for each farm holding.

Presently, an average of 102 man days are spent cultivating the family's holding each year while about 204 man days are spent as hired labor, mostly in nearby rubber plantations. Therefore, each farmer family has 294 man days not productively utilized. For the total study area this equals 5,586,000 man days per year.

Table 13 depicts the seasonal labor requirements per acre of the 10 crops most commonly grown in the study area. The period from December to February has a very low labor requirement; this off-season coincides with the dry season. The most labor intensive season appears to be from April to June especially for annual crops. This is the season for land prep-

TABLE 13. AGRICULTURAL CALENDAR AND CROP LABOR REQUIREMENTS PER ACRE, BONG COUNTY

Crop	Operations	January	February	March	April	May	June	July	August	September	October	November	December	Total per acre
Upland rice	Land preparation	3	3	4	5	5								
	Sowing					1	3	3						
	Miscellaneous jobs								5	6	2			
	Harvesting + handling										7	8		55
Cassava	Land preparation	2	3	3										
	Planting		2	3										
	Weeding				2	1	1	1						
	Harvesting					2	2	3	3	2				30
Swamp rice	Land preparation				9	9	9							
	Sowing/planting						5	6						
	Weeding							5	5	5	5			
	Harvesting											7	8	73
Maize	Land preparation		4	4										
	Sowing			1	2	2								
	Weeding				2	3	3							
	Harvesting							2	2	2				27
Sugar cane	Land preparation			3	4	4								
	Planting			3	3	4								
	Weeding						3	3	2	2				
	Harvesting	1		2	2	2							2	40
Cocoa	Maintenance/harvesting									2	4	3	2	11
Oil palms	Maintenance/harvesting				2	7	5	3	1	3		1		22
Coffee	Maintenance/harvesting	3									3	4	5	15
Rubber	Maintenance/harvesting	5				5	5	5	5	5	5	5	5	45
Cashew	Maintenance/harvesting			1	1	3	2	2	1	1		1		12

Source: Agrar- Und Hydrotechnik, 1975.

aration and planting.

The use of the "Kuu System" or cooperative work groups is very common in the study area. About 80 percent of the agricultural households participate in these groups which are designed to provide labor for tasks too large to be effectively handled by family labor or when specific time restrictions require immediate completion of the task. Men and women usually form separate "Kuus" of 30 to 40 persons for a short time period. Kuu members are not paid for their efforts, but a reciprocal is expected from participants.

d. Capital and Financing

One of the major problems facing Liberian farmers today is the lack of sufficient capital to finance the land, seed, labor and other inputs necessary to produce a high yielding crop (Blanchard, 1967). The major demand for capital usually occurs in the planting season when a farmer's resources are lowest, after the non-revenue producing dry season.

No formal system of credit supply now exists in the project area for small-scale farmers. Approximately 84 percent of this type financing comes through family or other traditional sources. While some credit for agricultural programs has been extended recently by the Liberian Bank for Development and Investment, present institutional organizations limit credit availability to a few large scale projects. A nominal amount of credit has been extended to farmers in the project area by the Cooperative Credit and Marketing Division (CCMD) of the Ministry of Agriculture. CCMD loans in the project area totaled $762.60 in 1972 to 6 farmers, $437.90 in 1973 to 3 farmers, and $14,749.38 in 1975 to one farmer. Tree crop seedlings are supplied to farmers on a long-term credit basis by the Liberian Produce Marketing Corporation from its three central nurseries in the project area. A survey of area farmers conducted in 1972 revealed that 35 percent had loans with average debts of $32. The loans were received from relatives 62 percent of the time, 24 percent were from traditional saving societies and 14 percent from traders.

e. Equipment and Technology

The use of modern agricultural equipment and advanced technology is almost unknown among the small scale farmers of the project area. Most farming is performed by the farmer and his family or by work cooperatives. The most important equipment available to the farmer is a machete for bushing or defoliating trees, the hoe for loosening the soil and cassava planting and a sickle or knife for harvesting rice. No mechanical equipment is available to the farmers due to economic constraints and no beasts of burden can be utilized effectively because of their susceptability to Trypanosomiasis, a disease spread by the tsetse.

The low level of soil fertility and fertilizer usage dictates the use of the "slash and burn" method of agricultural production with annual crops.

Rice is usually planted the first year. After the first year crop is harvested, the soil is much poorer and is usually planted in cassava the second year. After the second year and sometimes the first, the field usually is abandoned due to low nutrient levels and allowed to lie fallow and revegetate for a number of years.

This highly labor intensive technology, requiring a large portion of the farmer's time, perpetuates the farmer's low productivity by severely restricting the size of the area he is able to cultivate. All farming tasks, including tilling of the soil, are done by hand. Experiments using power tillers have been conducted, (personal communication, CAES Suakoko) but were abandoned due to high cost and ineffective maintenance.

Some cultivation of swamp rice by the traditional farming sector has been undertaken but poor varietal selection and lack of water control systems have prevented yields from reaching anticipated levels. As in the case of annual crops, primitive farming practices also prevent a high yield in tree crops. Lack of care of planted seedlings, poor weed control and insufficient or harmful pruning are significant factors in explaining the low yields. All agricultural yields could be improved significantly with the proper utilization of improved farm implements, more vigorous varieties, fertilizer and improved pest and disease control measures.

f. Fertilizer Usage

Probably the most serious problem associated with traditional agriculture in Liberia is low soil fertility, due primarily to phosphorus fixation. A low soil nitrogen level is a problem in the study area, but is minimized by the shifting cultivation methodology utilized. After a fallow period of about ten years, mineralization of organic material can supply enough nitrogen for cultivation of one or two additional crops.

The use of fertilizer is almost unknown in Liberia. The Ministry of Agriculture (1976a.) reports that only 1 percent of Liberian farmers use fertilizer as a rice production practice. Bong County has the highest rate of fertilizer usage in Liberia with 3 percent. It is hypothesized, however, that the large number of experimental farming operations in the county is at least partially responsible for this factor. The economic viability of fertilizer usage associated with shifting cultivation is not known. If a particular crop site were to be abandoned after one or two years, the economic benefits of fertilizer usage might become severely restricted.

g. Pest Control

The presence of agricultural pests reduces the productivity of Liberian farms, however, the incidence of pest damage is not as high in this type agriculture where various vegetables are intercropped with rice crops as in a monocultural agriculture. The most serious pest problems confronting Liberian rice farmers are caused by groundhogs (Thryonomys

sevinderianus) and Weaver birds (Ploceus cucullatus). Control measures for these pests have only a limited effect. Ministry of Agriculture (1976) statistics reveal that 77 percent of Bong County rice farmers use groundhog fences to control these pests. During times when the rice crop is vulnerable to Weaver birds the farmer usually has someone in the rice field to scare these birds away using either noise or shiney objects.

Blast, a serious fungal disease caused by Pyricularia aryzae, also occurs in the study area. Other fungal diseases occuring include brown spot, leaf scald and sheath blight. Rice breeding programs are now underway to minimize the effect of these diseases genetically. Insect pests affecting rice production include: Stemborers, (Maliarpha seperatella) and (Chilo voccanius), Whorl Maggot (Hydrellia), and Caseworm (Nymphula depunctalis). Insect damage to rice crops only occurs sporadically and no steps are currently being taken to prevent damage.

The evidence of pest damage in cocoa plants is quite high. Termite or stemborers often attack young trees soon after planting. Later, severe damage to the trees often is inflicted by Capsids (Sahlhergella singularis Distantiella theohroma and Helopeltis spp.). Rodents such as squirrels, rats and porcupines often cause severe damage to the mature crops by eating the pods. The mature pod is also attacked by the fungus Phytophthara palmivora causing black pod disease which may cause losses of up to 25%. In addition to these pests, a number of seedlings are often killed by the fungus Rhigoctomia bataticals while still in the nurseries. The fungicide Dithane M-45 is the only pest control means presently being utilized.

3. Crop Marketing Considerations

a. Level of Subsistence Agriculture

The availability of crops to market is severely restricted by the nature of the Upper Bong County traditional farm which is predominately subsistence oriented. Given this high level of subsistence farming, Liberian society is twice the loser; the nation's food deficit, especially in rice, continues to grow larger while the farmers, trapped in poverty, are cut off from income opportunities which might enable them to modernize, increase their production and improve their standard of living.

As previously mentioned, the average farm size in Upper Bong County is about 1 hectare (2.3 acres). This low figure is attributable to the 15 percent of farms which are less than 0.2 hectare. It can be assumed that production on farms of less than 0.5 hectare (1.25 acres) is below subsistence level. This is about 40 percent of the farms in the study area. Statistics acquired from National Rice Production Estimates (Republic of Liberia, Ministry of Agriculture, 1976a.) state that 68 percent of Bong County households growing rice produce enough rice for the members of the household.

