IICA

INTER-AMERICAN INSTITUTE FOR COOPERATION ON AGRICULTURE

OAS

S E C O N D   D R A F T

THE GENERATION AND TRANSFER OF TECHNOLOGY TO SUPPORT COTTON PRODUCTION IN THE CARIBBEAN

VOLUME I of 111

PART 1 - PROJECT SUMMARY

PART 2 - COTTON RESEARCH AND DEVELOPMENT PROJECT

July, 1992

VOLUME I

PART 1

PROJECT SUMMARY

VOLUME I

PART 1

PROJECT SUMMARY

VOLUME I

PART 1

PROJECT SUMMARY

Page No.

VOLUME I

PART 1

PROJECT SUMMARY

A PROGRAMME FOR RESEARCH AND DEVELOPMENT FOR WEST INDIAN SEA ISLAND COTTON AND THE GENERATION AND TRANSFER OF TECHNOLOGY IN SUPPORT OF COTTON PRODUCTION IN THE CARIBBEAN

PART 1

PROJECT SUMMARY

1. INTRODUCTION

1.1 Background to Feasibility Study

During the past five years there has been a renewed interest in the production of Sea Island Cotton in some countries of the Caricom Region, namely Antigua and Barbuda, Barbados, St. Kitts/Nevis and Montserrat.

Prior to 1970 agriculture dominated activity in these countries especially with respect to contributions to GDP, unemployment and foreign exchange earnings. Subsequently, growth in other sectors, particularly, tourism and manufacturing has outstripped that of agriculture thus reducing its relative contribution.

It has been generally recognised that agriculture must be fully exploited as a means of generating increased economic activity and to alleviate certain short-term problems particularly unemployment and foreign exchange earnings so as to enable countries to achieve their long-term goal of self-sustaining growth.

The strategy for achieving these goals include, inter-alia, the diversification of the agricultural export base. Sea Island Cotton by virtue of such factors as its market security and suitability within farming systems has been identified as having the potential to contribute significantly to the foreign exchange earnings. The revival of the Sea Island Cotton industry now forms part of national and regional plans for agricultural diversification.

> "Among cotton breeders, geneticists and in the textile industry; Sea Island Cotton is viewed as having an extremely high quality of long, silky lint produced under conditions peculiar to the West Indies. Its origins have been described by Hutchinson and Manning (1945) and the effect of environment on the quality of its line outlined by Hutchinson (1943). Plant breeders, agronomists and cotton producers recognise that the varieties of Sea Island Cotton grown in the West Indies have failed when tried in a large number of other countries including

Egypt and the Sudan. Brown (1938) recorded such failures, stating (p. 32) "that it (Sea Island) has been tried in India, in Egypt, and in other parts of Africa and Australia and on various islands in the Pacific Ocean but found to be unsuited to all these regions except the islands (West Indies)". We have no reason to believe that the culture of Sea Island varieties outside the West Indies has been any more successful in recent years".

The above opinion was given by Professor N.L. Innes and Mr. John T. Mitchell in a joint opinion on Sea Island Cotton written in 1987.

The selection of Sea Island Cotton as one of the crops to be given priority development is an obvious choice. Historically, cotton growing dates back to the discovery of the Region. It commands best prices world wide because of the cachet of exclusivity it carries in the textile business, and it is not subjected to the vagaries of competition on international markets. Moreover, there is already established a niche at the top market segment for all items manufactured from its superior fibre. The project proposals seek to remove constraints inhibiting the successful and sustainable development of an Integrated Sea Island Cotton industry.

2. ECONOMIC REVIEW OF COUNTRIES

2.1 Overview of the Economies of Sea Island Cotton Producing Countries

The islands of Antigua and Barbuda, Barbados, Montserrat and St. kitts and Nevis are all situated in the Eastern Caribbean (see location map attached as Annex I) and with the exception of Barbados belong to the Organization of Eastern Caribbean States. They are strongly tied economically and politically to the United States and the United Kingdom. The economies of these countries are characterized by limited natural resources, small markets, declining terms of trade, and mounting foreign debt. Summary data characterizing their economies are presented in Table 1.1 and more detailed information is given in Annex II. Macroeconomic Information about the four 94) countries is presented in Volume III.

The countries are small in terms of land size, with a combined land area of only 1245 km^2. The total population in 1989 was estimated at 398.2 thousand inhabitants, with Montserrat having the smallest population at 12.0 thousand and Barbados the largest at 255.8 thousand.

The countries have experienced slow rates of population growth and in some cases there have been periods of population decline. While birth rates are fairly high relative to death rates, the

ability and willingness of people to emigrate have kept down population growth rates and have helped mitigate population pressure on land and resources.

While Antigua and Barbuda, Montserrat, and St. Kitts and Nevis have experienced good economic growth rates in the 1980's resulting in rising levels of per capita income, Barbados, in 1990, experienced a negative GDP growth of 3.5%, the first time since 1982. For the period 1980-1985, average annual growth in real GDP ranges from -0.3% in Barbados to 5.4% in Antigua and Barbuda. Average annual growth rates were significantly higher in the 1985-1989 period, ranging from 3.1% in Barbados to 8.1% in Montserrat.

Despite the good economic growth experienced by these countries, they still fall in the general middle income category of developing countries. St. Kitts and Nevis recorded the lowest nominal per capita income of US$2357 in 1989. At the other end of the spectrum is Barbados with a nominal per capita income of US$5662. Inspite of the relatively high per capita incomes of cotton growing countries, poverty is still a fact of life in many parts of these countries, as income distribution is skewed. This seems to be a major factor explaining the high rates of emigration to Europe and North America in search of a better living.

TABLE 1.1
SUMMARY OF MAIN ECONOMIC INDICATORS (1989)

ITEM	Antigua and Barbuda	Barbados	Montserrat	St. Kitts and Nevis
1. Land Area (km²)	440.3	431.0	103.0	269.3
2. Population (1,000) 1989	82.9	255.8	12.0	43.0
3. Population Growth				
1980-85	0.7	0.2	0.4	0.1
1985-89	2.3	0.2	0.2	-0.5
4. Real GDP Growth (%)				
1980-85	5.4	-0.3	1.8	4.9
1985-89	5.6	3.1	8.1	6.4
5. Nominal GDP per Capita 1989 US$	3604	5662	3975	2357
6. Agr. Share of GDP (%), 1989	4.0	5.3	4.3	9.2
7. Trade Balance, 1989 (US$ million)	-316.2	-552.1	-24.7	-73.0
8. Current Account Balance 1989 (US$ million)	-81.8	-2.6	13.5	-18.7
9. Net capital movement 1989 (US$ million)	-81.9	-39.7	na	25.0
10. External Debt 1989 (US$ million)	236.9	469.4	3.4	32.5
11. Debt Service, 1989 (US$ million)	1.0	78.8	0.2	1.6
12. Debt service % of GDP 1989 (%)	0.3	10.9	0.6	1.5
13. Current Budget Deficit 1989 (US$ million)	-4.2	68	1.0	2.9
14. Total Deficit 1989 (US$ million)	-14.4	-33.2	na	-1.4
15. Current Revenue % GDP	21.2	34.1	22.7	31.2
16. Capital Expenditure of % of GDP, 1989	2.7	7.0	na	4.0

a/ 1988 figures

A hallmark of each country is a persistent and large deficit in merchandise trade. These deficits have been offset by net transfers consisting of foreign private investment and to a large measure economic aid under a combination of bilateral and multilateral lending programmes. In 1989, the external debt of Barbados was US$469.4 million or US$1,835 per capita. The external debts of the other countries in 1989 were much smaller and ranged from US$32.4 million in St. Kitts and Nevis to US$236.9 million in

Antigua and Barbuda. Per capita external debts were also follows: Antigua and Barbuda US$3236; Montserrat US$283; and St. Kitts and Nevis US$739.

Another interesting feature of the economies of cotton growing countries is the level of government expenditures and associated domestic debt situation. In 1989 the size of the government current revenues as a percentage of GDP were as follows: Antigua and Barbuda, 21.2%; Barbados 34.1%; Montserrat 22.7%; and St. Kitts and Nevis 31.2%. These figures represent moderately high levels of government activity in the economies of these countries. On the other hand, all governments have made concerted efforts to balance their fiscal budgets over time. There were small deficits in some years and small surpluses in other years.

Government capital expenditures as a percentage of GDP varied widely among the countries. The 1989 levels ranged from 2.7% in Antigua and Barbuda to 7.6% in Barbados.

2.2 Sectoral Analysis

(a) Agriculture

The structure of the economies of participating countries changed significantly in the 1980's (Table 1.2). Between 1980 and 1989, agriculture's share of GDP declined in Antigua and Barbuda, Barbados, and St. Kitts and Nevis, but increased in Montserrat. The relative decline of the sugar industry in Antigua and Barbuda, Barbados and St. Kitts and Nevis over this period may be partially responsible for the negative change in the relative contribution of agriculture to GDP in these countries. In itself, a decline in the relative importance of the agricultural sector is not a bad sign since primary industries generally become less important as a country develops, and the countries experienced respectable economic growth in the 1980's.

In 1989 the contribution of agriculture to total GDP were as follows: Antigua and Barbuda 4.0%; Barbados 5.3%; Montserrat 4.3%; and St. Kitts and Nevis 9.2%.

Although the agricultural sector has experienced only modest growth at best, it is very important to the economies of the countries, because it provides a living for a large percentage of the population, and has been a major source of foreign exchange earnings for the countries. There are however, major impediments to achieving better and environmentally sound performance in the agricultural sectors of the region. These include cultural bias against the sector, infrastructural constraints, lack of institutions for efficient marketing and processing, and the low levels of technology usages in the system.

TABLE 1.2
SHARE OF SELECTED SECTORS IN GDP FOR PARTICIPATING MEMBER COUNTRIES

Country	Agriculture		Manufacturing		Hotel and Restaurants	
	1980	1989	1980	1989	1980	1989
Antigua and Barbuda	7.1	4.0	5.3	3.1	13.9	16.5
Barbados	9.9	5.3	11.9	8.1	11.9	11.9
Montserrat	2.4	4.3	3.5	6.0	2.8	3.9
St. Kitts and Nevis	16.0	9.2	15.2	15.7	4.3	8.0

Currently, the importance of sugar-cane and banana and the need to diversify agricultural production dominates the thinking and strategy for this sector. There is considerable pessimism about the outlook for sugar and banana because (a) it is believed with good reason that Caribbean countries will lose their price subsidies from the UK some time after January 1, 1993 when EC -92 goes into effect, and (b) the region has low productivity and high production costs and will not be able to compete well in the larger international dollar market.

At the same time, progress has been very slow in finding attractive crops to replace sugar-cane and banana on at least some crop acreage. One such crop could be cotton.

(b) Manufacturing

The performance of the manufacturing sector in the 1980's was mixed. Only Montserrat experienced significant increases in manufacturing share of GDP, with St. Kitts and Nevis increasing its relative share marginally, and Antigua and Barbuda and Barbados showing declines.

The outlook for manufacturing is not promising for several reasons. First, the educational levels in some countries cannot support growth in high technology industries, while relatively high wage rates make the region uncompetitive in the manufacture of many products compared to countries in Asia and the Western Hemisphere which have lower wage costs. The wage rate problem will be exacerbated if future growth in tourism countries continues to bid up real wage rates.

(c) Tourism

Overall, the hotel and restaurant (tourism) sector performed the best in the 1980'. Its relative importance increased in all countries. While it is still a small sector in Montserrat, it accounted for as much as 8.0%, 11.9%, and 16.5% of GDP in St. Kitts and Nevis, Barbados and Antigua and Barbuda, respectively.

The historical performance of the tourism sector supports the view that this sector has the most favourable outlook for the countries (Table 1.3). During the 1980-1989 period, estimated expenditures by tourists increased at average annual rates of 20.9% for Antigua and Barbuda, 18.3% for Barbados, 17.4% for Montserrat and 18.1% for St. Kitts and Nevis.

TABLE 1.3
TOURISM DATA FOR PARTICIPATING COUNTRIES

	1980	1985	1986	1987	1988	1989
1. Antigua and Barbuda						
Arrivals (1,000)	205.0	249.8	281.3	326.7	389.5	383.5
Estimated Expend. (US$m)	42.0	132.5	156.2	186.7	213.5	231.8
2. Barbados						
Arrivals (1,000)	369.8	359.2	369.5	421.8	401.0	399.6
Estimated Expend. (US$m)	251.0	309.0	323.7	378.6	459.3	526.3
3. Montserrat						
Arrivals (1,000)	20.5	24.6	26.1	28.2	30.3	32.1[a]
Estimated Expend. (US$m)	4.3	7.7	8.1	9.4	10.9	11.8[a]
4. St. Kitts and Nevis						
Arrivals (1,000)	38.5	79.1	83.8	97.9	123.3	108.7
Estimated Expend. (US$m)	13.4	31.0	38.0	47.7	53.8	60.0

a/ Estimated

2.3 The International Economic Context: Problems and Opportunities

Economic and political development in the world could pose a serious challenge for the countries in sustaining economic growth and be cost competitive in external markets. While many individuals, especially the policy makers are aware of them, little thought appears to have been given to their quantitative impact on economic growth prospects for Caribbean countries. Some of these external developments are discussed briefly below.

(a) Single European Common market of 1992

The single European Market of 1992 has raised the possibility of the Caribbean losing its preferential markets for its main exports, sugar and bananas. No one knows how fast the subsidies on these commodities will be phased out or whether their will be some form of economic compensation paid to Caribbean countries by the EC for loss of export earnings. While the available evidence at this point in time does not indicate an immediate or perhaps even a medium term loss of these markets, general developments inside and outside of Europe signals the possibility of contracting export markets for Caribbean agricultural products. These include the consequences of the single market, technological changes, efforts to reform the Common Agricultural Policy (CAP),

possible implications of certain agreements from the GATT negotiations, and the development of special trading arrangements between the EEC and other regions including the Mediterranean and North Africa, Latin America and Eastern Europe.

It is envisaged that Latin American countries would be the most important rivals with the Caribbean for agricultural market shares in Europe and North America. A major implication of such developments would be the adverse economic and social consequences which a reduced market and declining prices for the major agricultural exports would have on Caribbean economies, given the current price advantage which Latin America agricultural producers have vis-a-vis their Caribbean counterparts.

There probably are steps that the sugar and banana producing countries of the region could take to provide an orderly transition to a more competitive dollar market, but the implications of these steps need to be studied. Some of the measures that might be looked at are:

- Expanding efforts to increase sugar and banana productivity and competitiveness in the dollar market, although studies indicate improvements in this area are only a partial answer.

- Making greater efforts to stimulate economic production of alternative crops (e.g. cocoa, coffee, spices, cut flowers and fresh fruits and vegetables), and to put in place efficient marketing systems to serve both the domestic and export markets that would provide a stable if not regulated market at prices that are attractive to farmers.

- Making sugar and banana production less profitable through a combination of taxing exports and withdrawing any input subsidies as a way to force farmers to diversify production for the market.

Unless policymakers and farmers in the region better understand the options available to them and the practical implications of each option, little may be done to ease the transition costs that will be experienced by Caribbean producers.

Given the importance of sugar cane and banana production to the countries of the Caribbean there is a good chance that EC-92 will impose a major external shock that will be very disruptive and painful to the fragile economies of the area, particularly those countries that depend heavily on them to

earn foreign exchange. The Caribbean Community Agricultural Sector programme, IICA's PLANLAC component for the Caribbean, the USAID financed projects such as the Agricultural Diversification Programme in the OECS and the TROPRO project to promote the export of products other than sugar and banana, are steps in the right direction in preparing for the EC-92 period and beyond.

(b) North American Free Trade Agreement (NAFTA)

Within a year or so the North American Free Trade Agreement will be in place and the United States, Mexico, and Canada will have a common market. Studies done to date by and for agencies of the U.S. government indicate the following results of a NAFTA that are relevant to the Caribbean region:

- The benefits of expanded trade in NAFTA will come in part from displacing trade with third countries, with additional trade gains coming from more rapid economic growth within NAFTA.

- Within the constraints imposed by U.S. phytosanitary regulations, Mexico will benefit greatly from expanded exports of fresh and processed fruits and vegetables to the United States and Canada.

- Manufactures based on low cost labor will expand rapidly in Mexico and the products will be shipped to the United States and Canada. Expanded manufacturing opportunities will also attract capital and management from the United States and Canada as well as from third countries who wish to establish a production base in Mexico to serve the NAFTA market.

None of these developments will be especially good news for Caribbean countries. Individually and collectively, Caribbean nations should be looking at and evaluating policy options available to them for dealing with the growth in competition they will face as a result of NAFTA.

(c) Enterprise for the Americas Initiative (EAI)

The Bush Administration in the United States of America has announced its EAI for Latin America and the Caribbean. Specifics about the EAI have not yet been fleshed out, but it is known that the Initiative proposes action in three key areas: (1) external debt; (2) investment promotion; and (3) strengthening trade relations. EAI does not propose a development strategy, but rather it constitutes a mechanism

for accelerating ongoing reforms particularly privatisation of public sector companies, development and enactment of patent protection laws and repatriation of profits on investment along the lines proposed by multilateral financial institutions with the support of the U.S. government.

(d) Democratization and Liberalization of the Cuban System

It is a widely held view that the Castro regime in Cuba will be forced to embark on a process of democratization and liberalization of the cuban economic system, given the deteriorating state of the country's economy and the withdrawal of Soviet aid. Europeans and Jamaicans investors have already begun to develop hotels and tourist facilities in Cuba. The Cuban - American Community is just waiting with capital and management to go back to Cuba and the foci of their investment plans are broad - tourism, manufacturing, agriculture, and trade. These private U.S. initiatives will undoubtedly be bolstered by official aid from the U.S. government. Once Cuba becomes liberalized in reality, it will be a strong magnet drawing scarce capital and management and tourists away from the rest of the Caribbean region. Caribbean countries are thus likely to be one of the casualties in the wake of Cuba's liberalization.

(e) Eastern Europe and the Old USSR

On a much larger scale than Cuba, the demise of communism and the emergence of democracy and market economies in Eastern Europe and the republics of the former Soviet Union have captured the political attention of the industrialized countries and may yet entice western firms to invest capital and deploy management into this region on a significant scale. Both governments and private sectors have limited capacities and a need to focus on what they consider to be priority issues, areas, and markets. They cannot nor do they wish to give equal emphasis to all areas. Many parts of the developing world are already losing out in the attention race. How will Caribbean countries fare?

A related point about Eastern Europe and the former Soviet Union is worth contemplating. They have a tremendous need for investment capital. If that need is ultimately met by industrialized countries and multilateral lending institutions such as the World Bank, the European Bank for Reconstruction and Development, and the IMF, the real cost of borrowing will remain high and could increase. This may be especially so if the United States and some other developed countries continue to run large budget deficits.

(f) General Comments

The above possibilities have enormous implications for Caribbean economies in general, and specifically for the region's agricultural sector. The challenges will be many and severe. How successful the Caribbean can deal with such challenges will ultimately depend on such interrelated factors as its preparedness to meet these, its choice of strategies, the political commitment of its governments, efforts to deepen the integration process and the swift execution of policy decisions.

Caribbean government must also be ready to react to the effects of certain decisions which metropolitan countries, the major trading partners of countries of the region, might be forced to take if the needs of Eastern Europe and the countries of the former Soviet Union are greater than the capacity of official sources and multilateral lending agencies can satisfy. Additionally, efforts to influence holiday makers to try new destinations, more restrictive immigration policies or decisions favouring immigrants from the Old World rather than from the Caribbean will all impact unfavourable on Caribbean economies.

3. Development of Sea Island Cotton Industry

The increasingly poor outlook for sugar and many of the other primary products produced by the four(4) countries and their declining contribution to GDP coupled with the other world political and economic developments that threaten sustaining economic growth in them, have focussed attention on the need to address the problems inhibiting a sustainable level of production of Sea Island Cotton in keeping with the governments firm commitment to the development of an integrated Sea Island Cotton industry in the region.

The tremendous potential of the Sea Island Cotton industry for contributing to the diversification of the regional economy in terms of its contribution to the generation of foreign exchange and the creation of opportunities has been recognised because of the tremendous capacity of this crop to attract increasing levels of valued added at every stage of the processing cycle. The achievements of the Japanese company which now purchase and process all lint produced by the four (4) cotton growing countries in term of the quality and the variety of materials, garments and other items manufactured from West Indian Sea Island Cotton is the assurance that the successful development of an integrated Sea Island Cotton industry can contribute significantly to industrial development not only in the four(4) producing countries but in the wider Caricom and Caribbean region.

Cotton production in the region has exhibited a downward trend over the last decade, even through the crop has been grown in the region since the early days of colonization, in one instance since 1627, production has been erratic with both areas planted and yields fluctuating widely. Reasons for low and fluctuating yields include:

(a) the subsistence nature of production and the resulting low yields, It is evident that inadequate pest control, limited fertilizer application and plant density factors contribute to low yields;

(b) low levels of management and poor profitability as a result of low yields and the high cost of harvesting;

(c) the apparent inability to mobilise resources or the commitment for production at adequate levels despite a clearly stated and repeated policy decision by governments to develop an integrated Sea Island Cotton industry. A powerful sugar lobby, in the case of Barbados, which fears that funding for the programme of sugar price support would be reduced by the inclusion of cotton and other non-sugar crops, magnified erosion problems and questionable management techniques.

(d) a failure to formulate a programme to ensure and support cotton growing by small farmers because of their historical contribution to agricultural output.

(e) a crop management approach suitable for sugar production, but which is inappropriate for any other crop especially Sea Island Cotton.

Several studies have been undertaken, on the agricultural sector or on cotton particularly,

i. Integrated Cotton Textile Industry for the Eastern Caribbean, Phase I - Cotton Farming Feasibility Study, prepared by FJD Bilodeau and Associates.

ii. Feasibility study for the spinning, weaving and dyeing of Sea Island Cotton. A study by Tootal Textiles International Limited - 1987, Manchester, UK.

iii. Barbados - An Agricultural Sector Study prepared by Landell Mills Commodities Studies - 14-16 George Street, Oxford, UK.

iv. Analytical Study of the Agricultural Sector of Barbados - 1971 by International Development Services Inc, 1625 K. Street NW, Washington DC.

The case for establishing a fully integrated Sea Island Cotton Industry was addressed in depth by the Bilodeau and Tootal Studies and the feasibility of such a venture promoted. Moreover, the Japanese Company which has been processing all lint produced in the region since 1987 has examined the Tootal Study and has produced its own "feasibility study" which confirms that a spinning, weaving knitted and dyeing facility requiring 336,000 pounds of lint would become profitable within the fourth year of operation.

The governments of Antigua and Barbuda, Barbados, St. Kitts/Nevis and Montserrat, in giving effect to their commitment to establish an integrated Sea Island Cotton Industry agreed that it should be based on a joint venture company involving Japan. Caribbean Sea Island Cotton Company a semi-private company was created in 1988 to develop cotton growing, process and market all Sea Island Cotton Unit produced in the four(4) countries. This Company has ceased its operational functions because of serious infelicities by the proposed major equity shareholder, a non-regional company and the responsibility has been taken over by a new company.

This new company, Caribbean Cotton Company Incorporated, which is owned 51% by the government of Barbados has also among its shareholders the governments of Antigua and Barbuda (8%) St. Kitts/Nevis (4%) and Montserrat (4%). The remaining 8% is available for purchase by regional cotton growers. So far only one grower has acquired shares in the venture. There was no alternative to the government of Barbados becoming the major shareholder if the new company was to commence operations immediately after governments' decision not to permit any further involvement by the offending company. It is understood that the government of Barbados intends to divest itself of a significant portion of the equity held at an appropriate time. Growers, growers associations and nationals of the four (4) producing countries should be afforded the opportunity to acquire those shares.

The successful development of the sugar industry in the region has been due, to a large extent, to the presence of extensive research and development infrastructure directed at ensuring a continuous and sustainable production at the optimum level. Problems relating to pest control and eradication, suitability of varieties, mechanical harvesting, juice and sucrose content were under constant study with the results of research being made available to all growers, irrespective of size along with any new technologies developed by local facilities or obtained from foreign producers. The same approach was used with other crops and mineral resource of economic importance in the region and elsewhere.

A careful review of Sea Island Cotton growing in recent times reveal that there are certain major constraints to achieving an enduring and stable level of production, necessary if the aim of

localizing all facets of processing beyond the ginning stage, is to be realized. These constraints are many and include both technological and non-technical factors. If appropriate and urgent measures are not taken to reverse the declining trend in both the level of production and lint quality, the possibility of achieving the real benefits expected from the development of a fully integrated industry will not be realized. Cotton growing might disappear or the region remain a primary producer of a commodity which will be processed beyond the ginning stage elsewhere outside the area.

In order to develop a rational programme for a sustainable level of Sea Island Cotton production, action must be taken to control limiting factors in order to reduce their possible impact on the crop or on its management. The elaboration of a research and development programme with an integrated "technology package", specifically designed for Sea Island Cotton growers will help to make this crop more manageable and competitive at the farmers' level. The package should include:

- Selection of varieties with better agronomical and technological characteristics;

- Production and distribution of pure and good quality seed;

- Improvement of pests weed control;

- Improvement of agronomical techniques (plant population, spacing, fertilization, etc.)

Non-technological factors inhibiting production include:

- Poor institutional support services to the cotton farmers

- Wear and ineffective farmer's organisational at both national and regional levels

- Weak and inadequate marketing arrangements

- inadequate incentives to cotton farmers

The technological factors that must be addressed are:

i. a deficiency in genetic improvement programmes;

ii. a poor organised and maintained germplasm bank;

iii. an absence of a comprehensive programme of multiplication and certification of cotton seeds;

iv. a low level of technology usage on farms;

v. the use of poor agronomic practices;

vi. high crop losses;

vii. a lack of irrigation because of very prohibitive cost;

viii. the production of poor quality cotton lint;

ix. inadequate production diversification and inter-sectoral linkages.

The overall objective of the research and development programme is increased levels of output and profitability within the Sea Island Cotton industry. In order to achieve this goal and halt and turn around the downward trends in production now discernable, it is vital that a comprehensive cotton development programme be implemented as quickly as possible, with the following objectives:-

(a) to increase the levels of cotton production and productivity;

(b) to improve the quality of cotton lint produced;

(c) to strengthen the institutional support services provided to farmers;

(d) to strengthen cotton farmer's organisations at the national and regional levels;

(e) to provide adequate incentives to farmers;

(f) to strengthen the marketing system/arrangements; and

(g) to support product diversification efforts and inter-sectoral linkages.

The achievement of the objectives of increased acreage, yields and profitability are considered necessary and sufficient grounds for fully exploiting the potential of the industry in terms of increasing cotton farmers income, earning additional foreign exchange, creating additional employment and/or strengthening inter-sectoral linkages. Moreover, by achieving a sustainable level of production, at the farm level it will be possible not only to increase the export of lint but to attain the ultimate and very important goal of the proposed integrated Sea Island Cotton industry by providing the minimum required level of raw material necessary to support a facility which would take the processing of cotton beyond the lint stage as well as see the manufacture of fabrics, finished goods and other by-products which can be obtained from Sea Island Cotton.

The proposed study project (Volume I - Part II) will focus on the generation of technology and it's transfer to farmers, therefore the project will have as its primary aim, increasing the level of productivity within the cotton industry and improving the quality of the lint produced.

Specifically the project will aim at:

(a) Increasing the levels of modern technology usage;

(b) establishing a comprehensive seed production and certification programme;

(c) improving the quality of Sea Island Cotton genetic material;

(d) improving agronomic practices through the application of applied research;

(e) reducing crop losses;

(f) increasing factor productivity;

(g) developing programmes for the ongoing testing of soils and of lint quality;

(h) fostering the development of a mechanism which would not damage by staining or cutting the cotton staples.

There is also an urgent need for strengthening the existing institutional capacity for the generation and transfer of technology in support of the production of cotton in the Caribbean.

The need is fully justified because of the apparent reluctance of growers to become fully involved in the production of a crop which was grown successfully in the region since its settlement and was exported in significant quantities for many years immediately after settlement. But there is some justification for farmers hesitancy when confronted with the twin problem of declining yield and lint quality, as well as poor pest management techniques and questionable approaches to crop management and the lack of a concentrated and continuing technical support programme. No long or short term research has been undertaken at developing new varieties of Sea Island Cotton or maintaining at their best, those admirable qualities responsible for the renown "spinnability" of Sea Island Cotton. Attributes which place lint, yarn, fabrics and other goods manufactured from it beyond market forces making it, as a result, the most sought after natural fibre in the world.

Achieving a sustainable level of production of high quality cotton can only be achieved through a long term research and development programme. It should devise a technology package easily

implemented by growers, with the constant assistance of an extension service dedicated to helping farmers to maximise returns from their investment because there is a continuing research capability finding solutions to problems as they arise.

The project proposals and recommendations are considered to constitute a programme of work which will achieve the stated goal of increased production and profitability of the crop to the farmer, an achievement considered attainable not only by the growers but industry managers, professional and technical personnel connected with the industry and with the management of agriculture in the Region.

4. Executing Agency

The proposed Executing Agency, West Indian Sea Island Cotton Association Incorporated has a constitutional responsibility for the promotion and development of Sea Island Cotton. It owns the trade mark by which Sea Island Cotton yarn and fabrics and items made from the fibre are separated for all other cottons. The Association therefore has an obligation to develop standards for Sea Island Cotton as well as to take all necessary steps to maintain and improve those characteristics which give the fibre its exclusivity.

The Association has not functioned recently, in accordance with its charter more because of circumstances beyond its control than as a result of willful negligence. It was a relic of a colonial past which maintained functional control over it and created the mistaken belief among its owners that they was no cause for concern about it. Perhaps, the reasons why it was forgotten in the heady aftermath of the independence can be found by examining the history of its creation.

An active and properly functioning Association, willing and ready to promote and defend the integrity of Sea Island Cotton is an absolute necessity. The efficient use of the Trade Mark, its promotion and defence together with ever increasing yields of high quality lint, is the best assurance growers have that Sea Island Cotton can be a profitable crop to grow.

