

Republic of Liberia



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(UNDP)**



**UNDP Global Project:
Capacity Development for Policy Makers
to Address Climate Change**

Final report

**Assessment of Investment and Financial Flows
for Adaptation in the Agriculture Sector
in Liberia**

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Investment and Financial Flows to Address Climate Change UNDP Global Project

Climate Change poses significant challenges to development and policy makers are faced with complex tasks to respond to them and to ensure sustainable development. Particularly in Least Developed Countries decision makers have to balance poverty alleviation, economic development as well as social and environmental questions, while also questions of costs that occur with associated policies and measures play a vital role.

To better understand the magnitude of funds needed to tackle climate change now and in the long term, developing countries are undertaking assessments of investment and financial flows (I&FF) to address climate change for key sectors in a groundbreaking UNDP Environment & Energy Group project: Capacity Development for Policy Makers to Address Climate Change.

Liberia is one of 19 countries participating in this project, which was launched in May 2008 with the generous contributions of the Government of Norway, Government of Finland, Government of Switzerland as well as the UN Foundation and UNDP.

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List of Acronyms

CAAS-Lib	Comprehensive Assessment of the Agricultural Sector of Liberia
CARI	Central Agricultural Research Institute
CBL	Central Bank of Liberia
CFSNS	Comprehensive National Food Security & Nutrition Survey
EFI	Environmental Foundation International
EPA	Environmental Protection Agency
GDP	Gross Domestic Product
GOL	Government of Liberia
I&FF	Investment and Financial Flows
FAO	Food and Agriculture Organization
MLME	Ministry of Lands, Mines and Energy
MOA	Ministry of Agriculture
MOF	Ministry of Finance
NAPA	National Adaptation Programme of Action
NFSNS	National Food Security & Nutrition Strategy for Liberia
NGO	Non-Governmental Organization
O&M	Operation and Maintenance
PRS	Poverty Reduction Strategy
UNDP	United Nations Development Programme
UNFCCC	United Nations Framework Convention on Climate Change
UL	University of Liberia
UNMIL	United Nations Mission In Liberia

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Executive Summary

There are five major sub-sectors under the agriculture sector of Liberia, namely: crop production, plant protection, soil & water management, livestock production and fishery. These subsectors play vital role in the socio-economic development of the country.

Historical data collected cover the period 2000 to 2005. The year 2005 was selected as the base year. Let it be registered that obtaining data on investments was insufficient due to 14-year civil crisis where most offices were either looted or destroyed. Due to the unavailability of data from 2000 to 2004 for the HICP, historical data from 2005 to 2008 were used.

Based on the scope, the following adaptation options were envisaged:

- Improve soil fertility by maintaining fast growing nitrogen fixing trees species and using multi-purpose tree species;
- Plant protection;
- Development of the livestock species most resistant to climatic conditions;
- Development of fishery (fish farming and aquaculture);
- Intercropping, irrigation and the improvement of farming practices.

The results of this assessment indicate that adequate investments in agricultural development could play a crucial role in overcoming the challenges posed by climate change. The grand total of funds required is \$1,407.39M for Liberia agriculture. Investment on crop production will require \$315.53M. This amount on investment for crop production is the highest of all investments considered in the study. There will be a need to develop proper land tenure systems. In addition, drought/flood resistant crops should be bred. Also, fishery netted second to crop production with the amount of \$274.33M. Fishery was followed by plant protection with the \$137.18M. The bulk of these investments will be needed from 2022 to 2030. This implies that machineries, construction of basic infrastructure like farm-to-market road, storage, processing of agricultural produce to add value are expected to be in full operation. The increase in investment flows in these years could be attributed to mechanized agriculture due to the population growth rate; and as the population gets well-informed and skillful, there will be increase in income alongside with growing consumption patterns.

However, interestingly, requirement on investment of soil and water management yielded the least (\$41.23M) among the five sub-sectors. This could be best explained by the fact that this sector is often given low consideration. In actuality, soil and water conservation must be accorded the highest priority in allotting investment. Reasons being, there is a need to invest modern irrigation facilities and other appropriate technology such as adopting water-saving agricultural technologies, developing alternative water sources and facilitating the design and management of adaptive irrigation and drainages for higher agricultural productivity.

Investments in livestock production and plant protection were \$137.18M and \$137.18M respectively. These funding requirements are relatively high due to the decimated nature of the livestock sub-sector which needs to be developed to increase the productive capacity of livestock by providing farmers access to more inputs and support services. With respect to plant protection, much investment must be made to reorganize the Plant Protection Directorate either at CARI or within the Ministry of Agriculture.

Households will require most funding with total amount of \$633.35M, followed by corporation (\$492.61M) and then government (\$281.49M). The reason for the households being allotted greatest amount is that Liberia has many impoverished small-scale farmers who are most vulnerable to the adverse impacts of climate change. Additionally, the government of Liberia has developed its Food and Agricultural Policy with a pro-poor and pro-growth framework to transform the sector from a state of subsistence to semi-mechanized operations which could be driven by increased levels of capital investments in the sector, particularly in the value chains such as processing, storage and marketing.

Over 75 percent of the country's population of 3.475 millions engaged either directly or indirectly in smallholder subsistence farming or fisheries. In view of the aforementioned, agriculture is the single most important source of livelihood for most rural Liberians.

The current food and Agriculture policy neither specifies the adaptation measures nor the cost required to enable farmers cope with the impacts of climate change. Hence, it would be prudent for MOA to revise its policy on food security and agriculture by capturing the selected adaptation activities and interventions stated in this assessment. The MOA to redefine its main roles and functions, and restructure its central structures to support the GOL policies as stated in the Statement of policy Intent for Agriculture in the Comprehensive Food Security and Nutrition Survey (2006), Comprehensive Assessment of Agricultural Sector in Liberia (2007), Food and Agriculture Policy and Strategy (2008), Poverty Reduction Strategy (2008), and to rebuild its technical services to respond to the needs of the agriculture sector. Key components of these agriculture policies include:

Pro-poor agriculture and agric business development, including: The provision of micro-finance to needy farm family even with relatively no collateral; the supply of timely and relevant farm inputs; low-cost extension services to needy farmers.

Food and nutrition security, including: Identifying local food items, evaluate their nutritional contents; create awareness on local food items and promote/ encourage their consumption; understanding seasonal crops to know their availability, encourage and promote the production of local food items.

Intensification and diversification of farming farming system, including: proper land use plan; optimal water usage; crop rotation; low-external inputs (e.g. chemical fertilizer/ pesticide); resistant crops and animals.

Farm mechanization, including: Introduction of appropriate technology; animal traction draught; irrigation.

Increased market access, including: Improved transport system (e.g. Farm-to-market road); fair price for local agricultural produces, quality control of agricultural products; formation of cooperatives.

Reduce post-harvest losses, including: Processing of agricultural produces to add value chain; improved storage; pest control.

Human and institutional capacity building, including: Develop a national policy on climate change; provision of funding to build human capacity on climate change and food security; genuine collaboration between local and foreign partners; working closely with research institutions and foreign partners to enhance the generations of innovations.

Although these policies intend to improve the agricultural sector of Liberia, they do not however address adaptation measures to climate change. Based on the assessment results of this study, it is necessary for GOL to mobilize sufficient financial resources to address the issue of climate change in the agricultural sector. Furthermore, there is a need to capture the additional fund required to cope with the impacts of climate change into the national budgetary allotment since the sector is the major source of livelihood for greater number of Liberians. In this regard, other important stakeholders and partners such as NGO's and civil society organizations would be encouraged to provide financial and technical support.

During the assessment, it was difficult to collect data on investment and financial flows for the period 1995 to 2000 to form part of the historical period because of the problem of missing data during the civil crisis in Liberia. Due to insufficient data collected on the contribution of households, estimates were based on assumptions of CBL as well as the common agricultural practices of small-scaled farmers.

To calculate the cost of adaptation activities, the percent (%) was allotted based on expert judgment which might have led to over or understatement of the values in each sector. In the analysis carried out, the level of disaggregation of data does not indicate all sources of I&FF.

1. Introduction

1.1 Objectives

Agricultural production in Liberia is heavily dependent on climate, water resources and soil conditions and is therefore very sensitive to climate change. Agriculture is very significant as a priority sector for assessing investment and financial flows for Liberia. Basically, agriculture is a major source of employment due to the fact that nearly 70 percent of the economically active population is engaged in the sector and it is the dominant contributor currently to export trade and earnings (accounting for over 90 percent of exports, nearly all being rubber), and a source of livelihood for a greater number of people than any other sector (PRS, 2006). To address the impacts of climate change in Liberia such as floods, drought, soil erosion, reduction in grazing for livestock, etc. It is important to devise various measures to deal with agricultural production in the face of climatic variability.

Adaptation measures relative to climate change in the agricultural sector are numerous and varied and therefore require huge financial resources for human and technical capacity building. The objective of this assessment is to evaluate investment and financial flows (I&FF) and sources of finance needed to address climate change concerns at the national level.

This assessment specifically seeks to:

- Analyze past and current national efforts to address climate change;
- Assess the types and magnitude of changes in investments in physical assets and in programs, and associated operation and maintenance costs to implement a set of adaptation measures in the agriculture sector;
- Determine the various entities responsible for those investments and the sources of their investment funds;
- Provide information needed by policymakers to address the issues of climate change;
- Facilitate the integration of climate change issues into national development and economic planning.

The expected outcomes are:

- National awareness raised;
- Investment and financial flows for adaptation in the agriculture sector assessed;
- Information provided to identify national priorities to address climate change.

Background

1.2.1 Previous Analysis Used

Liberia ratified the United Nations Framework Convention on Climate Change in 2002 and its First National Communication is still in progress.

The National Adaptation Programme of Action (NAPA) document has identified three key climatic hazards which include changes in rainfall patterns, extreme coastal flooding events and sea level rise. These hazards pose serious threats to local livelihoods, ecosystems and economic development. According to the NAPA document (2008), decreases in agricultural production associated with reduced rainfall patterns have been observed. A synthesis of the vulnerability of Liberian farmers indicates that their livelihoods are highly tied to dependable rainfall (NAPA, 2008). Changes in rainfall patterns have increased the vulnerability of farmers as it is becoming increasingly difficult to identify the optimal time to plant crops, thereby resulting in low yields.