Rubber, coffee, cocoa and palm kernels are considered to be almost exclusively cash crops. However, it is estimated that 80 percent of the rice and corn, 70 percent of the palm oil, 60 percent of the fruits and vegetables and 20 percent of the sugar cane produced is for consumption within the producing household. Of the average 102 days of labor spent cultivating the family farm, only 6 percent of the effort is invested in recognized cash crops.

b. Liberian Food Production/Consumption

Approximately 230,000 metric tons (505 million pounds) of rice was produced in Liberia in 1975. In addition to this, 31,000 metric tons (67.5 million pounds) were imported accounting for 39.9 percent of all food imports (Republic of Liberia, Ministry of Planning and Economic Affairs, 1976). No significant amount of rice is exported from Liberia. Coffee, cocoa and palm products represent the only significant export of agricultural products. These products comprise 3 percent of total exports with a value of $12.1 million.

A substantial decline in rice imports has occurred since 1974. The Ministry of Planning and Economic Affairs (1976) attributes this decline to domestic marketing improvements and to a negative response to significantly higher prices which have more than doubled for imported rice since 1970. Table 14 details production/consumption rice statistics for 1967 through 1974.

With respect to foods other than rice, exports and imports appear to be more balanced,although no accurate figures are available. The 1975 Liberian production of non-rice foods was about 88 percent of total consumption. A discussion of per capita consumption and nutritional considerations for all foods may be found in the public health section of this assessment.

c. Farm to Market Transport

The existing transportation facilities for the study area have been described previously. The lack of an adequate farm to market transportation system has long been a problem to Liberia in general and to Upper Bong County in particular.

Prices charged by private transportation operators to convey produce to market range up to $0.68 per ton/kilometer ($1.10 per ton/mile). Excessive profit can be blamed for a portion of this high rate but much of the cost is attributable to poor road conditions. Presently there are only 129 kilometers (80 miles) of farm to market roads in the study area; conditions on these roads is generally poor with average running width of only 3 meters (10 feet). Under present conditions, 45 percent of the farmers in the study area live over 1.6 kilometers (1 mile) from a road, forcing them to carry their produce over long distances by head on foot. The situation does not encourage increased production and severely limits cash crop production.

TABLE 14. PRODUCTION AND CONSUMPTION OF RICE IN LIBERIA

Years	Imports		Estimated rice production[1]	Estimated total consumption	Rate of self-sufficiency
	1000 T	Value (1000 $)	(1000 T)	(1000 T)	(%)
1967	34.4	6,564	73.0	107.4	68.0
1968	45.4	8,681	73.5	119.0	61.8
1969	27.8	5,201	78.8	106.0	74.3
1970	49.0	9,771	84.7	113.7	63.4
1971	54.1	9,969	89.6	143.7	62.4
1972	41.8	7,777	94.4	136.2	69.3
1973	45.4	10,653	100.3	145.7	68.8
1974	28.0[2]	13,263	97.5	125.5	77.7

Sources: Ministry of Planning and Economic Affairs
WARDA, Annual Rice Statistics 1974. (Draft)

1 Rice available for consumption, excluding seed requirements and losses.

2 Preliminary figure from the Rice Committee within the MOA.

241

d. Cooperatives and Commodity Dealers

The first cooperative societies were formed in Liberia in 1971 under an act passed in 1936 and seem to be gaining in popularity; the societies were appointed as buying agents for the Liberian Produce Marketing Corporation (LPMC). In the project area, however, the cooperative movement has be less than totally successful. Cooperatives exist at Gbatala, Palala, and Kpatawee, but none have achieved effective operation at this writing. These cooperatives have been unable to compete effectively with the large number of young Liberians already established as purchasing agents for agricultural products. The functions of this type of cooperative are threefold; the granting of a credit, the supplying of inputs, and the marketing of produce. Failure in any of the functions can seriously restrict the effectiveness of the cooperative.

In 1975, only 3 percent of coffee producers sold to co-ops in Bong County, 37 percent sold to LPMC and 68 percent to commodity brokers. Co-ops purchased none of the cocoa while LPMC purchased from 21 percent of the producers and commodity brokers from 83 percent (Republic of Liberia, Ministry of Agriculture, 1976a.). The failure of these figures to add up to 100 percent stems from the fact that some producers sold to more than one buyer.

Under present conditions in Bong County, the marketing of agricultural products is on three levels. At the apex of this marketing structure is the LPMC, a semi-governmental organization, which is obligated to purchase all coffee, cocoa, palm kernels, rice, maize and piassava offered for sale at pre-set fixed prices. The LPMC has an export monopoly on coffee, cocoa and palm kernels, the major agricultural exports of Liberia. The second marketing level includes the licensed agents of LPMC who purchase directly from the farmer or from independent sub-agents. (The advent of a successfully operating cooperative would negate or effectively replace the need for these agents.) The third existing marketing level is the village traders, predominately Lebanese, who act as the independent sub-agents for LPMC agents. These sub-agents purchase directly from the farmer or from small intermediaries with whom the farmer is often compelled to deal in order to transport his produce. The multi-level complexity of this marketing structure results in the farmer receiving only 50 to 60 percent of world market prices for his produce and yields profits as high as 8.5 percent for LPMC. In addition to the low prices set by LPMC, marketing research done by Agrar- Und Hydrotechnik (1975) indicates that the addition of transportation charges, incorrect weighing, and payment of prices lower than those set, result in prices actually paid being 20 to 25 percent lower than official LPMC prices.

e. Foreign Export

Exports have long been an important part of the Liberian economy. After iron ore and diamonds, which in 1975 accounted for 79.1 percent of total exports, agricultural products (especially rubber) constitute the major portion of exports (Republic of Liberia, Ministry of Planning and Economic

Affairs, 1976). Table 15 summarizes the major exports for Liberia from 1970-1975. The United States is the principal buyer of rubber and coffee; the Netherlands buys most of the cocoa and palm kernels, and West Germany buys most of the piassava and some palm kernels, rubber, and cocoa.

4. Government Programs

The administrative agency responsible for agricultural development in Liberia is the Ministry of Agriculture. The long term goals of this ministry include diversification of agricultural economy, increased modernization of agricultural production, increased real income of farmers, maximization of material income, and provisions for a more nutritive diet for the entire population.

The Expanded Rice Development Project, launched by MOA in 1972, is designed to encourage the development of swamp land for continuous rice cultivations, and discourage the system of shifting cultivation. This project is functioning in the study area and provides services ranging from site selection to land preparation and provides seed, fertilizer and chemicals. The Expanded Rice Development Project, prepared and planted 495 acres within the project area between 1972 and 1975.

Another "Special Rice Project" was begun in 1974 in the Kpatawee Clan area of Upper Bong County. This program called for clearing of 891 hectares in 1975, of which 4 for upland rice and 0.8 for swamp rice will be allocated to each of 200 participating farmers. All cultivating except harvesting, which will be done by the farmers themselves, will be performed by Agrimeco (Agriculture Mechanization Company). Through 1974 a total of 403 hectares in Bong County had been planted under this program. After one or two rice crops the entire upland area is to be planted in coffee, cocoa or oil palms with seedlings supplied by LPMC.

The development of the Rice Cultivation Project was established in 1970, with the Food and Agricultural Organization of the United Nations as executing agency and MOA as cooperating agency for GOL. This project, originally slated for termination in 1974, has been extended. The long range objective is rice self-sufficiency through increased production. Achievement of this goal is envisioned through expansion of the area under rice cultivation, reinforcing institutional frameworks, agricultural extensions, agricultural engineering, farm credit, cooperation and marketing. All activities for this project are carried out through the Central Agriculture Experiment Station at Suakoko. Immediate and long term approaches to increased rice production are included for both upland and swamp rice farming.