The governments of Antigua and Barbuda, Barbados, Montserrat and St. Kitts/Nevis, aware of the increasingly negative signals indicating changes in trading patterns, reduced access to protected markets, serious competition for investment dollars from sources that did not exist up to the end of 1990, along with other developments and changes in the international economic environment, are convinced that certain high employment industries based on marketing and production strengths, with no foundation in raw materials, cannot be sustained for much longer. That is why it is of the utmost importance that their agricultural diversification programme be fully implemented as quickly as possible. Priority

being given to those aspects involving crops in which there is a relative advantage or have the capacity to create secondary and allied industries.

5. Linkages and Beneficiaries

The development of an industry, based on an agricultural product which has been linked to the economic fortunes of the Caribbean from the time of settlement of some, if not all producing countries, will bring significant benefits to those countries and the wider region. It will have many beneficiaries.

The crop is environmentally compatible, and can easily be grown by small farmers or on family farms. It will trigger the development of many industries, including, the manufacture of clothing, furnishings, fabric designing, surface printing as well as an array of products from the processing of cotton seed. Women can and will play an important role in many aspects of this industrial development.

The governments of Antigua and Barbuda, Barbados, Montserrat and St. Kitts/Nevis, over the period of the project will contribute an estimated US$666.9 per annum by transferring to the project's administration, equipment, real property and other facilities presently used for Sea Island Cotton production in their respective countries as well as creating the environment in which the successful implementation of the prescribed programme of research and development and assistance to growers can be implemented.

6. Institutional Strengthening

It is proposed therefore that the governments proceed urgently with the reorganisation of the West Indian Sea Island Cotton Association Inc, to provide a management structure expected in keeping with the requirement of an organisation with such a pivotal role to play in the development of this important segment of the agricultural diversification programme of the governments of the four (4) producing countries. The Association would then have two major functions:

i. Develop, implement, monitor results of the research and development programme.

ii. Control, protection, promotion and use of the trade mark WISICA.

WISICA's charter documents should be amended to provide a suitable management structure with an Executive Secretary/Executive Director with overall responsibility to its Board of Directors for the efficient administration of the Association's affairs, particularly the promotion, protection and control of its Trade Mark and the implementation of the Research and Development

Programme. Membership of the Board should be expanded in view of the need for experienced and well qualified technical advice it will require. The research and development programme will be the day to day responsibility of a high level scientist who should function as Director of Research and Development, while matters relating to the control protection promotion and use of the trade mark should be under the control of another person with the appropriate background who should also be responsible for the day to day administration and management of the affairs of the Association. Suitable technical, administrative and secretarial support personnel should also be recruited.

A Cotton Industry Development Board should be established which will have the overall responsibility for the direction and development of the various facets of the integrated Sea Island Cotton Industry, production, processing, manufacturing, research and Trade Mark promotion, protection and licensing. A project Management Committee should also be set up to develop and monitor the implementation of the research programme. An organogramme showing the overall structure and linkages for the industry is provided in Part II to this Volume.

7. Project Implementation Schedule, Monitoring and Evaluation

The projects implementation schedule calls for a pre-investment period of nine to ten months during which it will be necessary to present the draft to CARICOM and participating countries, review and analyse their comments and/or observations and adjust the text where necessary and appropriate for presentation to the funding agency. There is a period of two months to react to its to make any required amendments or adjustments. It is anticipated that all arrangements will be completed so that the process of implementation can commence no later than twelve months after presentation to CARICOM has been made.

8. Project Benefits, Costs and Financing

The cost of implementing the programme of work envisaged in the project document is estimated at US$7,608 million at current prices up to and including those years during which loan/grant funds will be required from the European Economic Community. However, an additional US$15,108 million will be required to cover costs up to the end of the ten (10) year period expert opinion believes is necessary to achieve, in full, the objective of the proposed programme.

Detailed costings are shown in Table 4.1 in Part 2 to this Volume and a breakdown of those costs is a follows:

ESTIMATED PROJECT COST (US$000)

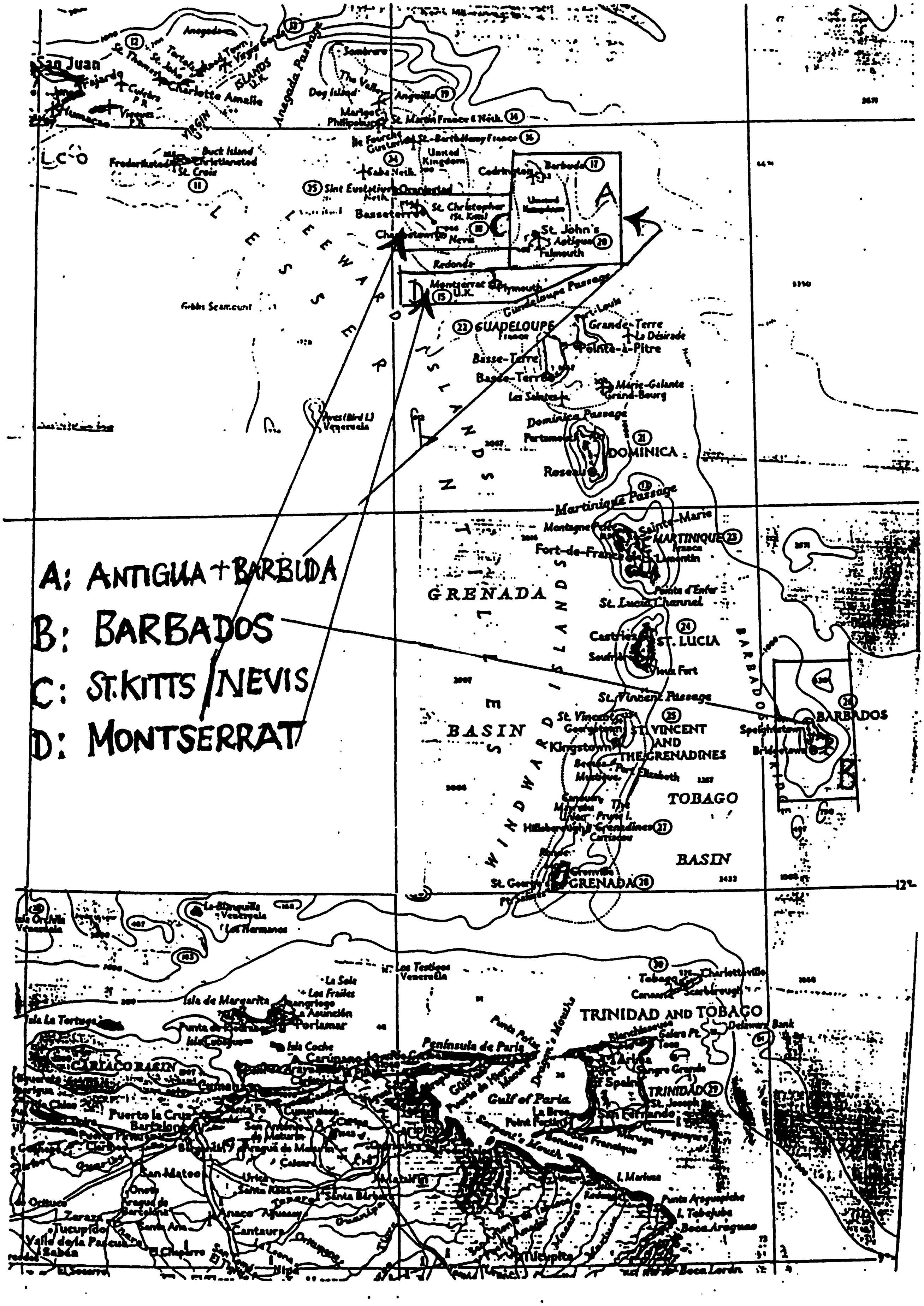
ITEM	HEADING	FIVE YEARS	TEN YEARS
1	Administration	365	710
2	Professional Cost	3625	7250
3	Consultants	90	180
4	Support Staff	1085	2190
5	Training	270	495
6	Travel	350	700
7	Per Diem	250	500
8	Direct Investment	372	696
9	General Support	435	870
10	Unallocated Costs	766	1517
	TOTAL ESTIMATED COSTS	7,608	15,108

After the expiry of the project's funding period it is anticipated that the Association will be able to meet the cost of maintaining a full research programme with the same extension capability directed at providing maximum support to growers. The cost will be met from the moneys received for royalty payments which will amount to 75% of total receipt from all sources.

9. Conclusion

The proposed study is presented in three (3) parts. An overview/project summary and the project proposals with financial implications, the executing agency and monitoring mechanism in Volume I. Volume II provides a comprehensive history of the cotton production experience of the four (4) producing countries, while Volume III contains macro-economic information about Antigua and Barbuda, Barbados, Montserrat and St. Kitts/Nevis.

The long term future of the Sea Island Cotton Industry in the Caribbean and the realization of the very considerable contribution to improving the contribution agriculture can make to the gross domestic product of the four (4) producing countries depends entirely on the full and faithful implementation of the prescribe research and development programme elaborated in Part II to this Volume.



LOCATION MAP

ANNEX 2

COUNTRY DATA: ANTIGUA AND BARBUDA

AREA (km^2): 442

	1983	1984	1985	1986	1987	1988	1989	1990
MID-YEAR POPULATION ('000)	74.6	75.1	75.6	76.3	77.1	80.8	82.9	na
PER CAPITA GDP (Current prices; $)	2055	3311	2648	3092	3555	4090	4595	na
GROSS DOMESTIC PRODUCT (GDP)								
GDP at current market prices ($ mn)	413.8	468.5	540.8	636.9	740.0	892.3	1028.5	na
Demand components:								
Consumption expenditure	308.1	413.5	485.2	563.8	644.4	na	na	na
Gross domestic investment	84.6	110.6	151.6	231.9	312.2	na	na	na
Exports of goods and n.f.s	270.3	345.3	409.6	482.7	521.2	na	na	na
Imports of goods and n.f.s.	249.2	401.0	505.6	641.5	737.7	na	na	na
Gross domestic savings ratio	25.5	11.7	10.3	11.5	12.9	na	na	na
Sectoral distribution of current GDP (%)								
Agriculture	21.8	19.3	23.2	4.7	4.8	4.4	4.0	na
Mining	2.3	3.0	4.6	1.9	2.4	2.3	2.6	na
Manufacturing	17.6	19.3	20.3	4.1	3.8	3.3	3.1	na
Utilities	10.3	12.5	17.2	3.8	3.6	4.3	4.1	na
Construction	20.5	27.3	35.7	9.6	11.9	13.1	15.5	na
Transport and communication	63.5	70.9	81.4	16.8	16.1	15.2	14.3	na
Tourism or hotels and restaurants	45.5	58.7	73.5	15.4	15.6	15.9	16.5	na
Wholesale and retail trade	38.7	43.1	48.2	10.0	9.8	9.3	9.7	na
Government services	59.5	63.4	67.9	14.9	14.4	16.2	15.4	na
Other services	93.4	107.8	119.1	24.5	22.9	21.0	19.6	na
Less: imputed service charges				5.7	5.3	4.9	4.6	na
GDP at current factor cost	356.1	403.5	464.8	525.5	614.2	730.8	806.6	na
GDP at constant 1977 prices	218.6	234.9	253.1	274.3	298.3	320.9	340.8	na
Annual rate of growth in GDP (%)	6.9	7.5	7.8	8.4	8.8	7.6	6.2	na
LABOUR FORCE AND EMPLOYMENT								
Labour force ('000)	30.4	na	na	na	na	na	na	na
Employment rate (%)	79.2	na	na	na	na	na	na	na
MONEY AND PRICES ($ mn)								
Consumer prices (all items index)	444.9	462.9	na	469.0	516.0	533.8	na	na
Net foreign assets				(9.1)	(6.6)	23.0	6.6	na
Commercial banks' loans and advances	212.7	248.3	300.3	351.6	421.0	495.7	565.2	602.3
Government	28.8	33.7	33.3	50.2	64.3	73.7	77.6	67.5
Private	183.9	214.6	267.0	301.4	356.7	422.0	487.6	534.8
Estimated tourism expenditure (US$ mn)	59.1	89.0	110.9	156.2	186.7	213.5	na	na
CENTRAL GOVERNMENT FINANCES ($ mn)								
Current revenue	87.8	99.9	117.7	159.9	181.5	204.3	208.6	233.5
Current expenditure	111.5	112.9	122.7	147.9	187.0	212.2	195.9	228.0
Current account surplus/(deficit)	(23.7)	(13.0)	5.0	12.0	(5.5)	(8.0)	12.7	(4.6)
Capital revenue	1.4	2.3	2.4	0.7	1.5	5.8	6.2	na
Capital expenditure	16.6	32.6	37.4	74.9	35.0	29.6	27.4	18.5
Overall surplus/(deficit)	(39.1)	(43.3)	(40.0)	(62.2)	(39.0)	(31.8)	(8.5)	na
Financing (domestic sources)				na	na	na	na	na
Financing (external sources)				na	na	na	na	na
BALANCE OF PAYMENTS (US$ mn)								
Merchandise exports (f.o.b)	226.8	358.8	449.1	30.9	28.5	30.4	na	na
Merchandise imports (c.i.f)	49.7	42.6	45.0	(312.6)	(284.1)	(302.1)	na	na
Balance of trade				(281.7)	(255.6)	(271.7)	na	na
Net balance on services account	9.3	14.6	12.2	142.6	166.9	208.2	na	na
Current account balance	(7.6)	(3.0)	(11.4)	(129.8)	(85.5)	(64.1)	na	na
Capital inflows	1.2	3.4	12.2	133.2	72.2	36.0	na	na
Official	(0.7)	(2.0)	3.2	107.4	49.7	(14.4)	na	na
Private	1.9	5.4	9.0	25.8	22.5	50.4	na	na
Overall balance	(6.4)	0.4	0.8	3.4	(13.3)	(28.1)	na	na
Change in reserves ( ) = increase				(9.1)	4.4	0.3	na	na
EXTERNAL PUBLIC DEBT (US$ mn)								
Disbursed debt outstanding	62.7	58.7	62.2	186.4	231.4	242.8	260.1	268.3
Debt service payments	9.5	10.0	8.6	7.0	15.8	14.7	3.4	15.4
Amortisation	6.0	7.1	6.5	2.0	9.1	6.7	2.0	11.7
Interest payments	3.5	2.9	2.1	4.9	6.7	8.0	1.4	3.7
Debt service ratio (%)	9.0	6.9	4.8	3.4	7.2	5.5	1.2	na
AVERAGE EXCHANGE RATE								
Dollar(s) per US dollar	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7

SOURCES: Statistical Division; Development Planning Office; Ministry of Finance; ECCB; OECS Secretariat

COUNTRY DATA: BARBADOS

AREA (Km²): 431

	1983	1984	1985	1986	1987	1988	1989	1990
MID-YEAR POPULATION ('000)	251.2	252.0	252.7	253.1	253.5	254.3	255.8	257.3
POPULATION GROWTH RATE (%)			0.2	0.3	0.1	0.1	0.1	0.1
PER CAPITA GDP (Current prices; $)	4205	4569	4790	5228	5747	6094	6673	6652
GROSS DOMESTIC PRODUCT (GDP)								
GDP at current market prices ($ mn)	2112.7	2302.7	2421.0	2646.1	2913.7	3099.2	3413.9	3423.0
Demand components:								
Consumption expenditure	1667.3	1819.5	1864.1	2161.1	2431.5	2541.3	2917.6	3050.0
Gross domestic investment	421.2	373.9	371.8	423.8	466.7	543.3	656.3	623.0
Exports of goods and n.f.s	1489.8	1656.4	1632.7	1495.9	1340.1	1509.7	1445.9	1375.0
Imports of goods and n.f.s.	1465.6	1547.1	1447.6	1434.7	1324.6	1495.1	1605.9	1625.0
Gross domestic savings ratio	21.1	21.0	23.0	18.3	16.5	18.0	14.5	10.9
Sectoral distribution of current GDP (%)								
Agriculture	139.3	141.4	160.1	146.3	171.6	172.9	153.0	178.4
Mining	16.3	29.4	44.0	16.9	18.4	17.1	17.5	19.5
Manufacturing	238.7	264.1	231.7	229.3	223.6	240.2	233.3	236.8
Utilities	52.9	68.0	74.7	72.2	80.7	84.8	91.6	97.7
Construction	132.5	130.0	114.7	131.4	144.3	170.3	196.7	181.1
Transport and communication	154.1	171.0	185.0	197.5	225.4	226.6	227.8	224.0
Tourism or hotels and restaurants	186.5	206.8	214.0	233.9	270.0	315.1	346.1	324.8
Wholesale and retail trade	378.5	412.3	486.0	485.7	529.9	547.8	596.2	590.1
Government services	264.3	295.5	344.0	379.0	428.8	435.1	503.4	534.6
Other services	339.8	356.6	387.0	405.1	410.3	458.0	530.9	547.1
Less: imputed service charges								
GDP at current factor cost	1902.9	2075.1	2241.6	2297.3	2503.0	2667.9	2896.5	2934.1
GDP at constant 1977 prices	751.2	778.3	785.8	827.0	848.3	877.5	909.0	877.0
Annual rate of growth in GDP (%)	0.4	3.6	1.0	5.1	2.6	3.4	3.6	-3.5
LABOUR FORCE AND EMPLOYMENT								
Labour force ('000)	112.2	112.3	113.2	118.2	121.2	123.8	124.5	125.2
Employment rate (%)	85.0	82.9	81.3	17.8	17.9	17.5	15.6	17.9
MONEY AND PRICES ($ mn)								
Consumer prices (all items index)	137.7	144.1	149.7	1.3	3.4	4.8	6.2	3.0
Net foreign assets				403.0	477.7	574.6	514.6	558.0
Commercial banks' loans and advances	776.4	807.2	849.4	880.1	960.0	1047.6	1198.0	1247.1
Government	6.6	7.4	7.6	97.8	101.0	68.2	57.6	50.6
Private	769.8	799.8	841.8	782.3	859.0	979.4	1140.4	1196.5
Estimated tourism expanditure (US$ mn)	251.6	284.2	309.0	323.7	378.6	459.3	526.3	470.0
CENTRAL GOVERNMENT FINANCES ($ mn)								
Current revenue	541.1	572.0	643.6	670.3	726.7	882.4	987.6	953.6
Current expenditure	487.3	559.8	626.3	627.2	748.1	780.9	851.7	965.8
Current account surplus/(deficit)	53.8	12.2	17.3	43.1	-21.3	101.5	135.9	-12.2
Capital expenditure	126.8	134.2	142.8	165.1	198.3	225.0	202.3	214.7
	-73.5	-12.4	125.5	-122.3	-219.7	-123.5	-66.4	-226.9
Financing (domestic sources)	34.0	24.3	57.6	-3.8	91.9	16.2	70.7	171.9
Financing (external sources)	27.6	55.8	38.7	152.2	75.9	74.8	2.7	82.2
Residual	-11.9	-41.4	29.2	-26.1	51.9	32.5	-7.0	-27.2
BALANCE OF PAYMENTS (US$ mn)								
Merchandise exports (f.o.b)	273.7	341.7	302.2	245.7	132.2	145.7	147.8	158.5
Merchandise imports (c.i.f)	-624.7	-662.6	-611.2	-605.7	-535.8	-603.2	-699.9	663.5
Balance of trade	-351.0	-321.0	-309.0	-360.1	-403.6	-457.5	-552.1	-505.0
Net balance on services account	279.9	320.7	349.5	332.0	343.5	442.2	543.6	487.5
Current account balance	-50.3	14.4	40.5	-16.4	-53.5	2.4	-2.6	-4.5
Capital inflows	51.8	-14.4	-5.3	5.9	50.7	22.2	-39.7	-53.5
Official	28.7	6.3	28.7	na	na	na	na	na
Private	23.1	-20.7	-34.0	na	na	na	na	na
Change in reserves ( ) = increase	-21.3	-5.0	-43.3	10.5	2.8	-24.6	42.3	58.0
EXTERNAL PUBLIC DEBT (US$ mn)								
Disbursed debt outstanding	173.7	182.6	222.0	431.8	465.2	479.0	469.4	465.1
Debt service payments	21.1	23.7	30.4	74.8	106.1	90.3	78.8	123.5
Amortisation	9.2	11.3	14.7	39.9	67.5	50.9	43.5	89.0
Interest payments	11.9	12.4	15.7	34.9	38.6	39.5	35.3	34.5
Debt service ration (%)	2.8	2.9	3.7	10.0	15.8	12.0	10.9	17.7
AVERAGE EXCHANGE RATE								
Dollar(s) per US dollar	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0

SOURCES: Barbados Statistical Service

COUNTRY DATA: MONTSERRAT

AREA (Km^2): 103

	1983	1984	1985	1986	1987	1988	1989
MID-YEAR POPULATION ('000)	11.7	11.8	11.9	11.9	12.0	12.0	12.0
PER CAPITA GDP (Current prices; $)	2738	2941	3142	3465	3997	4516	na
GROSS DOMESTIC PRODUCT (GDP)							
GDP at current market prices ($ mn)	86.5	93.7	100.0	111.3	129.5	146.3	na
Demand components:							
Consumption expenditure	101.6	109.5	116.7	123.0	140.2	147.8	na
Gross domestic investment	25.6	24.7	26.2	38.4	50.2	69.0	na
Exports of goods and n.f.s	18.5	12.8	11.7	11.5	14.3	9.4	na
Imports of goods and n.f.s.	59.2	53.3	54.6	61.5	75.2	79.8	na
Gross domestic savings ratio	(17.5)	(16.9)	(16.7)	(10.5)	(8.3)	(1.0)	na
Sectoral distribution of current GDP (%)							
Agriculture	3.3	4.0	4.3	5.0	4.5	4.3	na
Mining	0.7	1.1	1.2	1.4	1.5	1.4	na
Manufacturing	5.3	5.6	5.1	5.9	5.9	6.0	na
Utilities	3.0	3.3	3.3	3.8	3.8	3.3	na
Construction	5.7	6.2	7.1	8.2	11.8	12.0	na
Transport and communication	8.5	9.7	11.0	12.1	12.1	11.6	na
Tourism or hotels and restaurants	3.0	3.2	3.7	4.2	3.9	3.9	na
Wholesale and retail trade	13.1	12.7	13.2	14.7	15.7	19.1	na
Government services	14.8	17.1	18.2	9.0	8.6	8.7	na
Other services	19.3	20.4	21.4	40.6	36.9	34.0	na
Less: imputed service charges				5.0	4.6	4.4	na
GDP at current factor cost	76.7	83.3	88.5	97.9	113.5	128.8	na
GDP at constant 1977 prices	41.6	42.3	44.3	46.9	51.9	58.4	na
Annual rate of growth in GDP (%)	(2.8)	1.8	4.6	5.9	10.8	12.4	na
LABOUR FORCE AND EMPLOYMENT							
Labour force ('000)	5.1	5.2	5.3	5.3	5.2	5.2	5.2
Employment rate (%)	7.0	5.8	5.3	4.2	2.0		
MONEY AND PRICES ($ mn)							
Consumer prices (all items index)	4.7	5.5	2.7	3.1	3.7	3.6	na
Net foreign assets	11.0	11.7	12.3	0.8	1.8	9.7	36.2
Commercial banks' loans and advances	30.8	32.6	32.7	34.2	35.5	40.9	52.4
Government	3.1	4.4	3.9	2.6	2.4	1.3	1.0
Private	27.7	214.6	28.8	31.6	33.1	39.6	51.4
Estimated tourism expenditure (US$ mn)	6.0	28.2	7.7	8.1	9.4	10.9	na
CENTRAL GOVERNMENT FINANCES ($ mn)							
Current revenue	20.9	21.6	24.0	25.0	27.9	30.2	na
Current expenditure	20.0	21.4	21.3	23.4	26.7	29.2	na
Current account surplus/(deficit)	0.9	0.2	2.6	1.6	1.2	1.0	na
Capital revenue	4.5	4.6	5.6	8.7	8.7	na	na
Capital expenditure	(3.6)	(4.4)	(3.0)	(7.1)	(7.5)	na	na
Overall surplus/(deficit)	0.1	-	-	-	na	na	na
Financing (domestic sources)	3.7	3.5	4.2	6.7	na	na	na
Financing (external sources)	0.2	(0.9)	1.2	0.4	na	na	na
BALANCE OF PAYMENTS (US$ mn)							
Merchandise exports (f.o.b)	6.9	4.7	4.3	2.6	3.5	2.2	na
Merchandise imports (c.i.f)	20.8	18.2	18.5	(19.8)	(25.3)	(26.9)	na
Balance of trade	(13.9)	(13.5)	(14.2)	(17.2)	(21.8)	(24.7)	na
Net balance on services account	6.6	7.0	7.7	6.3	7.6	8.8	na
Current account balance	(7.3)	(6.5)	(6.5)	10.7	12.0	13.5	na
Capital inflows	7.3	5.9	6.4	(0.2)	(2.3)	(2.4)	na
Official	1.5	3.7	2.6	na	3.5	2.3	na
Private	5.8	2.2	3.8	na	na	na	na
Overall balance				na	na	na	na
Change in reserves ( ) = increase				(2.8)	(1.3)	0.1	na
EXTERNAL PUBLIC DEBT (US$ mn)							
Disbursed debt outstanding	2.7	3.6	3.7	3.0	3.4	3.5	3.4
Debt service payments	0.2	0.4	0.4	0.2	0.2	0.3	0.4
Amortisation	0.1	0.3	0.3	0.1	0.1	0.1	0.1
Interest payments	0.1	0.1	0.1	0.1	0.1	0.1	0.2
Debt service ratio (%)	2.6	8.2	9.9	na	na	na	na
AVERAGE EXCHANGE RATE							
Dollar(s) per US dollar	2.7	2.7	2.7	2.7	2.7	2.7	2.7

SOURCES: Statistics Department; Eastern Caribbean Central Bank' CDB Estimates

COUNTRY DATA: ST. KITTS AND NEVIS

AREA (km²):269

	1983	1984	1985	1986	1987	1988	1989	1990
MID-YEAR POPULATION ('000)	45.5	45.7	45.8	45.8	46.5	47.2	47.5	na
PER CAPITA GDP (Current prices; $)	1297	1415	1471	2067	2295	2604	na	na
GROSS DOMESTIC PRODUCT (GDP)								
GDP at current market prices ($ mn)	159.4	174.6	181.9	255.6	288.1	331.9	na	na
Demand components:								
Consumption expenditure	179.4	178.2	185.2	na	na	na	na	na
Gross domestic investment	49.9	53.3	53.0	na	na	na	na	na
Exports of goods and n.f.s	85.6	104.0	113.8	na	na	na	na	na
Imports of goods and n.f.s.	155.5	160.9	170.1	na	na	na	na	na
Gross domestic savings ratio (%)	(12.5)	(2.1)	(1.8)	na	na	na	na	na
Sectoral distribution of current GDP (%)								
Agriculture	16.2	19.7	17.0	10.7	10.8	1.0	9.2	na
Mining	0.5	0.4	0.5	0.2	0.2	0.3	0.4	na
Manufacturing	17.6	22.6	21.9	15.3	14.8	15.9	15.7	na
Utilities	1.4	1.4	1.5	2.1	1.2	1.0	0.9	na
Construction	15.0	12.8	14.9	7.8	8.9	10.3	11.8	na
Transport and communication	16.4	19.5	21.1	12.3	12.4	14.5	14.4	na
Tourism or hotels and restaurants	4.4	5.2	6.1	7.5	9.1	7.9	8.0	na
Wholesale and retail trade	18.3	20.7	24.0	13.1	13.8	12.7	12.6	na
Government services	29.9	26.1	37.3	19.2	18.6	17.8	18.0	na
Other services	84.1	27.9	29.9	17.9	15.6	15.6	15.6	na
Less: imputed service charges	7.1	8.9	8.0	6.1	5.4	6.0	6.6	na
GDP at current factor cost	136.5	157.5	166.1	214.3	239.7	278.5	302.3	na
GDP at constant 1977 prices	87.7	80.8	91.6	108.4	116.4	124.6	130.9	132.9
Annual rate of growth in GDP (%)	(16.0)	3.5	0.9	6.2	7.4	7.0	5.1	1.5
LABOUR FORCE AND EMPLOYMENT								
Labour force ('000)	na	na	na	na	na	na	na	na
Employment rate (%)	na	na	na	na	na	na	na	na
MONEY AND PRICES ($ mn)								
Consumer prices (all items index)	166.0	168.5	173.3	174.0	175.6	176.0	189.4	196.4
Money supply (MI; end of period)	na	na	na	na	na	na	na	na
Commercial banks' loans and advances	147.4	168.1	194.2	198.6	160.6	226.4	295.6	325.5
Government	57.0	67.9	89.1	90.7	33.5	53.6	68.0	88.9
Private	80.4	98.1	105.1	107.9	127.1	172.8	227.6	236.6
Estimated tourism expenditure (US$ mn)	11.1	15.4	30.5	22.6	30.6	32.9	33.8	na
CENTRAL GOVERNMENT FINANCES ($ mn)								
Current revenue	38.2	42.8	40.8	52.6	62.1	79.3	91.3	100.8
Current expenditure	41.4	42.6	45.1	49.3	58.7	78.5	85.4	105.9
Current account surplus/(deficit)	(3.2)	0.2	4.3	3.3	3.4	0.8	5.9	(5.1)
Capital expenditure	11.3	3.6	13.8	16.2	9.3	15.2	11.6	5.6
Overall surplus/(deficit)	(14.4)	(8.4)	(18.1)	(12.9)	(5.9)	(14.4)	(5.7)	(10.7)
Financing (domestic sources)	0.5		na	na	na	na	na	na
Financing (external sources)	13.6	14.8	na	na	na	na	na	na
BALANCE OF PAYMENTS (US$ mn)								
Merchandise exports (f.o.b)	29.2	20.7	18.0	23.6	27.5	30.3	29.3	na
Merchandise imports (c.i.f)	54.2	50.6	53.2	64.6	79.9	94.7	104.6	na
Balance of trade	(25.0)	(29.9)	(35.2)	(41.0)	(52.4)	(64.4)	(75.3)	na
Net balance on services account	na	na	na	21.6	25.5	32.8	34.6	na
Transfers (net)				11.0	13.1	15.2	14.0	na
Current account balance	(14.5)	(10.2)	(11.4)	(8.3)	(13.7)	(17.6)	(26.7)	na
Capital inflows	6.5	6.0	12.7	11.4	14.3	15.0	na	na
Official	1.4	na	na	na	na	na	na	na
Private	5.1	na	na	na	na	na	na	na
Net change in international reserves	(0.1)	na	na	na	na	na	na	na
EXTERNAL PUBLIC DEBT (US$ mn)								
Disbursed debt outstanding	12.0	14.6	20.4	17.8	21.3	26.9	31.9	35.1
Debt service payments	0.7	1.1	1.9	1.1	1.4	1.6	1.9	2.3
Amortisation	0.3	0.6	0.6	0.6	0.8	0.9	1.1	1.1
Interest payments	0.4	0.5	1.3	0.5	0.6	0.7	0.8	1.2
Debt service ratio (%)	2.2	3.1	4.8	2.2	2.3	2.5	2.8	2.8
AVERAGE EXCHANGE RATE								
Dollar(s) per US dollar	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7

SOURCES: Economic Affairs Secretariat, OECS; Eastern Caribbean Central Bank

VOLUME I

PART 2

COTTON RESEARCH AND DEVELOPMENT PROJECT

VOLUME I

PART 2

COTTON RESEARCH AND DEVELOPMENT PROJECT

Page No.