Various measures were identified by the NAPA document, namely:

- Carrying out the timing of crop cultivation in response to changing patterns of rainfall;
- Intercropping, irrigation, and the optimization of lowland/swamp farming practices;
- Pest control including fencing of farms against rodents, birds scare scrolls, regular weeding, and the use of high echoing bells;
- Maintaining fast growing nitrogen fixing tree species to improve soil fertility and using multi-purpose tree species on farmlands to maintain forest cover.

In similar manner the Poverty Reduction Strategy document or national blueprint was able to echo key challengers facing agricultural transformation such as increasing food crop yields by adopting new technologies and techniques. Improving access to quality planting materials and other timely farm inputs (fertilizers, better extension services etc) were listed. Additionally, finding alternative to the main culprit of land degradation which having to be Liberians chief farming method (slash-and-burn) needs to be studied to understand why Liberian farmers still practice this rudimentary farming method in this 21st century. There is a need to also review why illegal and the use of inappropriate gadgets are employed into our coastal lines.

1.2.2. Institutional Arrangement and Collaboration

The implementation of the I&FF assessment is a responsibility of the Environmental Protection Agency (EPA) which is the National Focal Point and the Designated National Authority to the UNFCCC. A coordinating team which is nationally-driven has been instituted and comprised of public institutions, civil society organizations and non-governmental organizations. This team is composed of the following:

- Environmental Protection Agency (EPA);
- Ministry of Agriculture (MOA);
- Ministry of Lands, Mines and Energy (MLME);
- Ministry of Finance (MOF);
- Central Bank of Liberia (CBL);
- United Nations Development Programme (UNDP);
- University of Liberia (UL);
- Environmental Foundation International (EFI).

1.2.3. Basic Methodology

The basic methodology for conducting I&FF assessments comprises eight sequential steps to be undertaken for each identified sector. Once sectoral assessments are completed, the results are compiled and compared across sectors; and a synthesis report is prepared. The eight steps include:

- i. Establish key parameters of the assessment**
 - Define in details the scope of the sector;
 - Specify the assessment period and the reference year;
 - Identify preliminary adaptation measures;
 - Choose the analytical approach.

- ii. Compile historical I&FF data and operation and maintenance costs (O&M), subsidies and other input data for scenarios**
 - Compile historical annual I&FF, broken down by entity and source of investment;
 - Compile historical annual O&M costs, broken down by entity and source of investment;
 - Compile historical annual subsidy costs if subsidies are explicitly included in the assessment;
 - Compile other input data for the scenarios.

- iii. Defining the baseline**
 - Describe the socio-economic and technological change, national and sectoral plans, and expected investments, given the current national and sectoral plans.

- iv. Derive annual IF, FF and O&M costs and subsidies if included explicitly for the baseline**
 - Derive the annual I&FF for each type of investment broken down by investment entity and source of funding;
 - The annual O&M costs broken down by investment entity and source of funding;
 - The annual cost of subsidies for each type of investment and for I&FF and O&M costs if subsidies are explicitly included in the assessment.

- v. Define the adaptation scenario refers to an adjustment of an ecosystem in response to actual or expected climate stimuli or their impacts, which in most cases moderately harm or exploits opportunities that are beneficial to the system.**

- vi. Describe the socio-economic and technological change, adaptation measures and investment, given the implementation of adaptation measures and estimate annual I&FF, O&M costs and subsidies, if included explicitly for the adaptation scenario**
 - Estimate the annual I&FF for each type of investment broken down by investment entity and source of funding and the annual O&M costs for each IF, broken down by entity and source of investment financing.

- Estimate the annual cost of subsidy for each type of investment relevant for I&FF and O&M costs if subsidies are explicitly included in the assessment.
- vii. Calculate changes in I&FF and O&M costs and subsidy if included explicitly required to implement adaptation measures**
- Calculate the changes in I&FF and cumulative O&M costs by source of funding for each type of investment and for all types of investment (the total investment);
 - Calculate the changes in annual I&FF and O&M costs for each type of investment and for each source of funding and all types of investment and sources of funding, consider calculating the subsidy changes, if subsidies are explicitly included.
- viii. Assess policy implications**
- Re-assess the initial prioritization of adaptation measures undertaken in step 5;
 - Identify policy measures to encourage induced changes in I&FF.

1.2.4 Key Terminologies

The following key terms are used in this report:

Investment Flow (IF) - the capital cost of an active material with a lifespan of more than a year.

Financial flows (FF) - the ongoing expense for programmatic measures, the FF covers expenses other than those for the expansion or installation of new physical assets.

Material goods purchased with investment flows (IF) have **operation and maintenance (O&M)** costs shareholders (that is to say, permanent fixed costs and variable costs such as wages and raw materials).

Households- Individual or group of individuals (i.e. families) who act as a financial unit.

Companies- include financial institutions (banks and microfinance institutions), non-financial enterprises, as well as profit and nonprofit organizations).

Entity- connotes a person of legal age or institution/business that has a legal and separately identifiable existence that is capable to address issues affecting the agricultural sector as they relate to climate change.

Sources- refer to the type of economic - instruments that I&FF mechanism uses to generate revenue. Source criterion mainly connotes non-market mechanism such as the writing of proposal for a donation like tax on sovereign wealth funds. It could also be the carbon market where revenue could be generated.

Scenario- is a characterization of consistent and plausible conditions over a specified period. There are two different scenarios. The baseline scenario describes the conditions of the status-quo, i.e. a description of what will probably happen if no new policy measures to cope with climate change are set in place during the assessment period (2005-2030). The adaptation scenario includes new measures to address the potential impacts of climate change.

Assessment period- the time horizon for assessment, i.e. the number of years covered by the baseline and the adaptation scenarios and associated annual I&FF and O&M costs. The assessment period to assess I&FF should cover at least 25 years and not more than 30 years.

Reference year- the first year of the assessment period, that is to say the first year of the baseline. The base year should be a recent year for which information on I&FF and O&M costs are available.

2. Scope, Data input and Scenarios

2.1 Sectoral Scope

Liberia's agriculture sector is dominated by traditional subsistence farming systems mainly in the uplands, characterized by labor intensity like shifting cultivation and low technologies. These have resulted to low productivity. Production of rice and vegetables occupy about 87% of cultivated land, but below national requirements (Topor, 2009). Small acreages of tree crops are maintained for generating cash income. Commercial agricultural activities are almost exclusively plantation estates of rubber, oil palm, coffee and cocoa, the latter two are produced exclusively for export, with little value addition done for rubber and oil palm. Besides the plantation estates, very little private sector investment has been made in the agriculture sector, except for limited commodities trading which has persisted over the years. Land and water resources are abundant and offer potential for significant expansion of agriculture production. There is no shortage of water resources for agriculture development. An estimated 600,000 hectares of land for irrigation exist, with less than 1% of it developed. Agriculture contributed 54.9% of the GDP in 2005 (National Human Development Report of Liberia, 2006).

There are five major sub-sectors under the agriculture sector of Liberia, namely: crop production, livestock production, plant protection, fishery and soil & water management. These sub-sectors play a vital role in the socio-economic development of the country.

2.1.1 Crop Production

The main food crops grown in Liberia include rice, root and tubers, sugar cane, legumes, maize, plantain, bananas, etc. while the main tree crops include rubber, coffee, cocoa and oil palm. All of the food crops grown are meant for home consumption; but far too low (30 percent only of the total food requirement) to meet consumers' need (UNMIL, 2007). In terms of plantation, Liberia has over ten multi-national companies, most of which are in rubber production, such as FRC, LAC, SRC, etc. however, there are others that are engage into oil palm plantation such as SIME Darby and Golden Veloleum. Production grew in 1999 to 62,705 mt. (valued at US\$33.3 M) from 48,916 mt. (valued at US\$28.9 M in 1998) - an increase of 28.2 percent. In 2000, production of rubber rose to 102,412 mt. (valued at US\$53.2 M), 63.3 percent increase over 1999 production. In 2002, rubber contributed more than US\$57.4 M (UNEP, 2004). Foreign investors own and operate eight large-scale rubber plantations with total acreages of 57,000 hectares (ha), of which few are managed to international standards, but with persistent clamors of violations of basic workers' rights (CAAS, 2007).

2.1.2 Livestock Production

This sub-sector plays a major role in agricultural development. The livestock subsector has been decimated as a result of the civil conflict, and current livestock population is below 10 percent of national requirements. Liberia has an estimated 2 million hectares of pastureland yet the

livestock sector accounts for only an estimated 14 percent of agricultural GDP which is far below potential (CAAS-Lib Synthesis Report, 2007). This subsector is not well developed which can be explained by the high annual importation of livestock and livestock products. Although the local breeds of cattle, goat, sheep, pig, rabbit, guinea pig, chicken, duck, and guinea fowl raised in Liberia are well adapted to the local conditions, their productive capacity is lower than the exotic breeds. Traditional livestock farmers use local, less productive animal breeds and basic techniques, with access to few inputs, and receive limited or no support services from government. (current livestock population and the national requirement in figures)

2.1.3 Fishery

Liberia has a long coastal line of 520 km and a continental shelf which extends 200 nautical miles offshore. There are also six major rivers and several streams that run inland and use for multiple purposes including fishing. This industry provides bulk of the animal protein in the typical Liberian diet. The fishery subsector is under-developed with only about 6.8% of sustainable yield harvested annually. The fishery subsector includes an established marine fishery involving industrial and artisanal fishing activities, an inland fishery which is exclusively artisanal, and aquaculture practiced in rural areas through fishpond culture. This subsector provides about 3 percent of GDP. In the industrial fishery subsector, 4,200 persons are employed, 75 percent of whom are Liberians, making up about 11 percent of the total employment in the fisheries subsector. Artisanal fishery is estimated to provide a means of livelihood for about 33,120 full-time fishers and processors in both marine and inland waters, 61 percent of whom are Liberians and 60 percent are female (CAADP, 2009). Aquaculture is still underdeveloped and remained mainly at the subsistence level with no major fish multiplication and distribution taking place.