The Chinese Agriculture Mission (CAM), established in 1961, had developed about 4,000 acres of irrigated rice fields by 1974. At that time, 82 members of this mission were carrying out operations such as land development, experimentation, demonstration, extension, and training. The CAM personnel were incorporated into several GOL programs such as the Expanded Rice Development Project and Special Rice Projects. Due to Liberian recog-

TABLE 15. VOLUME, VALUE AND UNIT PRICE OF MAJOR EXPORTS, 1970-1975

Major Exports	1970	1971	1972	1973	1974	1975
Iron Ore						
Value, $ million	150.7	160.6	182.7	196.7	262.2	295.6
Volume, million LT	23.3	20.9	22.6	25.2	25.2	18.1
Unit Price, $ per LT	6.47	7.68	8.08	7.81	10.40	16.22
Rubber						
Value, $ million	36.2	32.5	29.0	42.9	64.5	46.2
Volume, million pounds	183.9	186.5	182.9	188.9	190.1	178.5
Unit Price, cents per lb.	19.7	17.4	15.9	22.8	33.9	25.9
Diamonds						
Value, $ million	27.9	28.2	31.7	49.3	29.9	18.4
Volume, 1000 carats	790	739	880	812	636	419
Unit Price, $ per carat	35.32	38.16	36.02	60.71	47.01	43.91
Logs and Lumber						
Value, $ million	5.8	8.0	8.2	16.6	17.6	12.8
Volume, 1000 board feet	65,095	86,800	93,948	105,087	80,348	42,274
Unit Price, $ per 1000 bd. ft.	88	92	87	158	219	303
Coffee						
Value, $ million	3.3	4.0	4.6	5.1	4.0	4.5
Volume, million pounds	10.9	12.2	12.3	15.1	7.5	9.1
Unit Price, cents per lb.	30.3	32.8	37.4	33.8	53.3	49.4
Cocoa						
Value, $ million	1.0	1.3	1.5	1.9	4.3	4.4
Volume, million pounds	3.6	6.1	7.0	5.3	7.3	7.0
Unit Price, cents per lb.	27.8	21.3	21.4	44.2	58.9	62.9

Source: Ministry of Planning and Economic Affairs

nition of the People's Republic of China, all Nationalists Republic of China personnel were withdrawn in early 1977. The field team studied the work of the CAM at Fava and observed flourishing swamp rice areas. Much of the higher land that has been cleared is now planted in oil palm and Liberian-American plans for a processing plant adjacent to a water impoundment area have been completed. The status of future Chinese involvement was unknown, but Fava residents indicated that they expected People's Republic of China personnel to replace the departed Nationalists.

The Liberian Agricultural Extension Service has been operating in the project area for some time. This service is severely undermanned, (an agent to farmer ratio of 1:1,400 existed in the study area in 1975). Such a ratio is far too high to initiate rapid change in conditions, particularly when compounded by a serious lack of transportation facilities. There are 18 extension agents dealing with farmers directly. In addition, there are three aides running demonstration farms and two rural youth teachers instructing through the primary schools.

The Agricultural Mechanization Company (Agrimeco) is a government-owned corporation managed by Agridev of Israel. Agrimeco provides services including land clearing, land preparation, sowing, construction of irrigation works, and construction and maintenance of access roads. The organization and equipment of Agrimeco is geared toward large-scale activities and is not generally suited to traditional farm work.

The Central Agricultural Experimentation Station has been operating at Suakoko since 1951. CAES provides many experimental services to the farmers of the project area, mostly through association with other projects. Some of the services provided by CAES include varietal improvements, fertilization experimentation and advice on weed and pest control for both upland and swamp rice. Other studies carried out by CAES include feasibility studies for various levels of mechanization and research on a variety of other crops, especially those feasible for rotation or interspaced with rice crops.

5. Forestry Concession

The timber industry in Liberia is increasing in importance annually. There are some 275-300 tree species in Liberia of which 90 have been selected for exploitation. The principle problems facing forest industries in Liberia are lack of transporation, shortage of capital, and the fact that many Liberian species are unknown to the world market. These problems, however, are being overcome and the future of the Liberian timber industry appears excellent.

Bong County to date has not played an important role in the Liberian timber industry. A pending application by a Swedish paper company for a 80,972 hectare (200,000 acre) timber concession located in the southern part of the project area could markedly increase pulp wood production in

Bong County but would reduce substantially the amount of land available for the agricultural development. The concession operations would involve the clearing and planting of 4,049 hectares (10,000 acres) per year of Pinus carabea, a fast growing species for pulp production.

The 80,972 hectares would be selected from a total area of 135,628 hectares (335,000 acres) delineated in Figure 5. The only land excluded from the concession would be existing settlements, swamp areas, a 1-kilometer strip on each side of the Gbarnga to Botata road and a 10-kilometer strip on each side of the LAMCO railroad and an existing iron ore concession area. In addition to the loss of 80,972 hectares (excluding swamps) from the project area, 2,800 farmers would be displaced and the labor requirements of this concession would alter the labor balance in the region.

F. PUBLIC HEALTH

The baseline health condition of a rural African population such as the one in Upper Bong County, Liberia is a function of many factors. Some factors which must be taken into consideration are; the dietary structure of the population, the indigenous diseases associated with that population, customs, and various other external factors that might exert some influence. Any one of these factors might significantly affect or damage the health condition of the population. For example, if the population is relatively free of disease, but suffering from poor nutrition, it has a poor health profile. Conversely, a population that is well fed, but riddled with disease, also has a poor profile. In the case of rural Liberia, it can be generalized that the population suffers both from chronic nutritional deficiencies and high levels of indigenous disease. This means, simply, that the general health of the rural population is poor.

A condition of poor general health and nutrition among rural African populations has existed and has been recognized for an extensive period of time. For example, it has been stated that, with the possible exception of the Pastoralists living in the Somaliland, in the better water savannahs of West and East Africa, and some isolated groups which have not broken the boundaries of their primitive ecology, no African populations have diets that are adequate in both energy producing and protective elements (Strong, 1930). Similarly, it is estimated that 90 percent of the people in Liberia live on diets below the "safety line" (Kittrell, 1947). There is no evidence to indicate that this condition has changed appreciably in 1977.

Another factor of considerable importance in determining the overall health quality of a population is the rate of growth. African nations are among those having the highest growth rates in the world. According to the World Bank Atlas (published by the International Bank for Reconstruction and Development) the annual increase in the population of Liberia is approximately 3 percent. This places Liberia very close to the top of world population growth rates. Such a rate has a significant impact on food, health care and other requirements. While there is some indication

that population growth is slightly less in the cities among the better educated populace compared to rural areas, the differences are relatively small. Figure 12 ranks birth rate in Liberia by literacy status of the mother and it can be noted that, while there is some difference between literate and illiterate mothers, the overall rate is still extremely high.

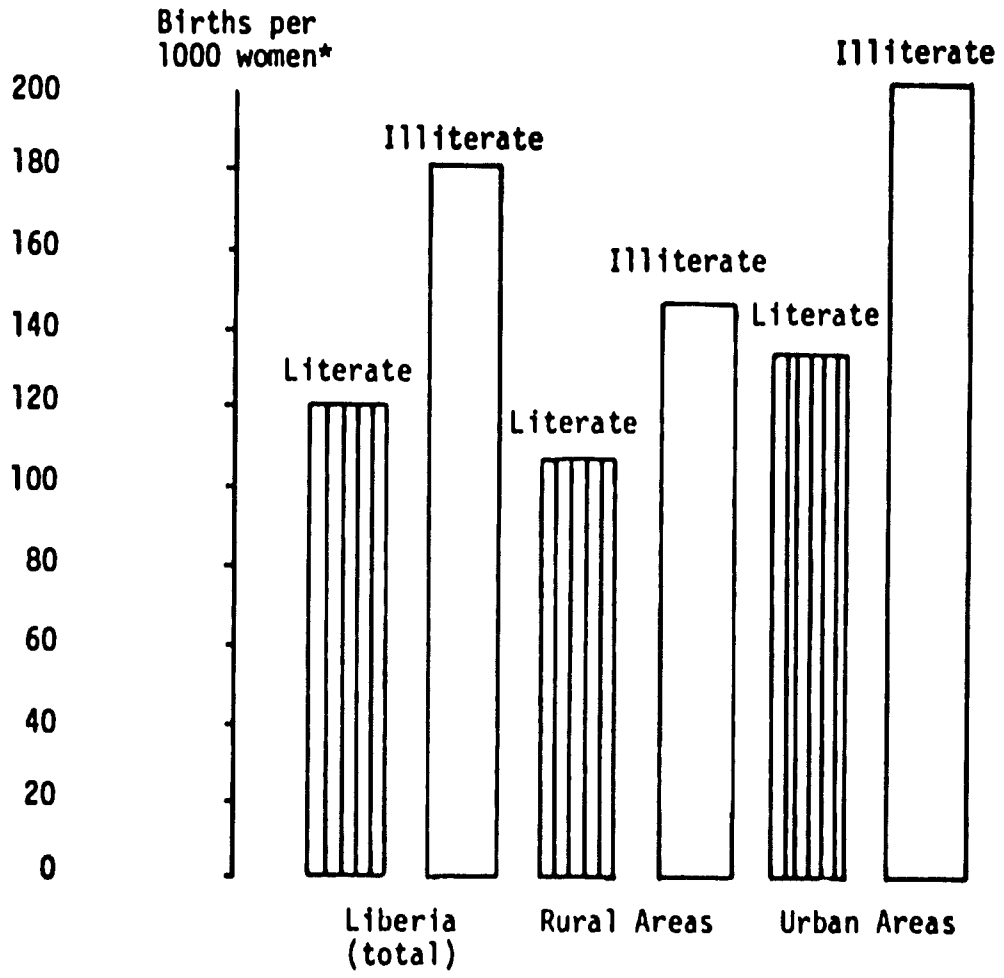
Practically speaking, a 3 percent birth rate means the population of Liberia is doubling every 21 to 22 years and that it is necessary for the country to double its agricultural output every 20 years, as well as double health care and other institutional facilities, in order to keep the population precisely where it is today. This will, of course, exert profound impact on future development of the country. The Government of Liberia has assembled a reasonably good collection of demographic data (Republic of Liberia, Ministry of Planning and Economic Affairs, 1973), but these studies indicate a population growth rate even higher than that suggested by the World Bank. According to the Ministry of Planning and Economic Affairs, in a report to the second session of the Legislature in 1977, the population growth rate for Liberia is approximately 3.3 percent. This would rank Liberia at the highest level of population growth in the world. Even though the infant mortality rate is high, the fertility rate is probably at its theoretical maximum. Approximately 42 percent of the population now is below 15 years of age and the dependency ratio of the country is approximately 80 per 100 potential workers. This, in itself, exerts a powerful impact on the ability of the country to provide adequate food and health care (Neal, 1976).