CHAPTER I

CHAPTER II

CHAPTER III

CHAPTER VI

CHAPTER VII

CHAPTER I

1.1 Introduction

The cotton industry is of great importance to the national economies of Caribbean countries in particularly Antigua and Barbuda, Barbados, Montserrat, St. Kitts and Nevis, and to a lesser extent Guyana, Jamaica and St. Vincent. This is because of its tremendous potential for generating foreign exchange, creating employment, import substitution, and establishing inter-sectoral linkages through the development of secondary industries such as textile, animal feed, and oil, fats, soaps and other products.

The exceptional quality of the fibre, marked by its extreme silkiness, length and fineness, has made the Sea Island Cotton the best in the world. This unique quality has given it worldwide recognition and a premium price for Caribbean producers. The "West Indian Sea Island Cotton" has become the trademark of the Sea Island Cotton produced in the region.

The Cotton Industry, however, has failed to exploit its potential. At one time, Sea Island Cotton production in the Eastern Caribbean States reached a lint production of close to 3 million pounds annually from 16,000 acres of land. Today approximately 1,000 acres of cotton are being cultivated in the four producing countries surveyed. The reasons for this drastic reduction are many and include both technological and non-technical factors. If appropriate and urgent measures are not taken to reverse this declining trend, the industry as such could disappear.

1.2 Problems affecting the Cotton Industry

The major factors limiting cotton production in the Caribbean have been identified as follows:

1.2.1 Non-technological factors

(a) Poor institutional support services available to cotton farmers due mainly to:

- deficiencies in extension and research services;
- limited access to credit and poor and inadequate credit delivery programme; and
- inadequate land policy especially with respect to non-sugar agriculture.

(b) Weak and ineffective cotton farmers' Organization at both the national and regional level as a result of:

- poor participation of cotton farmers in the organizations;

- weak organizational and management skills among members; and

- inoperative group dynamics.

(c) Weak and inadequate marketing arrangements due mainly to:

- Ineffective and inefficient harvest and post harvest handling/collection system;

- poor transportation facilities/arrangements;

- inadequate product/by-product promotion; and

- poor and ineffective pricing system.

(d) Inadequate incentives for cotton producers.

- relative low profitability of cotton production compared to other agricultural enterprises such as vegetables (onions and peanuts).

- competition from low price synthetic fibres;

- lack of monetary incentives for cotton producers; and

- high cost and shortage of agricultural labour due to demand pull from other sectors.

1.2.2 Technological Factors

1.2.2.1 Pre-production

(a) Deficiency in the genetic improvement programmes resulting in the:

- use of low yielding Sea Island (SI) Cotton varieties;

- use of planting materials with limited resistance to pests and diseases; and

(b) Poorly organized and maintained germplasm bank.

(c) Absence of comprehensive programme of multiplication and certification of cotton seeds.

1.2.2.2 Production to Harvest

(a) Low levels of technology usage on farm due to:

- lack of validated research and development;
- death of trained personnel to generate and transfer cotton technology;
- low levels of motivation among cotton farmers;
- ineffective methods of technology transfer; and
- high cost of agricultural labour.

(b) Poor agronomic practices being employed such as:

- inadequate and inappropriate fertilization programmes and application methods;
- inadequate and inappropriate applications of pesticides and herbicides;
- inappropriate plant spacing;
- inadequate crop rotation programmes;
- inadequate use of growth regulators;
- inadequate use of defoliants;
- lack of applied research on late planting and inter-cropping; and
- poor soil conservation measures.

(c) High crop losses due to:

- poor harvesting practices; and
- high incidence of pests and diseases as a result of a lack of an effective, environmentally sound integrated pest management programme.

(d) Low levels of factor productivity due to:

- the use of marginal agricultural lands;
- scarce and expensive labour
- lack of and prohibited high cost of irrigation; and
- limited mechanization of some farm operations.

1.2.2.3 Post Harvest

(a) Poor quality of cotton lint produced due to:

- deterioration of Sea Island genetic material;
- inadequate and inappropriate pests and diseases control programmes;
- inappropriate harvest and post harvest handling of seed cotton; and
- absence of a programme of lint quality testing.

(b) Inadequate production, diversification and inter-sectoral linkages as a result of:

- limited supply of seed cotton available because of the low levels of production and productivity;
- absence of facilities for spinning and weaving of cotton lint due to the region's limited expertise in the relevant technologies as well as the initial high investment cost;
- limited facilities for processing of cotton seed into animal feed, oil and other products;
- limited market information on the various by-products;
- unclear government policy with respect to downstream processing of cotton, and lack of institutional support (except in Montserrat).

These constraints are organized and presented as problem trees in Figures 1.1 through 1.8. The general problem tree showing cause - effect relationship is presented in Figure 1.1, while the second-level problems are further defined and elaborated in Figures 1.2 through 1.8.