In conclusion, the agricultural sector is vulnerable to climate change. The key activities listed below for this sector will enable Liberia to adapt to the adverse impacts of climate change, and a number of measures should be undertaken to enable the country to address the issue of food security and general economic crisis.

- Intercropping, irrigation and the improvement of farming practices;
- Agricultural meteorological information system and timing of cropping calendars;
- Pest control including fencing of farms against rodents, bird scare scrolls, regular weeding, and the use of high echoing bells;
- Development of the livestock species most resistant to climatic conditions;
- Development of fish farming (aquaculture and fishing);
- Improve soil fertility by maintaining fast growing nitrogen fixing tree species and using multi-purpose tree species.

2.1.4 Plant Protection

With increases in temperature, pests and diseases would have the tendency to proliferate, causing havoc to plants and animals. For example, in 2009, a serious outbreak of a breed of

caterpillar worms (*Achaea catocaloides* Genué) infested thousands of acres of land and consuming the leaves of many tree/crop species along its path. The entire crop of some small farmers can sometimes be lost through a serious outbreak of pests and diseases.

Between 1985 and 1989, a department of Plant Protection was operational at the Agricultural Research Institute (CARI), Suakoko, Bong County, Liberia. But since the war ended in 2003, no effort has been made to reorganize any Plant Protection Directorate – either at CARI or within the Ministry of Agriculture properly. The only entity operational with regards to plant and disease control is the Quarantine Bureau under the Ministry of Agriculture. The Quarantine Bureau ensures that plants and animals entering or leaving the Country are free of endemic pests and diseases.

2.1.5 Soil and Water Management

The land area of Liberia is about 111,370 km² of which 96,160 km² (86 percent) is dry land. The rest, 15,210 km² and constituting 14 percent of the surface area are covered by water (Farnga, 2009). According to the above author, nearly 5.4 percent of Liberian land amounting to about 600,000 hectares (ha) is said to be cultivated but 220,000 ha of this is under permanent crop or plantation, while the rest is arable. Farming is carried out both in the uplands and the lowlands (or swamps). Although substantial work has not been done with respect to soil suitability, it is generally believed that swamps are more productive for rice cultivation than the uplands.

The Irrigation potential of Liberia is estimated at about 600,000 ha but only about 1,000 ha is suitable for surface irrigation facility. Total water managed area in 1987, including swamp rice cultivation, is estimated at about 20,100 ha. These include equipped lowlands (2,000 ha) and non-equipped cultivated swamps (18,000).

Soil survey and classification

Prior to 1987, surveys of a large number of small farms were carried out by the Land and Water Resources Department of the Central Agricultural Research Institute (CARI) in Suakoko and the Land Development Division of the Ministry of Agriculture in Monrovia. These surveys were designed to assist in the production of food and cash crops. Medium-scale surveys of large farms were also undertaken by different bodies. Surveys and crop suitability interpretation were carried out by integrated agricultural development projects in Lofa, Bong, Nimba and Grand Gedeh Counties in the northern, north-eastern and south-eastern Liberia. All the extensive surveys were carried out by foreign consultants.

Data on crop water requirements is practically not available for the calculation of crop-water requirements. Rice and vegetables are two most important food crops with regards to water management in Liberia. even for the same crops, water requirement is higher in the drier than the wetter regions. Total rainfall amounts are always higher than the crop water requirements

but their distribution can be a problem. However, standard values can be assumed for crop coefficient since there is no such data available in the country.

The upland soils are generally acidic, with low fertility, low water holding capacity and prone to soil erosion. Unfortunately, farmers do not pay particular attention to field soil and water conservation practices but this poses an important research problem. The farmers in recent time have complained that over the recent years, delays of the onset of the rainy season have led to late planting. This shows that rainfall patterns are changing and poses a new challenge to field water management. Farmers that crop on the slopes are faced with different problems in soil water management in a typically Rainfed culture. It is generally known that soil water on slopes deplete much faster because of faster subsurface flow induced by the generally acute slopes. There is also the risk of soil erosion and nutrient loss on the slopes. On the whole, drainage is generally good on the slopes. Not much attention has been given to these groups of farmers when it comes to land and water management.

Lowland water management is practiced largely during the dry season; the farmers take advantage of the residual moisture of the soil in the swamps to grow vegetables. Also, upland irrigation has not been seriously considered an issue in Liberia probably because of water surpluses in all the agro ecological zones and the availability of large areas of swamps for rice and vegetable production. Urban and peri-urban agriculture is also gaining momentum in Liberia, due to the large markets in the urban centers for vegetable crops produced through such activities. The potential for the use of motorized pumps for irrigation from shallow wells in support of the urban and peri-urban agricultural activities also exist especially in and around Monrovia, the Capital City.

2.2 Data Input and Scenarios

2.2.1 Period of assessment and costing parameters

Historical data collected cover the period 2000 to 2005. The year 2005 was selected as the base year. Let it be registered that obtaining data on investments was insufficient due to 14-year civil crisis where most offices were either looted or destroyed. In short, the entire socio-economic activities came to a complete halt. However, as can be seen from Table 1, during the training it was decided that since data from 2000 to 2004 was not available for the HICP, the 2005 to 2008 should be used. Figure depicted in Table 1 were obtained from the Central Bank of Liberia Annual Reports. In similar manner, data on Table 2 regarding GDP at current prices were inputted from Central Bank of Liberia. In order to obtain GDP at constant prices, GDP at current prices were divided by HICP and multiply by hundred, as can be gleaned from Table 3.

Table 1: Harmonized Index of Consumer Price

Year	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
HICP						100	111.91	124.3	136.69	

Source: CBL Annual Report, 2009

Table 2: GDP at current prices

Year	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
		521.9	560.7	432.6	526.6	577.6	642.5	696.5	754.5	

Source: CBL Annual Report, 2009

Table 3: GDP at Constant Prices

Year	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
						577.6	574.1221	560.3	551.9789	

Source: CBL Annual Report, 2009

2.2.2. Analytical Approach

All the data on I& FF in United States currency has been obtained from existing documentation on the projects funded and implemented in the agricultural sector. Bulk of the relevant data was obtained from annual financial reports and statistical reports from civil society, NGOs and government entities. To derive the GDP at constant price (that is at 2005 price), the GDP at current price of each year was divided by the corresponding harmonized index of consumer price. In table 4, 25 percent of the total value of the I& FF was used to calculate the O&M per year considering the standards set by GOL regarding the agriculture sector. In table 5, the base year data were provided by CBL and projections were made by using the annual growth rate of investment estimated at 1.5 percent. The adaptation scenario is based on an overall annual growth rate of investment in the agricultural sector estimated at 1.5 percent. Projections of annual values of investment and financial flows for each investment entities (household, corporation and government are included in Table 5. These estimates combined for each type of activity for the periods 2005-2030 are shown in Table 6. Total value of all the years (i.e., 25 years) was used to derive the cumulative discounted IF, FF and O&M.

The data obtained from households, business and government agencies have been compiled in excel spreadsheets provided in the UNDP reporting guidelines. In the compilation of historical data, there were difficulties encountered. These include but not limited to:

- Unavailability of relevant historical data from 1995 to 2000;
- Fragmentation of historical data due to the civil crisis;
- Unavailability of resource persons who were either killed or fled the country for greener pasture;
- Insufficient data on the contribution of households and businesses to investment activities and financial flows.

For the interpolation of missing data, the assumption adopted is the use of the least value of the series of entity flows and other estimates are based on assumptions provided by CBL. Regarding the lack of information on the contribution of certain entities, the analytical

approach relied on common practices observed in the financing of agricultural projects and programmes.

2.2.3. Historical data on I & FF and O&M costs and Subsidies

Historical data on I & FF and O&M costs were collected over the period 2001 to 2009. Data for 2005 were collected to serve as the basis for the projections from 2010- 2030. Among the sources used in data collection, the relevant sources include the following:

- CBL annual and quarterly reports
- National fiscal budget 2001- 2009
- Changes in the operation cost of the agriculture sector
- The socio- economic data from the National Adaptation Program of Action (NAPA)
- Population growth trend from Liberia Institute for Statistics and Geo-Information Services (LISGIS)
- National Food Security and Nutritional Survey data from the ministry of Agriculture.
- Food and Agriculture Policy and Strategy, MOA (2008).

Of the various activities identified for assessing the I & FF the main focus was placed on the key subsectors which include crop productions, livestock production, fishery, plant production and soil & water management.

2.2.4. Baseline Scenario

The baseline scenario describes the conditions of the status quo. Furthermore, it reflects the continuation of the historical trends of achieving the investment and financial flows from 2001 – 2030. Based on the available data at the Liberia Institute for Statistics and Geo-Information Services (LISGIS), the population of Liberian is estimated at 3.476 millions in 2008, with annual growth rate at 2.1 percent.

The total population of Liberia would double the 2008 figure in 34 years (i.e., by 2042) if the observed annual growth rate of 2.1 percent persists into the future (LISGIS, 2008). Generally, females constitute bulk of the agricultural labor force where they carry out most of the trading activities in rural areas and play important role in the informal networks of linking the rural and urban markets. As a result of this, greater opportunities in agriculture and rural development are expected to be provided for women and youth.

Agriculture made a significant contribution of about 52 percent to the total GDP in 2005 (MOA, 2008). Demand in food crops is anticipated to increase due to the short period of time within which the population is expected to double and the fact that food crop production is the most important source of livelihood for the majority of the rural population. Notwithstanding, investment in revitalizing the value chains of agricultural commodities are expected to significantly improve access to food, generate sustainable, rewarding employment, and

improve livelihoods of rural communities, thereby significantly contributing to the consolidation of economic recovery and development.