1. Nutrition

The nutritional characteristics of the population is a function of many factors. The most obvious one is food, both in terms of quantity and quality, but there are a number of other factors that must be taken into consideration. For example, the consumption patterns of the population, the customs affecting the diet, economic factors, and numerous other considerations are involved. However, for the purposes of this assessment, a few simple facts on the dietary intake and some analyses of the general nutritional condition of the population should sufficiently substantiate rural Liberian nutritional conditions.

Conflicting data exist on general rural health conditions. For example, a recent study indicated that some of the more obvious characteristics associated with nutritional deficiencies (such as the swollen belly and other such overt signs) are less apparent in Liberia than in Ghana. The conditions are certainly less apparent than in Upper Volta where there are some severe nutritional problems. In fact, the study concluded that nutrition did not seem to be a major problem (Gibson, 1977).

However, most other studies provide strong indications that the nutritional condition of the Liberian is quite poor. Children, in particular, are suffering from high levels of chronic malnutrition and various dietary deficiency problems. The health baseline of the population, as associated with nutrition, must be categorized as extremely poor and since nutritional



*Based on childbearing age between 10 and 49 years.

Figure 12. Birth Rates by Literacy Status of Mother.

deficiency tends to be physically and intellectually debilitating, this has a profound impact on the productivity of the populace.

a. Principal Foods and Consumption Patterns

A number of crops are grown in Bong County but the principal ones for consumption are rice and cassava. These foods, especially cassava, and high in carbohydrates and very deficient in other nutrients. However, recent studies indicate that portions of the population receive adequate nutrition. Table 15 shows three samples of a typical daily food intake for selected populations in a village near Gbarnga (Nowick, 1964). Obviously, no deficiency of protein, carbohydrate or fat exists in these diets. Although certain minerals may be in short supply, the general condition of the population would be good.

However, such data can be misleading. The area has a variable food supply and during much of the year, the population does not eat well. Other studies (e.g. Clark, 1975) indicate that the typical rural resident eats two major meals per day (mid-day and evening) but in many areas only one significant meal per day is eaten. Protein intake is extremely low and ranges between 23 and 29 grams per capita per day which is below FAO recommendations. Protein intake by children is particularly low and significant signs of protein deficiency diseases such as Kwashiokor have been found.

The reduced dietary intake is also associated with certain mineral and vitamin deficiencies. In particular, the hemoglobin of both adults and children indicates a general tendency toward anemia. This is a particullar problem in pregnancy, where the demands on the mother are somewhat larger, and contributes to children's disorders. According to the 1968 West Africa Conference on Nutrition and Child Feeding, more than 80 percent of the population in Liberia has clinical or sub-clinical signs of some deficiency further complicated by the severe and widespread prevalence of parasitic infections such as hook worms and schistosomiasis (Clarke, 1975). These parasitic infections contribute to anemia. So, in effect, the population is exposed to a double sword; that of nutritional deficiency and parasitic induced problems.

Table 17 provides an analysis of the edible portion of representative Liberian foods while Table 18 shows the percentage of FAO recommendations for a 2 to 4 year old child in one serving of selected Liberian foods. In looking at Table 18 the nutritional intake of a child when consuming the normal portion of any specific food type can be determined. Unfortunately, neither table specifically states the actual dietary intake; but, as previously discussed, the intake is generally below the FAO recommended levels.

If the common food types in the typical diet (e.g., rice, cassava, etc.) are examined, certain deficiencies become readily evident. The general concensus among investigators, including the Ministry of Planning of the Government of Liberia and field team observations, indicates that

TABLE 16. DAILY FOOD INTAKE

Product	Per Day (g)	Calories	Protein (g)	Fat (g)	Carbo-hydrates (g)	Calcium (mg)	Iron (mg)	Vit. A (IU)	Vit. B (mg)	Vit. C (mg)
Sample #1										
Rice	320	1,123	24.5	1.0	254	29	2.0	--	.256	--
Palm oil	90	810	8.1	90.9	--	--	--	72,000	.144	--
Meat	200	350	52.0	20.4	--	22	3.8	--	.200	8
Potato greens	250	72	4.7	.5	--	--	4.5	2,500	--	--
Pepper	30	5	.2	--	--	--	.1	75	.026	30
Totals	890	2,360	89.5	111.9	254	51	10.4	74,575	0.626	38
Sample #2										
Rice	320	1,123	24.5	1.00	254	29	2.00	--	.256	--
Palm oil	90	810	8.1	90.00	--	--	--	72,000	.144	--
Okra	120	18	1.2	.01	--	--	.75	560	.600	--
Meat	200	350	52.0	20.40	--	22	3.80	--	.200	8
Bitter balls	180	45	2.0	.60	--	--	1.20	900	.300	20
Pepper	30	5	.2	--	--	--	.10	750	.026	20
Totals	940	2,351	88.0	112.01	254	51	7.85	74,210	1.526	48
Sample #3										
Rice	320	1,123	24.5	1.0	254	29.00	2.00	--	.256	--
Palm oil	90	810	8.1	90.0	--	--	--	72,000	.144	--
Cassava greens*	100	134	1.3	.2	--	--	10.00	--	--	--
Fish	120	220	42.0	5.0	--	.07	4.00	--	.520	--
Pepper	30	5	.2	--	--	--	.10	750	.026	30
Totals	660	2,292	76.1	96.2	254	29.07	16.10	72,750	.946	30

* Cassava greens are consumed in large amounts. Their iron content has been established for the purpose of this study by Dr. W. W. Nowicki, Professor of Biochemistry, the University of Texas--Medical Branch, Galveston, Texas.

TABLE 17. NUTRITIONAL CONTENT OF 100g EDIBLE PORTION OF REPRESENTATIVE LIBERIAN FOODS.

	Protein (grams)	Calcium (mg)	Iron (mg)	Vit. A (IU)	Vit. C (mg)
Rice	8.0	10	2	-	-
Cassava	0.7	25	1	-	30
Plantain	1.0	7	0.5	100	20
Peanut	15.0	30	1.5	-	-
Lima bean	20.0	90	6.0	-	-
Eggplant	1.0	10	1.0	-	5
Potato Greens	5.0	250	4.0	3000	100
Cassava Leaf	2.0	80	2.5	1000	50
Okra	2.0	70	1.0	150	25
Pumpkin	1.0	20	0.8	350	15
Butter Pear	1.5	10	1.0	200	15
Banana	1.0	7	0.5	100	10
Grapefruit	0.5	20	0.5	-	40
Orange	0.8	30	0.5	30	45
Soursop	1.0	25	0.5	-	30
Guava	1.0	15	1.0	200	200
Mango	0.5	10	0.5	600	30
Papaya	0.6	20	0.5	1000	50
Pineapple	0.4	20	0.5	100	30
Red Palm Oil	0.0	0	0	20,000	0
Fish, fresh water	18.0	50	1.0	-	-
Fish, dried	63.0	3000	8.5	-	-
Sardines	20.0	400	3.0	200	0
Snail	12.0	1500	8.0	-	-
Termites	10.0	12	1.0	-	-
Beef	16.0	10	2.5	-	-
Eggs	13.0	55	2.8	1000	-
Goat	16.0	11	2.5	-	-
Liver	20.0	10	10	20,000	30.0
Chicken	19.0	15	1.5	-	-
Milk, human	1.3	30	0.2	160	4.0
Chilies	15.0	150	9.0	1000	10
Palm Wine	0.2	-	0.3	-	145
Kolanut	9.0	15.0	6.0	-	-
Sweet Potato	1.5	25	1.0	100	30

TABLE 18. PERCENTAGE OF FAO RECOMMENDATIONS FOR A 2-4 YEAR OLD CHILD IN ONE SERVING OF SELECTED LIBERIAN FOODS.