FIGURE 1.1
PROBLEM TREE: GENERAL CAUSE - EFFECT RELATIONSHIP

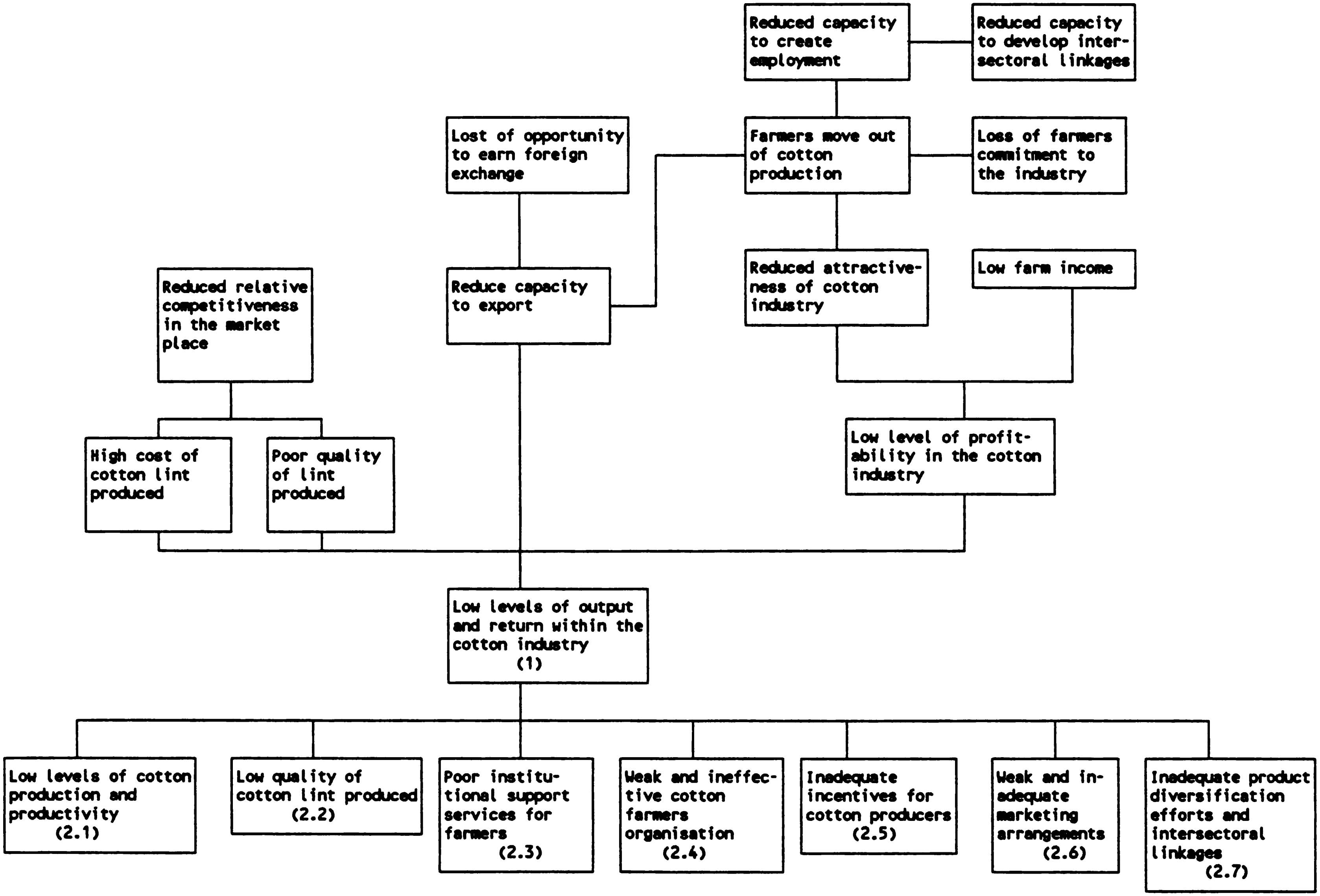


FIGURE 1.2
F LOW LEVELS OF COTTON PRODUCTIVITY

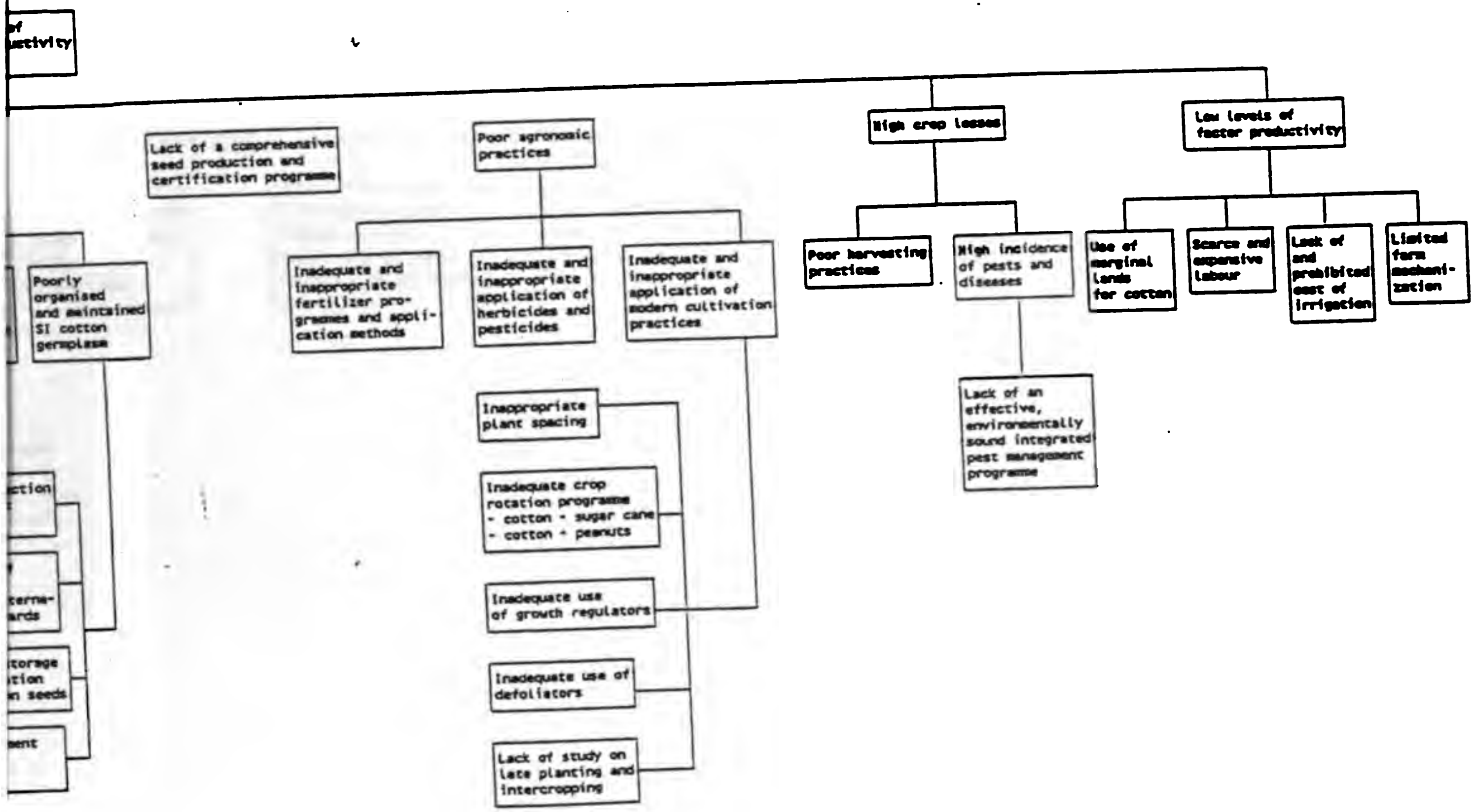


FIGURE 1.2
F LOW LEVELS OF COTTON PRODUCTIVITY

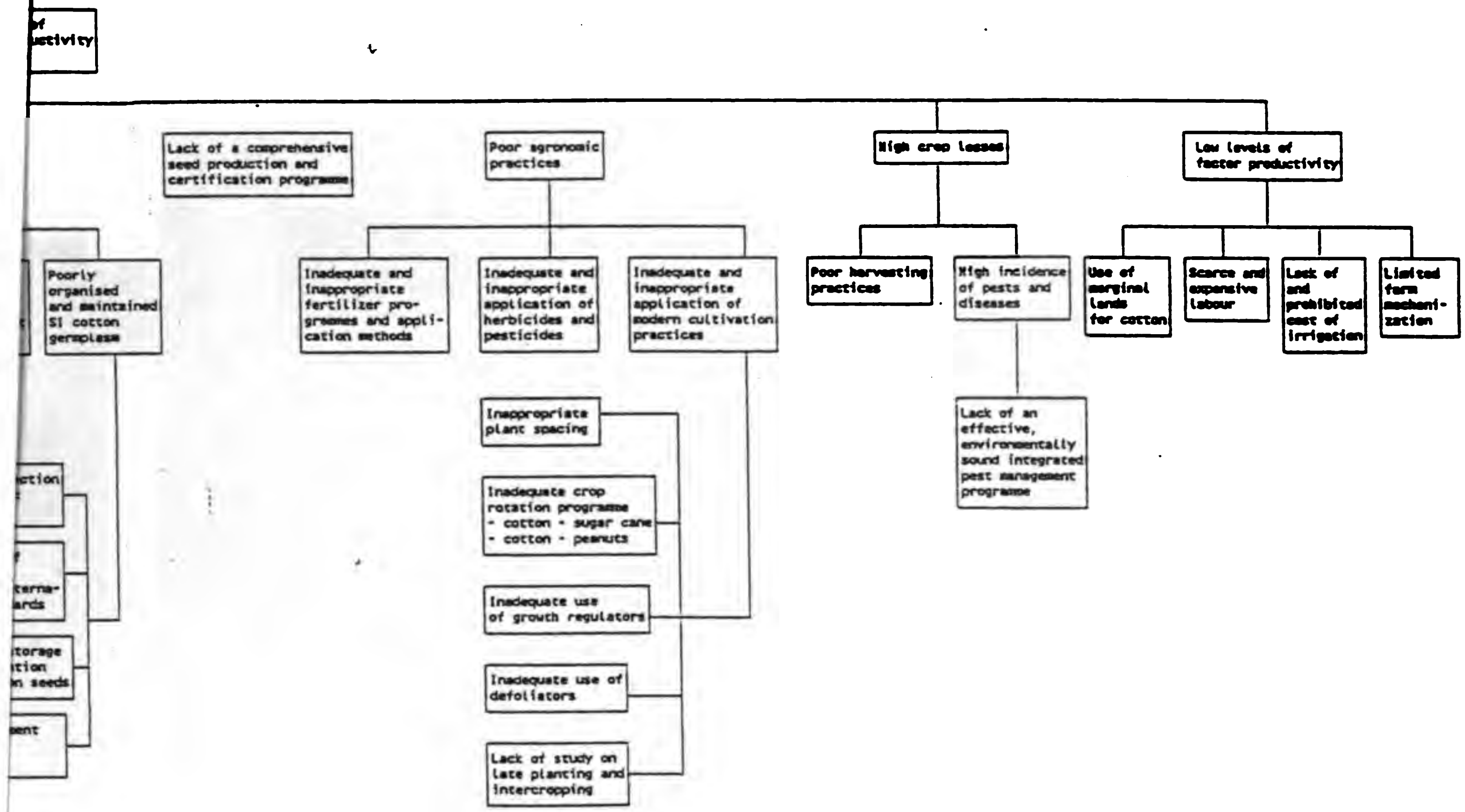


FIGURE 1.3
PROBLEM TREE: CAUSE OF POOR QUALITY OF COTTON LINT

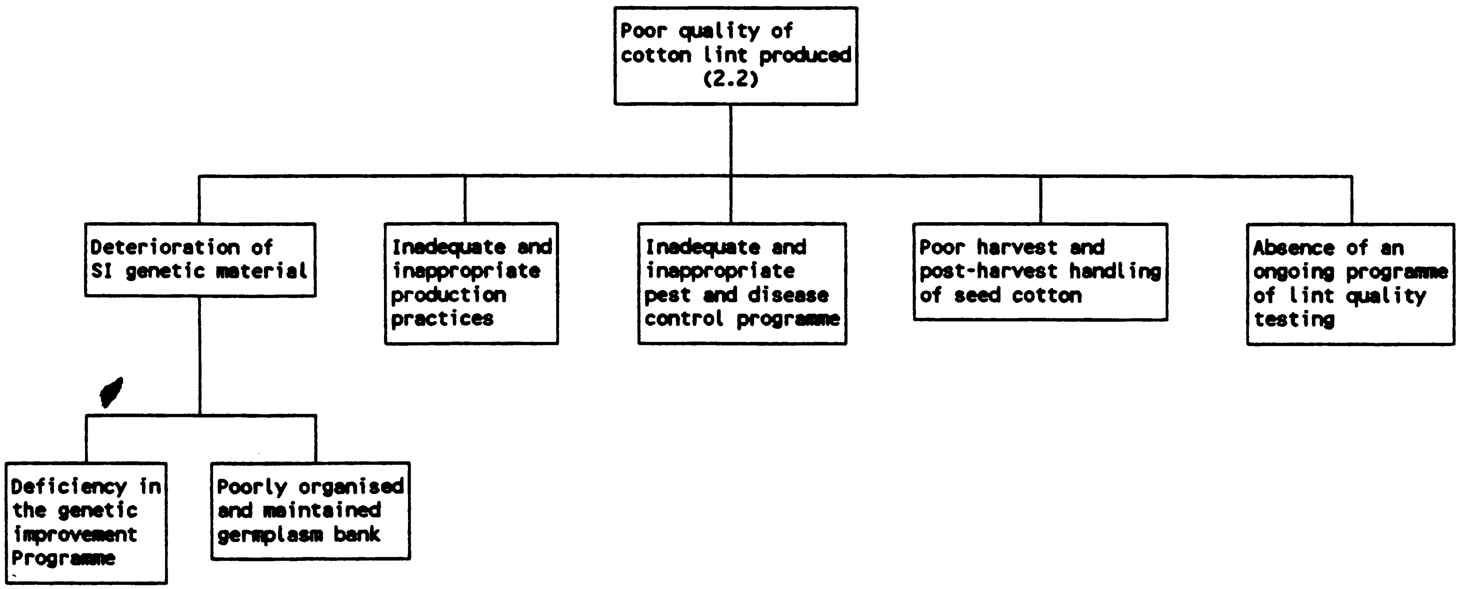


FIGURE 1.4
PROBLEM TREE: CAUSE OF POOR INSTITUTIONAL SUPPORT SERVICES TO FARMERS

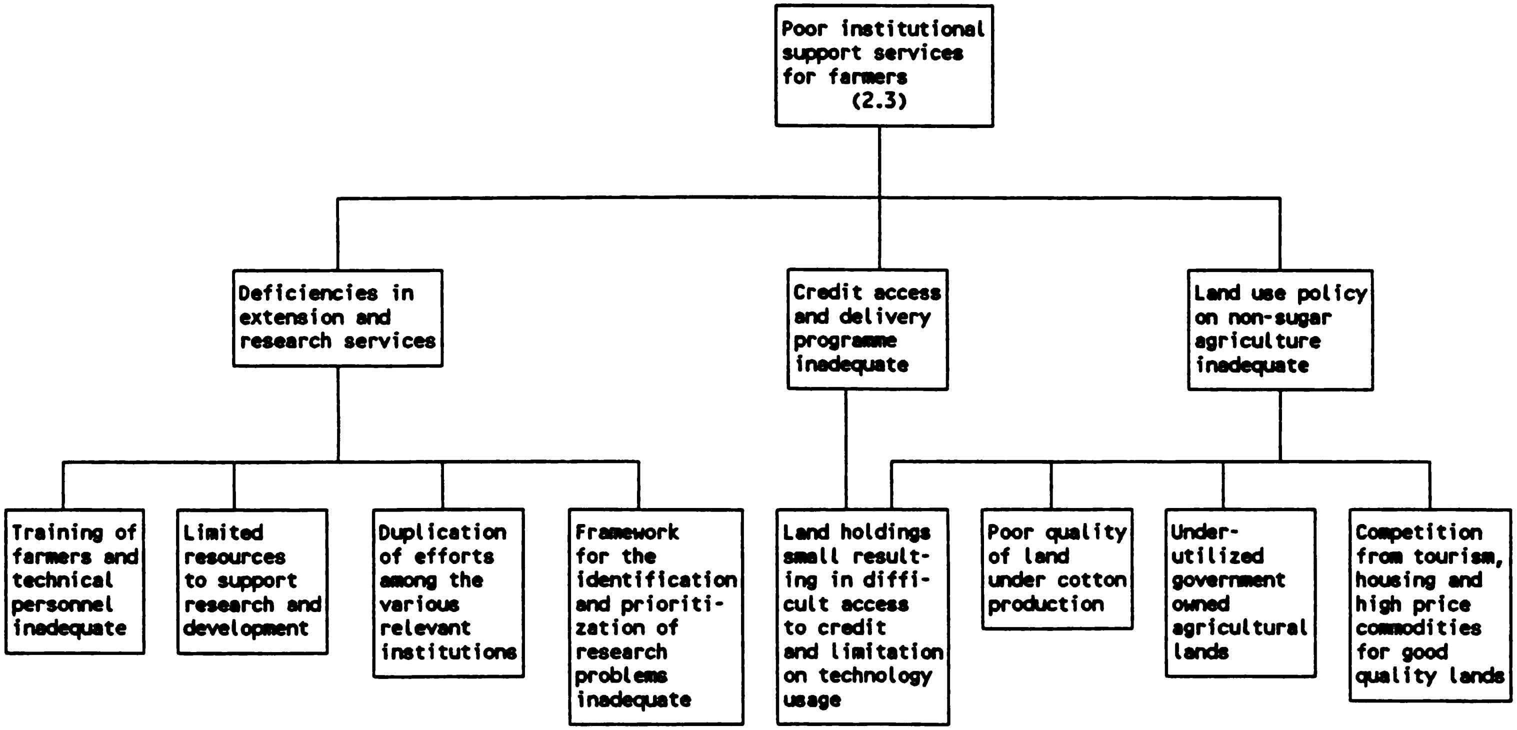


FIGURE 1.5
PROBLEM TREE: CAUSE OF WEAK AND INEFFECTIVE COTTON FARMERS ASSOCIATIONS

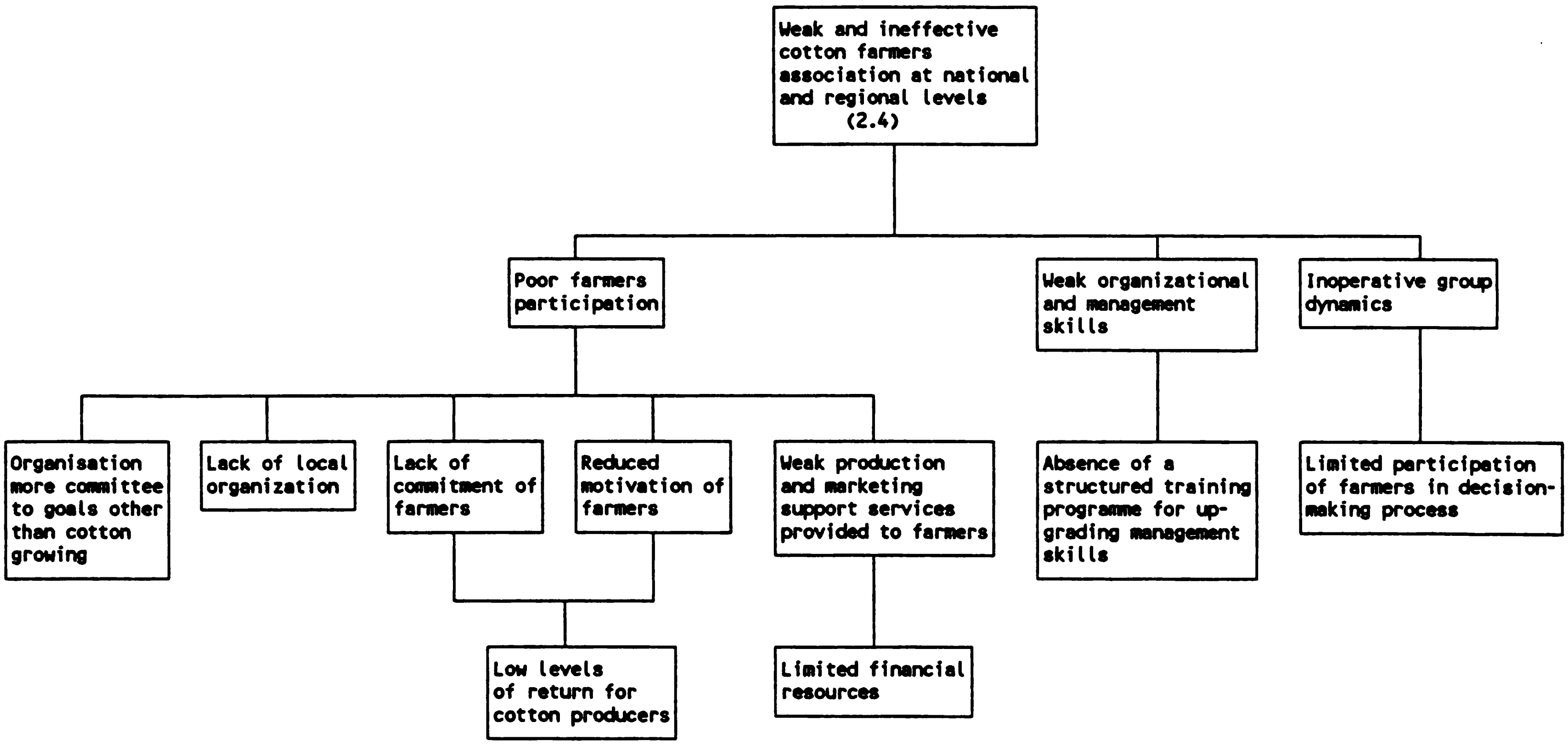


FIGURE 1.6
PROBLEM TREE: CAUSE OF WEAK AND INADEQUATE MARKETING ARRANGEMENTS

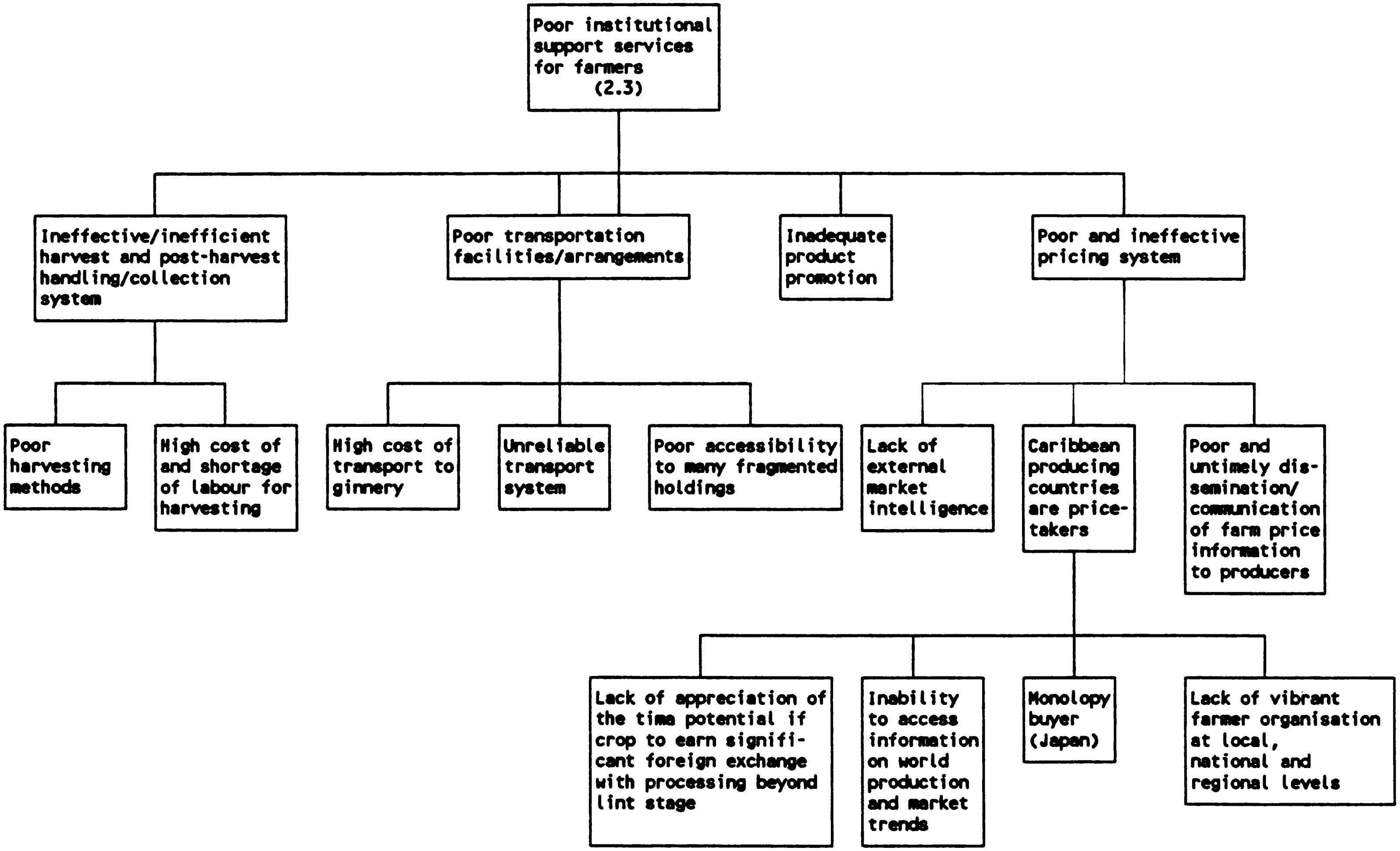


FIGURE 1.7
PROBLEM TREE: CAUSE OF INADEQUATE INCENTIVES FOR COTTON PRODUCERS

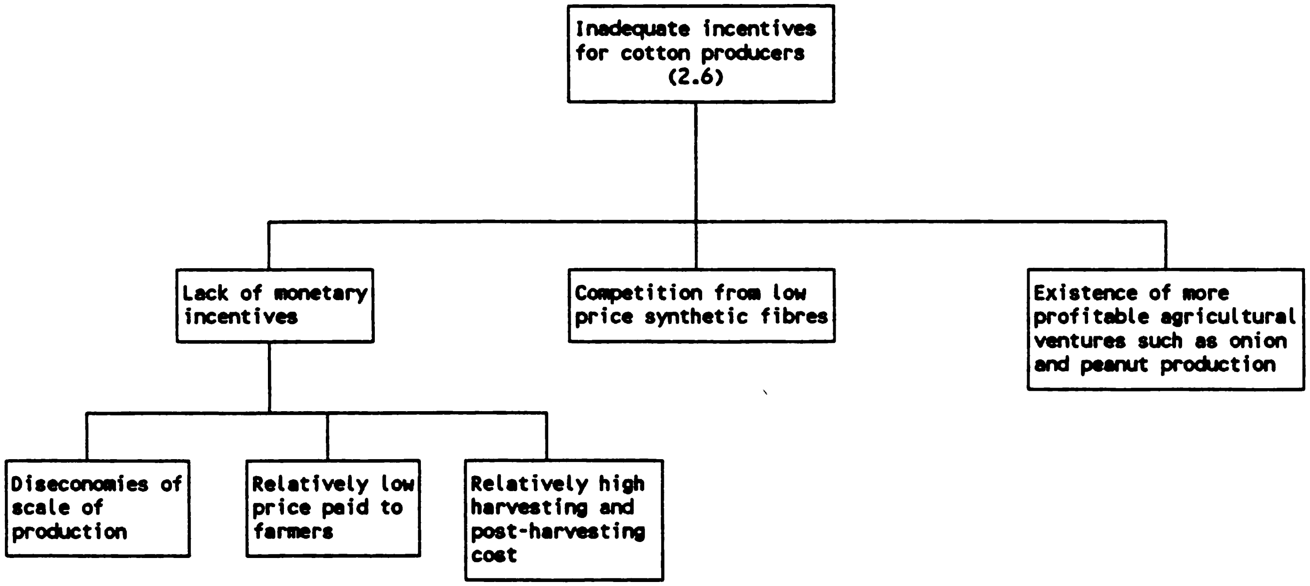
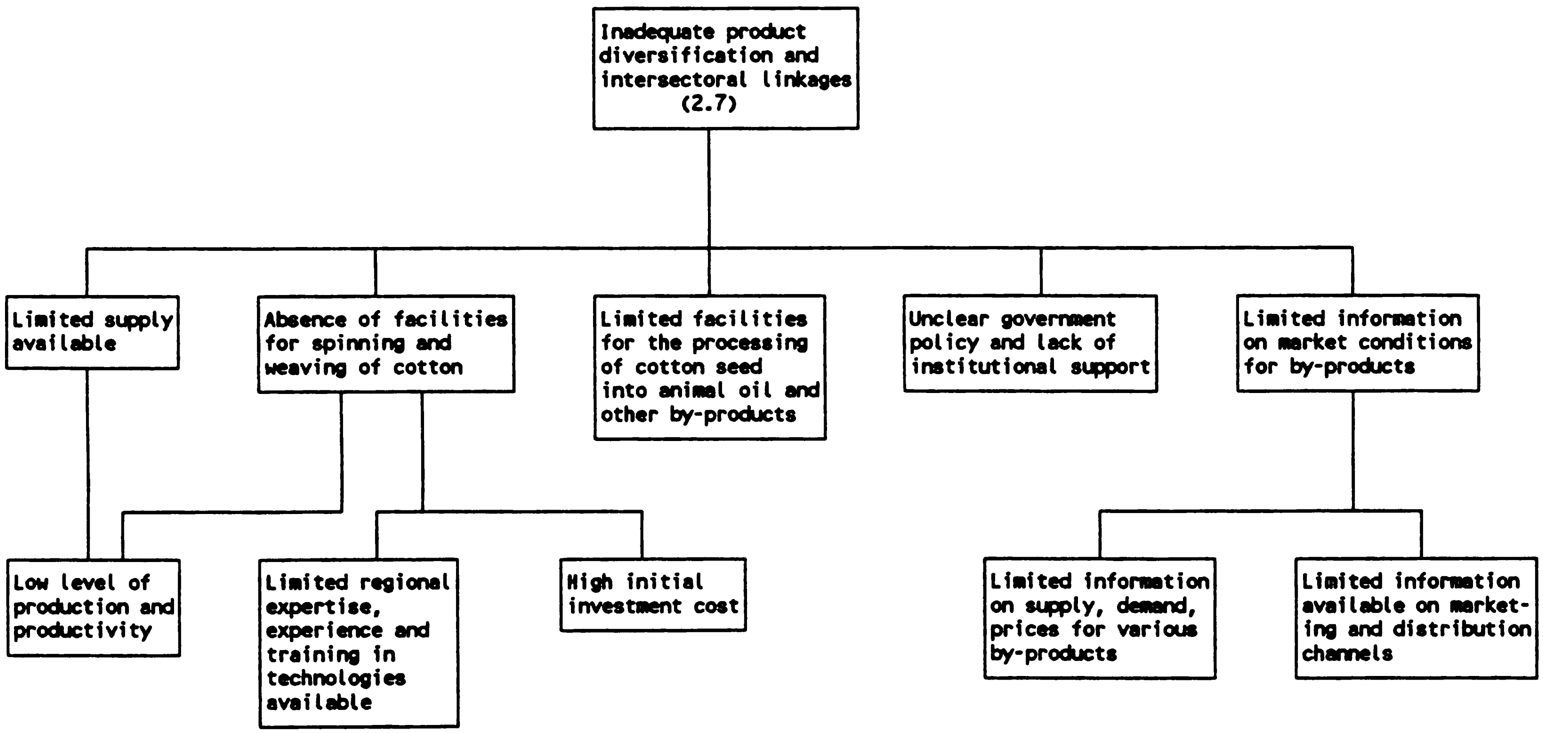


FIGURE 1.8
PROBLEM TREE: CAUSE OF DIVERSIFICATION AND INTERSECTORAL LINKAGES



1.3 Past and Current Research Activities

A review of current Cotton research and development programmes of the different countries, has revealed a dismal state of affairs.

The level of development of the Research Programme varies from country to country. The establishment of the Central Cotton Station in Antigua and Barbuda has certainly provided the country with an advantage over the others in the areas of research and seed multiplication. However, the regional role that Antigua and Barbuda plays in this aspect has benefitted the neighbouring islands by its dissemination of useful data for improving, the technology package of each country.

Generally speaking the Research Programme on the Sea Island Cotton shows a considerable reduction in activities to the extent that, at present, Antigua and Barbuda no longer plays its original role mandated, except in providing planting material. Barbados, for its part, is currently developing a research and seed multiplication programme which is a significant step towards the revival of the Sea Island Cotton industry in the region.

In the area of genetic improvement, activities have been reduced to a minimum and, at present, only Barbados is conducting any form of breeding work. It is important to intensify efforts in this area in order to create new MSI varieties as well as increase the major attributes of existing varieties. The fact is that in the past there had been little work done to improve the SI genetic stock. Emphasis should now be placed on the "modernization" of the SI cotton to return it to the high position it held among cottons previously, which makes it the most sought after textile fibre.

As far as the Germplasm Bank is concerned, the collection SI genetic material is now confined to just a few lines which do not represent the whole SI genetic pool. Before any comprehensive breeding/selection work can be started, it is absolutely necessary to develop the SI cotton Germplasm Collection. Efforts have already been initiated in Barbados to this end.

Unlike in the past when there was a substantial amount of agronomic research activities in the region, it now seems that only Barbados is currently participating actively in this endeavour. It is also apparent that problems related to the growing of the cotton crop such as fertilization, plant population, weed control, pests and diseases control, etc are serious limiting factors to optimal production. With this in mind, it is important to initiate a rational agronomic research programme with the objective of developing a new technology package better adapted to modern crop management requirements.

Seed production constitutes the main activity of the Antigua Cotton Station. Its Pedigree Seed production process involves more of a system of seed selection than a strict multiplication process. The stages of multiplication following the Pedigree Seed stage should be improved in order to produce better quality planting materials. In this context, it is highly recommended that the seed production programme comply with international standards and follow a system of seed certification to ensure quality seeds with respect to genetic and physical properties.

CHAPTER II

2. PROJECT OBJECTIVES

2.1 General objective

The overall goal of the project is to increase the levels of output and profitability within the cotton industry. In order to achieve this goal it is vital that a comprehensive cotton development programme be implemented with the following objectives:

(a) To increase the levels of cotton production and productivity;

(b) To improve the quality of cotton lint produced;

(c) To strengthen the institutional support services provided to farmers;

(d) To strengthen cotton farmers' organizations at the national and regional levels;

(e) To provide adequate incentives to cotton farmers;

(f) To strengthen the marketing systems/arrangements; and

(g) To support product diversification efforts and inter-sectoral linkages.

The achievement of the above objectives is considered necessary and sufficient conditions for exploiting the full potential of the industry. The project general objective tree is presented in Figure 2.1.

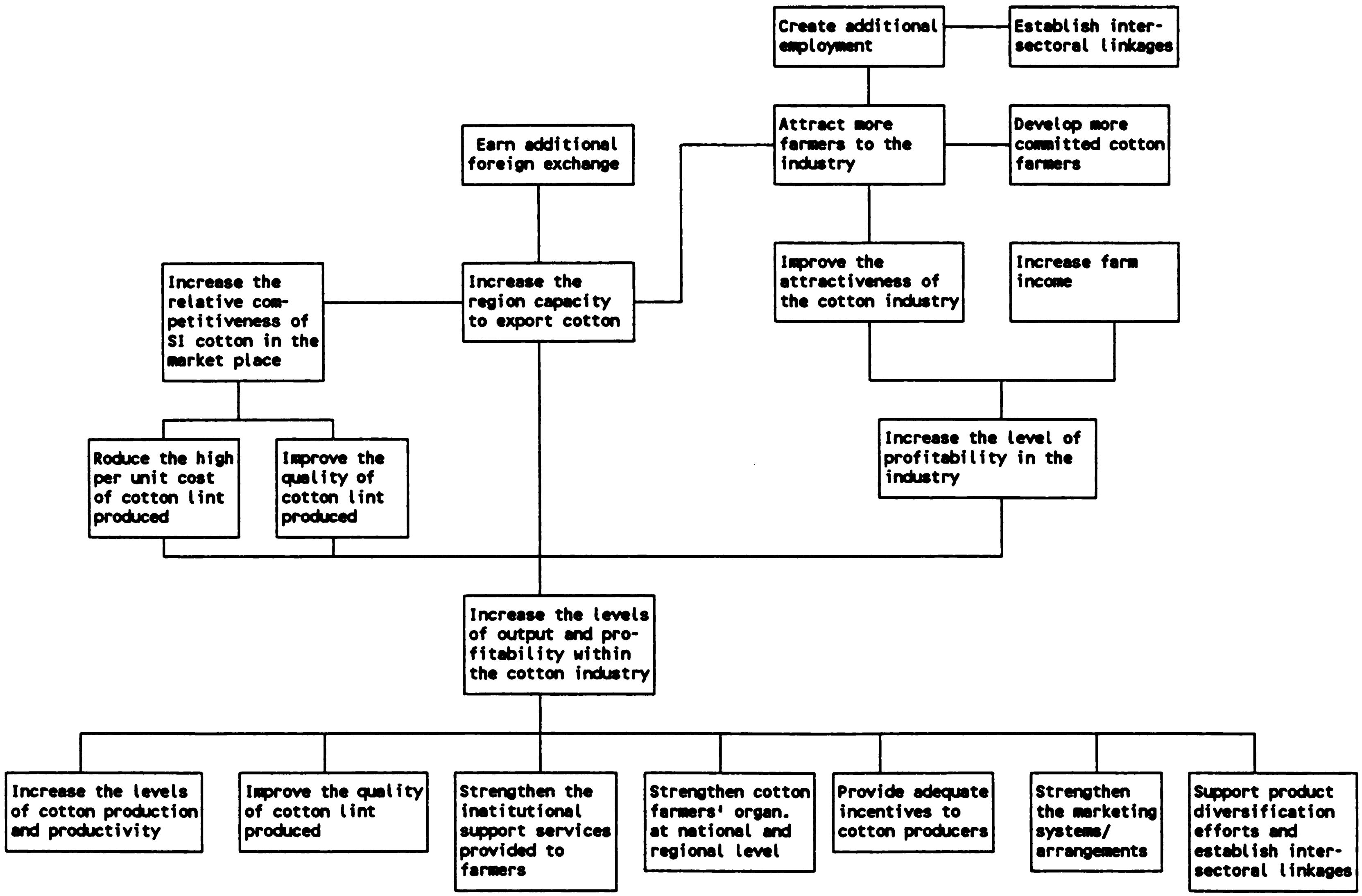
2.2 Specific objective

Notwithstanding the existence of necessary and sufficient reasons for developing a viable integrated cotton industry in the region, this purpose of the particular project will be limited to increasing the level of productivity within the cotton industry and improving the quality of the cotton lint produced. Specifically the project will aim at:

(a) Increasing the levels of modern technology usage through the:

- generation and validation of improved technology;
- training of technical personnel in the relevant areas;

FIGURE 2.1
GENERAL OBJECTIVE TREE



- strengthening of the institutional framework for research, development and extension; and

- increasing the levels of adoption of improved technologies at the farm level.

(b) Establishing a comprehensive Seed Production and Certification programme.

(c) Improving the quality of the Sea Island Cotton genetic material by:

- developing Sea Island Cotton varieties that are high yielding, resistance to pests and diseases, and of high lint quality; and

- establishing and maintaining a Sea Island Cotton Germplasm Bank.

(d) Improving the agronomic practices through the application of applied research to:

- develop and transfer appropriate fertilizer programmes and application methods;

- develop and transfer appropriate pests and diseases control programmes; and

- develop and transfer modern methods of cultivation.

(e) Reducing crop losses through the:

- the training of workers in appropriate harvesting methods; and

- the development of an environmentally sound integrated pest management programme.

(f) Increasing factor productivity through the:

- development and transfer of appropriate fertilization and soil conservation practices for marginal lands;

- training of workers in appropriate production techniques;

- development and use of irrigation systems where appropriate; and

- increasing the level of research and application of farm mechanization.

(g) Developing programmes for ongoing testing of lint quality.

These specific objectives are further defined and presented in Figure 2.2.

FIGURE 2.2
SPECIFIC OBJECTIVE TREE

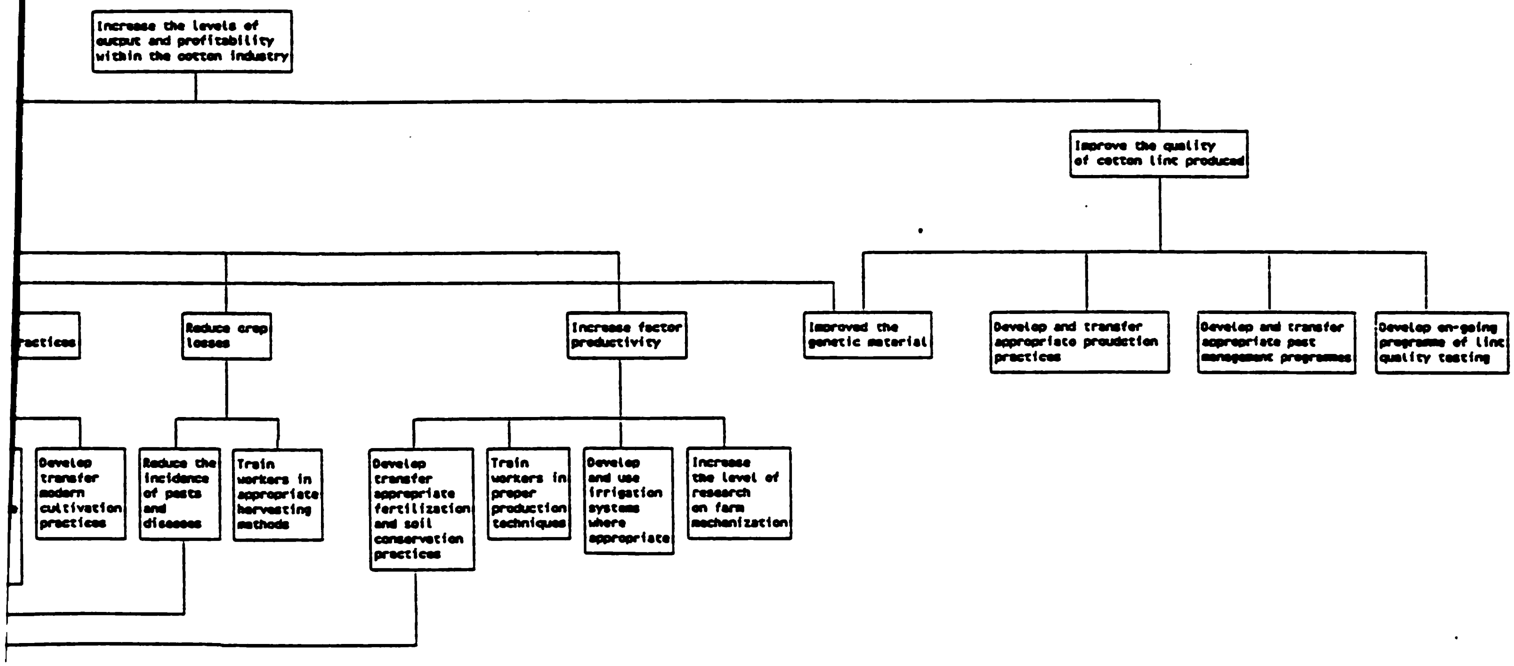
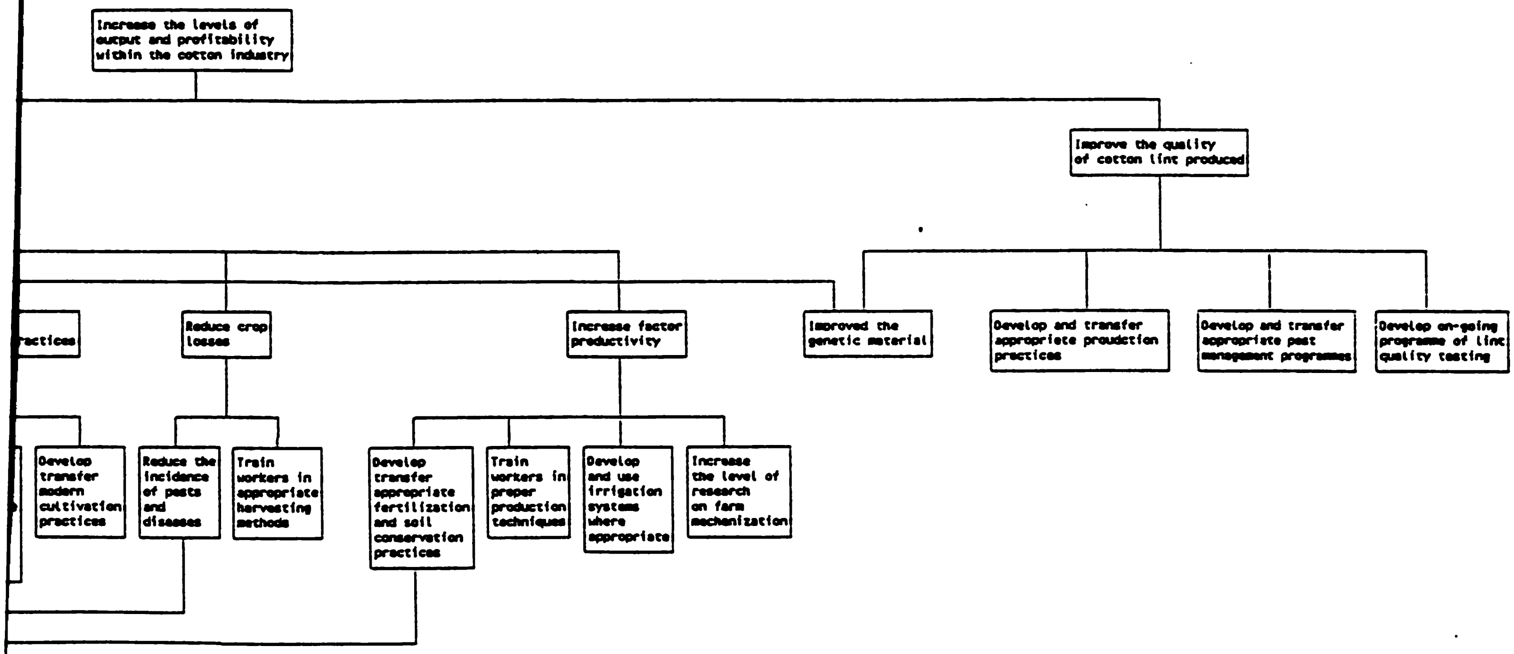


FIGURE 2.2
SPECIFIC OBJECTIVE TREE



CHAPTER III

3. PROJECT COMPONENTS

3.1 Introduction

The establishment of a viable, productive and efficient regional Sea Island Cotton industry in the Caribbean will depend heavily upon the implementation of a successful technology generation and transfer programme. It is, therefore, imperative that the Sea Island Cotton producing countries develop a strong regional research and development programme to support the production of this commodity. In particular, one of the main outputs of this intervention would be a technology package which can help cotton growers optimize their production.

The development and formulation of any research and development programme should take a regional approach in order to be complimentary, and to avoid the duplication of efforts, facilities and costs. All Sea Island producing countries should therefore actively participate in such a regional initiative.

Barbados, through the now defunct Caribbean Sea Island Cotton Company, had shared the vision of developing a regional approach to the generation and transfer of cotton technology with the establishment of a Research Centre envisioned to serve also the cotton industry in the region.

Research and Seed multiplication activities are presently concentrated in two countries, namely:

Antigua and Barbuda: Operates a cotton station mainly devoted to the production of the MSI pedigree seeds for the region. It does not carry out any research/experimentation activities at present; this country also maintains the local cotton Germplasm Collection.

Barbados: The Ministry of Agriculture, Food and Fisheries has designed a 4 year research project 1988-1992 under which several activities have already been initiated in the areas of Pest Control, Agronomy and Breeding, mostly with external technical assistance. The Government is scheduled to install a fibre testing laboratory to support the breeding programme. It has also started a Sea Island Cotton Germplasm Collection.

Nevis and Montserrat have no particular cotton research structures and do not conduct any research activities in Sea Island Cotton at present.

The development of any comprehensive regional research/ experimentation project should take into account the existing unique research structures and capabilities of each country.

Furthermore, the proposed research programme should be developed with an integrated approach, taking into consideration all the different aspects of the cotton production; namely, genetic improvement and seed production. Agronomy, pest control and improvements in the mechanisation for transfer of technologies to farmers.

3.2 Components

During the life of the project the following components and related activities will be undertaken in order to achieve its desired objectives.

3.2.1 Genetic Improvement

3.2.1.1 Objective and general strategy

The general objective of any cotton genetic improvement programme is to create new genetic material with significantly better characteristics than the existing commercial variety(ies) in terms of yield, lint recovery (% fibre), lint quality or any other important agronomic traits (such as plant height and canopy, pest and disease tolerance/resistance, earliness, etc.)

Any cotton breeding programme must be able to respond to the basic objective of maintaining the exceptional lint quality of the Sea Island variety (length, strength and silkiness of the fibre). A more specific objective would be to "modernize" the Sea Island Cotton by engineering a new type of plant. With this in mind, the breeding/selection programme should be designed to achieve the following:

- improvement of the yield potential;

- increase of the lint recovery;

- improvement of its harvestability, this includes a significant reduction of the crop cycle, a more regrouped fruiting period, a more compact plant canopy and an open boll.

- maintenance or improvement of the lint quality: in particular fibre maturity should be improved.

To achieve these goals, the breeding work should be carried out on an integrated approach, taking into consideration, at the same time, all the different selection parameters which are of prime importance to the cotton productions system, namely:

At the farmers level:	yield, earnings, plant canopy, type of bolls and pest-disease resistance/tolerance.
At the ginnery level:	lint recovery; and
At the textile mill level:	lint quality

The pressure of selection should employ specific parameters which are considered eliminatory factors in the selection process, as follows:

- At the first level of selection, emphasis should be put on the yield factor because it is of utmost importance to the cotton growers. As a general rule any genetic material which does not show better yield results than the check variety should be systematically discarded from the varietal experimentation.

- At the second level of selection, weight should be given to lint recovery which is the main concern of the ginners. Any line which does not present a good % fibre, higher than that of the check variety should be likewise eliminated from the selection programme.

- At the third and last level of selection, the lint quality should be taken into consideration (for which the staple length, fineness, fibre strength and maturity are the most important characteristics). At this stage, any line which does not possess the SI lint characteristics should be discarded.

Of course, other factors can also be taken into consideration during the selection process, such as earliness, plant height, plant canopy, boll characteristics (which are parameters directly related to the harvestability of the crop), and pest-disease resistance/tolerance. However, these are not eliminatory parameters in the breeding procedure except for the susceptibility to a serious disease of major pest.

At each level of selection, there are 2 courses of action to be taken based on the analysis of the results: either to discard the line because of non-compliance to basic selection requirements or to retain it for further testing. This methodology allows the elimination of poor material from the breeding/selection system and the maintenance of the most promising lines (combining good yield,

high lint recovery and satisfactory lint quality) for further experimentation.

3.2.1.2 Organization of a regional Sea Island Cotton Germplasm Collection

(a) Objectives

An evaluation of the existing SI Germplasm collection in the region has revealed its weak points, namely:

- limited SI genetic material
- inadequate storage conditions; and
- poor management of the collection.

The development of any comprehensive breeding programme requires access to a sufficient quality of genetic material. It is therefore indispensable to be able to establish, organize and maintain an adequate germplasm collection. With this in mind, it recommended that a Regional Sea Island cotton Germplasm Collection Center be set up which could ultimately serve as the world depository of the Sea Island genetic stock.

The objective of the Germplasm Collection should be:

- to preserve and maintain all SI genetic resources;

- to evaluate all cultivars according to international standards (IBPGR/IRCT standards);

- to identify the most promising/interesting lines in order to initiate a comprehensive breeding programme;

- to preserve the original seed (nucleus seed) of any commercial variety from which seed multiplication can eventually be carried out;

- to store all cotton genetic material that was introduced in the region (in particular, other "barbadense" cottons).

(b) Establishment of the SI Germplasm Collection

In order to achieve these objectives, the first step in establishing the SI Germplasm Collection is to gather all the SI genetic resources available in the world. One way by which this Collection can be developed gradually is by tapping the resources of existing cotton Germplasm Collections (IRCT-CIRAD), USDA, Antigua and Barbuda, St. Vincent, Barbados, Israel, China, India.

(c) Maintenance procedure

Self pollination should be strictly implemented to preserve the genetic identity of each cultivar.

In addition to the seed maintenance process, the genetic material should be evaluated using the IBPGR/IRCT list of descriptors. This procedure is necessary to describe the cultivars and to verify their genetic purity; eventually this will help to identify interesting genetic material for further experimentation (breeding programme or variety tests).

The following experimental design is proposed to evaluate and maintain the cultivars of the collection:

- no replication.

- one row of 20m per cultivar with a checkline (MSI commercial variety) for every 10 varieties.

- out of the 20m row, 10m are used for producing the seeds (with self pollination) and the other 10m for evaluation (with open pollination).