Table 4. Base year (2005) IF, FF and O&M Data for Each Investment type, Investment entity in million US\$

Entities	Source	Crop Production			Livestock Production			Fishery			Plant protection			Soil & Water Management		
		IF	FF	O&M	IF	FF	O&M	IF	FF	O&M	IF	FF	O&M	IF	FF	O&M
Household	Domestic	1.035	0.270	0.329	0.450	0.090	0.135	0.900	0.225	0.28	0.450	0.090	0.14	0.14	0.045	0.05
Corporation	Foreign and domestic	0.805	0.210	0.256	0.350	0.070	0.105	0.700	0.175	0.22	0.350	0.070	0.11	0.11	0.035	0.04
Government of Liberia	Foreign and domestic	0.460	0.120	0.146	0.200	0.040	0.060	0.400	0.100	0.13	0.200	0.040	0.060	0.060	0.020	0.020
Total		2.3	0.6	0.73	1	0.2	0.3	2	0.5	0.63	1	0.2	0.3	0.3	0.1	0.1

Source: CBL Annual Report, 2009

Table 5. Baseline Scenario: Investment in I F, FF and O&M in millions US Dollars- at Current Prices

Year	Crop Production			Livestock Production			Fishery			Plant protection			Soil & Water Management		
	IF	FF	O&M	IF	FF	O&M	IF	FF	O&M	IF	FF	O&M	IF	FF	O&M
2001	0.5	0.1	0.15	0.2	0.1	0.08	0.5	0.1	0.15	0.2	0.1	0.08	0.1	0	0.03
2002	1.6	0.4	0.5	0.7	0.2	0.23	1.4	0.2	0.4	0.7	0.2	0.23	0.2	0.1	0.08
2003	0.9	0.2	0.28	0.4	0.1	0.13	0.7	0.2	0.23	0.4	0.1	0.13	0.1	0	0.03
2004	1.2	0.3	0.38	0.5	0.1	0.15	0.5	0.3	0.2	0.5	0.1	0.15	0.2	0	0.05
2005	2.3	0.6	0.73	1	0.2	0.3	2	0.5	0.63	1	0.2	0.3	0.3	0.1	0.1
2006	2.7	0.7	0.85	1.2	0.3	0.38	2.4	0.6	0.75	1.2	0.3	0.38	0.4	0.1	0.13
2007	4.8	1.2	1.5	2.1	0.5	0.65	4.1	1	1.28	2.1	0.5	0.65	0.7	0.2	0.23
2008	5.8	1.5	1.83	2.5	0.6	0.78	5	1.3	1.58	2.5	0.6	0.78	0.8	0.2	0.25
2009	11.2	2.8	3.5	4.8	1.2	1.5	9.6	2.4	3	4.8	1.2	1.5	1.6	0.4	0.5
2010	2.88	0.75	0.91	1.25	0.25	0.38	2.5	0.63	0.79	1.25	0.25	0.38	0.38	0.13	0.13
2011	3.59	0.94	1.14	1.56	0.31	0.47	3.13	0.78	0.98	1.56	0.31	0.47	0.47	0.16	0.16
2012	4.49	1.17	1.43	1.95	0.39	0.59	3.91	0.98	1.23	1.95	0.39	0.59	0.59	0.2	0.2
2013	5.62	1.46	1.78	2.44	0.49	0.73	4.88	1.22	1.54	2.44	0.49	0.73	0.73	0.24	0.24
2014	7.02	1.83	2.23	3.05	0.61	0.92	6.1	1.53	1.92	3.05	0.61	0.92	0.92	0.31	0.31
2015	8.77	2.29	2.78	3.81	0.76	1.14	7.63	1.91	2.4	3.81	0.76	1.14	1.14	0.38	0.38
2016	10.97	2.86	3.48	4.77	0.95	1.43	9.54	2.38	3	4.77	0.95	1.43	1.43	0.48	0.48
2017	13.71	3.58	4.35	5.96	1.19	1.79	11.92	2.98	3.76	5.96	1.19	1.79	1.79	0.6	0.6
2018	17.14	4.47	5.44	7.45	1.49	2.24	14.9	3.73	4.69	7.45	1.49	2.24	2.24	0.75	0.75
2019	21.42	5.59	6.8	9.31	1.86	2.79	18.63	4.66	5.87	9.31	1.86	2.79	2.79	0.93	0.93
2020	26.78	6.98	8.5	11.64	2.33	3.49	23.28	5.82	7.33	11.64	2.33	3.49	3.49	1.16	1.16
2021	33.47	8.73	10.62	14.55	2.91	4.37	29.1	7.28	9.17	14.55	2.91	4.37	4.37	1.46	1.46
2022	41.84	10.91	13.28	18.19	3.64	5.46	36.38	9.09	11.46	18.19	3.64	5.46	5.46	1.82	1.82
2023	52.3	13.64	16.6	22.74	4.55	6.82	45.47	11.37	14.32	22.74	4.55	6.82	6.82	2.27	2.27
2024	65.37	17.05	20.75	28.42	5.68	8.53	56.84	14.21	17.91	28.42	5.68	8.53	8.53	2.84	2.84
2025	81.71	21.32	25.93	35.53	7.11	10.66	71.05	17.76	22.38	35.53	7.11	10.66	10.66	3.55	3.55
2026	102.14	26.65	32.42	44.41	8.88	13.32	88.82	22.2	27.98	44.41	8.88	13.32	13.32	4.44	4.44
2027	127.68	33.31	40.52	55.51	11.1	16.65	111.02	27.76	34.97	55.51	11.1	16.65	16.65	5.55	5.55
2028	159.59	41.63	50.65	69.39	13.88	20.82	138.78	34.69	43.72	69.39	13.88	20.82	20.82	6.94	6.94
2029	199.49	52.04	63.32	86.74	17.35	26.02	173.47	43.37	54.64	86.74	17.35	26.02	26.02	8.67	8.67
2030	249.37	65.05	79.15	108.42	21.68	32.53	216.84	54.21	68.3	108.42	21.68	32.53	32.53	10.84	10.84
Total	1266.35	330.05	401.8	550.49	110.71	165.35	1100.39	275.16	346.58	550.49	110.71	165.35	165.55	54.82	55.12

Source: CBL Annual Report, 2009

Table 6. Baseline Scenario: Investment in IF, FF and O&M in millions US Dollars from 2005-2030 at Current Prices

Year	Crop Production			Livestock Production			Fishery			Plant protection			Soil & Water Management			Total
	IF	FF	O&M	IF	FF	O&M	IF	FF	O&M	IF	FF	O&M	IF	FF	O&M	
2005	2.30	0.60	0.73	1.00	0.20	0.30	2.00	0.50	0.63	1.00	0.20	0.30	0.30	0.10	0.10	10.26
2006	2.70	0.70	0.85	1.20	0.30	0.38	2.40	0.60	0.75	1.20	0.30	0.38	0.40	0.10	0.13	12.39
2007	4.80	1.20	1.50	2.10	0.50	0.65	4.10	1.00	1.28	2.10	0.50	0.65	0.70	0.20	0.23	21.51
2008	5.80	1.50	1.83	2.50	0.60	0.78	5.00	1.30	1.58	2.50	0.60	0.78	0.80	0.20	0.25	26.02
2009	11.20	2.80	3.50	4.80	1.20	1.50	9.60	2.40	3.00	4.80	1.20	1.50	1.60	0.40	0.50	50.00
2010	2.88	0.75	0.91	1.25	0.25	0.38	2.50	0.63	0.79	1.25	0.25	0.38	0.38	0.13	0.13	12.83
2011	3.59	0.94	1.14	1.56	0.31	0.47	3.13	0.78	0.98	1.56	0.31	0.47	0.47	0.16	0.16	16.03
2012	4.49	1.17	1.43	1.95	0.39	0.59	3.91	0.98	1.23	1.95	0.39	0.59	0.59	0.20	0.20	20.04
2013	5.62	1.46	1.78	2.44	0.49	0.73	4.88	1.22	1.54	2.44	0.49	0.73	0.73	0.24	0.24	25.05
2014	7.02	1.83	2.23	3.05	0.61	0.92	6.10	1.53	1.92	3.05	0.61	0.92	0.92	0.31	0.31	31.31
2015	8.77	2.29	2.78	3.81	0.76	1.14	7.63	1.91	2.40	3.81	0.76	1.14	1.14	0.38	0.38	39.14
2016	10.97	2.86	3.48	4.77	0.95	1.43	9.54	2.38	3.00	4.77	0.95	1.43	1.43	0.48	0.48	48.92
2017	13.71	3.58	4.35	5.96	1.19	1.79	11.92	2.98	3.76	5.96	1.19	1.79	1.79	0.60	0.60	61.15
2018	17.14	4.47	5.44	7.45	1.49	2.24	14.90	3.73	4.69	7.45	1.49	2.24	2.24	0.75	0.75	76.44
2019	21.42	5.59	6.80	9.31	1.86	2.79	18.63	4.66	5.87	9.31	1.86	2.79	2.79	0.93	0.93	95.55
2020	26.78	6.98	8.50	11.64	2.33	3.49	23.28	5.82	7.33	11.64	2.33	3.49	3.49	1.16	1.16	119.44
2021	33.47	8.73	10.62	14.55	2.91	4.37	29.10	7.28	9.17	14.55	2.91	4.37	4.37	1.46	1.46	149.30
2022	41.84	10.91	13.28	18.19	3.64	5.46	36.38	9.09	11.46	18.19	3.64	5.46	5.46	1.82	1.82	186.63
2023	52.30	13.64	16.60	22.74	4.55	6.82	45.47	11.37	14.32	22.74	4.55	6.82	6.82	2.27	2.27	233.29
2024	65.37	17.05	20.75	28.42	5.68	8.53	56.84	14.21	17.91	28.42	5.68	8.53	8.53	2.84	2.84	291.61
2025	81.71	21.32	25.93	35.53	7.11	10.66	71.05	17.76	22.38	35.53	7.11	10.66	10.66	3.55	3.55	364.51
2026	102.14	26.65	32.42	44.41	8.88	13.32	88.82	22.20	27.98	44.41	8.88	13.32	13.32	4.44	4.44	455.64
2027	127.68	33.31	40.52	55.51	11.10	16.65	111.02	27.76	34.97	55.51	11.10	16.65	16.65	5.55	5.55	569.54
2028	159.59	41.63	50.65	69.39	13.88	20.82	138.78	34.69	43.72	69.39	13.88	20.82	20.82	6.94	6.94	711.93
2029	199.49	52.04	63.32	86.74	17.35	26.02	173.47	43.37	54.64	86.74	17.35	26.02	26.02	8.67	8.67	889.91
2030	249.37	65.05	79.15	108.42	21.68	32.53	216.84	54.21	68.30	108.42	21.68	32.53	32.53	10.84	10.84	1112.39
Total	1262.13	329.06	400.49	548.70	110.22	164.44	1097.30	274.35	345.61	548.70	110.22	164.74	164.93	54.71	54.92	5630.53