Food (quantity of serving)	Protein (g--%)	Calcium (mg--%)	Iron (mg--%)	Vit. A (IU--%)	Vit. C (mg--%)
Vitality					
Cassava leaf (½ cup cooked)	0.5--1.7	20--4	.8--8	250--8.4	15--50
Potato greens (½ cup cooked)	1.2--4	80--16	1.0--10	750--25	25--83
Pumpkin (½ cup cooked)	0.5--1.7	10--2	0.4--4	175--5.9	7--23
Sweet potato (½ cup cooked)	0.7--2.3	13--2.3	0.5--5	50--1.6	15--50
Okra (½ cup cooked)	1.0--3.3	35--7	0.5--5	75--2.5	13--43
Eggplant (½ cup cooked)	0.5--1.7	5--1	0.5--5	--	2--6.6
Red palm oil (1 tbsp.)	0.0---	0.0---	0---	2500--83	0---
Chilies (2 small)	0.7--2.3	7--1.5	0.5--5	50--1.6	0.5--1.7
Butter bean (½ cup = ½ small)	0.7--2.3	5--1	0.5--5	100--3.3	7--23
Banana (½ med. = 1 whole small)	1.0--3.3	7--1.5	0.5--5	100--3.3	10--33
Grapefruit (½ medium)	0.5--1.7	20--4	0.5--5	--	40--130
Orange (1 medium)	0.8--2.6	30--6	0.5--5	30--1	45--150
Soursop (½ cup pulp)	1.0--3.3	25--5	0.5--5	--	30--100
Guava (1 small)	0.2--0.6	4--0.8	0.2--2	50--1.7	50--170
Mango (1 medium)	0.5--1.7	1.0--0.2	0.5--5	600-20	30--100
Pawpaw (½ cup pulp)	0.6--2.0	20--4	8.5--5	1000--33	50--170
Pineapple (½ cup pulp)	0.4--1.3	20--4	0.5--5	100--3.3	30--100
Palm wine (½ cup)	0.2--0.6	--	0.3--3	--	145--480
Growth					
Fish, fresh water (1 oz.)	6.0--20	15--3	0.3--3	--	--
Dried fish (1 tsp.)	10.0--33	500--100	1.0--15	--	--
Sardines (1 oz.)	7.0--23	130--26	1.0--10	70--2.3	--
Snails (1 oz.)	4.0--11	500--100	2.7--27	--	--
Termites (1 oz.)	3.0--10	4.0--0.8	0.3--3	--	--
Beef or bush meat goat (1 oz.)	5.0--17.0	3.0--0.6	1.0--10	--	--
Eggs (1 medium)	6.0--20	25--5	1.5--15	500--16.8	--
Liver-any kind (1 oz.)	7.0--23	3.0--0.6	3.0--30	6500--216	10.0--33
Chicken (1 oz.)	6.0--20	5.0--1.0	0.5--5	--	--
Milk, human (1 cup)	3.0--10	60--12	0.4--4	320--10.7	8.0--25.6

the nutritional condition of the Upper Bong County population is substantially below satisfactory standards. (Clarke, 1975, Neal, 1976)

b. Customs Affecting the Diet

There is a ritualistic character associated with the cultivation, preparation and consumption of foods. These customs are particularly manifest with respect to pregnant women and children, and frequently contribute to many nutritional problems. For example, it is customary to wean children at a relatively early age and put them on essentially adult types of food before their digestive systems mature. As a consequence, although they may receive adequate quantities of food, they are not able to suitably process them. Some residents will not give children meat until they talk well because to do so early is believed to give them worms, cause them to be disrespectful of elders, or steal food from others. Eggs are sometimes not given to children in the belief that they will cause the child to be retarded and unable to speak because the egg is a silent thing. Bananas are not given to children because they are believed to be the cause of an open mold or depressions caused in the forehead. (The latter condition is not uncommon and can be associated with the dehydration that results from various forms of diarrhea and other ailments.)

Among the acceptable foods for children are fruits, which they are encouraged to pick themselves. Termites are also considered excellent because they represent new life coming from beneath the earth. The termites are parched, fried in oil or eaten raw and are considered a delicacy. A diet of fruit and termites is questionable from a nutritional standpoint. Diarrhea is a particular problem among children which is hardly surprising considering the high levels of enteric parasitic infections and the effects of various fruits.

The list of taboos for pregnant women are extraordinary in content and number in the hundreds. To name a few: a pregnant woman should not eat any kind of egg because it will cause her to abort; a pregnant woman should not eat water deer or ground squirrel as this will cause the baby to have fits; a pregnant woman should not eat any large animal because if she does she will have a premature child; a pregnant woman should not eat hog meat as this will cause the child to scratch his nose like a hog; and a pregnant woman should not eat catfish as it makes the child have bloody stools.

These customs, in association with the generally deficient foods in the diet, contribute to the poor nutrition of rural Liberians. Poor nutrition can have many manifestations, one of which is anemia. Table 19 shows hemoglobin values for mothers and children in the study area. With one exception, values are all below those considered to be acceptable. In general, anemia is widespread and contributes significantly to the general health deficiency of the population in the area. Of course, care must be exercised when assuming such data are specifically related to dietary problems since anemia can be caused by other factors

TABLE 19. HEMOGLOBIN VALUES OF MOTHERS AND CHILDREN

Group/Location	Number	Mean	Std. Dev.
Mothers			
Hospital (Curran)	55	9.74	2.06
Hospital (E.L.W.A.)	98	11.12	1.62
Children			
All villages	177	10.30	1.46
Wozi	43	10.18	1.51
Zolowu	35	10.20	1.39
Kiliwu	35	11.35	0.79
Yiella	19	10.16	1.39
Yukpadu	45	9.77	1.52

such as parasitic infections. However, the concensus seems to be that diet has a significant role in the development of anemic problems (Clarke, 1975). Other deficiency diseases can be associated with shortages of vitamins and minerals.

c. Nutritional Deficiencies

Since the rural population of the study area has a diet that is inadequate both in quantity and quality as well as one that is strongly influenced by customs, many nutritional deficiencies exist. This has been verified by several investigators but the number of nutritional studies are limited and frequently have been site specific. It is difficult to draw generalities from such limited evidence, but for the most part, the studies are consistent in their findings. Based on the results of past and ongoing studies plus field observations and Liberian statistics, it can be concluded that the general population of the study area does not have an adequate nutritional intake. Of particular concern are protein deficiency diseases such as kwashiokor, various forms of vitamin and mineral deficiency diseases, and some of the debilitating side effects associated with chronic diarrhea and dehydration.

Table 20 shows nutrient intake for a hypothetical child. These data are quite recent and, therefore, may be considered as representative of present conditions. There are a number of deficiencies in protein, vitamin, and mineral constituents. Protein deficiencies may produce kwashiokor and can be involved in the development of anemia, while reduced iron intake contributes to anemic conditions. Tables 21 and 22 summarize some of the signs of nutritional deficiency found throughout the population of the study area.

2. Domestic Water Supply and Sewage Disposal Systems

It can be generally stated that water supplies and sanitation systems in the study area are at a primitive level. Through custom, people tend to collect their water from any available source, and since they are indiscriminate, it is not uncommon for water to be obtained from a contaminated source. There are no public water or sewage systems in the rural area, although a public water supply project at Gbarnga is scheduled for completion in 1978. The report made by the Ministry of Planning and Economic Affairs to the second session of the Legislature of Liberia in 1976, contains no mention of other water or sewer construction in the study area. Water supply systems in other county seats are in various phases of planning, design or construction (Republic of Liberia, National Planning Council, 1976).

Sanitary sewage disposal and treatment is unknown throughout most of the Upper Bong County. This in itself does not constitute a significant health hazard unless there is cross contamination between the disposal sites and the water supplies. Because of the customs of the natives, cross contamination happens quite frequently and tends to increase the incidence of a number of vector borne diseases such as schistosomiasis.