- planting distance: 1.50m x 0.50m (or 60' x 20') with one plant per hill.

- self-pollination should be implemented until about 0.5 kg (about one pound of selfed seed cotton can be harvested.

(d) Frequency of seed multiplication

A complete evaluation should be conducted at least once for each cultivar: this includes a botanical, agronomical and technological description of the genetic material; then, subsequent evaluations can be limited to the agronomic and technological aspects each time the material is multiplied for seed maintenance.

As a general rule, seed multiplication should be carried out whenever a cultivar shows seed viability problems or in the case of seed shortage within the collection. Because the self pollination method gradually reduces the existing genetic variability within each genetic material, it is highly recommended to multiply the seeds of the collection only if absolutely necessary; otherwise, not too frequently.

The frequency of seed multiplication can be significantly reduced by the use of a cold storage facility (at least once every 6 years).

(e) Organization of the Regional Sea Island Cotton Germplasm Center

While all the Sea Island Cotton producing countries may be interested in maintaining their own SI genetic stock, there should only be one Sea Island Cotton Germplasm Collection Center established under the integrated SI cotton project for the region. This Center would serve as the international depository of the SI genetic resources and in time could provide the other participating countries with data and ultimately seeds.

The creation of the center would require adequate cold storage facilities to safeguard the genetic material from adverse condition. Cultivars should be introduced into the seed bank under specific accession numbers with their name, country of origin and any other pertinent information (year of introduction, year of multiplication, etc.)

Good agronomic practices as well as the efficient deployment of a highly trained field staff for selfing, ginning etc. are vital in ensuring the maintenance of good seed quality and in avoiding the mismanagement of the seed multiplication process.

Only acid-delinted seeds should be stored. These should be kept in small hermetically sealed plastic containers/cans.

The management of the Cotton Germplasm Center should be the responsibility of the Cotton Breeder. He should work closely with the Fiber Testing Laboratory to evaluate the lint quality and with the Seed Quality Laboratory to monitor the seed viability during storage.

3.2.1.3 Model of a breeding/selection programme

(a) Introduction

The main purpose of this programme is to develop new SI lines which manifest better characteristics than the current commercial MSI variety.

The breeding/selection strategy as elaborated here under, is a practical approach in the efficient selection of superior SI genetic material. The evaluation of the SI progenies/lines should be limited to the most important parameters of selection such as yield, lint recovery, fibre quality and to some specific plant characteristics related to the harvestability aspect of the Sea Island Cotton. It is important to lighten the selection workload as much as possible by foregoing the physical measurement of plant features that are not directly relevant to the breeding process, such as flower count, height of the first fruiting

branch, loculi per boll, number of monopodia, sympodia, and bolls, etc. However, a complete evaluation of the genetic material is recommended at the point when it reaches the commercial variety stage.

For reasons mentioned earlier, it is proposed that a breeding programme be initiated using only Sea Island genetic material.

The various steps involved in this breeding and selection programme are presented in Annex 1 and are described as follows:

(b) Creation of genetic variability

Genetic variability can be obtained by implementing a programme of crosses (single or dialelic) involving the best/most interesting SI cultivars which have been identified in the Cotton Germplasm Collection. This can be followed by a second cycle of crosses between F1's (4-way crosses) or between F1 and other SI lines (3-way crosses) and a possible third cycle of crosses can be carried out between F11's of different genetic backgrounds. All of these crosses should widen the base of the genetic variability and favor the creation of new SI genetic recombinations.

It is also possible to achieve genetic variability by introgressing "barbadense" characteristics in the SI genetic stock by means of crosses of SI material with other "barbadense" cottons followed up by a back-cross programme with SI lines. This method could be an appropriate means to create new cotton plant types.

(c) Single plant selection

After the programme of crosses, conventional breeding procedures should be adopted. The F1 and F2 generations (following the last cycle of crosses) should be multiplied by self pollination.

Single plant selections would be carried out within the F2 population using agronomic parameters such as plant canopy, height, boll characteristics, earliness, varietal resistance/ tolerance, etc.

At the laboratory level, a second pressure of selection should be applied taking into consideration the lint recovery and any plant which does not show an acceptable % fibre should be systematically eliminated. A third pressure of selection should be undertaken, this time taking into account the lint quality. In order not to overcharge the workload in the fiber testing laboratory, fibre analysis should be limited to

genetic material with good lint recovery. At this level of selection, the fibre analysis could be concentrated on staple length, strength and fineness/maturity, parameters by which the SI lint/quality can best be characterized.

Any interesting genetic material which results from this selection procedure, would be kept for further evaluation.

(d) Evaluation of the progenies

The evaluation of the progenies is the first step in the assessment of the newly created genetic material.

(i) Objective

The objective of this process is to select new lines manifesting superior characteristics to those of the current commercial variety MSI.

(ii) Methodology

- number or rows per plot: one (1)
- length of the rows: 10 m
- planting distance: the same as for commercial production
- thinning: one plant per hole
- experimental design: one row per progeny (with no replication) with a check line (MSI variety) for every 10 progenies;
- recommended production technology: optimal in terms of fertilization, weed and pest control;
- multiplication of seed by self pollination
- location: Research Stations.

(iii) Characters to be evaluated

- plant height and canopy
- boll characteristics; mean boll weight
- disease/pest susceptibility
- earliness index (first harvest total harvest)
- lint recovery
- fibre quality (complete analysis)

With respect to the determination of the % Fibre and lint quality, it is imperative that the working sample represent the total harvest.

(e) Preliminary variety trial

(i) Objectives

- to evaluate the most promising progenies identified in the preceding selecting process according to a statistical experimental design.

- to identify new lines which produce significantly better results than the check variety MSI

- to verify the genetic stability of the new material

(ii) Methodology

- experimental design: balanced lattice 4x4 or 3x3
- number of rows per plot: one (1)
- planting distance: the same as for commercial crop
- length of the row: 10 m
- production technology: optimal
- seed multiplication: one replication can be selfed for seed production
- location: Research Stations

(iii) Characters to be evaluated

- plant height and canopy
- boll characteristics and mean boll weight (determined in the open pollinated replications based on 20 bolls per plot)
- seed cotton yield (at harvest, selfed bolls are picked separately from the open pollinated ones in the selfed replication)
- earliness index
- lint recovery
- lint quality

In order to limit the number of lint samples to be analysed in the laboratory, testing to determine lint recovery and fibre quality should be conducted on a per line/variety instead of a per plot basis.

(f) Advanced variety trial

(i) Objectives

- to identify new lines with significantly superior yield, % Fiber and lint quality.

- to evaluate the most promising lines identified in the Preliminary Variety Trial (using a statistical experimental design) and to confirm their agronomic and technological characteristic.

(ii) Methodology

- experimental design: Randomized Complete Blocks with with 6 or 8 varieties (including the check variety) and 6 or 8 replications.
- number of rows per plot: 3
- row length: 10 m
- planting distance: the same as for commercial crop with one plant per hole.
- production technology; optimal
- seed multiplication: all lines/varieties to be multiplied by self pollination is a separate area.
- location: Research Stations

(iii) Characters to be evaluated

- plant height and canopy
- boll characteristics/mean boll weight
- seed cotton yield (based on the central row harvest of each plot)
- earliness index
- lint recovery
- fibre quality

(g) Regional variety trial

The regional variety trial should be conducted over a minimum period of two years.

(i) Objectives

- to test the best genetic material selected from the advanced variety trials in the different cotton areas under commercial growing conditions.

- to select the best line (s) for commercial release at the farmer level.

(ii) Methodology

- experimental design: Randomized Complete Block with 4 to 5 varieties (including the check variety MSI) and 6 replications.
- number of rows per plot: 4
- length of row: 10 m
- planting distance: the same as for commercial production

- planting distance: the same as for commercial production
- production technology: farmer's growing techniques.
- place of implementation: within the cotton areas of the SI producing countries. This experiment should be conducted in commercial fields under farmer growing techniques.

(iii) <u>Characters to be evaluated</u>

- seed cotton yield (based on the harvest of the 2 central rows of each plot)
- lint recovery
- fibre quality

As a result of this experimentation process, it would be possible to find one or more variety(ies) with significantly superior qualities to the current commercial lines within any of the participating countries. This material should eventually be recommended for commercial release to farmers.

(h) Production of the breeder seed

The few lines, which have reached the regional variety trial step, should be multiplied simultaneously by self pollination or in isolated fields to produce the Breeder Seeds. These seeds could eventually serve to initiate the seed multiplication programme if and when a line is recommended for commercial release to the farmers.

3.2.2 Development of a Comprehensive Seed Production and Certification Programme

3.2.2.1 Objectives

Seeds for planting are the end product of a series of steps that include growing, harvesting, conditioning, sorting and distributing, during which seeds can be subject to quality degradation due to mixture and/or deterioration.

Thus, the main concerns of seed production are as follows:

(i) to maintain the genetic/varietal purity throughout the seed multiplication process;

(ii) to produce sufficient quantity of planting material of good quality;

(iii) to minimize the risk of deterioration of the seeds during the successive production steps;

(iv) to contribute to the rapid propagation of new varieties at the farmer level.

In the case of Sea Island Cotton, the specific objective would be to meet the demand of all the participating SI producing countries for SI planting material.

Management of seed production will entail the production of seeds under optimal conditions in order to ensure the highest quality and purity of seeds through all stages of production.

3.2.2.2 Model of cotton seed multiplication programme

(a) Introduction

The success of any seed multiplication programme depends upon the ultimate quality of the planting material produced for distribution to farmers; seed quality includes varietal purity and intrinsic quality of the seed in terms of germination, seed viability and vigor, physical purity and phytosanitary state.

To produce high quality cotton seeds, it is necessary to have an efficient seed production quality control and certification systems. Assuming that SI varieties do not fall under the hybrid category, this could be achieved by adhering to the international cotton seed multiplication and certification standards (Annex 2) described as follows:

(b) Multiplication scheme

The SI cotton seed multiplication programme should follow the internationally accepted seed multiplication scheme involving the following seed classes:

(i) Nucleus seed (N.S)

Nucleus seed is directly issued from the breeding and selection programme; it is considered as the purest seed (usually selfed) and is generally kept in the cotton Germplasm collection in small quantity and multiplied by self pollination to maintain seed supply.

(ii) Breeder seed (B.S)

Issued from the Nucleus seed, the Breeder Seed is generally produced on a small isolate plot under the control of the breeding institution (it can also be multiplied by self-pollination).

(iii) Foundation Seed (F.S)

It is the progeny of the Breeder Seed, multiplied on an isolated plot under strict control to maintain the specific genetic purity and identity of the variety.

(iv) Registered Seed (R.S)

It is the progeny of the Foundation Seed (or accessorily of B.S) and is multiplied on an isolated area and handled following specific procedures to maintain satisfactory genetic purity.

(v) Certified Seed (C.S)

Certified Seed is produced from the Registered Seed (or accessorily from B.S. or F.S.) on an isolated area and is handled following acceptable procedures to maintain satisfactory varietal purity. Certified Seed is normally equivalent to the so-called "planting" seeds generally sold/distributed to farmers for commercial cotton production.

The above multiplication scheme which does not involve any selection process will preserve the genetic identity of the variety from the original seed state to the planting material state. It also ensures that the variety will be grown for years without any major genetic change/erosion.

(c) Seed multiplication field standards

To carry out the objectives of the seed multiplication programme, we must take into account some basic standards at the field level:

(i) Isolation

As a general rule, a seed production field/area must be at least **200m** away from any commercial cotton area planted with the same cotton species, and **800m** away from any other species of cotton. This isolation distance may be reduced to 50m when adjacent cotton fields are planted with the same variety.

When self pollination is implemented (production of nucleus and possibly Breeder Seeds), isolation is not required.

(ii) Self pollination

Nucleus Seeds should be multiplied only by self pollination, while Breeder Seeds could be produced either by self pollination or by open pollination on an isolated plot, depending on personnel resources and area targeted. Subsequent categories of seeds are produced with open pollination.

(iii) Rogging of off-type plants

Elimination of off-type plants is necessary to maintain the genetic purity of the variety. The so-called off-type plant is any plant which does not correspond to the botanical/morphological description of the variety (color of the pollen, color of the petal, hairiness character of the leaf, shape of the leaf, plant height/canopy, etc.) Rogging must be conducted during the vegetative stage of the crop.

Tolerated quantities of off-types vary according to seed class, as shown in Annex 2.

(iv) Efficient crop management

The most effective production technology should be implemented in the seed multiplication areas in order to ensure high yields. Special attention should be given to soil preparation, fertilization, pest (especially pink boll worm) and weed control thinning and planting distance.

(v) Harvest standards

Only well-dried, clean and pest free seed cotton which has not been damaged by rain should be packed for seed production at any seed class level.

Ideally, only the bottom and middle bolls of the crop, representing approximately 70 to 80% of the total harvest, should be kept for seed production. Top production, which may be immature (drought affected) or damaged by late pest infestations (pink bollworm, cotton stainers), should be converted to industrial seed cotton.

When it comes to self pollinated seed classes, only selfed bolls must be harvested and kept for seed production.

(vi) <u>Field inspections</u>

Regular field inspections should be carried out by the seed certification department/seed multiplication personnel, to verify compliance with the field standards. Seed production fields should be inspected at least 3 times during the crop cycle, as follows"

- <u>at seedling stage</u>, to verify adherence to the isolation standard and to evaluate the crop stand (plant population, weed problem, seed borne diseases).

- <u>at flowering stage</u>, to assess the crop stand in terms of weed and pest control and implement rogging of off-types.

- <u>at bursting stage</u>, to assess the crop stand and supervise the harvest activities.

Any farm/field which does not meet the field standards requirements, must be disqualified from seed production.

(d) Seed quality standards

The purpose of seed production is to produce seeds of high quality and to ensure and maintain this throughout the multiplication process, the ultimate step of which is seed quality control.

The main objective of seed quality control is to ensure that only planting material of desired quality standards will be produced and released to farmers. Because seed quality is a composite of several factors, it can only be determined by testing each of its aspects. Seed testing entails the evaluation of the planting quality (or value) of the seeds in terms of germination, seed purity and moisture content.

Cotton seed testing should be always done in accordance with international procedures and seed certification regulations. Seed quality should comply with standards as proposed in Annex 2.

Any seed lot which does not meet the required standards should not be used as planting material.

3.2.2.3 Seed Certification

Seed certification is designed to guarantee the genetic purity and identity of the variety and to ensure high standards of seed quality.

The seed certification process requires the following elements:

(i) official certifying agency
(ii) crop and variety eligibility
(iii) compliance to the official seed multiplication scheme; and
(iv) adhere to certification standards (field and seed quality standards).

Its application includes the following control measures: fields inspections during the crop stage to verify eligibility of the crop for seed production, seed quality testing and evaluation of the genetic purity of the variety.

Upon completion of all seed quality control measures, the certifying agency will issue a corresponding certificate and provide official tags to be attached to each bag of the approved seed lot.

3.2.2.4 Seed marketing system

Seed distribution is normally regulated through a seed marketing system by which seed moves from the production site to the end consumers who finally plant them. It includes the following steps:

- seed treatment
- packaging
- labelling; and
- storage and distribution

The seed marketing system must be designed to conserve seed purity and quality during the various steps following certification.

In the case of the Sea Island cotton production, where the main seed infestation problems come from the pink bollworm and bacterial blight, it is highly recommended that seeds be subjected to a chemical delinting process rather than the more common mechanical method.

Given the existing general lack of adequate storage facilities for planting material, special efforts should be made to correct this situation.

3.2.2.5 Standard operating procedures for seed cotton processing

Basically, these standard operating procedures involve the handling and processing of seed cotton intended for seed production.

With respect to the production of registered and certified seeds, it is best to have a separate processing and warehousing facility to prevent the seed cotton and seeds from mixing with commercial cotton. However, since the seed production programme would probably have to use existing commercial infrastructures in the production of the planting seeds, it is important that specific guidelines be followed to ensure seed purity and quality during the processing stage. These are as follows:

a) Delivery of seed cotton

Seed cotton intended for seed production should be delivered at the ginnery site separately, under the supervision of the seed multiplication personnel.

b) Storage of seed cotton

In case the seed cotton for seed production cannot be ginned immediately, it should be stored properly and classified according to variety, seed category and location/producer. This should be separated from the commercial seed cotton, and should always be supervised by the seed multiplication personnel.

c) Ginning activity

Ginning is a crucial post-harvest activity in the seed production process because it can seriously affect seed purity (through mechanical seed mixture) and quality (through seed damage). In order to reduce these risks, specific ginning guidelines should be strictly observed, these are:

- gin separately the seed cotton for seed production from that of commercial cotton.

- thoroughly clean all ginnery parts (particularly the gin stands and seed conveyors) as well as the ginning platform prior to the start of the ginning.

- ensure operations that the ginning process is conducted properly and accurately (machine calibration).

- gin seed cotton according to variety, seed class and location/producer.

d) Seed storage

Seeds for planting should be stored on wooden pallets in an area that has been thoroughly cleaned. Seed lots should be organized according to variety, seed class and

location/producer. The storage structure must be concrete, weather-proof, with good ventilation for seed conservation.

3.2.3 Agronomic research Programme

3.2.3.1 Objective

Agronomic factors can be an important part of the problem of low yields at the farmer's level. A review of the existing cultural practices shows clearly that the SI crop is not being intensively cultivated, due to a large extent to the failure of cotton growers to follow current SI cotton production technology. It is important to note that some agronomic aspects of the SI production such as fertilisation, plant population and weed control still constitute very serious limiting factors to its cultivation, even though these basic problems have been studied periodically by the Research Department.

It is therefore important to initiate a rational agronomic research programme with the objective of optimizing SI production and developing a new technology package better adapted to the requirement of modern crop management. Based on the agronomic problems presently inhibiting the SI production, research and experimentation should concentrate on the following aspects:

- fertilization
- weed control
- plant population; and
- crop rotation

Although land preparation is another important limiting factor to SI production, no further investigation is necessary in this area in view of the fact that present recommendations provide appropriate solutions to the problem, these include measures for soil conservation.

Other agronomic aspects such as irrigation, plant growth regulator, defoliation, intercropping and planting date, are also covered in this proposal.

3.2.3.2 Agronomic Research and Experimentation Activities

(a) Fertilization Studies

Cotton has been grown for decades using the same fertilization method, without verifying if this is still appropriate considering the actual fertility level of the soil.

(i) <u>Subtractive fertilization experiment</u>

As the mineral nutrition of the plants is provided by the soil, fertilization serves to compensate for any deficiency that may exist to ensure optimal production. In line with this, any fertilization study must be able to pinpoint the particular soil deficiency (latent or real) and to formulate the appropriate fertilization (formula and dosage) to correct the problem.

With respect to Sea Island Cotton production, it is recommended that a study be conducted in the main cotton growing areas to evaluate the existing fertilization methods, determine any soil deficiency and, eventually to propose appropriate recommendations.

To achieve the objective of this fertilization study, it is proposed that a subtractive (so called because it involves subtracting or removing a main element from the recommended NPK fertilization formula) fertilization experiment be implemented as follow:

* **Treatments involved:**

- recommended NPK fertilization formula
- PK formula (without N)
- NK formula (without P)
- NP formula (without K)
- without fertilizer

* **Experimental design:**

Randomized Complete Blocks
5 treatments x 6 replications

* **Experimental plot**

6 rows of 10 m. long

* **Planting distance**

The same as in commercial fields

* **Location**

Main cotton growing areas in each island (including research stations)

* **Factors to be evaluated**

- soil analysis of the experimental plots
- foliar analysis (on a per plot basis)

- seed cotton yield (based on the 2 central rows of each plot)
- lint recovery per treatment
- lint quality per treatment

This experiment should be carried out at the same location over a minimum period of 3 years.

At the end of this study, we should be able:

- to establish the yield level under natural soil fertility (without the application of fertilizer)
- to determine any soil deficiency
- to evaluate the current fertilization method
- to formulate new fertilization recommendations

(ii) Nitrogen fertilization study

Nitrogen appears to be a very important element in the actual fertilization formula. It would be interesting to study the effect of different Nitrogen levels and timing of application on SI cotton yield to determine the optimal level of N and frequency of application which could maximize yields.

(iii) Study on foliar fertilizers

Since the use of foliar fertilizers can be used to correct some specific deficiencies or to complement the basal application, studies should be made to evaluate their effect, in varying formulas on the SI cotton, especially on the late planting type.

(b) Weed control experimentation

The problem of weeds appears to be a serious constraint to the production of Sea Island cotton. Weed control, which is usually done manually, requires a high number of man days. At present effective weed control measures are not implemented because of the serious problems of a shortage of manpower and high labor costs. It is important that solutions be found to eradicate or minimize the weed problem, in order to ensure the proper development of the crop. In this regard, it is recommended that the agronomist evaluate different weed control methods other than hand weeding and focus on the development of a weed control strategy combining chemical, mechanical and agronomic measures that can be integrated into the proposed technology package to the farmers.

It is recommended that an intensive study be carried out on the following:

- the effectiveness of herbicides on the control of the different types of weeds infecting in cotton fields. This should include pre-and-post-emergence herbicides, dosage and timing of application.

- the influence of agronomic factors such as weed control during the "close season", planting distance, crop rotation, etc., on controlling weeds.

It is recommended that an evaluation of herbicides be conducted on each island after having established a list of the main types of weeds found in the different cotton growing areas.

(c) Plant Population Study

Although the plant population aspect of cotton growing has been intensively studied in the past, it still remains a problem in some countries, like Nevis and Barbados.

It should be reiterated that the plant population study covers 2 aspects: spacing between plants and number of plants per hole.

The study to determine the optimal population should be undertaken in relation with soil fertility, mechanical planting, and rotation with sugar cane, as in the case of Barbados. It is proposed that this study employ different spacing distances between rows as well as between plants within the row with one or two plants per hole, and evaluate the results against those based on the actual planting distance recommendation in each of the Sea Island producing countries.

Aside from the basic agronomic characteristics of the crop (yield, plant height and boll weight) the study should also consider changes, if any, with respect to pest and weed problems.

(d) Crop rotation system

Cotton has been grown in the West Indies as a monocrop for years, therefor most cotton growers do not implement any system of crop rotation.

Generally speaking, a crop rotation system enables farmers to use the land more efficiently and to diversify their sources of income. There are also agronomic benefits from crop

rotation such as improved soil fertility and the likely effect on weed and pest control.

It is therefore recommended that a study be made of the different systems best suited to the growing conditions of the region, such as cotton-sugarcane (Barbados) or cotton-peanuts as against the cotton monocrop system.

(e) Other agronomic aspects

(i) Irrigation study

Erratic weather conditions in producing countries adversely affect cotton production, consequently, it is important to look into the prospect of irrigation as a means of reducing the effect of water shortages which can have a negative impact on yields.

However, water shortages in producing countries make the construction of irrigation systems a difficult proposition. It is therefore reasonable to assume that if any irrigation project is ever undertaken, priority would have to certainly be give to other highly important crops such as vegetables. In any case, farmers have gone into cotton production with the knowledge that this crop is better able to withstand drastic weather conditions than most other crops.

(ii) Plant growth regulator study

There is no need to conduct any specific studies on the use of plant growth regulators since pertinent data are already available in other countries which can be readily applied to local production.

In this connection, it is recommended that demonstration plots be set up at farmer's field level using the available data and recommendations available from previously conducted experiments on utilising growth regulators. These demonstration plots should be used to study the effect of the growth regulator on the fiber quality of the Sea Island Cotton. Eventually, the results from this activity can be used if and when the application of plant growth regulators is recommended for inclusion in the SI production technology package.

(iii) Defoliation study

The comments made on plant growth regulators are applicable.

(iv) Late planting date study

Some farmers start plantings cotton after the recommended date and it would be interesting to know the results of this practice on yields lint recovery and fibre quality. A study on the effects of this practice should also take account of its impact on weed and pest control.

(v) Intercropping Study

No study on the effects of intercropping in necessary because cotton is intensively cultivated and the number of farmers whe could benefit from it is only marginal. Furthermore, previous studies have not yielded significant results.

3.2.4 Crop Protection

The general objective of a research programme on crop protection would be the development of an effective, environmentally sound Integrated Pest Management programme for Sea Island Cotton in the region. The major components of this programme are as follows.

3.2.4.1 Pheromone Research - Activity 1

a) evaluate the efficacy of formulations of gossyplure or pink bollworm pheromone for mating disruption at different pest densities and at different agroclimatological areas.

b) investigate Alabama pheromone isolated from local populations, for monitoring and mating disruption.

c) isolate from and test pheromone against local populations of Heliothis

3.2.4.2 Insect Growth Regulator Studies - Activity 2

a) investigate the efficacy of chitin inhibitors against the range of cotton pests.

b) investigate delayed effects of IGRs on oviposition and egg viability of major pests.

c) determine the impact of IGRs on natural enemies of cotton pests.

3.2.4.3 Biocontrol Studies - Activity 3

a) population interaction studies of Bemisia and its most effective natural enemies.

b) population interaction studies of Alabama and the pupal parasite Brachymeria.

c) impact of releases of Bracon hebator on off-season and in-crop populations of Heliothis virenscens.

d) develop local formulations of Nuclear Polyhedrosis virus for trials against major lepidopterous pests.

3.2.4.4 Chemical Control Studies - Activity 4

a) to evaluate for selectivity and efficacy of chemicals against cotton pests and natural enemies.

3.2.4.5 Mechanical Devices - Activity 5

a) develop and evaluate mechanical devices e.g. yellow traps or suction traps against whiteflies for monitoring or direct control.

b) establish mechanisms for monitoring pest population cycles and maintain quarantine controls against the movement of pests between countries.

3.2.4.6 Ecological/Action Threshold Studies - Activity 6

a) determination of action/economic threshold levels for major pests.

b) ecological studies of major pests and population cycles in relation to pest management strategy.

The results of the above research would lead to the development the technology for an integrated pest management package for transfer to farmers.

Activity allocation per country in the time frame recommended for this study:-

COUNTRY	ACTIVITY	TIME (years) 1	2	3	4	5
	1					
Antigua, Barbados	a	*	*	*	*	*
Antigua, Barbados	b	*	*	*	*	*
Barbados	c		*	*	*	*
	2					
Antigua, Barbados, Montserrat, Nevis	a	*	*	*	*	*
Barbados	b	*	*	*	*	*
Antigua, Barbados, Montserrat, Nevis	c	*	*	*	*	*
	3					
Barbados	a	*	*	*	*	*
Antigua, Barbados, Montserrat, Nevis	b	*	*	*	*	*
Antigua, Barbados, Montserrat, Nevis	c	*	*	*	*	*
Barbados	d			*	*	*
	4					
Antigua, Barbados, Montserrat, Nevis	a	*	*	*	*	*
	5					
Barbados	a			*	*	*
Antigua, Barbados, Montserrat, Nevis	b	*	*	*	*	*
Antigua, Barbados, Montserrat, Nevis	6 a & b	*		*	*	*

3.2.5 Agricultural Engineering

3.2.5.1 Mechanical Harvester

The most critical area to be addressed with respect to the agricultural engineering facilities and services component of the Research and Development Programme is the feasibility of developing a machine to harvest Sea Island cotton. However, the potential for the design and construction of such a machine seems quite limited.

Based on the present characteristics of the Sea Island cotton plant, a number of factors militate against the design of a suitable harvester for this crop.

Some of these factors are:

- Plant height - (tall plants)
- Long growing period (long fruiting period)
- Boll do not open sufficiently (80 - 85% needed)
- Defoliants cannot be used as bolls will not mature (late rain may also cause severe damage to the crop)

There are also some associated technical problems:

- Topography and field sizes in a large number of cases (small farmer's fields) would exclude the use of mechanical harvesters.

- The use of mechanical harvesters will require the acquisition additional equipment at the ginnery level to clean both the harvested material and the lint.

- The length of the fibre is reduced by every handling and cleaning operations to which it is subjected.

A crop improvement research programme to look at the following should be considered:

- Improvement in the configuration of the plant.

- Reduction of the crop cycle, without a corresponding reduction in the length of the fibre.

- Development of canopy that is more adaptable to the mechanical harvester; i.e. height, configuration of plant, and a more open boll.

- Speeding up the maturing process of the bolls without affecting length and quality of the fibre.

3.2.5.2 Lint Fibre Testing Laboratory

Although the lint characteristics of the Sea Island cotton remain good, lately there have been feedback indicating a decline of its fibre quality. A study conducted in Barbados during 1990/91 on the lint recovery and the fibre quality of the MSI progenies shows a wide range of values: lint recovery ranging from 25 to 30%; staple length ranging from 34-6 to 39.8mm; strength from 27.4 to 33.6 g/tax; and standard fineness (Hs) from 158 to 192. These results have demonstrated that MSI line recovery is lower than the given standard of 33%; and the staple length, with values lower than 44mm, is shorter.

The establishment of a lint quality testing laboratory is therefore extremely essential if the cotton breeder is to be assisted in making the necessary improvements in the quality of the Sea Island cotton lint. It is proposed that existing accommodation at the Barbados Standards Institute building be refurbished for this purpose. The laboratory should have two rooms; one for preparing the samples for testing and for storage, and the second for housing the laboratory equipment.

3.2.6 Institutional Strengthening

3.2.6.1 Introduction

The need to strengthen the institutional capacity for the generation and transfer of technology to support the production of Sea Island Cotton in the Caribbean has been fully identified, justified and assigned top priority among the project activities. It is therefore necessary to re-organise existing research and development programmes with a view to formulating a new technology package and the selection of better varieties that will enable the farmers to optimise their production, thereby making SI cotton a more profitable crop. This should also serve to preserve the SI genetic material and prevent any further deterioration.

An integrated research programme covering the following should be undertaken:

- Genetic improvement
- Agronomy
- Pest and disease control; and
- Seed multiplication and certification

It is also recommended that a regional institutional approach be adopted in the implementation of this research programme, integrating all four SI producing countries into a <u>single research structure</u>. Participating countries should coordinate their activities in order to maximize research resources and avoid duplication of efforts, facilities and costs, while sharing the benefits and results of the project.