Source: CBL Annual Report, 2009

Table 7. Baseline scenario: Cumulative discounted IF, FF and O&M Estimates by Investment type, Investment entity in million US\$

Entities	Source	% Allotted	Crop Production			Livestock Production			Fishery			Plant protection			Soil & Water Management			Total
			IF	FF	O&M	IF	FF	O&M	IF	FF	O&M	IF	FF	O&M	IF	FF	O&M	
Household	Domestic	45%	567.96	148.08	180.22	246.92	49.60	74.00	493.79	123.46	155.52	246.92	49.60	74.13	74.22	24.62	24.71	2533.734
Corporation	Foreign	35%	441.75	115.17	140.17	192.05	38.58	57.55	384.06	96.02	120.96	192.05	38.58	57.66	57.73	19.15	19.22	1970.682
Government of Liberia	Domestic	20%	252.43	65.81	80.10	109.74	22.04	32.89	219.46	54.87	69.12	109.74	22.04	32.95	32.99	10.94	10.98	1126.104
Total		100%	1262.13	329.06	400.49	548.70	110.22	164.44	1097.30	274.35	345.61	548.70	110.22	164.74	164.93	54.71	54.92	5630.52

Source: CBL Annual Report, 2009

2.2.5 Adaptation Scenario

Effective adaptation measures are more important in the agricultural sector today than they have ever been; with the current erratic weather conditions, there is a need for more attention to be paid to the various adaptation options. Table 9 explains the cost of adaptation measures under sub-sectors in the agricultural sector from 2005 to 2030. Data from Table 7 were selected and used in Table 9 to derive the adaptation cost. Based on the scope, the following adaptation options were envisaged:

Improve soil fertility by maintaining fast growing nitrogen fixing trees species and using multi-purpose tree species: The activities under this option which will enhance resilience of the soil to climate change include action to defend and restore soil, soil water conservation and integrated management of soil fertility. The total cost for improving soil fertility under soil and water management for adaptation is \$26.025M. Under investment 30% or \$15.084M is being allotted for soil fertility activities derived from \$52.68M. Activities included in this subsector are not limited to using leguminous cover crops which provides a more lasting protective cover for soil conservation. Leguminous cover crops reduce the need for nitrate fertilizer and improve the quality of grazing land that provides high protein forage to complement the low quality natural pasture. The concept of using vetiver grass as a vegetative means of soil and moisture conservation is another ideal means of soil conservation. Forty percent (40%) or 5.28M of the financial flow under Soil and Water Management was given to soil fertility. Activities under this aspect include developing the human capital to sustain the adaptation while operations and maintenance (O&M) is assigned 30% or \$4.941M of the \$16.47M. These activities under O&M are personnel cost and maintenance of plant and equipment.

Plant protection: This includes measures to promote the fight against the emergent of new diseases or the proliferations or rapid spread of old diseases because of climate change. It is also the question of diagnosing these diseases and providing effective coping mechanisms. There is a need for surveillance to bring about the control of pests and diseases due to climate change. As shown in Table 9, the total of \$ 93.875M is given the subsector plant protection. Forty percent or \$63.216M of the \$158.04M for investment (I) under plant protection is allotted for purchasing equipment and building infrastructure such storage for storing pesticides, herbicides, and protective gears, whereas 30% or \$15.836M of the \$39.59M in table 7 is allocated for capacity building and programs. For operations and maintenance (O&M), 30% or \$14.823M of \$49.41M is allotted for paying wages and maintaining the facilities.

Development of the livestock species most resistant to climatic conditions: It is important to plan activities to select animal species that best adapt to changing climate. The development of adequate prophylactic programs and program of animal breeding will serve as effective coping mechanisms in this regard. As indicated in table 9, the total of 118.019M is assigned to development of livestock. 45% or 71.118M of 158.04M investment (I) under livestock production is allocated for purchasing materials for constructing animal pens, provisions for vaccinating animals and logistics for livestock officers. 35% or 34.125M of the total Financial

Flow (97.5M) under livestock production is dedicated to funding prophylactic programs whereas 20% or 12.776M of the total O&M (63.88M) is allotted for maintenance.

Development of fish farming (aquaculture and fishing): In some counties (lowland areas), the development of fishponds will be a solution for the diversification of activities and efficient use of rainwater. This has the advantages to channel and store rainwater and to reuse it to avoid flooding but also to diversify the products in the context of climate change. Special initiatives and actions will be promoted to increase fish supplies through continuing and increasing availability of special kits/fishing gear and outboard motor to artisanal fisheries groups; facilitating access to improved and secured fish landing areas, and processing facilities including cold storage; credit, training and other support services for those engaged in artisanal fishing and aquaculture.

Intercropping, irrigation and the improvement of farming practices: Intercropping is a common traditional farming practice among subsistence farmers in Liberia where farmers sometimes intercropped main crop which is rice with cassava that is a security crop. To fully improve this practice, more vegetables like pepper, eggplants and others should be intercropped. General perception of farmers for such practice include sowing of fast growing crops with slow growing crops so that the fast growing crops are harvested before the slow growing crops start to mature. Interestingly, local farmers should grow well-matched crops which do not compete with each other but encourage biodiversity by providing a ideal environment for soil organisms and insects. This is a brilliant farming practice which could be further improved by the Ministry of Agriculture through its extension services such as the provision of improved planting materials, basic training and the intensification and diversification of farming in the country. As shown in table 9, 40% or 147.54M out of the total investment (368.85M) under crop production is dedicated to purchasing farm implements, whereas 30% or 27.678M of the total FF (92.26M) is provided for implementing programs. 30% or 34.584M of the total O&M is allocated for paying wages and maintaining the infrastructure.

Farming Practice: Slash and burn or shifting farming which serves as the primary practice by almost all local Liberian farmers is often seen as the chief culprit for land degradation and unsustainable as the current population growth rate of 2.1 % may allow such farming today. The population will not allow a long fallow period during which the forest recovers, completes the shifting cycle. Why it is true that traditional slash and burn farming systems are vulnerable to pressures from modern Liberian society, it will be of interest to note that how little effort has been made to improve these systems by building on indigenous insights and initiatives.

These adaptation measures have been selected after consultation with the various policy documents, plans, strategies and programs of agricultural and resources development through adaptation to climate change.

Table 8. Adaptation Scenario: Estimates of Annual Amount of IF, FF and O&M by type of activity in million US\$

Year	Crop Production			Livestock Production			Fishery			Plant protection			Soil & Water Management			Total
	IF	FF	O&M	IF	FF	O&M	IF	FF	O&M	IF	FF	O&M	IF	FF	O&M	
2005	2.88	0.75	0.91	1.25	0.25	0.38	2.50	0.63	0.79	1.25	0.25	0.38	0.38	0.13	0.13	12.83
2006	3.38	0.88	1.06	1.50	0.38	0.48	3.00	0.75	0.94	1.50	0.38	0.48	0.50	0.13	0.16	15.49
2007	6.00	1.50	1.88	2.63	0.63	0.81	5.13	1.25	1.60	2.63	0.63	0.81	0.88	0.25	0.29	26.89
2008	7.25	1.88	2.29	3.13	0.75	0.98	6.25	1.63	1.98	3.13	0.75	0.98	1.00	0.25	0.31	32.53
2009	14.00	3.50	4.38	6.00	1.50	1.88	12.00	3.00	3.75	6.00	1.50	1.88	2.00	0.50	0.63	62.50
2010	3.59	0.94	1.14	1.56	0.31	0.47	3.13	0.78	0.98	1.56	0.31	0.47	0.47	0.16	0.16	16.03
2011	4.49	1.17	1.43	1.95	0.39	0.59	3.91	0.98	1.23	1.95	0.39	0.59	0.59	0.20	0.20	20.04
2012	5.62	1.46	1.78	2.44	0.49	0.73	4.88	1.22	1.54	2.44	0.49	0.73	0.73	0.24	0.24	25.05
2013	7.02	1.83	2.23	3.05	0.61	0.92	6.10	1.53	1.92	3.05	0.61	0.92	0.92	0.31	0.31	31.31
2014	8.77	2.29	2.78	3.81	0.76	1.14	7.63	1.91	2.40	3.81	0.76	1.14	1.14	0.38	0.38	39.14
2015	10.97	2.86	2.86	4.77	0.95	1.43	9.54	2.38	3.00	4.77	0.95	1.43	1.43	0.48	0.48	48.30
2016	13.71	3.58	4.35	5.96	1.19	1.79	11.92	2.98	3.76	5.96	1.19	1.79	1.79	0.60	0.60	61.15
2017	17.14	4.47	5.44	7.45	1.49	2.24	14.90	3.73	4.69	7.45	1.49	2.24	2.24	0.75	0.75	76.44
2018	21.42	5.59	6.80	9.31	1.86	2.79	18.63	4.66	5.87	9.31	1.86	2.79	2.79	0.93	0.93	95.55
2019	26.78	6.98	8.50	11.64	2.33	3.49	23.28	5.82	7.33	11.64	2.33	3.49	3.49	1.16	1.16	119.44
2020	33.47	8.73	10.62	14.55	2.91	4.37	29.10	7.28	9.17	14.55	2.91	4.37	4.37	1.46	1.46	149.30
2021	41.84	10.91	13.28	18.19	3.64	5.46	36.38	9.09	11.46	18.19	3.64	5.46	5.46	1.82	1.82	186.63
2022	52.30	13.64	16.60	22.74	4.55	6.82	45.47	11.37	14.32	22.74	4.55	6.82	6.82	2.27	2.27	233.29
2023	65.37	17.05	20.75	28.42	5.68	8.53	56.84	14.21	17.91	28.42	5.68	8.53	8.53	2.84	2.84	291.61
2024	81.71	21.32	25.93	35.53	7.11	10.66	71.05	17.76	22.38	35.53	7.11	10.66	10.66	3.55	3.55	364.51
2025	102.14	26.65	32.42	44.41	8.88	13.32	88.82	22.20	27.98	44.41	8.88	13.32	13.32	4.44	4.44	455.64
2026	127.68	33.31	40.52	55.51	11.10	16.65	111.02	27.76	34.97	55.51	11.10	16.65	16.65	5.55	5.55	569.54
2027	159.59	41.63	50.65	69.39	13.88	20.82	138.78	34.69	43.72	69.39	13.88	20.82	20.82	6.94	6.94	711.93
2028	199.49	52.04	63.32	86.74	17.35	26.02	173.47	43.37	54.64	86.74	17.35	26.02	26.02	8.67	8.67	889.91
2029	249.37	65.05	79.15	108.42	21.68	32.53	216.84	54.21	68.30	108.42	21.68	32.53	32.53	10.84	10.84	1112.39
2030	311.71	81.32	98.93	135.53	27.11	40.66	271.05	67.76	85.38	135.53	27.11	40.66	40.66	13.55	13.55	1390.49
Total	1577.67	411.33	500.00	685.88	137.78	205.93	1371.63	342.94	432.02	685.88	137.78	205.93	206.16	68.39	68.65	7037.93