TABLE 20. NUTRIENT INTAKE OF HYPOTHETICAL CHILDREN*

Nutrient	Amount Consumed	RDA	Percent RDA
	(Female, 4 yrs.)		
Calories	628.5	1800.0	40
Protein (Gm.)	11.6	30.0	38
Calcium (Mg.)	76.5	800.0	9
Iron (Mg.)	4.5	10.0	44
Vitamin A (I.U.)	2117.7	2500.0	84
Ascorbic acid (Mg.)	59.5	40.0	148
Thiamin (Mg.)	.6	.9	59
Riboflavin (Mg.)	.3	1.1	23
Niacin (Mg.)	6.3	12.0	52
Vitamin E (Mg.)	6.0	9.0	77
Iodine (Mcg.)	34.0	80.0	42
Zinc (Mg.)	2.0	10.0	20
Magnesium (Mg.)	131.2	200.0	65
Vitamin B_6 (Mcg.)	476.0	900.0	52
Vitamin B_{12} (Mcg.)	.8	1.5	50
Folacin (Mcg.)	67.8	200.0	33
Sodium (Mg.)	59.0	1000.0	5
Potassium (Mg.)	1110.0	1500.0	74
	(Male, 5 yrs.)		
Calories	895.0	1800.0	49
Protein (Gm.)	34.1	30.0	113
Calcium (Mg.)	170.0	800.0	21
Iron (Mg.)	9.0	10.0	90
Vitamin A (I.U.)	5059.5	2500.0	202
Ascorbic acid (Mg.)	81.0	40.0	202
Thiamin (Mg.)	1.2	.9	131
Riboflavin (Mg.)	.5	1.1	47
Niacin (Mg.)	10.9	12.0	90
Vitamin E. (Mg.)	7.5	9.0	82
Iodine (Mcg.)	35.5	80.0	44
Zinc (Mg.)	5.3	10.0	52
Magnesium (Mg.)	215.5	200.0	107
Vitamin B_6 (Mcg.)	842.0	900.0	93
Vitamin B_{12} (Mcg.)	2.0	1.0	166
Folacin (Mcg.)	138.1	200.0	69
Sodium (Mg.)	396.0	1000.0	39
Potassium (Mg.)	1775.0	1500.0	118

cont'd.

TABLE 20. cont'd.

Nutrient	Amount Consumed	RDA	Percent RDA
	(Female, 7 yrs.)		
Calories	594.0	2400.0	24
Protein (Gm.)	18.8	36.0	52
Calcium (Mg.)	81.0	800.0	10
Iron (Mg.)	5.4	10.0	54
Vitamin A (I.U.)	2669.5	3300.0	80
Ascorbic acid (Mg.)	52.0	40.0	130
Thiamin (Mg.)	.6	1.2	50
Riboflavin (Mg.)	.3	1.2	25
Niacin (Mg.)	7.4	16.0	45
Vitamin E (Mg.)	5.4	10.0	54
Iodine (Mcg.)	24.5	110.0	22
Zinc (Mg.)	3.0	10.0	30
Magnesium (Mg.)	108.5	250.0	43
Vitamin B_6 (Mcg.)	690.0	1200.0	57
Vitamin B_1 (Mcg.)	1.5	2.0	75
Folacin (Mcg.)	82.0	300.0	27
Sodium (Mg.)	81.0	1000.0	8
Potassium (mg.)	1190.0	1500.0	79
	(Male, 10 yrs.)		
Calories	1236.0	2800.0	44
Protein (Gm.)	25.0	40.0	56
Calcium (Mg.)	146.0	1200.0	12
Iron (Mg.)	9.0	18.0	53
Vitamin A (I.U.)	4811.5	5000.0	96
Ascorbic acid (Mg.)	60.0	45.0	133
Thiamin (Mg.)	1.1	1.4	80
Riboflavin (Mg.)	.5	1.5	31
Niacin (Mg.)	11.7	18.0	64
Vitamin E (Mg.)	11.0	12.0	91
Iodine (Mcg.)	40.5	130.0	31
Zinc (Mg.)	4.1	15.0	27
Magnesium (Mg.)	195.5	370.0	50
Vitamin B_6 (Mcg.)	728.0	1600.0	45
Vitamin B_{12} (Mcg.)	1.5	3.0	50
Folacin (Mcg.)	124.5	400.0	31
Sodium (Mg.)	150.0	2000.0	7
Potassium (Mg.)	2060.0	3000.0	68

* From Clarke, 1975.

TABLE 21. PREVALENCE OF SIGNS OF NUTRITIONAL DEFICIENCIES BY TRIBE (BOTH SEXES).

Symptom	Number Affected			
	Loma (N = 418)		Kpelle (N = 340)	
	N	%	N	%
Hair				
Depigmentation	5	1.19	10	2.94
Skin				
Xerosis	3	0.72	1	0.29
Low Turgor	4	0.96	0	
Pale Color	0		0	
Skeletal				
Thin	15	3.59	18	5.29
Undermusculature	9	2.15	12	3.53
Bossing	1	0.24	1	0.29
Eyes				
Conjunctivitis	8	1.91	17	5.00
Pale Conjunctiva	36	8.60	28	8.24
Mouth				
Caries	25	5.98	10	2.94
Infection-Thrush	9	2.15	0	
Enamel Hypoplasia	12	2.87	27	7.94
Gingivitis	2	0.48	14	4.12
Pyorrhea	1	0.24	19	5.59
Abdomen				
Potbelly	123	29.42	52	15.29
Dehydration	3	0.72	3	0.88
General Condition				
Average	397	94.98	307	90.29
Poor	21	5.02	33	9.71
General Complaints (first and second complaint combined)				
Fever	217	51.91	175	51.47
Worms	27	6.46	79	23.24
Diarrhea	60	14.35	69	20.29
Cough	76	18.18	63	18.53
Cold	13	3.11	15	4.41
Dermatitis and Country Sores	11	2.63	22	6.47
Infection	8	1.91	13	3.82

TABLE 22. PREVALENCE OF SIGNS OF NUTRITIONAL DEFICIENCIES BY AREA (BOTH SEXES).

Symptom	Number Affected			
	Rural (N=1279)		Urban (N=292)	
	N	%	N	%
Hair				
Depigmentation	23	1.79	1	0.34
Skin				
Xerosis	2	0.16	1	0.34
Low Turgor	9	0.70	0	
Pale Color	3	0.23	0	
Skeltal				
Thin	61	4.77	7	2.40
Undermusclature	31	2.42	1	0.34
Bossing	2	0.16	0	
Eyes				
Conjunctivitis	50	3.91	6	2.05
Pale Conjunctiva	123	9.62	21	7.19
Mouth				
Caries	65	5.08	1	0.34
Infection-Thrush	10	0.78	0	
Enamel Hypoplasia	69	5.39	18	6.16
Gingivitis	45	3.52	2	0.68
Pyorrhea	30	2.35	4	1.37
Abdomen				
Potbelly	260	20.33	3	1.03
Dehydration	8	0.63	20	6.85
General Condition				
Average	1188	92.89	257	88.02
Poor	85	6.65	35	11.99
General Complaints (first and second complaint combined)				
Fever	733	57.31	148	50.68
Worms	134	10.48	49	16.78
Diarrhea	63	4.93	61	20.89
Cough	104	8.13	62	21.23
Cold	28	2.19	20	6.85
Dermatitis and Country Sores	14	1.09	15	5.14
Infection	14	1.09	14	4.79

3. Indigenous Diseases

Indigenous disease tend to be prevalent among populations that have poor health practices and nutritional conditions. The list of diseases found in the study area is extremely long and includes the following: schistosomiasis; onchocerciasis; malaria; trypanosomiasis; Lhasa fever; filariasis; pneumoconiosis; leprosy and tuberculosis. Several such as schistosomiasis, onchocerciasis, malaria and trypanosomiasis, are of greater significance than others.

It is particularly difficult to establish a baseline with respect to the levels of indigenous disease in Upper Bong County. In general, data are virtually nonexistent since there have been very few studies performed in the project area. What few studies have been done are usually specific to a certain area, specific to a certain disease, or may suffer from a variety of problems. As a consequence, conclusions about disease levels in this particular region must be derived from a number of assumptions and a limited data base. However, the conclusions are consistent with those made in similar, more thoroughly documented areas of the world. No evidence has been found to indicate that the study area has more resistance to indigenous disease than other areas of the world. As a consequence, it is reasonable to assume that the conditions described from the limited data base are, in fact, realistic (Nowicki, 1964; American Public Health Association, 1977). Table 23 shows the percentage of helminthic (parasitic worm) infestation in school children and Table 24 gives helminthic infestation with respect to residence. Tables 25 and 26 provide further information of the level of helminthic contamination in the population. It should be noted that these studies were done on school children and the data have been extrapolated to include the entire population.