A unique feature of this arrangement would be the implementation of a common research and experimental methodology by all participating countries.

The implementation of the proposed research and development programme should therefore focus on the existing research structures, namely:

<u>Barbados</u>: There exists a very active cotton research department under the Ministry of Agriculture although there is no actual cotton research station at present. Coupled with this, the government is very committed to cotton research as evidenced by the purchase of laboratory ginning equipment and the subsequent installation of a fibre testing laboratory to upgrade the breeding activities. There also exists a seed testing laboratory which was installed in 1984 under an FAO project. Recently, the cotton department has launched efforts to develop SI Cotton

Germplasm Collection with the help of IRCT-CIRAD and the Antigua and Barbuda Cotton Station.

<u>Antigua</u>: A Central Cotton Station already exists which is producing Pedigree Seeds for the region, although research activities are no longer being conducted. It is equipped with an antiquated ginning machinery and has good office and storage facilities. Its Cotton Germplasm Collection has significantly decreased and no longer represents the total Sea Island genetic stock.

<u>Nevis/ Montserrat</u>: There are no existing research structures and no research/experimentation activities are conducted.

3.2.6.2 Options for Institutional Strengthening

The motivation for the conclusion that an integrated Sea Island Cotton Industry be developed involving the governments and cotton farmers in the four producing countries was the inescapable fact that no one country alone had the capability of fully exploiting the very significant benefits which would accrue from offered as a result of being the sole producers of a rare natural fibre.

One acknowledged constraint to the achievement of this idea is the lack of a sustainable supply of Sea Island Cotton lint at the minimum level which make processing in the regions beyond the ginning stage an assured and successful enterprise. There are many non-agronomic reasons why production in contemporary times has been erratic and these can only be resolved by finding solutions of a non-scientific nature.

It is also widely acknowledge that production will remain erratic until growers have access to the latest know-how available for cotton production and can easily apply the results of research generated in the region as well as other available and applicable technology adapted to suit local conditions and respond to local problems. One way of ensuring all growers have access to the same technology for resolving problems would be through the development of a centralized, autonomous, regional Sea Island Cotton research and development programme. It is strongly recommended that such a programme be established without further delay.

In arriving at this conclusion several options were examined particularly within the context of the existing institutional arrangements and facilities in Antigua and Barbuda, Barbados, Montserrat and St. Kitts/Nevis. The mandates and operational procedures of the several cotton units or divisions within the

various regional Ministries responsible for agriculture, the Montserrat Sea Island Cotton Company, Caribbean Cotton Industries Incorporated located in Barbados and the West Indian Sea Island Cotton Association Inc, as well as the main regional agricultural research and development institution, the Caribbean Agricultural Research and Development Institute, were carefully reviewed and examined.

One option which was also reviewed was the institutional strengthening of existing research and development structures, i.e. the cotton station in Antigua and Barbuda and the Cotton Development Programme in Barbados. However, if efficiency and focus are to be assured, these units will require a great degree of autonomy. Since the work of the two units at two different locations must be complementary, extensive institutional coordination would be required. Other producing countries would also have to be afforded access to the research and development work, which would only be achieved by forging further links with institutions and agencies operating in those countries. Upgrading of the Barbados component into a Research and Development Centre would be possible but it would still not be autonomous nor would it easily develop suitable linkages with other countries, and assume a regional rather than national programme and approach.

A second option considered was the creation within Caribbean Cotton Industries Incorporated (CCII) of a Research and Development centre to provide the level of coordination and linkages described earlier. The management of CCII believes that it should be given this responsibility in keeping with its mandate to be the focus of the integrated Sea Island Cotton Industry involving the four (4) producing countries and their farmers.

It is also the mandate of the West Indian Sea Island Cotton Association Inc to develop Sea Island Cotton. Its charter/governing statute states that it has the responsibility and obligation <u>inter alia</u> to:-

(a) "promote and protect the West Indian Sea Island Cotton Industry in the islands of Antigua and Barbuda, Barbados, Montserrat, Nevis, St. Christopher, Anguilla, St. Vincent and the Grenadines and the other islands and countries of the Commonwealth Caribbean"........

(b) "consider, discuss and take action on questions directly and indirectly relating to or affecting the Sea Island Cotton Industry including the production of Seed Cotton and all products and by-products manufactured therefrom, to register and protect its Trade Market world-wide and to collect and disseminate information concerning Sea Island Cotton and the Trade Mark"........

(c) "promote research and other scientific work in connection wit the Sea Island Cotton and generally in connection with any branch of trade of commerce producing, using or handling Sea Island Cotton lint, yarn or fabric or any other of the Sea Island Cotton plant or producing machinery, accessories, substance or appliances to be used in the Sea Island Cotton Industry"........

(d) "retain and employ scientific or skilled persons:"........

(e) "establish, equip, maintain and alter laboratories, workshops, experimental ginneries, factories and other processing plants and Sea Island Cotton fields and to cultivate lands in connection with the same and to establish, form and maintain museums, collections, libraries and collections of literature, statistics and information relating to the Sea Island Cotton Industry or to matter of interest to members of the Association"........

(f) "negotiate, arrange and make arrangements for the carrying out of research work of any kind in connection with the West Indian Sea Island Cotton Industry"........

(g) encourage the discovery of and investigate and make known the merits and nature of inventions, improvements, methods, operations, processes, designs and materials which may be capable of being used for any of the purposes of the West Indian Sea Island Cotton Industry"........

The Association is in no way relieved of these onerous and important obligations because it has failed to uphold its very specific mandate and was permitted to do so for reasons too numerous to mention but which explain why this valuable commodity has not become a principal export item and an important contributor to Gross Domestic Product of producer countries.

A third option would be to assign the responsibility for the implementation and management of the programme to the Caribbean Agricultural Research and Development Institute (CARDI) an autonomous Research and Development Institute with members of its staff, and facilities in the twelve (12) member countries comprising CARICOM.

CARDI has and maintains suitable linkages with the various national, regional and international research and development agencies, institutions, departments of agriculture, and a good track record in the organisation, management, administration and implementation of:

(i) regional research and development programmes funded by CDF, USAID, UNDP, FAO, CIDA, IFAD and BDDC;

(ii) commodity networks;

(iii) major consultancies involving farm management, research and development and feasibility studies.

The Institute has been identified by the Standing Committee of Ministers Responsible for Agriculture (SCMA) who also constitute its governing body, as the Executing Agency for this project. CARDI has on its Board of Directors, representatives from all twelve member states of CARICOM. It meets twice each year. CARDI provide the institutional framework for better coordination, organisation and management of the Cotton Research and Development Programme in the region. The projects will fit into CARDI's present crop production programme.

While the arguments for assigning the responsibility for the coordination, organisation and management of this project to CARDI are compelling, there are factors of immediate and future concern that are equally compelling and suggest that an alterative arrangement to making CARDI the executing agency be considered. That alternative is a re-organised and efficiently functioning WISICA Inc.

3.2.6.3 Mission Statement of the Research and Development Division

The mission of the CRDP is to serve Caribbean Cotton growers, processor and marketers in accessing and applying valid technological options which result in:

(i) optimum production management systems

(ii) efficient processing of the harvest production (seed cotton) into high value commodities (lint and seed by-products) which expand marketing opportunities and increase profits and foreign exchange earnings

(iii) development of permanent integrated Sea Island Industry in this region

The successful fulfillment of the mission will be expressed especially in:

(i) Increased production and productivity of Sea Island Cotton.

(ii) Consistent production of high-quality lint and cotton seed by products.

(iii) Reduce per unit production costs to growers and processors.

(iv) Sustainable development of the cotton industry, through continuous supply of high-quality, high-value products and enlightened management of the natural resources in the Caribbean on which Sea Island Cotton production is based.

3.2.6.4 CRDP Programme Scope of Action

The action scope of the CRDP will encompass those disciplinary areas which have been identified too weak for supporting and ensuring viable technological modernization of Sea Island cotton production in the Caribbean. These comprise the six subject matter areas of:

1) Plant Breeding
2) Commercial Seed Production
3) Agronomy
4) Crop Protection
5) Seed Technology
6) Engineering

Other areas can be added later when the needs of the industry so dictate.

The technical activities of the CRDP, during the lifetime of this project can be grouped along four main lines of operations:

1. Technology generation, based on local research or on introduction of technological inputs from outside.

2. Technology transfer, to cotton growers, processors and marketers.

3. Technical service support, to facilitate the adoption of valid technologies by targeted users.

4. Diffusion of information to policy makers, other R/D structures concerned with the development of the Sea Island cotton industry, and general public to garner continued support for the activities of the CRDP.

3.2.6.5 Institutional Organisation

The CRDP will be organized as a network system in which all cooperating countries will be assigned specific as well as common technical responsibilities.

The existing and former cotton Research and Development Programmes in Antigua and Barbuda, Barbados and Montserrat.

- the current Cotton Research/Development Programme of the Ministry of Agriculture of Antigua and Barbuda;

- the current Cotton Research/Development Programme of the Ministry of Agriculture of Barbados (BGI);

- the former Cotton Research/Development Programme of the Ministry of Agriculture of Montserrat (MST);

- the current Cotton/Small Farm Equipment Project of the Ministry of Agriculture of Nevis (NVS)

as well as the current Cotton/small farm equipment project in Nevis will be incorporated into a common functional structure. This institutional arrangement will have Barbados on the nucleus node, linked to three satellite nodes, one each in Antigua and Barbuda, Barbados, Montserrat and St. Kitts and Nevis.

Associate nodes may be developed as other countries or institutions express a wish to participate in the CRDP. This provision is made especially for Belize, Guyana, Jamaica or St. Vincent and the Grenadines.

The Caribbean Cotton Research and Development Network will function as the technology generation and transfer arm of the Sea Island Cotton industry in the core countries covered by this Project. It will establish links with relevant R/D institutions within and outside region. The main ones include:

- CARDI
- IICA
- IRCT of France
- Israel Cotton Research/Development agencies, and
- UWI
- Supima Cotton Association of America

Technical information and materials may be exchanged with public or private cotton Research and Development structures, in Africa (e.g. Senegal, Egypt), Asia (e.g China and India), Central America (El Salvador, Mexico, Nicaragua), North America (USA) and South America (Brazil, Paraguay, Peru).

Each of the six technical components units of CRDP will be led by a competent subject matter specialist (Unit Leader), who will guide, support, monitor and evaluate the work of the professional team assigned to each unit including the corresponding advisory committees by R/D projects within each unit.

A Director, Research and Development should be recruited on the basis of experience professional qualifications and aptitude for management and scientific leadership. The Director, Research

and Development will lead CRDP and be its principal representative in all technical matters.

The Director of Research and Development will be responsible inter alia for overseeing the planning of annual work programme, supervising implementation of CRDP's work programme, receiving and processing R/D project reports, evaluating results and presenting to Project Management Committee a consolidated Annual Report on technical activities and programme performance.

3.2.6.6 Management

The technical work programme of CRDP will be approved by the Board of Directors of WISICA which should be expanded to ensure the following representation:

(i) A representative nominated by each of the Ministries Responsible for Agriculture in Antigua and Barbuda, barbados, Montserrat and St. kitts/Nevis;

(ii) A representative nominated by the Board of Management of Cotton Growers Associations in Antigua and Barbuda, Barbados, Montserrat and St. kitts/Nevis;

(iii) The Chairman in office of Caribbean Cotton Industries Incorporated;

(iv) The Managing Director of Caribbean Cotton Industries Incorporated or his Representative;

(v) The Executive Director of WISICA;

(vi) The Director, Research and Development of WISICA;

(vii) A Representative appointed by the University of the West Indies, Cave Hill Campus;

(viii) A nominee of the Permanent Secretary, Ministry of Agriculture, Food and Fisheries who shall be a legally qualified person;

(ix) The Executive Director of CARDI or his nominee.

The Chairman of the Board of Directors will be appointed by the Minister Responsible for Agriculture of Barbados after consulting with the Ministers Responsible for Agriculture of Antigua and Barbuda, Montserrat and St. Kitts from among suitable national of the four (4) producing countries (Antigua and Barbuda, Barbados, Montserrat and St. Kitts/Nevis).

CHAPTER IV

4. PROJECT BENEFIT, COST AND FINANCING

4.1 Project Cost

The estimated cost of the project up to and including those years that loan/grant funds will be required from the EEC is put at US$7,608 million. However, the estimated cost of the project, on the assumption that it covers a ten (10) year period is US$15,108 million. A detailed breakdown of the estimate by years and line-item appear in Table 4.1.

(a) Administration

This is the cost of the project executing unit. The total of US$71,000 per annum breaks down in $20,000 for travel and per diem for members of the project management committee.

(b) Professional Cost

The total of US$725,000 per annum for this item includes renumeration as well as recruitment costs for both national and international professionals.

(c) Consultants

The total of $18,000 is for consultant fees for three professionals man-months per year as back-stop support for the project in critical areas of plant protection.

(d) Support Staff

This consists of US$219,000 for staff that are expected to support for the field trials and evaluation work.

(e) Training

This covers the cost for post-graduate training of counterpart staff, intensive short courses, as well as workshops and seminars.

(f) Travel and Per Diem

The total of US$120,000 allocated annually covers the cost of local, regional and international travel for consultants, international professionals, and local counterpart staff. The travel component is estimated at US$70,000 and that for per diem put at US$50,000.

(g) Direct Investment Cost

Direct investment cost is estimated at US$296,000 in year 1 and US$19,000 annually, thereafter, except at the beginning of year 6 when replacement investment cost of US$248,000 will have to be made. US$90,000 is allocated for the purchase of six (6) duty free vehicles, three for Barbados (Headquarters) and one each for Antigua, Montserrat and St. Kitts/Nevis.

(h) General Support

The total of US$87,000 budgeted is for purposes of providing general office supplies, leasing of space for the head office in Barbados and the three regional sub-offices, for printing and publishing training materials, for communications, and for the operations and maintenance of the vehicles.

(i) Unallocated Costs

These have been calculated using international guidelines.

4.2 Project Benefit

The magnitude of the benefits accruing from the full implementation of the project with respect to (a) increased cotton acreage under production (b) increased levels of productivity, (c) incremental cotton lint output and (d) incremental export revenues are presented in Tables 4.2 through 4.5, respectively. Acreage under production is expected to move from 1,022 acres in year 1 to 8,000 acres by year 10. Cotton lint yield per acre is projected to increase from an average of 336 pounds per acre in year 1 of the project to 441 pounds per acre by year 5 of the project.

The increased acreage and improved productivity are expected to combine to produce an overall output of 3.193 million pounds of cotton lint, having a total export value of US$17.53 million by year 10 of the project.

4.3 Economic Analysis

The production cost model for an acre of cotton is presented in Table 4.6. Incremental net economic benefit is expected to total some US$52.4 million over the life of the project (10 years). This incremental analysis is presented in Table 4.7. Incremental economic analysis before financing is presented in Table 4.8.

The economic benefit/cost ratio at a discount rate of 12% is estimated at 1.38, while the Net Present Value (NPV) at similar rate of discount is put at some US$11.23 million (See Table 4.9). Details of the assumptions used in the economic analysis are presented in Annex 3, while economic price and marketing costs calculations for cotton lint are presented in Annex 4. Projected

royalty available for cotton research and development is presented in Annex 5.

4.4 Sensitivity Analysis

Analysis were conducted to examine how sensitive the project's Benefit/Cost Ratio, Net Present Value, and Economic Rate of return are to:

(a) a fall in the market price for cotton lint; and

(b) a shortfall in the anticipated new lands under production.

Market Price for Cotton Lint

A market price for US$4.00 per pound for cotton lint was assumed. The analysis, as presented in Annex 6A and 6B show that the project is highly sensitive to market price changes. A US$1.50 reduction (27.3%) in US$5.50 to US$4.00 per lb cotton lint, resulted in the EIRR of project moving from 46.6% to 5.2%. It should be noted however, that line, yarn and products made from genuine Sea Island Cotton would not be subjected to the vagaries of fluctuations on the international commodity markets. Supply and demand can be controlled at every stage.

New Lands under Cotton Cultivation

A fifty percent (50%) shortfall in the new acreages under cotton cultivation was assumed. Results of the analysis, as presented in Annex 7A and 7B show that this project is not as sensitive to this variable, as it is to market prices.

4.5 Project Financing

The sources and uses of project funds is presented in Table 4.10. It is expected that during the first five years of the project a tranche of US$2.35 million will be provided by the EEC under Lome IV Regional Agricultural allocation. The participating countries are expected to make average annual contribution mainly in kind as follows:

County	Average Annual Contribution
	US$000
Antigua and Barbuda	201.8
Barbados	266.9
Montserrat	94.3
St. Kitts/Nevis	97.9

It is important to note that sustainability of the project is highly dependent on the achievement of substantial increased in regional cotton lint output for export and for processing into fabrics and other commodities once spinning, weaving , knitting and dyeing facilities are established. This is so, as a significant percentage of project funding (especially in the latter years) is expected to come from royalties to be generated from the sale of yarn.

TABLE 4.1
ESTIMATED PROJECT COST
(US $,000)

	YEARS										
	1	2	3	4	5	6	7	8	9	10	TOTAL
1. ADMINISTRATION											
1.1 General Administration	20	20	20	20	20	20	20	20	20	20	200
1.2 Project Coordinator	-	-	-	-	-	-	-	-	-	-	-
1.3 Project Secretary (1)	20	20	20	20	20	20	20	20	20	20	200
1.4 Computer Clerk/Typist (1)	12	12	12	12	12	12	12	12	12	12	120
1.5 Messenger/Driver	10	10	10	10	10	10	10	10	10	10	100
1.6 Office Attendant	9	9	9	9	9	9	9	9	9	9	90
											0
Sub Total Administration	71	71	71	71	71	71	71	71	71	71	710
2. PROFESSIONAL COST											
2.1 Director, Research & Development (Project Coordinator) (1)	60	60	60	60	60	60	60	60	60	60	600
2.2 Dep. Dir. Research & Development (Counterpart Breeder) (1)	50	50	50	50	50	50	50	50	50	50	500
2.3 Cotton Breeder Expert (1)	55	55	55	55	55	55	55	55	55	55	550
2.4 Counterpart Breeder (1)	30	30	30	30	30	30	30	30	30	30	300
2.5 Agronomist (2)	100	100	100	100	100	100	100	100	100	100	1000
2.6 Counterpart Agronomist (4)	100	100	100	100	100	100	100	100	100	100	1000
2.7 Agricultural Engineer (1)	40	40	40	40	40	40	40	40	40	40	400
2.8 Entomologist (1)	50	50	50	50	50	50	50	50	50	50	500
2.9 Director, Extenstion Unit (1)	40	40	40	40	40	40	40	40	40	40	400
2.10 Extension Officer (10)	200	200	200	200	200	200	200	200	200	200	2000
Sub Total Professional	725	725	725	725	725	725	725	725	725	725	7250
3. CONSULTANT											
3.1 Plant Protection (3PPM/yr)	18	18	18	18	18	18	18	18	18	18	180
4. SUPPORT STAFF											
4.1 Field Technicians (9)	135	135	135	135	135	135	135	135	135	135	1350
4.2 Field Workers (6)	54	54	54	54	54	54	54	54	54	54	540
4.3 Senior Laboratory Technician (1)	18	18	18	18	18	18	18	18	18	18	180
4.4 Laboratory Technician (1)	12	12	12	12	12	12	12	12	12	12	120
Sub Total Support Staff	219	219	219	219	219	219	219	219	219	219	2190
5. TRAINING	60	60	60	45	45	45	45	45	45	45	495

Table 4.1 cont'd

	YEARS										
	1	2	3	4	5	6	7	8	9	10	TOTAL
6. TRAVEL											
Local travel	40	40	40	40	40	40	40	40	40	40	400
Regional/International	30	30	30	30	30	30	30	30	30	30	300
Sub Total Travel	70	70	70	70	70	70	70	70	70	70	700
7. PER DIEM	50	50	50	50	50	50	50	50	50	50	500
8. DIRECT INVESTMENT											
8.1 Germplasm Collection	15										15
8.2 Breeding and Selection	28					3					31
8.3 Seed Production/Testing	8										8
8.4 Agronomy	5					5					10
8.5 Crop Protection	56	19	19	19	19	56	19	19	19	19	264
8.6 Fibre Testing Laboratory	76					76					152
8.7 Vehicles (6) at $15,000	90					90					180
8.8 Computers	14					14					28
8.9 Airconditioner/Humidifier	4					4					8
											0
Sub Total Investment	296	19	19	19	19	248	19	19	19	19	696
9. GENERAL SUPPORT											
9.1 General Supplies	18	18	18	18	18	18	18	18	18	18	180
9.2 Leasing of Buildings	30	30	30	30	30	30	30	30	30	30	300
9.3 Publications	12	12	12	12	12	12	12	12	12	12	120
9.4 Communications	18	18	18	18	18	18	18	18	18	18	180
9.5 Fuel, Lubricants and Maintenence	9	9	9	9	9	9	9	9	9	9	90
											0
Sub Total General Support	87	87	87	87	87	87	87	87	87	87	870
10. UNALLOCATED COST											
10.1 Physical Contingencies (10% of 8-9)	38	11	11	11	11	34	11	11	11	11	160
10.2 Price Contingencies (10% of 1-9)	160	132	132	130	130	153	130	130	130	130	1357
Sub Total Unallocated Cost	198	143	143	141	141	187	141	141	141	141	1517
TOTAL ESTIMATED COST	1794	1462	1462	1445	1445	1720	1445	1445	1445	1445	15108

TABLE 4.2
ESTIMATED EXISTING AND NEW CULTIVATION
(Acres)

COUNTRY	EXISTING CULTIVATIONS YR0	NEW CULTIVATIONS (TOTAL ACREAGE UNDER CONTROL) YR1	YR2	YR3	YR4	YR5	YR6	YR7	YR8	YR9	YR10
Antigua	95	95	150	350	750	1250	1800	2200	2500	2750	3000
Barbados	900	900	1200	1750	2100	2500	3000	3300	3600	3800	4000
Montserrat	0	0	15	50	100	160	200	240	260	280	300
St. Kitts/Nevis	27	27	60	120	180	250	300	400	500	600	700
Total	1022	1022	1425	2270	3130	4160	5300	6140	6860	7430	8000

TABLE 4.3
ESTIMATED EXISTING AND NEW AVERAGE ANNUAL YIELDS
(LBS PER ACRE COTTON LINT)

COUNTRY	EXISTING AVERAGE YIELD PER ACRE (LBS	ANNUAL AVERAGE COTTON LINT YIELD PER ACRE (LBS) YR1	YR2	YR3	YR4	YR5	YR6	YR7	YR8	YR9	YR10
Antigua	270	270	300	325	365	405	405	405	405	405	405
Barbados	350	350	385	420	475	525	525	525	525	525	525
Montserrat	200	200	220	240	270	300	300	300	300	300	300
St. Kitts/Nevis	120	120	130	145	160	180	180	180	180	180	180

Table 4.4
TOTAL INCREMENTAL OUTPUT FROM EXISTING AND NEW COTTON CULTIVATIONS
(Cotton Lint lbs.)

	PROJECT YEARS									
	1	2	3	4	5	6	7	8	9	10
NEW CULTIVATIONS										
Antigua	25650	45000	113750	273750	506250	729000	891000	1012500	1113750	1215000
Barbados	315000	462000	735000	997500	1312500	1575000	1732500	1890000	1995000	2100000
Montserrat	0	3300	12000	27000	48000	60000	72000	78000	84000	90000
St. Kitts/Nevis	3240	7800	17400	28800	45000	54000	72000	90000	108000	126000
Total - New	343890	518100	878150	1327050	1911750	2418000	2767500	3070500	3300750	3531000
EXISTING CULTIVATION										
Antigua	25650	25650	25650	25650	25650	25650	25650	25650	25650	25650
Barbados	315000	315000	315000	315000	315000	315000	315000	315000	315000	315000
Montserrat	0	0	0	0	0	0	0	0	0	0
St. Kitts/Nevis	3240	3240	3240	3240	3240	3240	3240	3240	3240	3240
Total - Existing	343890	343890	343890	343890	343890	343890	343890	343890	343890	343890
INCREMENTAL OUTPUT										
Antigua	0	19350	88100	248100	480600	703350	865350	986850	1088100	1189350
Barbados	0	147000	420000	682500	997500	1260000	1417500	1575000	1680000	1785000
Montserrat	0	3300	12000	27000	48000	60000	72000	78000	84000	90000
St. Kitts/Nevis	0	4560	8760	25560	41760	50760	68760	86760	104760	122760
Total - Incremental	0	174210	528860	983160	1567860	2074110	2423610	2726610	2956860	3187110

Table 4.5
TOTAL INCREMENTAL BENEFIT
(US$)

	PROJECT YEARS									
	1	2	3	4	5	6	7	8	9	10
NEW CULTIVATIONS										
Antigua	141075	247500	625625	1505625	2784375	4009500	4900500	5568750	6125625	6682500
Barbados	1732500	2541000	4042500	5486250	7218750	8662500	9528750	10395000	10972500	11550000
Montserrat	0	18150	66000	148500	264000	330000	396000	429000	462000	495000
St. Kitts/Nevis	17820	42900	95700	158400	247500	297000	396000	495000	594000	693000
Total - New	1891395	2849550	4829825	7298775	10514625	13299000	15221250	16887750	18154125	19420500
EXISTING CULTIVATION										
Antigua	141075	141075	141075	141075	141075	141075	141075	141075	141075	141075
Barbados	1732500	1732500	1732500	1732500	1732500	1732500	1732500	1732500	1732500	1732500
Montserrat	0	0	0	0	0	0	0	0	0	0
St. Kitts/Nevis	17820	17820	17820	17820	17820	17820	17820	17820	17820	17820
Total - Existing	1891395	1891395	1891395	1891395	1891395	1891395	1891395	1891395	1891395	1891395
INCREMENTAL BENEFIT										
Antigua	0	106425	484550	1364550	2643300	3868425	4759425	5427675	5984550	6541425
Barbados	0	808500	2310000	3753750	5486250	6930000	7796250	8662500	9240000	9817500
Montserrat	0	18150	66000	148500	264000	330000	396000	429000	462000	495000
St. Kitts/Nevis	0	25080	77880	140580	229680	279180	378180	477180	576180	675180
Total - Incremental	0	958155	2938430	5407380	8623230	11407605	13329855	14996355	16262730	17529105

Table 4.6
COTTON LINT PRODUCTION COST MODEL
(US $ PER ACRE)

	Financial Values		Conversion	Economic Values	
	Without Project	With Project	Factor (C.F)	Without Project	With Project
A. LABOUR					
Land Clearing (Amortized)	4.0	5.0	0.60	2.4	3.0
Land Preparation	62.5	68.0	0.60	37.5	40.8
Planting	33.0	35.0	0.60	19.8	21.0
Weed Control	78.0	102.0	0.60	46.8	61.2
Pests/Disease Control	104.5	185.5	0.60	62.7	111.3
Fertilizing	37.0	51.0	0.60	22.2	30.6
Cultural Operations	58.0	82.5	0.60	34.8	49.5
Harvesting	320.5	380.5	0.60	192.3	228.3
B. SERVICES	37.5	48.0	0.80	30.0	38.4
C. MATERIALS					
Seeds	6.0	9.0	0.80	4.8	7.2
Fertilizers	75.5	115.0	0.95	71.7	109.3
Weedicides	31.5	40.5	0.95	28.4	38.5
Pesticides	87.0	140.0	0.95	82.7	133.0
Cultural Operations	18.5	27.0	0.80	14.8	21.6
TOTAL COST	953.5	1289.0		650.9	893.6

Table 4.7
INCREMENTAL PRODUCTION COST OF PROJECT
(US$)

	PROJECT YEARS									
	1	2	3	4	5	6	7	8	9	10
1. With Project Production Cost										
Labour	427710	777480	1238510	1707730	2269700	2891680	3349985	3742815	4053810	4364800
Services	30660	54720	87170	120190	159745	203520	235775	263425	285310	307200
Materials	206850	441180	720790	969050	1287935	1640880	1900945	2123855	2300330	2476800
Total With Project Cost	665220	1273380	2046470	2796970	3717380	4736080	5486705	6130095	6639450	7148800
2. Without Project Production Cost										
Labour	427710	427710	427710	427710	427710	427710	427710	427710	427710	427710
Services	30660	30660	30660	30660	30660	30660	30660	30660	30660	30660
Materials	206850	206850	206850	206850	206850	206850	206850	206850	206850	206850
Total Without Project Production Cost	665220	665220	665220	665220	665220	665220	665220	665220	665220	665220
3. Incremental Cost										
Labour		349770	810800	1280020	1841990	2463970	2922275	3315105	3626100	3937090
Services		24060	56510	89530	129085	172860	205115	232765	254650	276540
Materials		234330	513940	762200	1081085	1434030	1694095	1917005	2093480	2269950
Total Incremental Production Cost		608160	1381250	2131750	3052160	4070860	4821485	5464875	5974230	6483580

Tables 4.8
TOTAL INCREMENTAL ECONOMIC ANALYSIS BEFORE FINANCING
(US$)