Source: CBL Annual Report, 2009

Table 9. Adaptation Scenario: Cumulative Discounted IF, FF, and O& M Estimates in million US\$ by Investment type, Investment entity

Entities	Source	Crop Production			Livestock Production			Fishery			Plant protection			Soil & Water Management			Total
		IF	FF	O&M	IF	FF	O&M	IF	FF	O&M	IF	FF	O&M	IF	FF	O&M	
Household	0.45	709.95	185.10	225.00	308.65	62.00	92.67	617.23	154.32	194.41	308.65	62.00	92.67	92.77	30.78	30.89	3167.09
Corporation	0.35	552.18	143.97	175.00	240.06	48.22	72.08	480.07	120.03	151.21	240.06	48.22	72.08	72.16	23.94	24.03	2463.29
Government of Liberia	0.2	315.53	82.27	100.00	137.18	27.56	41.19	274.33	68.59	86.40	137.18	27.56	41.19	41.23	13.68	13.73	1407.59
Total		1577.67	411.33	500.00	685.88	137.78	205.93	1371.63	342.94	432.02	685.88	137.78	205.93	206.16	68.39	68.65	7037.97

Source: CBL Annual Report, 2009

Table 10. Cost of Adaptation Measures during the period 2005 – 2030

Period	2005 - 2030			Total
	IF	FF	O & M	
% of Soil & water Management	0.3	0.4	0.3	
Soil fertility	61.85	27.36	20.60	109.80
% of Plant Protection	0.4	0.3	0.3	
Plant protection	274.35	41.33	61.78	377.47
% of Livestock Production	0.45	0.35	0.2	
Development of livestock	308.65	48.22	41.19	398.06
% of Fishery	0.5	0.25	0.25	
Development of fish	685.82	85.74	108.01	879.56
% of crop production	0.4	0.3	0.3	
Intercropping irrigation	631.07	123.40	150.00	904.47

Source: CBL Annual Report, 2009

3. Results

Adequate investments in agricultural development could play a crucial role in overcoming the challenges posed by climate change. As depicted in Table 11, the grand total is \$1,407.39M for Liberia agriculture. Investment on crop production will require \$315.53 M. This amount on investment for crop production is the highest of all investments considered in the study. There will be a need to acquire land or proper land tenure systems to be developed. In addition, the breeding of draught/flood resistant crops are to be conducted. Also, fishery netted second to crop production with an amount of \$274.33M. Fishery was followed by plant protection with \$137.18M. The bulk of these investments will be needed from 2022 to 2030 as depicted in the Table. This implies that capital items like machineries, construction of basic infrastructure like farm-to-market road, storage, processing of agricultural produce to add value are expected to be in full operation just to name a few. The increase in capital investment in these years could be attributed to mechanize agriculture due to the population growth rate; and as the population gets well-informed and skillful there will be increase in income alongside with growing consumption patterns. Additionally, this large capital investment could be due to the many multi-national corporations like Golden Veroleum, SIME Darby, etc., plantations will be in full operation and will need heavy investment on processing machines to add value to rubber, oil palm, rice, sugar cane, etc. being planted.

The high investment in the fishery sector can best be explained by the current revitalization of the Liberian fishery sector by the West Africa Regional Fishery program in collaboration with the Ministry of Agriculture. This could boost the fishery industry. During this time, the capacity of Liberians would have been built and modern fishing gadgets and equipment could have been brought into the country.

However, interestingly, requirement on investment of water and soil management yielded the least (\$41.23M) among the five sub-sectors. This could be best explained by the fact that this sector is often time given low consideration. In actuality soil and water conservation must be accorded the highest priority in allotting investment. Reasons being, there is a need to invest in modern irrigation facilities and other appropriate technology such as adopting water-saving agricultural technologies , developing alternative water sources and facilitating the designing and management of adaptive irrigation and drainages for higher agricultural productivity.

The pattern of 2022 to 2030 continues with crop protection equating to \$99.50M as the most funding requirement for O&M. Next is the fishery subsector netted \$86.40M. The machines bought during the operations will require maintenance such as replacement of spare parts, etc and operational cost like the buying of fuel and lubricants, etc.

Again, crop production and fishery funding requirements were \$82.27M and \$68.59M, respectively. Programs/activities to be undertaken include but not limited to developing a national policy on climate change; provision of funding to build human capacity on climate

change and food security; genuine collaboration between local and foreign partners and working closely with research institutions and foreign partners to enhance the generations of innovations.

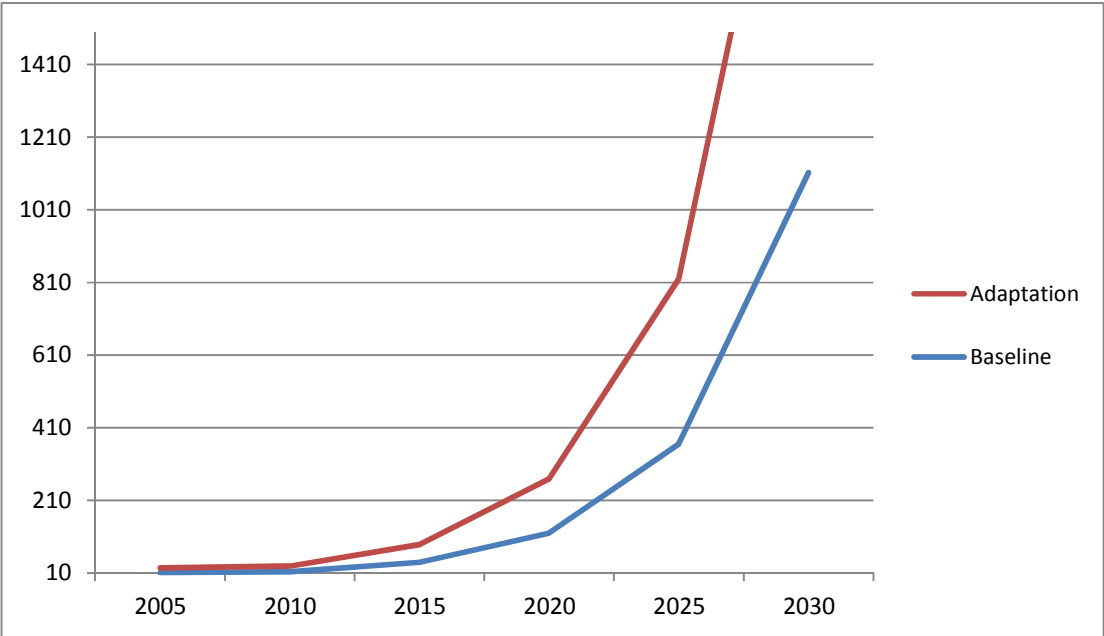
As clearly shown in table 12, households will required most funding with total amount of \$633.35M, followed by corporation (\$492.61M) and then government(\$281.49M). The reason for the households being allotted greatest amount is that Liberia has many impoverished small-scaled farmers who are most vulnerable to the adverse impacts of climate change. Additionally, the Government of Liberia has developed its Food and Agricultural Policy with a pro-poor and pro-growth framework to transform the sector from a state of subsistence to semi-mechanized operations which could be driven by increased levels of private capital investments in the sector, particularly in the value chains such as processing, storage and marketing. Under the government's food and agricultural strategy, the importance of fundamental orientations has been underscored, specifically in improving national food and nutrition security, enhancing agricultural productivity through private sector participation and strengthening human and institutional capacities.

Table 11. Estimated Incremental annual amounts of IF, FF and O&M in Millions of US\$ for the period of 2005 – 2030