The levels of infestations are high with variability from tribe to tribe and from village to village. However, on the average, the entire population is quite heavily infested. Schistosomiasis and malaria are very prevalent and many other diseases are common. It is not unusual to see patients with singular, double and triple helminthic infestations. It is likely that anyone living in this particular area will have at least one of the various parasites.

A list of indigenous diseases and their prevalence as updated by the Ministry of Health and Social Welfare (MHSW) for a nine month period from Januray 1 to September 30, 1976, is found in Table 27. Data obtained from Phebe Hospital and G. B. Dunbar Clinic, which are discussed below, indicate a definite under-reporting of endemic diseases to the MHSW.

a. Schistosomiasis

One of the most important diseases in the study area is schistosomiasis, a disease caused by infestation with blood flukes. Infection occurs

TABLE 23. INCIDENCE OF HELMINTHIC INFESTATION IN SCHOOL CHILDREN

Helminth	Infestation No. of Children	%
Ancylostoma	113	77
Ascaris	76	52
Schistosoma hematobium	56	38
S. mansoni	27	18
Strongyloides	22	15
Trichocephalus	18	--

TABLE 24. PERCENTAGES OF HELMINTHIC INFESTATIONS IN SCHOOL CHILDREN ACCORDING TO THEIR RESIDENCE.

Helminth	Percent Infestation Yila	Gbarguay-tu	Lamco[1]	Rock Crusher[1]	Old Yopea	Farms[2]
Ancylostoma	88	70	90	64	96	72
Schistosoma hematobium	44	35	60	48	48	8
S. mansoni	4	15	30	32	8	24
Ascaris	48	50	80	8	52	48
Strongyloides	20	15	20	16	16	16
Trichocephalus	--	--	--	--	--	--

1 Wells and Privies Available

2 Includes Several Small Settlements Attached to Six Farms

TABLE 25. SINGLE AND MULTIPLE INTESTINAL AND URINARY INFESTATIONS

No. of Species	Infestation No. of Children	%
0	11	8
1	26	18
2	60	41
3	39	27
4	9	6

TABLE 26. HELMINTHIC INFESTATIONS ACCORDING TO TRIBES

Helminth	Percent Infestation Mano	Bassa	Loma	Kpelle	Gio
Ancylostoma	74	78	60	60	60
Schistosoma hematobium	32	42	60	35	14
S. mansoni	12	27	12	20	14
Ascaris	40	57	12	75	60
Strongyloides	16	12	12	10	14

TABLE 27. INDIGENOUS DISEASE INCIDENCE, JANUARY-SEPTEMBER, 1976

	Liberia		Bong County	
Disease	Cases	Deaths	Cases	Deaths
Malaria	42,023	70	3,465	2
Schistosomiasis	1,077	-	191	-
Pneumonia	3,149	151	87	3
Measles	1,420	55	46	1
Dysentery	3,425	-	28	-
Cholera	508	8	-	-
Diarrhea	15,379	75	1,513	2
Leprosy	2,303	-	455	-
Tetanus	446	49	2	1
Pulmonary tuberculosis	726	22	5	-
Pertussis	1,161	1	1	-
Onchocerciasis	1,082	-	2	-
Infectious hepatitis	226	-	1	0
Total	72,934	431	5,796	9

when the free living trematode cercaria which has escaped from its intermediate snail host actively penetrates the skin of a human. Although no data specific to the project area are available, data from Phebe Hospital for a five month period in 1976 revealed 558 cases of Schistosoma haematobium infection and 304 cases of Schistosoma mansoni infection. Sodemon (1973) indicates that surveys taken at schools in Suakoko and Gbarnga showed the prevalence of S. mansoni was 49.6 percent at Suakoko and 66 percent in Gbarnga and the prevalence of S. haematobium was 49.7 percent in Suakoko and 44.4 percent in Gbarnga.

b. Malaria

Malaria has the highest incidence of any communicable disease in Liberia, a situation shared by virtually all of tropical Africa. Infection occurs when an infected anopheline mosquito bites a non-immune person, injecting parasitic sporozoites of Plasmodium spp. into the bloodstream. The sporozoites reach the liver via the bloodstream and each gives rise to 2,000 to 20,000 merozoites. After incubation, these merozoites enter the bloodstream, parasitizing the enthrocytes, causing chills and fever and often death. The infection rate is some parts of rural Liberia are stated to be as high as 80 to 100 percent. In 1976, 37,994 cases of malaria were reported by clinics in Bong County. For a five month period in 1976, Phebe Hospital made the microscopic diagnosis of 1,698 cases of malaria.

c. Onchocerciasis

The most dramatic form of filariasis is onchocerciasis or river blindness. Blindness occurs when the worm Onchocerca volvulva, which is transmitted by the black fly Simulium damnosum, comes in contact with the eyes. A rate of blindness of 1.18 percent has been found in the Bong County area, the majority of which appeared to be related to Onchocerciasis. The average age of onset of blindness was 48 years. Records from Phebe Hospital and C.B. Dunbar Clinic show that 33 percent to 51 percent of skin snips taken during 1973-1976 were positive for Onchocera microfilariae.

d. Trypanosomiasis

Trypanosomiasis is not a widespread problem in Liberia, but Trypanosoma spp. is present in the study area and is transmitted by several species of the tsetse. The trypanosome, a flagellated protozoan, causes a number of ailments including sleeping sickness. A review of the records of Phebe Hospital indicate that only 13 cases of trypanosomiasis were detected during the ten year period from 1967 to 1977.

e. Other

Many other diseases such as leprosy and tuberculosis are indigenous to the study area but will be little affected by the project. Members of the public health team have expressed concern over the possible development

of silicosis as a potential effect of inhaling lateritic dust. Many of the rural residents are presently subjected to high levels of lateritic dust. This is particularly true for people adjacent to rural roads where a substantial amount of reddish dust is caused by traffic during the dry season.

Additional concern has been expressed over the potential outbreak of Lhasa Fever, a viral infection which is not now a problem in Liberia. With implementation of a rice development project in Kenema, Sierra Leone, the incidence of Lhasa Fever increased significantly and is probably related to large grain storage areas that attract rats from the adjacent jungles. Thus, as a result of changed vector patterns, a disease that was indigenous, but of little significance, became a major problem (Comments by USAID). While there is no evidence that Lhasa Fever will increase in Bong County it is a potential problem that is of concern to those associated with the project. It must be noted that existing Bong and adjacent County rice storage areas have not stimulated the incidence of this virulent and dangerous disease.

4. Health Care

Health care in Liberia is characterized by an extremely limited number of medical/health care facilities and an extensive reliance of the rural population on tribal medical practices. In the rural Liberian tribe, rarely is modern medicine practiced and it is often difficult to encourage use of facilities even when they are available. Tribal medicine utilizes a number of herbs and drugs combined with various rituals and religious practices. Certain secret societies in this area are responsible for the passing of medical secrets from one generation to another and there are severe punishments for violations of the rules of these societies.

A major problem of providing health care for the rural population is the absence of an adequate number of clinics. Within Bong County, the National Public Health Service has a county hospital at Gbarnga (one is maintained at each county seat). Additionally, within Liberia the John F. Kennedy National Medical Center is in suburban Monrovia and has a number of associated out-patient clinics. There are several other hospitals in and around the Monrovia area, including a tuberculosis sanatorium, a psychiatric hospital and a maternity center. Various concessions in the country for mining and rubber plantations operate their own hospitals for their employees. There are a number of mission hospitals such as the Catholic Hospital close to Monrovia, operated by the Sudan Interior Mission, the Ganta Methodist Hospital at Ganta in Nimba County, Phebe Hospital at Suakoko in Bong County, operated by several churches and the Curran Lutheran Hospital in Zorzor. In addition, there are a variety of health posts, located throughout the country, staffed by health assistants under the supervision of the County Health Officer.

A comparison of the number of facilities to population indicates a large number of people per facility. The distribution of facilities is poor since most are located in urbanized areas. As a consequence, the rural population has little access to more than one facility and to reach it may require considerable and difficult travel. As a further complication, the occupancy rate in existing facilities is relatively high. For example, in 1970 the Curran Hospital was running at 130 percent occupancy and similar problems exist in most other hospitals in the country.

A good indicator of health care is mortality data. The death rate in Liberia is still extremely high, particularly in terms of infant mortality (143 per thousand) and the current average life span is 45.8 years. In addition, there are numerous problems associated with the hospitals. For example, the national hospital in Monrovia (the John F. Kennedy Center) has been characterized as having an extremely large number of administrative problems and appears to be inadequately staffed (Derryberry, 1974).