ITEM	PROJECT YEARS									
	1	2	3	4	5	6	7	8	9	10
1. Project Benefits										
1.1 Sales Revenue										
Antigua	0	106425	484550	1364550	2643300	3868425	4759425	5427675	5984550	6541425
Barbados	0	808500	2310000	3753750	5486250	6930000	7796250	8662500	9240000	9817500
Montserrat	0	18150	66000	148500	264000	330000	396000	429000	462000	495000
St. Kitts/Nevis	0	25080	77880	140580	229680	279180	378180	477180	576180	675180
Incremental Project Benefit	0	958155	2938430	5407380	8623230	11407605	13329855	14996355	16262730	17529105
2. Project Cost										
2.1 Capital Cost (R&D)										
General Project Administration	158000	158000	158000	158000	158000	158000	158000	158000	158000	158000
Technical Assistance	1022000	1022000	1022000	1007000	1007000	1007000	1007000	1007000	1007000	1007000
Travel and Per Diem	120000	120000	120000	120000	120000	120000	120000	120000	120000	120000
Materials and Equipment	296000	19000	19000	19000	19000	248000	19000	19000	19000	19000
Contingencies	198000	143000	143000	141000	141000	187000	141000	141000	141000	141000
Sub-Total Capital Cost	1794000	1462000	1462000	1445000	1445000	1720000	1445000	1445000	1445000	1445000
2.2 Production Cost										
Labour	0	349770	810800	1280020	1841990	2463970	2922275	3315105	3626100	3937090
Services	0	24060	56510	89530	129085	172860	205115	232765	254650	276540
Materials	0	234330	513940	762200	1081085	1434030	1694095	1917005	2093480	2269950
Sub-Total Production Cost	0	608160	1381250	2131750	3052160	4070860	4821485	5464875	5974230	6483580
2.3 Maintenance and Other Cost	0	51665	160280	294950	470360	622235	727085	817985	887060	956135
2.4 Marketing Cost	0	109355	339255	624310	995590	1317060	1538990	1731400	1877610	2023815
TOTAL INCREMENTAL COST	1794000	2231180	3342785	4496010	5963110	7730155	8532560	9459260	10183900	10908530
NET INCREMENTAL BENEFITS	-1794000	-1273025	-404355	911370	2660120	3677450	4797295	5537095	6078830	6620575

Tables 4.9
ECONOMIC COST/BENEFIT ANALYSIS
(Incremental Analysis)

ITEMS	PROJECT YEARS									
	1	2	3	4	5	6	7	8	9	10
1. Project Benefits		958155	2.9E+07	5407380	8623230	1.1E+07	1.3E+07	1.5E+07	1.6E+07	1.8E+07
2. Project Cost	1794000	2.2E+07	3342785	4496010	5963110	7730155	8532560	9459260	1E+07	1.1E+07
3. Net Farm benefit (1-2)	-1794000	-1.3E+06	-404355	911370	2660020	3677450	4797295	5537095	6078830	6620575
4. Discount Factor (12%)	0.893	0.797	0.712	0.636	0.567	0.507	0.452	0.404	0.361	0.322
5. Present Value Benefit (4x1)	0	763650	2091890	3439095	4889370	5783655	6025095	6058530	5870045	5644370
6. Present Value Cost (4x2)	1602000	1778250	2380063	2859462	3381083	3919188	3856717	3821541	3676387	3512547
7. Net Present Value (4x3)	-1602000	1014600	-287901	579631	1508231	1864467	2168377	2236986	2194458	2131825

(a) Economic Benefit/Cost Ration at Discount rate of 12%
Economic Benefit = US$40,565,700
Economic Cost = US$30,787,238
Benefit/Cost Ratio = 1.32

(b) Net Present Value (NPV) of Project at Discount Rate of 12%
NPV = US$9,779,474

(c) Economic Rate of Return (EIRR) of Project = 46.6%

Table 4.10
SOURCES AND USES OF FUNDS
(US$000)

ITEMS	PROJECT YEARS									
	1	2	3	4	5	6	7	8	9	10
1. Sources										
1.1 Loan/Grant - Lome IV	713	417	417	402	402					
1.2 WISICA's Contribution	256	255	255	255	255	255	255	255	255	255
1.3 R & D Royalty Allocation from sale of lint	61	92	157	237	341	431	494	548	589	630
1.4 Govt. of Antigua (Kind)	242	215	190	158	116	351	215	193	177	161
1.5 Govt. of Barbados (Kind)	317	284	251	211	159	453	284	257	237	216
1.6 Govt. of Montserrat (kind)	97	96	94	91	88	105	95	94	92	91
1.7 Govt. of St. Kitts/Nevis (Kind)	108	103	98	91	84	125	102	98	95	92
TOTAL SOURCES	1794	1462	1462	1445	1445	1720	1445	1445	1445	1445
2. Uses (Applications)										
2.1 Project Management	158	158	158	158	158	158	158	158	158	158
2.2 Technical Assistance and Training	1022	1022	1022	1007	1007	1007	1007	1007	1007	1007
2.3 Travel and Per Diem	120	120	120	120	120	120	120	120	120	120
2.4 Equipment and Materials	296	19	19	19	19	248	19	19	19	19
2.5 Contigencies	198	143	143	141	141	187	141	141	141	141
TOTAL USES	1794	1462	1462	1445	1445	1720	1445	1445	1445	1445

CHAPTER V

5. PROJECT EXECUTION

5.1 Institutional and Administrative Arrangements

5.1.1 Objectives

The overall objective of the project execution is to strengthen the research capability and technology transfer systems at the national and regional levels.

The specific objectives will be:

(a) to establish mechanisms for cooperation between participating countries to avoid duplication of efforts and to maximise the use of scarce resources

(b) to generate and transfer technology for various aspects of cotton production

(c) to improve the scientific proficiency of the human resources in research and transfer of cotton technology

(d) to develop linkages for better communication and information exchange between scientists, institutions and cotton growers in a timely manner.

5.1.2 Scope of Action of Project

The action scope of the project will encompass the following disciplinary areas:-

1. Plant Breeding
2. Agronomy
3. Crop Protection
4. Seed Technology
5. Commercial Seed Production
6. Engineering

Other areas may be added later as deemed relevant for the development of the cotton industry in the region.

The technical activities to be undertaken can be divided into:

(a) research and development

(b) provision of technical services

(c) training, seminars and workshops

(d) provision of supplies and equipment

5.1.3 Project Executing Unit (PEU)

There is in existence in the region an organisation which is mandated by its statute to undertake research and development activities set out in this project document. Moreover, the West Indian Sea Island Cotton Association Inc also has the responsibility to operate, advertise and protect the Trade Mark it owns. Inherent in this obligation is the need to establish standards for Sea Island Cotton and to certify lint and yarn quality as well as fabric and items manufactured from Sea Island Cotton.

WISICA has not carried out this mandate in full or with the efficiency or care required by its statute or in keeping with the intrinsic value and importance of this label. However, despite the obvious cachet of exclusivity attached to Sea Island Cotton, it is of the utmost importance to be able to identify and separate this fibre from other varieties of cotton at any stage in its use. It is only through the application of the Trade Mark that Sea Island is recognised and that the price disparity between Sea Island and any other variety of cotton can be maintained and enhanced.

For these reasons, it is proposed and strongly recommended that the task of the Project Executing Agency be assigned to a re-organised WISICA and it be given the authority and responsibility to plan, programme, co-ordinate, administer, monitor development and implementation of all aspects of project activities.

An Executive Director of WISICA should be the Chief Executive Officer of the re-organised Association and will be directly responsible to the Board of Directors of WISICA for the overall management and administration of the affairs of the organisation. A Director of Research and Development will be appointed and will have primary responsibility for all aspects of the research and development programme and will be advised and assisted by a Project Management Committee (PMC).

WISICA will be required to submit an annual report through its Board of Directors to the Cotton Industry Development Board.

The main duties and functions of the Executive Director should be:

(i) To provide the necessary administrative services (personnel, equipment and accessories, communication services) and technical support required by the personnel executing the Research and Development activities in accordance with the corresponding budget allocations.

(ii) To administer the financial resources of the program.

(iii) To contract the services of all international and national staff of the Association.

(iv) To contract the services of the international and other specialists for short-term assistance.

(v) To submit to the PMC and the Donor(s), the work plans and reports regarding the progress of the project.

(vi) To see to the provision by the participating countries of the counterparts/facilities required in the execution of the project.

(vii) To convene meetings of the PMC.

It is recommended that the project headquarters be located in Barbados. The place of work of the international and short-term specialists will be determined in accordance with the requirements of the project and the needs of the countries as specified in the work programme.

The unit which would have oversight functions on behalf of the CARICOM countries would be WISICA. A Cotton Industry Development Board should be established. This Board will be expected to give policy direction for the overall development of the Cotton Industry in the region. Membership should include:

(a) a Chairman - to be appointed by the Secretary General of CARICOM after consultations with the Board of Directors of CCII and WISICA Inc.

(b) the Chairmen of the Boards of Directors of WISICA Inc and CCII.

(c) the Executive Director of WISICA and the Managing Director of CCII.

(d) a high level representative appointed be each of the governments of Antigua and Barbuda, Barbados, Montserrat and St. Kitts and Nevis.

(e) a representative appointed by the Cotton Growers Associations in the four (4) producing countries.

(f) a representative of CARDI.

(h) a representative of the University of the West Indies.

There would be formed a Project Management Committee (PMC), which would have principal responsibility and authority for the direction supervision and functioning of the project network. The

Project Management Committee (PMC) should comprise:

(a) Representative of CARICOM who will be Chairman of the Committee.

(b) Representative of CCII.

(c) Representative of 4 participating governments

(d) Representative of the University of the West Indies, Cave Hill Campus.

(e) Representative of Cotton Growers Association where these are functional.

(f) Representative of CARDI.

(g) The Executive Director of WISICA.

(h) Director, Research and Development, WISICA.

The functions of this Committee would be:

(a) to determine priorities for agricultural research and development

(b) to facilitate information exchange between national, regional and international organizations on research programmes

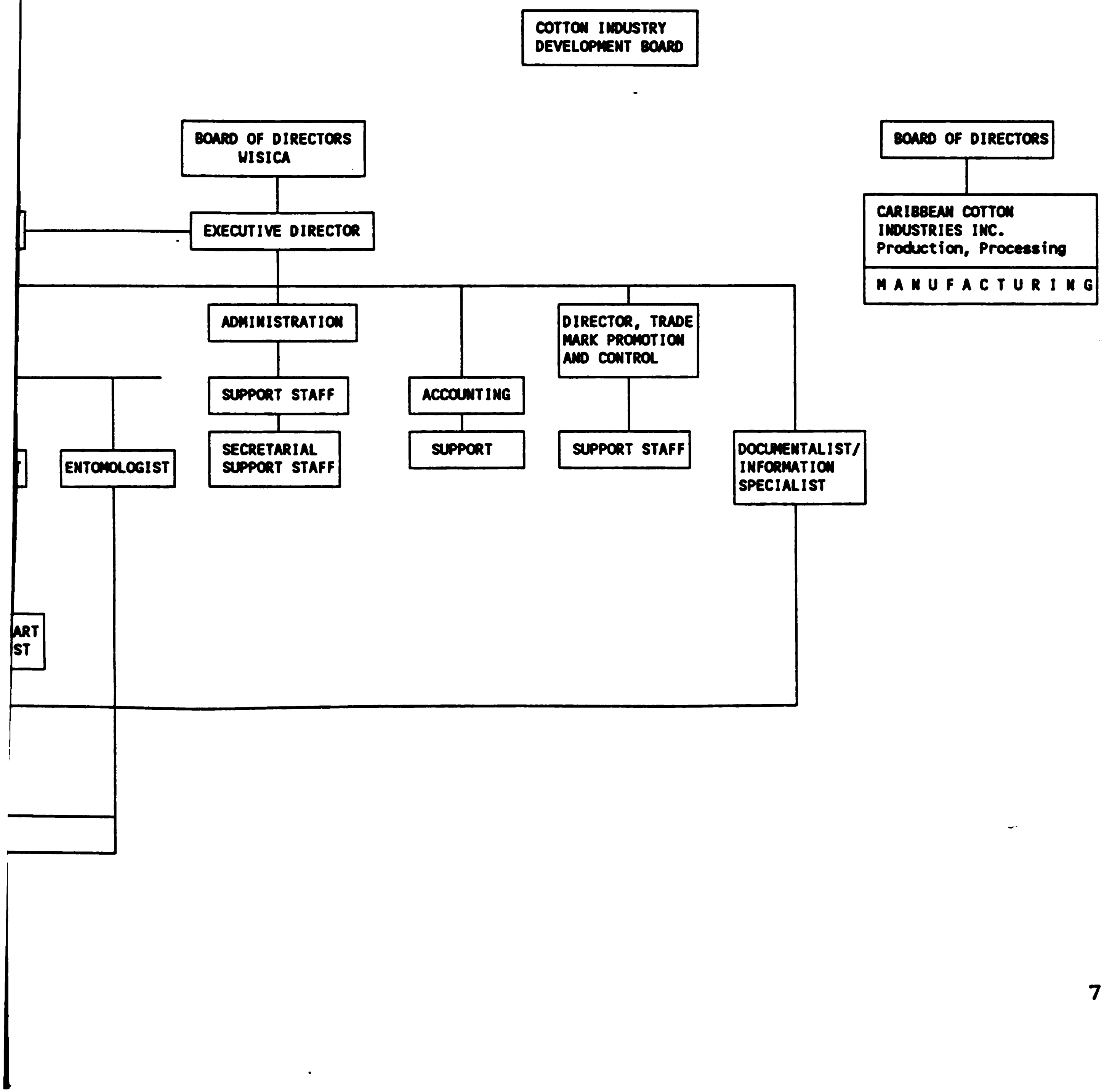
(c) to promote collaboration between national, regional and international organizations involved in agricultural research and development in the region

(d) to define research policy guidelines

(e) to approve the annual work programme and budget.

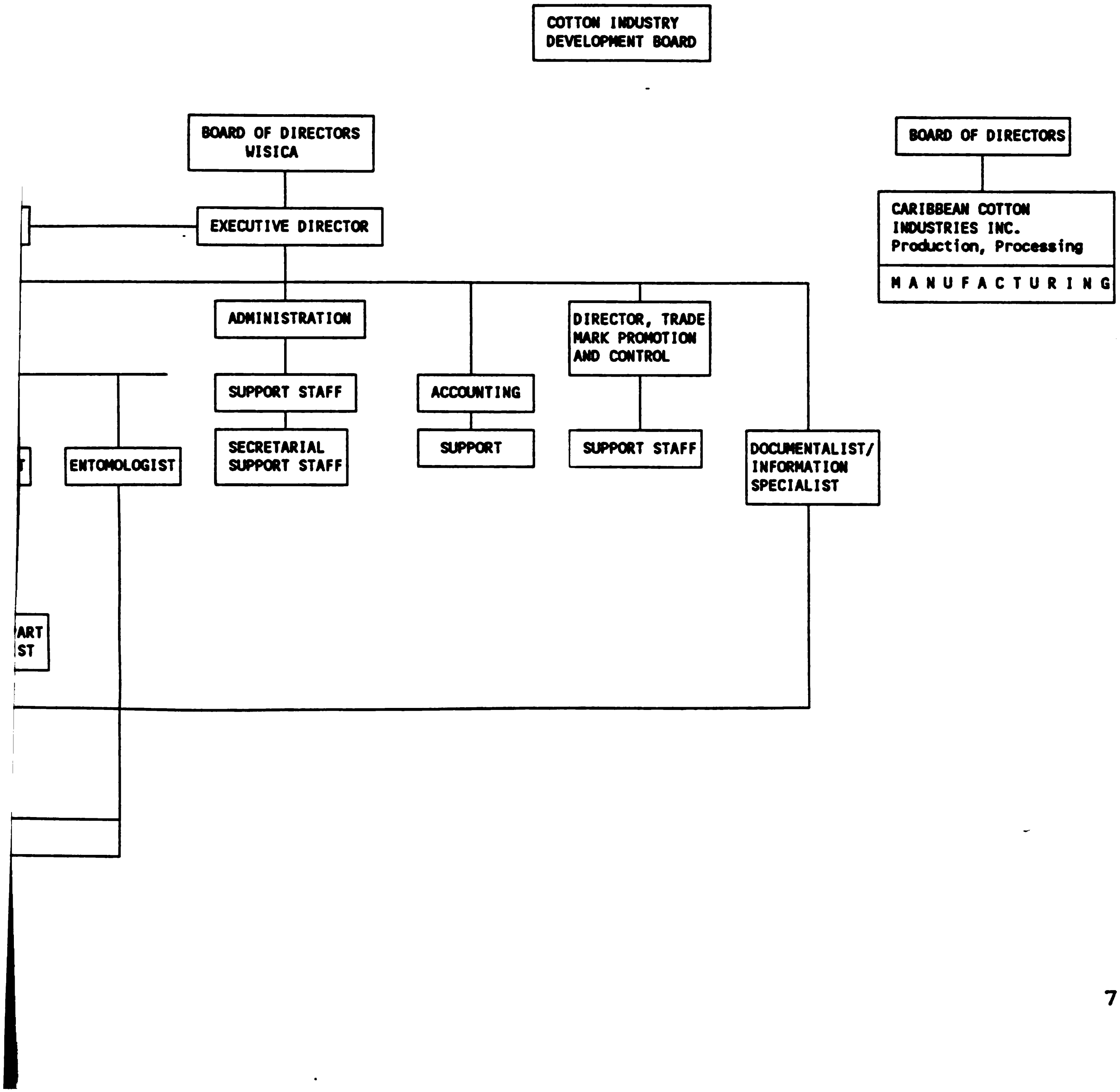
The Director of Research and Development of WISICA will head the project and will have primary responsibility for all aspects of the Research and Development Programme and its implementation

FIGURE 5.2



COTTON INDUSTRY DEVELOPMENT BOARD
BOARD OF DIRECTORS WISICA
BOARD OF DIRECTORS
CARIBBEAN COTTON INDUSTRIES INC. Production, Processing
M A N U F A C T U R I N G
EXECUTIVE DIRECTOR
ADMINISTRATION
DIRECTOR, TRADE MARK PROMOTION AND CONTROL
SUPPORT STAFF
ACCOUNTING
SECRETARIAL SUPPORT STAFF
SUPPORT
SUPPORT STAFF
DOCUMENTALIST/ INFORMATION SPECIALIST
ENTOMOLOGIST
ART
ST

FIGURE 5.2


COTTON INDUSTRY DEVELOPMENT BOARD
BOARD OF DIRECTORS WISICA
EXECUTIVE DIRECTOR
ADMINISTRATION
SUPPORT STAFF
SECRETARIAL SUPPORT STAFF
ACCOUNTING
SUPPORT
DIRECTOR, TRADE MARK PROMOTION AND CONTROL
SUPPORT STAFF
DOCUMENTALIST/ INFORMATION SPECIALIST
ENTOMOLOGIST
BOARD OF DIRECTORS
CARIBBEAN COTTON INDUSTRIES INC. Production, Processing
MANUFACTURING

The duties of the Director of Research and Development subject to any rules drawn up by the PMC should include the following:

(i) To be guided by the decisions of the PMC

(ii) To prepare documents and reports as required

(iii) To manage the activities of the Research and Development Programme

(iv) To draw up the long-term and annual work programs, budgets and program reports.

(v) To supervise and monitor research and development activities, identify and take, or when the necessary, propose measures to solve problems and optimize those activities

(vi) To control the project budget and expenses and ensure efficient financial management in accordance with the provisions and requirements of the project and CARDI

(vii) To provide liaison between the various components of the project and with international institutions

(viii) Convene technical seminars at which the research findings will be presented and discussed

(ix) Approve recommendations of candidates for training

(x) To liaison with other research institutions and/or networks engaged in activities of current or future interest to the sub-region

The Research Specialists should be recruited from the Caribbean and also from other areas where necessary and appropriate. However, recruitment within the sub-region must not be such as to weaken the national research systems. WISICA must develop the necessary linkages and enter into suitable relationship with agencies/institutions for consultancies and technical assistance.

A special Committee should be set up to draw up the qualifications, job descriptions and emoluments of the professional and technical personnel to be recruited for the Research and Development Programme. Membership should include:

(a) The Chief Personnel Officer, Barbados, who will be the Chairman.

(b) The Chief Agriculture Officer/Director of Agriculture in Antigua and Barbuda, Barbados, Montserrat and St. Kitts and Nevis.

(c) A representative of CARDI.

(d) A representative of the University of the West Indies, Cave Hill Campus.

The Officer responsible for Administration in WISICA should perform the duties of Secretary. This Committee would also conduct interviews of applicants and recommend suitable candidates for appointment subject to the Project Management Committee.

The Research Specialists will be funded either from programme funds or through technical assistance, they will work full time on the programme in support of project activities. They will be attached to the national unit but be required to serve in other countries. Their duties will be:

(i) To execute such activities as may be agreed upon by the PMC

(ii) To give support in specific areas to activities carried out by national or regional entities within the framework of the project

(iii) To carry out any further activities as may be determined by the Project Leader.

5.1.4 Participation of Beneficiaries

5.4.1.1 Introduction

The resources of the existing cotton Research and Development Programmes of the government of participating countries are expected to be transferred to WISICA for administration and management within the framework of the proposed project. The participating countries are therefore expected to provide:

(i) The professionals required for activities foreseen in the spheres of reciprocal technical co-operation and training

(ii) The necessary administrative installations and services for the execution of the project activities in the respective countries

(iii) The support required to carry out advisory activities and for the short term consultants in specific problems

(iv) Funding of the staff and operations of their units at a minimum of current levels.

5.1.4.2 Organization of the Cotton Germplasm Collection

On the basis of the proposal presented in Section 3.2.1.2, Chapter 3, only one SI Cotton Germplasm Collection should be maintained in the region. It should have the required storage and handling facilities.

It is recommended that this Germplasm Collection be based in Barbados inasmuch as it has already taken the initiative in this area and already has at its disposition seed and fibre testing laboratories which are indispensable in the management of the Collection.

Since this Germplasm Bank will serve as the World Depository of the SI genetic material, it would be prudent to maintain a duplicate of the entire collection in Antigua to back up the Barbados Germplasm Bank. This duplicate collection would not involve any multiplication nor evaluation functions. Seeds produced from the different Bank accessions would be systematically sent to Antigua for safe-keeping.

5.1.4.3 Breeding/selection programme

The mechanisms for implementing the breeding/selection programme are presented through the form of an organogramme in Figure 5.2. Following is a detailed explanation of these mechanics.

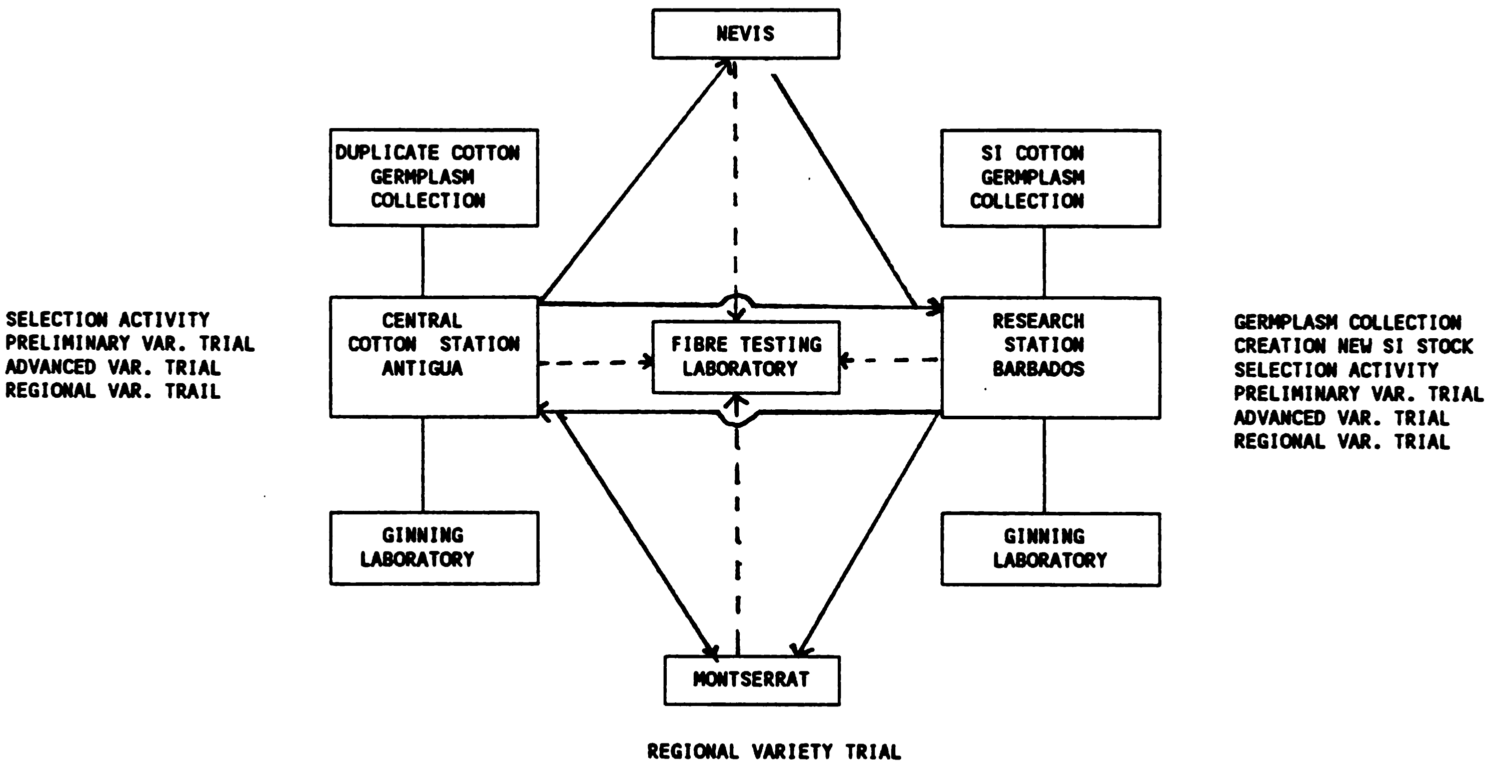
(a) Creation of genetic variability

With the assumption that Barbados would handle the germplasm collection, it is vital that basic breeding work aimed at creating genetic variability (programme of crosses and production of F2 seeds), be carried out in that country.

(b) Selection activity

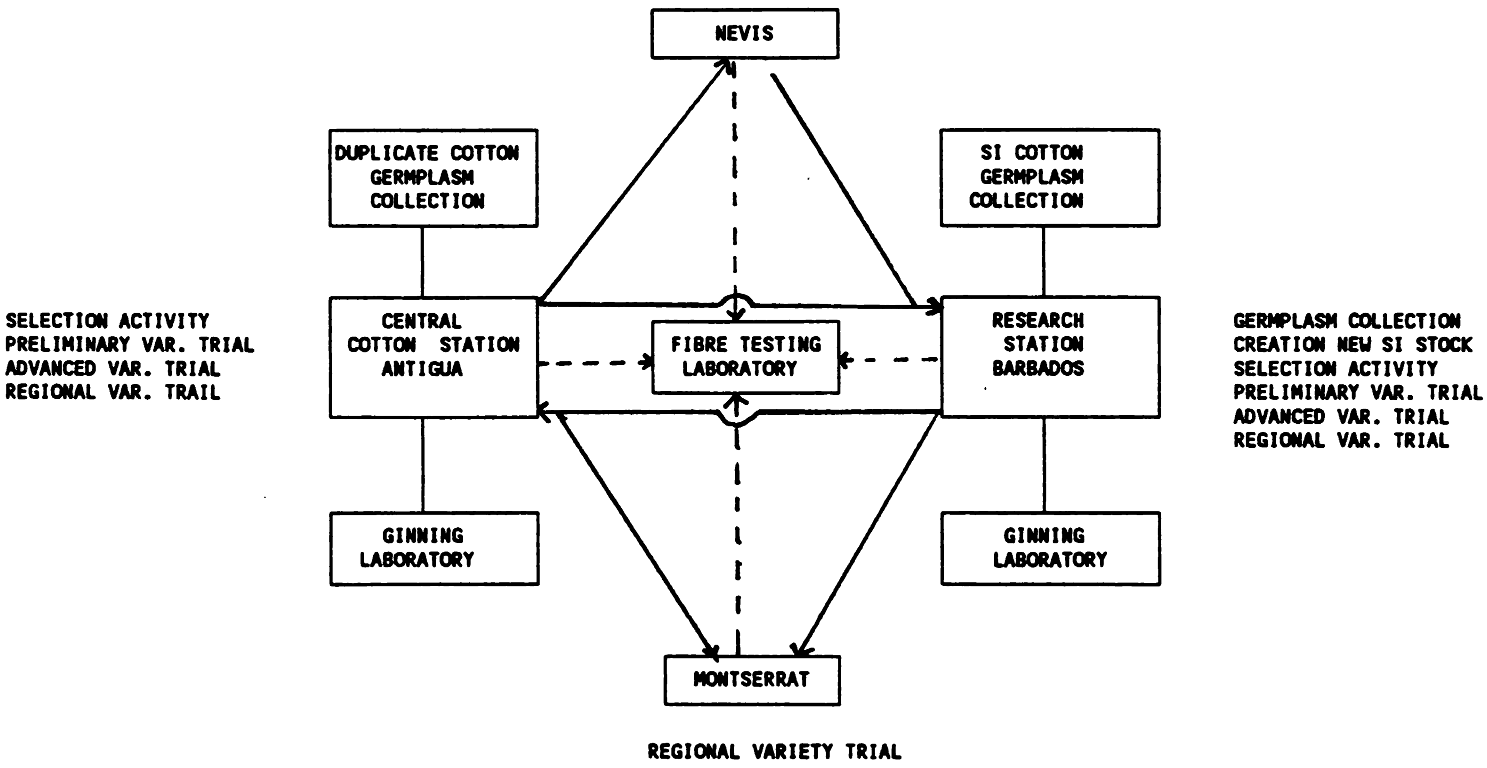
Selection activities should be conducted both in Barbados and Antigua using the F2 seeds produced and distributed by Barbados.

FIGURE 5.2
ORGANISATIONAL SET-UP OF THE PROPOSED SEA ISLAND
BREEDING AND VARIETAL EXPERIMENTATION PROJECT



: Exchange of genetic material
: Fibre samples sent for analysis

FIGURE 5.2
ORGANISATIONAL SET-UP OF THE PROPOSED SEA ISLAND BREEDING AND VARIETAL EXPERIMENTATION PROJECT



: Exchange of genetic material
: Fibre samples sent for analysis

Both countries, therefore, should effect the selection of new SI genetic material (from single plant selection to advance variety trial) under their own specific local growing conditions.

In this arrangement, the fibre testing laboratory facilities of Barbados could service both selection programmes.