Year	Crop Production			Livestock Production			Fishery			Plant protection			Soil & Water Management			Total
	IF	FF	O&M	IF	FF	O&M	IF	FF	O&M	IF	FF	O&M	IF	FF	O&M	
2005	0.58	0.15	0.18	0.25	0.05	0.08	0.50	0.13	0.16	0.25	0.05	0.08	0.08	0.03	0.03	2.57
2006	0.68	0.18	0.21	0.30	0.08	0.10	0.60	0.15	0.19	0.30	0.08	0.10	0.10	0.03	0.03	3.10
2007	1.20	0.30	0.38	0.53	0.13	0.16	1.03	0.25	0.32	0.53	0.13	0.16	0.18	0.05	0.06	5.38
2008	1.45	0.38	0.46	0.63	0.15	0.20	1.25	0.33	0.40	0.63	0.15	0.20	0.20	0.05	0.06	6.51
2009	2.80	0.70	0.88	1.20	0.30	0.38	2.40	0.60	0.75	1.20	0.30	0.38	0.40	0.10	0.13	12.50
2010	0.72	0.19	0.23	0.31	0.06	0.09	0.63	0.16	0.20	0.31	0.31	0.09	0.09	0.03	0.03	3.46
2011	0.90	0.23	0.29	0.39	0.08	0.12	0.78	0.20	0.25	0.39	0.08	0.12	0.12	0.04	0.04	4.01
2012	1.12	0.29	0.36	0.49	0.10	0.15	0.98	0.24	0.31	0.49	0.10	0.15	0.15	0.05	0.05	5.01
2013	1.40	0.37	0.45	0.61	0.12	0.18	1.22	0.31	0.38	0.61	0.12	0.18	0.18	0.06	0.06	6.26
2014	1.75	0.46	0.56	0.76	0.15	0.23	1.53	0.38	0.48	0.76	0.15	0.23	0.23	0.08	0.08	7.83
2015	2.19	0.57	0.08	0.95	0.19	0.29	1.91	0.48	0.60	0.95	0.19	0.29	0.29	0.10	0.10	9.16
2016	2.74	0.72	0.87	1.19	0.24	0.36	2.38	0.60	0.75	1.19	0.24	0.36	0.36	0.12	0.12	12.23
2017	3.43	0.89	1.09	1.49	0.30	0.45	2.98	0.75	0.94	1.49	0.30	0.45	0.45	0.15	0.15	15.29
2018	4.28	1.12	1.36	1.86	0.37	0.56	3.73	0.93	1.17	1.86	0.37	1.26	0.56	0.19	0.19	19.81
2019	5.36	1.40	1.70	2.33	0.47	0.70	4.66	1.16	1.47	2.33	0.47	0.70	0.70	0.23	0.23	23.89
2020	6.69	1.75	2.12	2.91	0.58	0.87	5.82	1.46	1.83	2.91	0.58	0.87	0.87	0.29	0.29	29.86
2021	8.37	2.18	2.66	3.64	0.73	1.09	7.28	1.82	2.29	3.64	0.73	1.09	1.09	0.36	0.36	37.33
2022	10.46	2.73	3.32	4.55	0.91	1.36	9.09	2.27	2.86	4.55	0.91	1.36	1.36	0.45	0.45	46.66
2023	13.07	3.41	4.15	5.68	1.14	1.71	11.37	2.84	3.58	5.68	1.14	1.71	1.71	0.57	0.57	58.32
2024	16.34	4.26	5.19	7.11	1.42	2.13	14.21	3.55	4.48	7.11	1.42	2.13	2.13	0.71	0.71	72.90
2025	20.43	5.33	6.48	8.88	1.78	2.66	17.76	4.44	5.60	8.88	1.78	2.66	2.66	0.89	0.89	91.13
2026	25.54	6.66	8.10	11.10	2.22	3.33	22.20	5.55	6.99	11.10	2.22	3.33	3.33	1.11	1.11	113.91
2027	31.92	8.33	10.13	13.88	2.78	4.16	27.76	6.94	8.74	13.88	2.78	4.16	4.16	1.39	1.39	142.39
2028	39.90	10.41	12.66	17.35	3.47	5.20	34.69	8.67	10.93	17.35	3.47	5.20	5.20	1.73	1.73	177.98
2029	49.87	13.01	15.83	21.68	4.34	6.51	43.37	10.84	13.66	21.68	4.34	6.51	6.51	2.17	2.17	222.48
2030	62.34	16.26	19.79	27.11	5.42	8.13	54.21	13.55	17.08	27.11	5.42	8.13	8.13	2.71	2.71	278.10
Total	315.53	82.27	99.50	137.18	27.56	41.19	274.33	68.59	86.40	137.18	27.81	41.23	41.23	13.68	13.73	1407.39

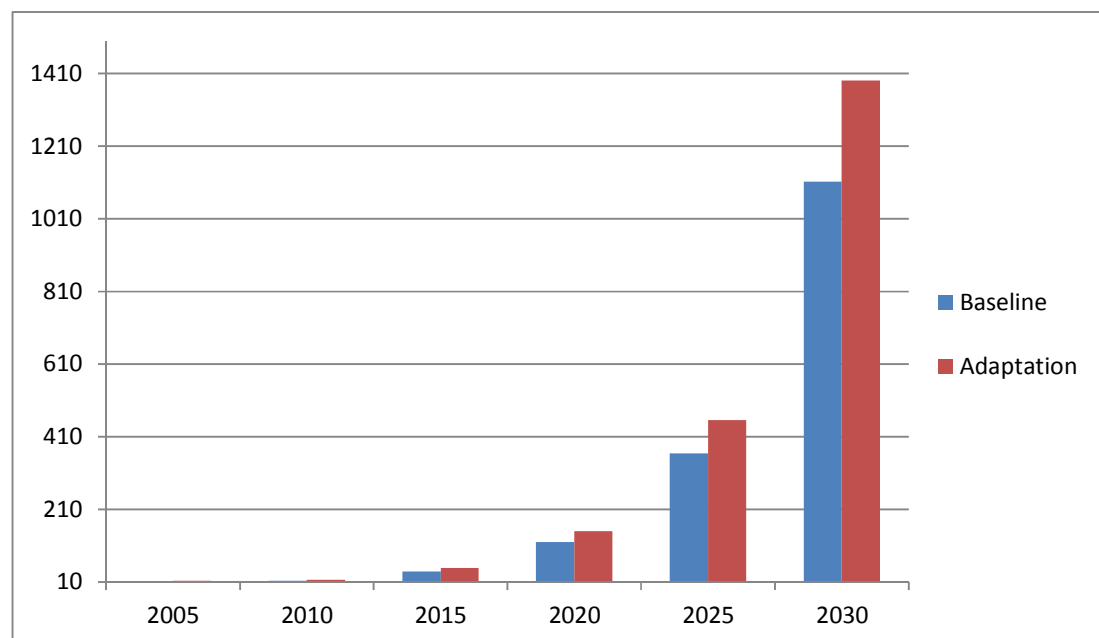
Source: Results of Assessment

Figure 1. Projections of Investment and Financial Flows in the Agricultural Sector 2005-2030



Source: Results of Assessment

Figure 2. Projections of Investment and Financial Flows in the Agricultural Sector 2005-2030



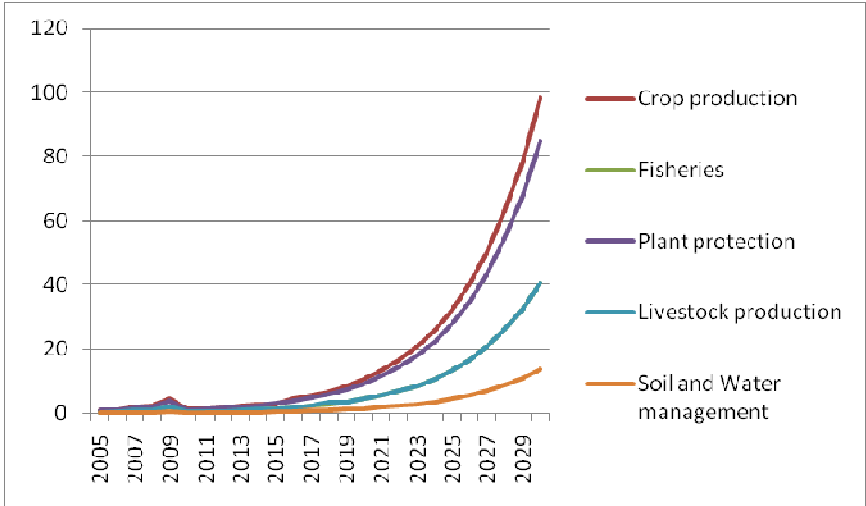
Source: Results of Assessment

Table 12. Estimated Incremental IF, FF and O&M in million US\$ by Investment type, Investment Entity

Entities	Crop Production			Livestock Production			Fishery			Plant protection			Soil & Water Management			Total
	IF	FF	O&M	IF	FF	O&M	IF	FF	O&M	IF	FF	O&M	IF	FF	O&M	
Household	141.99	37.02	44.78	61.73	12.40	18.67	123.45	30.87	38.88	61.73	12.40	18.54	18.55	6.16	6.18	633.35
Corporation	110.44	28.79	34.83	48.01	9.65	14.52	96.02	24.01	30.24	48.01	9.65	14.42	14.43	4.79	4.81	492.61
Government of Liberia	63.11	16.45	19.90	27.44	5.51	8.30	54.87	13.72	17.28	27.44	5.51	8.24	8.25	2.74	2.75	281.49
Total	315.54	82.27	99.51	137.18	27.56	41.49	274.33	68.59	86.41	137.18	27.56	41.19	41.23	13.68	13.73	1407.45

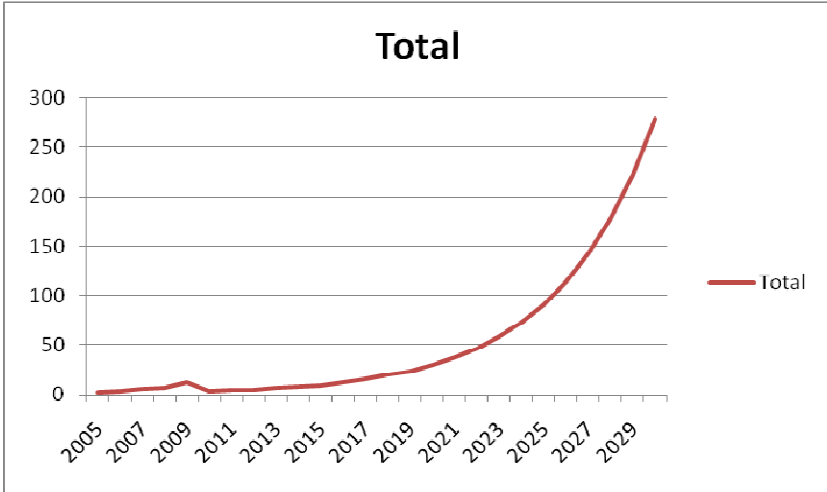
Source: CBL Annual Report, 2009

Figure 3. Estimated Incremental Annual Amounts of IF, FF and O&M in millions of US Dollars by Subsectors for the period 2005-2030