There is, at present, interest on the part of the Government of Liberia and other agencies, in the development of additional health care facilities. The annual report of the Ministry of Planning to the Legislature in 1976, explains the status of several new county hospitals, proposed or under construction. Funds are being allocated for increased malaria control within a 40 mile radius of Monrovia. A multi-purpose epidemiology team is to be established to deal with the various problems in the counties, including the development of immunization programs. Public health laboratories are planned and some additional funds have been allocated to improve the JFK Medical Center facilities. In addition to these GOL activities, there are several other health programs involving United States assistance. These include the USAID assistance to the JFK Medical Center, some funding programs for rural health management, the EEC health development project, and an interministerial committee on nutrition established in 1975 to foster dietary education (Neal, 1976).

While these programs represent progress in the context of the existing facilities, such activities represent a very small part of what must be done to develop proper health care levels. Efforts are hampered because of insufficient funding and the absence of sufficient skilled personnel to administer the various facilities. Without a sizable commitment of time, money and skilled personnel the present health care structure is not likely to improve and very probably will deteriorate as the population increases.

BIBLIOGRAPHY

BIBLIOGRAPHY

Agrar- Und Hydrotechnik GMBH. 1975. Upper Bong Rural Development Project Feasibility Study. Government of Liberia, Ministry of Agriculture.

Amachree, I.T.D. 1970. Agricultural Innovation in Rural Liberia: A Study of Farmers Among the Kissi. Monrovia.

American Public Health Association. 1977. Environment Health Assessment. Liberia, (Draft Interim Report). Washington, D.C.

Blanchard, D.G. 1967. The Development of Small Farm Agriculture in Liberia. Monrovia.

Boorman, J. 1970. West African Butterflies and Moths. Longman Group Ltd. London.

Booth, A.H. 1960. Small Mammals of West Africa. Longman Group Ltd. London.

Buchanan, T.S., Bullard, E.T., Phillips, J.T. Jr., and Roye, M.E. 1954. Station Note No. 2, Nursery Practices for Coffee. CAES, Suakoko. Liberia.

Cansdale, G.S. 1961. West African Snakes. Longman Group Ltd. London.

Chandler, A.C. and Read, C.P. 1961. Introduction to Parasitology. John Wiley and Sons, Inc. New York.

Clarke, Juna-Ann K. 1975. Nutritional Status of Children in Rural and Urban Liberia. Oakland, California.

Derryberry, M. 1974. Development of Outreach Program, J.F. Kennedy Medical Center. Report to APHA.

Elgood, J. 1964. Birds of the West African Town and Garden. Longman Group, Ltd. London.

Fanfant, R. 1972. Semi-detailed Soil Survey of Mid-Bong County. (unpublished).

Gibson, Ulrich. 1977. American Public Health Association. (personal communication).

Gledhill, D. 1972. West African Trees. Longman Group, Ltd. London.

Horsfall, W.R. 1962. Medical Entomology. Anthropods and Human Disease. Ronald Press. New York.

Hartley, W.J. 1959. Handbook of Liberian Ferns. Ganta, Liberia.

Holden, M. and Reed, W. 1972. West African Freshwater Fish. Longman Group, Ltd. London.

Hopkins, B. 1965. Forest and Savanna. Heinemann. Ibadan and London.

James, M.T. and Harwood, R.F. 1971. Herms's Medical Entomology. Macmillan Company. London.

Kittrell, F.P. 1947. A Preliminary Food and Nutrition Survey of Liberia, 1946-47. National Public Health Service. (mimeograph).

Koppen, W. and Geiger, R. 1930 and later. Handbuck der Klimatologie, 5 Volumes. Gebruder Borntraeger. Berlin.

Lichtenstein, E.P., Schulz, K.R., Skrentry, R.F., and Tsukano, Y. 1966. "Toxicity and fate of insecticides in water". Arch. Environ. Hlth. 12: 199-212.

Neal, D.F., Republic of Liberia, Ministry of Planning. Annual Report to the Second Session of the 48th Legislature, January 1, 1976 to December 31, 1976.

Nielsen, M.S. 1965. Introduction to the Flowering Plants of West Africa. University of London Press, Ltd. London.

Nowicki, E.L. 1964. Rural Public Health in Pictures, Bong County, Liberia.

Pearce, M.R. 1968. Nutrition in Liberia. West African Conference on Nutrition and Child Feeding. USPHS. Washington, D.C.

Pereira, H.C. 1973. Land Use and Water Resources in Temperate and Tropical Climates. Cambridge University Press. Cambridge, England.

Republic of Liberia, Ministry of Agriculture. 1976a. National Rice Production, 1975. Monrovia.

Republic of Liberia, Ministry of Agriculture. 1976b. Statistical Handbook, Republic of Liberia. Monrovia.

Republic of Liberia, Ministry of Planning and Economic Affairs. 1973. Demographic Profiles of Liberia, 1971. Monrovia.

Republic of Liberia, Ministry of Planning and Economic Affairs. 1974. Indicative Manpower Plan of Liberia for the Period 1972-1982. Monrovia.

Republic of Liberia, Ministry of Planning and Economic Affairs. 1975. 1974 Census of Population and Housing. Monrovia.

Republic of Liberia, Ministry of Planning and Economic Affairs. 1976. Economic Survey of Liberia, 1975. Monrovia.

Republic of Liberia, Ministry of Public Works. 1972. Liberian Highway Organization and Maintenance Study. Monrovia.

Republic of Liberia, National Planning Council. 1976. National Socio-Economic Development Plan. Monrovia.

Republic of Liberia, Office of National Planning. 1963. 1962 Census of Population. Monrovia.

Richards, P. W. 1952. The Tropical Rain Forest. Cambridge University Press. Cambridge, England.

Ruiz-tiber, E. 1976. Appraisal of Schistosomiasis and Approaches to its Surveillance and Control in Upper Lofa County, Liberia. C.D.C. Puerto Rico.

Sachter, M. and Hamer, K. "Reconnaissance of the Forests in Northwest Liberia and a Pilot Inventory in the LAMCO Concession on Mount Nimba". Tech. Rept. of the German Forestry Mission to Liberia. (mimeograph).

Schad, G. A. and Roseboom, L. E. 1976. Integrated Control of Helminths in Human Populations. Ann. Rev. Ecol. Syst. 7: 393-420.

Schulze, Willi. 1973. A New Geography of Liberia. Longman Group, Ltd. London.

Schwab, G. 1947. Report of the Peabody Museum Expedition to Liberia. Volumes 1 and 2. Tribes of the Liberian Hinterland. Cambridge University Press. Cambridge, England.

Sodeman, Wm. A. Jr. 1973. The Distribution of Schistosome Vector Snails in Central Liberia. Ann. Trop. Med. & Parasit. 67: 357-360.

Strahler, A. 1969. Physical Geography. John Wiley and Sons, Inc. New York.

Strong, R. P. ed. 1930. The African Republic of Liberia and the Belgian Congo. (Vols. I and II). Harvard University Press.

Tarpeh, D. N. and Mueller, J. V. 1970. A Study of Liberia's Traditional and Modern Land Tenure Systems. Suakoko, Liberia.

U. S. Agency for International Development. 1975. Liberia Rural Roads Study. Washington, D. C.

U. S. Agency for International Development. 1976. Project Review Paper, Upper Bong County Integrated Rural Development Project. Washington, D. C.

U. S. Department of Agriculture and U. S. Department of State. 1951. Reconnaissance Soil Survey of Liberia. Washington, D. C.

U. S. Department of Agriculture. 1961. A Universal Equation for Predicting Rainfall Erosion Losses. U. S. Agr. Res. Serv. Special Report. pp. 22-26.

U. S. Department of Defense. 1964. Area Handbook for Liberia. Washington, D. C.

U. S. Department of the Interior, U. S. Fish and Wildlife Service. 1976. "Endangered and Threatened Wildlife and Plants". Federal Register Vol. 41, No. 208 (27 October). Washington, D. C.

U. S. Department of the Interior, U. S. Fish and Wildlife Service. 1977. "International Trade in Endangered Species of Wild Fauna and Flora". Federal Register, Vol. 42, No. 35 (22 February). Washington, D. C.

U. S. Environmental Protection Agency. 1972. Pesticide Usage and Its Impact on the Aquatic Environment in the Southeast. Pesticide Study Series No. 8.

Uttormark, P. D., Chapin, J. D. and Green, K. M. 1974. "Estimating nutrient loadings of lakes from non-point sources". U. S. Environmental Protection Agency. Ecological Research Service.

World Health Organization. 1965. Protein Requirements. FAO/WHO Group. WHO Technical Report Series No. 30. Rome.

Voorhoeve, A. G. 1965. Liberian High Forest Trees. Centre for Agricultural Publications and Documentation. Wageningen, Holland.