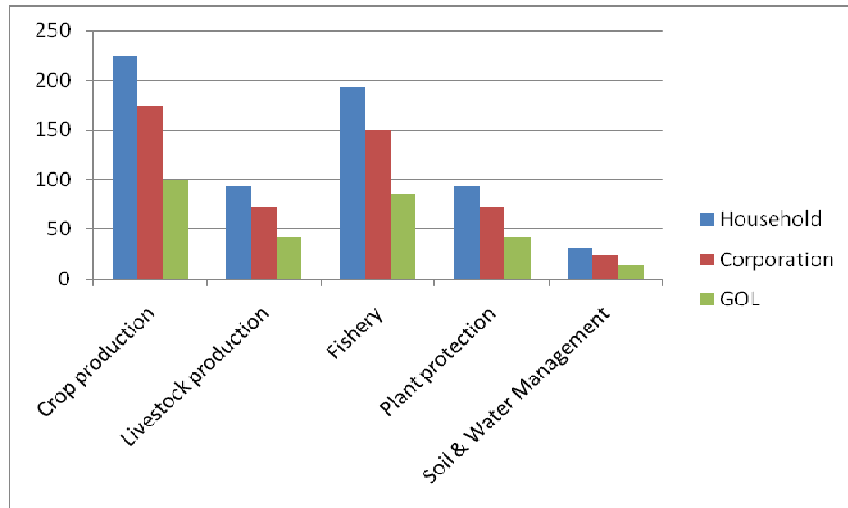
Source: Results of assessment

Figure 4. Total Estimated Incremental Annual Amounts of IF, FF and O&M in millions of US Dollars for the Period 2005-2030



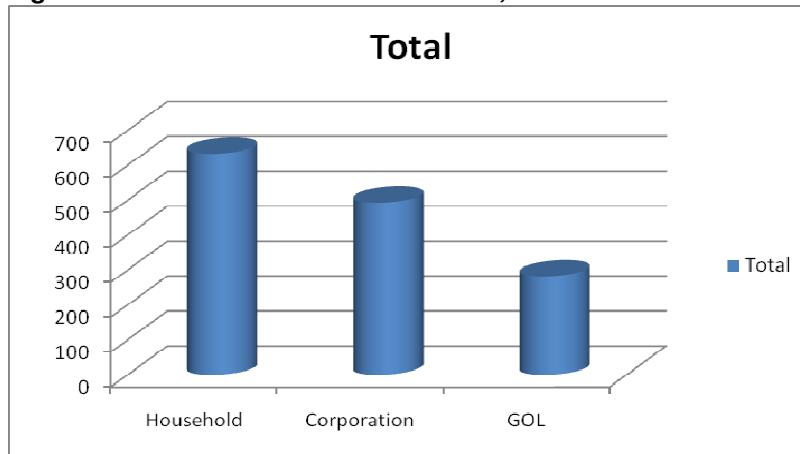
Source: Result of assessment

Figure 5. Estimated Incremental IF, FF and O&M in million US Dollars by Subsectors and Investment Entities



Source: Results of assessment

Figure 6. Total Estimated Incremental IF, FF and O&M in million US Dollars by Investment Entities



Source: Results of assessment

3.1 Policy Implications

Agriculture is the single most important source of livelihood for most rural Liberians. Over 75 percent of the country's population of 3.475 million are engaged either directly or indirectly in smallholder subsistence agriculture or fisheries. However, The MOA needs to redefine its roles and functions and restructure to support Climate change adaptation and mitigation programmes.

Attempts to develop an agricultural policy began years back but still remains inconclusive. The Act of 1972 established the MOA and provided its mandate, as well as institutional arrangements and responsibilities of the Ministry's sub-divisions. With support from FAO, the Ministry produced a "Statement of Policy Intent for Agriculture" with action plans for 2006 to 2007. The Statement provides the vision of the Government for a holistic development of agriculture with special focus on the transformation of smallholder agriculture into a sustainable, diversified, income-generating, modernized and competitive sector, well integrated into the domestic and international markets.

Following the recommendation of the Comprehensive National Food Security and Nutrition Survey (CFSNS), a draft National Food Security and Nutrition Strategy for Liberia (NFSNS) was produced on 8 May 2007. It highlighted cross-sectoral priority actions with emphasis on youth and women that have the highest levels of malnutrition and vulnerability. It also called for the establishment of the Food Security and Nutrition Coordination Commission.

In order to generate appropriate information on the status, potential and constraints of the sector, GOL carried out the Comprehensive Assessment of the Agricultural Sector of Liberia (CAAS-Lib), in collaboration with FAO, IFAD, and the World Bank. The CAAS-Lib provided the basis for formulating a comprehensive policy for the agriculture sector – the Food and Agriculture Policy and Strategy (FAPS). The FAPS identified priority areas for decision-making and future investments in the sector. Key components of the FAPS include:

1. Pro-poor agriculture and agric business development – Activities under this include:
 - a. The provision of micro-finance to needy farm family even with relatively no collateral;
 - b. The supply of timely and relevant farm inputs;
 - c. Low-cost extension services to needy farmers.
2. Food and nutrition security - Activities under this include:
 - a. Identify local food items, evaluate their nutritional contents;
 - b. Create awareness on local food items and promote/encourage their consumption;
 - c. Understanding seasonal crops to know their availability;
 - d. Encourage and promote the production of local food items.
3. Intensification and diversification of farming system - Activities under this include:
 - a. Proper land use plan;

- b. Optimal water usage;
 - c. Crop rotation;
 - d. Low-external inputs (e.g. chemical fertilizer/pesticide);
 - e. Resistant crops and animals.
4. Farm mechanization
Activities under this include;
 - a. Introduction of appropriate technology;
 - b. Animal traction draught;
 - c. Irrigation.
 5. Increased market access - Activities under this include
 - a. Improved transport system(e.g. Farm-to-market road);
 - b. Fair price for local agricultural produces;
 - c. Quality control of agricultural produces;
 - d. Formation of cooperatives.
 6. Reduce post-harvest loses - Activities under this include:
 - a. Processing of agricultural produces to add value chain;
 - b. Improved storage;
 - c. Pest control.
 7. Human and institutional capacity building - Activities under this include
 - a. Develop a national policy on climate change;
 - b. Provision of funding to build human capacity on climate change and food security;
 - c. Genuine collaboration between local and foreign partners;
 - d. Working closely with research institutions and foreign partners to enhance the generations of innovations.

The FAPS also contributed to the formulation of Government's Poverty Reduction Strategy (PRS). All of the policy documents on agriculture including the Poverty Reduction Strategy (PRS) were instrumental in preparing the Liberian Agriculture Sector Investment Programme (LASIP). LASIP identifies priority areas from which national objectives are to be aligned with the Comprehensive African Agriculture Development Programme (CAADP). The LASIP was in fact prepared as a partial requirement for the compact agreed by African Leaders under the CAADP, which was developed by African leaders to restore agricultural growth, develop rural economies, and enhance food security in an integrated fashion. It considers agriculture-led growth as the main strategy for poverty reduction and calls on the governments to allocate 10 percent of their budgets to the sector in order to achieve the 6 percent average annual growth needed to achieve the program's objectives.

Notwithstanding, the over-riding development policy in Liberia has been the Poverty Reduction Strategy, 2008-2011. The PRS provides a framework for medium to longer term socio-economic

development and is founded on four strategic pillars: Security, Economic Revitalization, Governance and Rule of Law, and Basic Services and Infrastructure. Overall, the Poverty Reduction Strategy is Liberia's blueprint for national development as well as a framework for the achievement of the Millennium Development Goals. The PRS acknowledges that "it is also important to increase preparedness against natural disaster, plan and establishing an inter-sectoral coordination mechanism to increase security against the threats of flood, coastal erosion, forest fires and chemical spills." It offers general opportunities for integrating climate change adaptation into national development as a cross cutting issue. However, at present, it makes little reference to climate change and does not fully exploit the opportunity.

In spite of all of the efforts thus far, there is no clear statement and assertive policy on climate change as yet. The only policy instrument on climate change is the National Adaptation Programme of Action (NAPA). However, the NAPA and its attendant focus have not sufficiently captured any serious attention of Government, especially the National Legislature.

The Government is taking steps to strengthen disaster management capacity nationwide. Under the coordination of the Ministry of Internal Affairs, a draft National Disaster Risk Management Policy is being formulated and a National Contingency Plan is being prepared. This includes the establishment of an institutional framework with the task of identifying and responding to disasters at national and local levels.

Policy development emanating from this study is the sure way of mainstreaming climate change adaptation efforts at the national, local and community levels. The results of this assessment will influence national budgetary planning and give GOL the resolve of addressing climate change by paying keen attention to adaptation in the agricultural sector. Basically, it is important that these vital statistical data provided by the study be integrated into rural development planning, National Communications, National Actions Plans and National Development Plans. This study raises the awareness of fundraising initiatives for climate change adaptation and helps political leaders such as cabinet ministers, lawmakers and County and district leaders understand the reasons for which adaptation should be integrated into national budgetary allocation. This study also gives rise to the development concept notes and ideas will be sharpened through seminars, policy dialogues and regular technical briefing papers for specific target groups. Through effective communication strategy and information dissemination on lessons learnt from the assessment, policy recommendations will be made for the consideration of policy makers.

In the workshop "National Inter-Ministerial & Stakeholder Dialogue on Climate Change" the working group on agriculture recommended some policy instruments, cardinal amongst which are the following:

1. Improve agro-forestry;
2. Incorporate the I&FF findings for agriculture in PRS-II;
3. Prepare an agricultural land use plan for the country;
4. Reduce taxes on farming inputs;

5. Subsidize farming implements/machines;
6. Mainstream climate change in the Agricultural Policy documents;
7. Promote adaptable varieties of agricultural crops;
8. Accelerate land zoning, conduct land suitability study;
9. Improve the marketing system;
10. Put in place a price policy for all agriculture commodities;
11. Promote aquaculture;
12. Secure access to land;
13. Strengthen extension service;
14. Integrate climate change into national planning with a wide participation of stakeholders;
15. Integrate climate change in long-term planning;
16. Address climate change using a broader programmatic approach as opposed to fragmented projects.

3.2 Key Uncertainties and Limitations of the methodology

During the assessment, it was difficult to collect data on investment and financial flows for the period 1995 to 2000 to form part of the historical period because of the problem of missing data during the civil crisis in Liberia. Due to insufficient data collected on the contribution of households, estimates were based on assumptions of CBL as well as the common agricultural practices of small-scaled farmers.

To calculate the cost of adaptation activities, the percent (%) was allotted based on expert judgment which might have led to over or understatement of the values in each sector.

In the analysis carried out, the level of disaggregation of data does not indicate all sources of I&FF funds.

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