(c) Establishment of a regional variety trial network

The next step to the advanced variety trial, is establishing a regional network of variety trials to evaluate the most promising line selected by Antigua and Barbados.

These regional variety trials should take place in the SI cotton growing areas of the different islands (Barbados, Antigua, Nevis and Montserrat) with the objective of formulating specific varietal recommendations for each country. Within the framework of this experiment, all the promising lines (maximum of 4) should be evaluated against a MSI check line at the farmer commercial field level.

In effect, the participation of both Nevis and Montserrat, is limited to this level of varietal experimentation.

The number of regional variety trials on each island would depend upon their individual potential cotton acreage. In the long-run, the network could consist of up to a total of 20 trials, broken down as follows:

Barbados : 6 to 7
Antigua : 6 to 7
Nevis : 3
Montserrat: 3

The results of these regional variety trials should be analysed region-wide as well as on a per country basis.

5.1.4.4 Seed production and certification programme

(a) Mechanisms

It is highly recommended that a seed certification system be implemented in order to safeguard the genetic specificity of the SI cotton, whose responsibility should fall in the hands of a seed certification body to be created for this purpose. In line with this it is proposed that each country create a seed certification department under the direct responsibility of the Ministry of Agriculture the certify the planting seeds.

The following is a detailed explanation of the mechanics of the proposed seed production programme:

- Antigua will remain in charge of producing the MSI pedigree seeds for the region. As much as possible the seed selection process should be avoided prior to the multiplication of seeds.

- Seed production activities would be concentrated in Antigua and Barbados. Antigua would be responsible for producing all its planting seed requirements, while Barbados will multiply its own planting material seeds.

- Due to the small cotton acreage potential of Nevis and Montserrat it is not necessary to undertake a seed production programme in these islands. In fact, it would be easier for them to import the required amount of certified seeds directly from Antigua or Barbados, which would allow them, therefore, to concentrate their efforts in commercial production.

With respect to the implementation of the seed multiplication programme, seed production should be carried out in the most suitable areas for cotton production in terms of climate and soil conditions, and should comply strictly with set standards.

(b) Establishment of a long-term seed multiplication programme

The development of SI cotton production in the region should be backed up by an efficient seed multiplication programme which would provide sufficient planting material when required.

The following is the proposed seed production scheme and corresponding acreage target based on the long-term projections for cotton production of a theoretical 6,600 acres.

Figures were computed based on : a seeding rate of 15 lbs/Ac; an average seed cotton yield of 1500 lbs/Ac; a seed production of 700 lbs of delinted and classified seeds per acre; and a 20% buffer seed stock at the certified seed level.

CROP YEAR	Y	Y+1	Y+2	Y+3
Antigua commercial area target (Ac)				3000
Barbados commercial target (Ac)				3000
Nevis commercial area target (Ac)				300
Montserrat commercial area target (Ac)				300
Total area target (Ac)				6600
Planting seed Requirements (lbs)				99000
20% buffer seed stock (lbs)				19800
Total seed requirements (lbs)				118800
Total Foundation Area (ac)	0.1			
F.S. production (lbs)	56			
Total Registered Area (Ac)		3.7		
R.S. Production (lbs)		2550		
Total Certified Area (ac)			170	
C.S. Production (lbs)			118800	
Total Commercial Area (Ac)				6600

This proposal is based on the following assumptions:

(i) The required quantities of FS, RS and CS would be produced yearly in order not to interrupt the multiplication cycle.

(ii) Antigua and Barbados would participate simultaneously in the seed production.

(iii) An intermediary seed multiplication scheme would be designed taking into consideration the gradual increment of cotton production until the long-term area targets can be attained.

5.1.4.5 Agronomic Activities

It is recommended that the main Agronomic experiments be conducted in each of the participating countries. These consist of the following:

(I) subtractive fertilization trial
(II) nitrogen fertilization experiment
(III) weed control experiment
(IV) plant population study

With respect to more specific experimentation, such as the foliar fertilizer trial and the crop rotation study, these could be carried out in Antigua and/or Barbados.

As much as possible, all agronomic studies should be restricted within the confines of the Research Stations to better monitor the implementation of experimental guidelines. In the case of Nevis and Montserrat, which have no Research Station, these same experiments can be applied in commercial fields.

5.1.4.6 Crop Protection

The allocation of the activities of crop protection research programme by country is presented in Table 5.1 below.

TABLE 5.1
CROP PROTECTION ACTIVITIES ALLOCATED BY COUNTRY

ACTIVITY	COUNTRY			
	Antigua/Barbuda	Barbados	Montserrat	Nevis
1. Pheromone Research				
1.1 Gassyplure or pink bollworm pheromone for mating disruptions	X	X		
1.2 Alabama pheromone for monitoring or mating disruptions	X	X		
1.3 Pheromone against local heliothis population		X		
2. Insect growth regulator studies				
2.1 Efficiency of chitin inhibitors	X	X	X	X
2.2 Effects of IGRs on egg viability of pests		X		
2.3 Impact of IGRs on natural enemies of cotton pests	X	X	X	X
3. Biocontrol studies				
3.1 Population interaction studies of Bemisia		X		
3.2 Population interaction studies of Alabama and Brachymeria	X	X	X	X
3.3 Impact of Bracon hebator on heliothis	X	X	X	X
3.4 Nuclear polyhedrosis virus against lepidiopterous pests		X		
4. Chemical control studies				
4.1 Selectivity and efficiency of chemicals against pests	X	X	X	X
5. Mechanical devices				
5.1 Yellow traps or suction traps against whiteflies		X		
5.2 Mechanisms for monitoring pest population cycles and maintain quarantine controls	X	X	X	X
6. Ecological/action threshold studies				
6.1 Action/economic threshold levels for major pests	X	X	X	X
6.2 Major pests and population cycles in relation to pest management strategy	X	X	X	X

5.1.4.7 Engineering

(a) Fibre Testing Laboratory

Barbados will be the centre for lint fibre testing. A central laboratory will be established that will receive samples from the participating countries for testing.

(b) Soil Cultivation

Various soil cultivation method trials will be carried out in the countries under the supervision of the agronomist.

5.2 Logistic Support

Specific requirements for the effective implementation of the proposed research and development programme are discussed here under:

5.2.1 Facilities

Adequate research facilities would be required to carry out effectively the programme. These are as follows:

Barbados: The cotton research unit would need building infrastructure to serve as a base for the different research activities (Genetics, Agronomy, Pest Control). This should include:
- adequate office space and storage rooms
- seed quality laboratory
- fibre testing laboratory
- Cotton Germplasm Collection storage room
- entomology laboratory

Also required is a separate Ginning infrastructure composed of a ginning room (to install the laboratory roller gin for breeding purposes and the industrial roller gin for seed production purposes) and adequate storage space to store all seed cotton issued from the selection and seed production (B.S. and F.S) programmes.

Antigua: The implementation of the proposed programme would require a building infrastructure to house the different offices as well as some laboratories (entomology, common laboratory for all research functions) and a separate ginning facility.

This could be provided for by rehabilitating existing buildings of the cotton station.

With respect to seed testing, this service could be provided by the CARDI seed technology laboratory (Betty's Hope Field Station).

Nevis and Montserrat: In each island a multipurpose room would be needed to house the office of the technical personnel and to provide storage/working space (to store the seed cotton from the different experiments, to weight and prepare the samples, etc.

5.2.2 Equipment

Specific equipment designed especially for crop improvement, seed production, agronomic activities, crop protection and agricultural engineering aspects of the proposed project would then be required as follows:

(i) Barbados

(a) <u>Cotton Germplasm Collection</u>

- Cold storage room (at 10-12^{0}C) with the following dimensions; 1:2xL:3xh:2 m equipped with one dehumidifier and adjustable metallic shelves.

- 150 (20 oz.) plastic containers or glass jars with screwable covers.

- 150 (8 oz.) plastic containers or glass jars with screwable covers (for the Antigua duplicate Germplasm Collection).

(b) <u>Breeding/selection programme</u>:

- Laboratory roller gin 12": (a new unit is already available).

- Electronic weighing scales: one unit with a 45 kg weighing capacity and a 5 or 10 g. precision, and one unit with a 2 kg weighing capacity and 0.1 g. precision.

- Material requirements for self pollination:
  - all purpose transparent glue (3M or UHU brand) to close tips of full grown buds: 250 tubes of 60 ml/yr.
  - soft metallic string (aluminum type) to mark the flower pedicels: 5 kg/yr.

- Cotton sacks: (flour sack-type) for harvesting seed cotton from experiments: 500 units (reusable)

- Paper bags: (different sizes) to harvest selfed seed cotton.

(c) Seed production:

- one industrial type roller gin (1m wide)

- weighing scale: the unit (45 kg capacity) intended for genetic work could be used.

(d) Agronomy

- Weighing scale: one unit with 45 kg capacity and 5 or 10 g precision.

(e) Crop Protection

- 100 pheromone trap units
- 1200 dispensers
- 1200 bait strips
- Rearing cages, boxes
- Insect proof nets and other materials
- Other mechanical devices
- 3 boom sprayer
- 20 ULV sprayers
- 5 mist blowers
- 10 knapsack sprayers
- Protective equipment

(f) Fibre testing Laboratory:

A fibre testing laboratory is needed for the evaluation of the progenies/lines generated from the breeding activities and the genetic material of the Germplasm collection. The following basic instruments are required:

- fibrograph Spinlab 530 (with accessories and fibrosampler 191)

- Spinlab stelometer 154

- Spinlab instaweigh 485 (electronic balance)

- Shirley Fineness Maturity Tester Series II (SDL 089 B)

- Shirley Fiber Blender (SDL 009)
- SDL Electronic Balance Model E 400 D

Aside from these specific fibre testing equipment, the laboratory would need an air conditioning unit and dehumidifier to maintain a standard temperature of $21^0C \pm 1^0C$ and relative humidity of $65 \pm 2\%$.

The installation of this laboratory would normally be taken care of by the Ministry of Agriculture.

(g) Seed Testing Laboratory:

All available equipment of the FAO Seed Laboratory could be rehabilitated for use in this project. An electronic balance (with a 2 Kg weighing capacity and a 0.1 g precision) to evaluate seed index would be required unless the seed laboratory is already equipped with the same.

(h) Soil and tissue testing laboratory:

A soil and tissue laboratory equipped with specific equipment to analyse soil and tissue samples may be required in case such service is not available in Barbados or Antigua.

(i) General Equipment

(i) Vehicles

- Barbados (3)
- Antigua (1)
- Montserrat (1)
- Nevis (1)

(ii) Two (2) computers with printers

(iii) Air conditioner, dehumidifier

(ii) Antigua

(a) Germplasm Collection

- one refrigerator (150-200 l) is required for storing the duplicate of the Barbados Cotton Germplasm Collection.

(b) Breeding/selection programme:

- laboratory roller gin 12": (an old unit in good running condition can still be used)

- electronic weighing scales: one unit with a 45 kg weighing capacity and a 5 or 10 g precision; one unit with a 2 kg weighing capacity and a 0.1g precision.

- material requirements for self pollination: (the same requirements as in Barbados)

- cotton sacks: 400 units (reusable)

- paper bags

(c) Seed Production

- one industrial type roller gin to replace the old one.

- weighing scale: the unit (45kg) weighing capacity intended for genetic work could be used.

(d) Agronomy

- weighing scale: one unit (electronic) with a 45kg weighing capacity and a 5 or 10g precision.

(e) Crop Protection

- 100 pheromone trap units
- 1200 dispensers
- 1200 bait traps
- rearing cages, boxes
- insect proof nets and other materials
- 2 boom sprayers
- 10 ULV sprayers
- 5 mist blowers
- 10 knapsack sprayers
- protective equipment

(f) Seed testing laboratory

Should coordinate with the CARDI seed laboratory for conducting seed quality tests.

(g) Fibre testing laboratory and soil/tissue laboratory

Should coordinate with Barbados.

(iii) **Nevis**

(a) Varietal and Agronomic Experimentation

- one electronic weighing scale with a 45kg capacity and a 5 or 10g precision

- 200 cotton sacks for harvesting seed cotton from experiments per plot.

Samples should be sent to Antigua and Barbados for analysis.

(b) Crop Protection

- rearing cages, boxes for insects

- insect nets and other materials
- 5 ULV sprayers
- 4 mist blowers
- 5 knapsack sprayers
- protective equipment

(iv) **Montserrat**

(a) Varietal and Agronomic Experimentation

- one electronic weighing scale with a 45kg capacity and a 5 or 10g precision.

- 200 units of cotton sacks for harvesting seed cotton from experiments per plot.

Samples should be sent Antigua or Barbados for analysis.

(b) Crop Protection

- rearing cages and boxes for insects
- insect nets and other materials
- 5 ULV sprayers
- 4 mist blowers
- 5 knapsack sprayers
- protective equipment

General Equipment

(i) Vehicles

- Barbados (3)
- Antigua (1)
- Montserrat (1)
- Nevis (1)

(ii) Two (2) computers with printers

(iii) Air conditioner, dehumidifier

5.2.3 Personnel

5.2.3.1 General

Presented in Table 5.2 is a list of personnel required for the execution of the project.

These requirements are considered to be the minimum level of professional and technical personnel required for the realisation of the objectives of the research and development programme, given the importance attached to the removal of the major constraints preventing the successful production of a sustainable level of Sea Island Cotton in the region.

5.2.3.2 Breeding/Selection Programme and Cotton Germplasm Collection

To implement the proposed breeding/selection programme it is recommended that an experienced cotton breeder be engaged as consultant for the project during a minimum period of 5 years with the following terms of reference:

1. To organize and implement the regional SI cotton breeding/selection programme according to the research proposal.

2. To organize and evaluate the Cotton Germplasm Collection.

3. To organize the SI cotton seed production and certification programmes within the region.

4. To coordinate the selection and varietal experimentation activities in the region with special emphasis on the organization and implementation of the regional variety trial network.

5. To supervise closely the selection work in Antigua and the varietal experimentation in Nevus and Montserrat.

6. To train national counterparts in breeding and selection of SI cotton as well as in the management of the Cotton Germplasm Collection.

7. To organize the Seed and Fibre Testing Laboratories.

This breeding expert would be based in Barbados and would be required to travel at least three times per year to Antigua, Nevis and Montserrat, to coordinate the programmed activities in these islands.

TABLE 5.2
PERSONNEL REQUIREMENTS

PERSONNEL	LEVEL		LOCATION AND NUMBER				
	International	National	Antigua	Barbados	Montserrat	Nevis	TOTAL
1. Administrative							
Project Secretary		X		1			1
Computer Clerk/Typist		X		1			1
Messenger/Driver		X		1			1
Office Attendant		X		1			1
2. Professional							
Director, Research and Development	X			1			1
Cotton Breeding Expert	X			1			1
Deputy Director of Research (Counterpart Breeder)	X		1				1
Agronomist (Seed Technology)	X			1			1
Agronomist (General)	X			1			1
Counterpart Agronomist		X	1	1	1	1	4
Entomologist				1			1
Agricultural Engineer	X			1			1
Chief Extension Service	X			1			1
Extension Officer		X	3	3	2	2	10
3. Consultants (Part-time)							
Cotton Breeding	X						
Plant Protection	X						
Agricultural Engineering	X						
4. Support Staff							
Field Technician (Agronomy)		X	1	1	1	1	4
Field Technician (Plant Breeding)		X	1	1			2
Field Technician (Crop Protection)		X	1	1	1	1	4
Field Technician (Engineering)		X		1			2
Field Workers		X	2	2	1	1	6
Laboratory Technician		X		2			2

In addition to the consultant, it is recommended that a special research team be formed to include the following:

Barbados:	1 Field Technician 2 permanent Field Workers
Antigua:	1 Breeder Counterpart (PhD/Ms level) 1 Field Technician 2 Permanent Field Workers
Nevis:	One Field Technician and 1 Field Worker
Montserrat:	One Field Technician and 1 Field Worker

5.2.3.3 Agronomy

To implement the proposed Agronomic Research Programme, it is recommended that two experienced cotton agronomist be engaged as consultants for the project during a minimum period of 5 years with the following terms of reference;

1. to organize and implement the regional agronomic research programme as proposed.

2. to initiate experimentation required for the improvement of the agronomic technology package.

3. to coordinate the agronomic experimentation activities in the region.

4. to supervise closely the agronomic research work in Antigua.

5. to train national counterparts in Cotton Agronomy.

6. to organize/coordinate activities of the Soil and Tissue Laboratory.

These agronomy experts would be based in Barbados and Antigua and would be required to travel, at least 3 times per year, to the other participating countries to supervise and coordinate the activities in each country.

The consultants would be working with the following national personnel:

Barbados:

1 counterpart agronomist) 1 field technician) 2 permanent field workers)	these personnel would be involved also with the breeding programme

Antigua:	The same personnel requirements as in Barbados.	
Nevis:	1 counterpart agronomist) 1 field technician) 1 field worker)	these personnel would be involved also with the varietal experimentation
Montserrat:	1 counterpart agronomist) 1 field technician) 1 field workers)	these personnel would be involved also with the varietal experimentation

5.2.3.4 Crop Protection

To implement the crop protection component of the project, it is recommended that an entomologist be engaged as consultant for the entire duration of the project with the follow terms of reference.

(a) To organize and implement the crop protection programme as set out in the project proposal.

(b) To coordinate external crop protection support actions such as technical assistance and consultancies.

(c) To train national counterpart staff in crop protection and the management of an integrated pest control programme.

(d) To coordinate the integration of the crop protection unit of the project with other national, regional and international pest control programmes.

(e) To advise on the necessary legislation to prevent the spread of cotton pests within and outside national boundaries.

The Entomologist will be based at the project headquarters and will be required to travel to the other participating countries to ensure the effective and efficient execution of the relevant national components of the crop protection programme.

The Entomologist will be ably assisted in each participating country by a field technician (crop protection) who will be responsible for on-site execution of the crop protection experimentation.

5.2.3.5 Extension Unit

Cotton farmers must be seen as managers of productive resources, aimed at achieving with equity sustained economic, social, cultural and political development of their rural families. They need to receive and adopt valid technological innovations which will boost the biological and economic efficiency of their enterprise on a long-term basis. Consequently the primary role of the Extension Unit within the project as a whole and at the national level in particular is to provide cotton growers with the relevant technical information to fulfill that purpose. The a Extension Unit will consists of eleven (11) Cotton Extension Officers, including a Chief Extension Service operating at the National Level.

To discharge its responsibility successfully and to meet the challenges, the unit will streamline its technology transfer strategy to, effectively and efficiently:

(a) Educate, motivate and train other farmers to take greater pro-active role in the framing of the annual work programme of the project and the national and regional policies for the development of the cotton industry in the Caribbean;

(b) Induce farmers to participate in the validation and demonstration of improved technologies which can be readily incorporated in their farming systems, at the lowest economic, social and environmental costs; and

(c) Inform farmers about and facilitate their access to other services (public and private) available to support all the three basic phases of cotton farming, spanning, pre-production, production-to-harvest, and postharvest (including handling, ginning, and marketing).

The Extension Unit will therefore be the crucial link between the project (research and development) and production (of seed cotton).

5.2.3.6 Agricultural Engineering Programme

To implement the Agricultural Engineering Programme which will be devised by the Project Management Committee, it is recommended that an experienced agricultural engineer be engaged for the project during a minimum period of five (5) years.

5.2.3.7 Consultancies and Training

(a) Consultancies

Short term consultants will be employed whenever the Director, Research and Development in consultation with Project Management Committee considers such recruitment to be necessary particularly in the plant protection area.

This consultant will work closely with both international and national professionals in the evaluation of the technical progress of the research work as well as (re)defining the research and developing focus.

(b) Training

There will be two aspects of training, namely:

(i) Training of Counterpart Staff

It is recommended that all national counterpart staff be provided advance training to improve their expertise in their functional areas. For this purpose special funds will be allocated for this activity.

(ii) Training of Farmers

To ensure that the technology generated are transferred to farmers, several farmer training workshops and seminars will be organised annually as one means of effecting such transfers. At least one regional and twelve (12) national (3 per country) workshops/seminars will be executed each year, covering the pre-production, production, and harvesting and post-harvest handling aspects of cotton farming.

5.3 Linkages with other Institutions

It is evident that the organization of this research project programme would depend highly on the establishment of linkages with other international cotton centers/institutes/organizations.

Through these linkages, there can be an exchange of scientific and technical information as well as of genetic material.

In establishing the SI Cotton Germplasm Collection, it is highly recommended that contacts be made with the other international Cotton Germplasm Banks like those of IRCT-CIRAD (in Montpelier, Franc) and USDA in the United States (Boulder, Colorado), etc.

It is essential to develop a scientific/technical library that would gather and compile all kinds of information about the cotton crop. In line with this, it is highly recommended that subscription be made to the most important scientific reviews and journals such as:

Crop Science
Agronomy Journal
Cotton Tropical (IRCT-CIRAD)

This will allow all researchers to update their scientific knowledge in the different areas of genetics, agronomy, entomology and seed production.

Cytogenetics and Biotechnology have always been looked upon as the most ideal approach to improving plant varietal resistance and other agronomic characteristics. However, the appropriate methodology has not yet been well developed for cotton and few results have been obtained up to now. In the meantime, efforts should be concentrated on the proposed conventional breeding methods until the time when a more viable alternative is found.

CHAPTER VI

6. PROJECT IMPLEMENTATION SCHEDULE, MONITORING AND EVALUATION

6.1 Implementation Schedule

The Project Implementation Schedule is shown in Table 6.1

TABLE 6.1
IMPLEMENTATION SCHEDULE PROJECT ACTIVITIES

ITEMS	PRE-INVESTMENT PERIOD MONTHS									INVESTMENT PERIOD				
	1	2	3	4	5	6	7	8	9	Yr 1	Yr 2	Yr 3	Yr 4	Yr 5-10
A. Tasks														
1. Presentation of Draft Project document to CARICOM and participating countries	x	x												
2. Adjustments			x											
3. Presentation to EEC					x									
4. Adjustments						x	x							
5. Negotiation with Donor Institution						x	x	x						
6. Project Implementation								x	x					
B. PROJECT COMPONENTS														
1. Genetic improvement programme										x	x	x	x	x
2. Organization of a Regional Sea Island Cotton Germplasm Bank										x	x	x	x	x
3. Seed Production and Certificate Programme										x	x	x	x	x
4. Agronomic Research Programme										x	x	x	x	x
5. Integrated Pest Management Programme										x	x	x	x	x
6. Lint Quality Testing											x	x	x	x
7. Farm Mechanization Research											x	x	x	x

6.2 Monitoring and Evaluation

6.2.1 Continuous Control and Monitoring

For the successful implementation of the project, activities will be monitored on a continuous basis.

Primary responsibility for monitoring programme activities will rest with the Programme Implementation and Evaluation office to be set in WISICA Inc, the Director, Research and Development and team leaders and the Subject Matter Specialists. A key element to the success of the project will be the rapid response to unexpected problems, correcting administrative bottlenecks, and facilitating communications.

6.2.2 Mid Term Evaluation

A project of this type (multi-national in scope) requires the continuous revision of the proposals contained in order to adjust to changing conditions. For this reason it is envisaged that a "rolling plan" approach will be undertaken with a review carried out every two years.

The Project Management Committee (PMC) will ensure an evaluation of its execution by independent specialists. The purpose of this evaluation will be to determine the extent of progress achieved, compared with the objectives and the budget as set out in the project proposal and in the 2-year work program. The evaluation report will comment on results achieved and put forward recommendations regarding action required and activities to be undertaken in the remaining period of execution of the project. These recommendations will be incorporated in the activities for the remaining period as a step in a replanning effort.

From this evaluation should therefore come carefully considered recommendations about how to improve the appropriateness of each aspect of the project design so that plans for further project implementation can be reviewed by the Project management Committee (PMC). As such the mid-term evaluation is considered an important management tool.

6.2.3 Final Evaluation

Upon the termination of the execution period of the project the Cotton Industry Development Board in consultation with the PMC and Board of Directors of WISICA Inc. and the Donor Agency may determine the need for a final evaluation to be conducted by independent specialists. This will basically be a systematic analysis of the elements of success and failure in the project experience to learn how better to plan for the future.

6.2.4 Evaluation Criteria

Evaluation will include financial, managerial and technical aspects of the project activities. With regards to the financial and managerial aspects, among the activities that will be considered are the following:

(i) cash flow situation;

(ii) effectiveness of budget management;

(iii) degree to which the coordination role is executed effectively, including organization of meetings, seminars, training sessions, as well as the delegation of responsibilities among the research specialists;

(iv) timeliness and quality of various reports; and

(v) interface with participating governments and other relevant institutions.

The evaluation of the technical aspects of the project will focus on a number of indicators established before hand. Such indicators will concern the utilization of inputs, crop yields, lint quality improvements, incidence of pests or diseases, levels of income achieved by farmers, as well as utilization of economic and social facilities established through the project, such as the number of technical personnel and farmers who have completed their training, the number of farmers adopting the new technologies, etc.

CHAPTER VII

7. RISKS AND ISSUES: <u>External Factors conditioning the Attainment of desired impact</u>

7.1 Market Stability

a) Price fluctuations

The current market demand and the high level of dependency of a consortion of Japanese firms for West India Sea Island Cotton suggest some guarantee of a measure of stability. Nevertheless, the price fluctuations as initiated by the Japanese buyer in 1986 when they reduced the price per lb lint from US$4.20 in 1986 to US$3.50 in 1987 was certainly a threat to the industry.

b) Harmonisation of pricing policy

The present situation which allows buyers of lint to independently negotiate price with individual producer countries of the region is very undesirable. Thus member countries should move towards harmonisation of pricing policy for the region under the umbrella of a common Cotton Industry Development Board.

c) Currency fluctuations

The heavy dependency of the region on the Japanese market can be risky since the currencies of the producer countries are tied to the US dollar. Hence changes in the US dollar relative to the value of the Japanese Yen, Barbados and EC dollars may adversely affect export revenue. The possibility of making forward contracts with agreed mechanisms for ensuring that payment is made at the best exchange rate prevailing over a period prior to shipment should be explored.

d) Trademark Control

The recent defence of the Trademark - WISICA - in Britain resulted in a definition of West Indian Sea Island Cotton as geographically confined to the West Indian Islands. The threat of 'illegal activity' in terms of imitation of products, although real, can be controlled to some extent. Tight control and policing of the trademark is absolutely necessary for the attainment of the desired impact. A re-organised re-focussed and efficiently function WISICA Inc would provide the necessary assurances.

7.2 Land

a) Availability

The constantly reducing arable acreage of land available for agricultural production affects allocations for each major crop. Cotton should be seen therefore as part of the menu rather than a replacement crop, and should be favoured in drier areas since it is a semiarid crop.

b) Distribution and Production

Particularly in Barbados, more than 80% of arable lands is defined as private plantation lands, traditionally and essentially sugarcane estates. These private estates must therefore be an integral part of a sustainable land base for cotton production where rotation with sugarcane, and the use of other conservation measures can be facilitated.

In Antigua and to some extent Montserrat and Nevis, where there are large acreages of crown lands, government policy may be facilitated through lease/rent arrangements to private individuals or corporations for efficient production. It is of the utmost importance to the maintenance of sustainable level of production required to keep the processing facilities that CCII maintain control over a minimum of 2,000 acres of land.

c) Soil Erosion

Present agronomic practices in terms of land preparation and crop maintenance, plus the nature of the crop in terms of soil coverage contribute significantly to soil erosion. Cotton cannot be sustained in the same areas year after year without rotation with sugarcane or any other thrash crop. Special emphasis should therefore be given to studying soil conservation methods of some of the countries with high and sustained levels of agricultural output from poor soils or without the benefit of color provided by grass crops.

7.3 Labour

a) Rate of unemployment

The rate of unemployment in the participating countries varies from about 15% in Barbados to about 5% in Antigua and even less in Montserrat. There is likely to be 'local' shortage of labour in some of these countries depending on the levels of production of cotton. The changing economic climate in these countries will likely lead to higher unemployment as the regional governments seek to restructure their economies. In this event, labour availability for cotton production may

increase. Every effort should be made to change the image of cotton growers and harvesting by the provisions of suitable carriers for pickers and for their comfort while picking. Emphasis should be given to end-products of this rare fibre and the high prices paid for them.

b) Labour distribution

At the regional level, unemployment is comparatively high, and especially in Guyana, Trinidad and the Windward Islands there is a more than adequate supply of relatively cheap unskilled labour. Immigration policies with respect to movement of labour is considered a critical issue. Such movement is already permitted for sugarcane harvesting in the region.

7.4 Capital

The main issue here is access to capital. Individual farmers have found difficulty in securing necessary working capital for cotton production. Further, individual attempts at securing imports are costly. It is recommended that the Cotton Industry Development Board or CCII take responsibility for production organisation, accessing of funds, bulk purchasing of imports and the establishment of a credit facility.

It might be appropriate, however, to note that there is a history in some of the growing countries of governments having to be the prime motivators of major industrial developments. This is due to the absence of a private sector with real venture capital which it is willing to risk on developmental projects even when the ultimate success of the venture is assured or the national interest dictates that no feasible alternative is possible or appropriate. Assistance from multilateral agencies should be more readily available to assist countries in overcoming this serious impediment to their development.

7.5 Conformity with the strategies and programmes of participating countries

The concept of developing and implementing a project to increase the production and productivity of cotton lint in the participating countries conforms with the strategies and programmes of establishing a regional integrated cotton industry. There is a universal commitment to agricultural diversification, and the development of environmentally sound pest management programmes to ensure sustainable development in the sector. Moreover, there is a clear recognition that to achieve the levels of cotton production attained in the 1940's-50's will require an effective regional approach in developing the Cotton Research Development and Extension capabilities, and, that at present, these capabilities are very limited.

7.6 CARDI as the implement Institution

The project will have a greater chance of success if institutionally housed in a re-organised WISICA Inc. with the appropriate technical and extension staff. The issues and constraints which the cotton industry faces are sufficiently unique as the require innovative regional solutions.

Moreover, by institutionally housing this project in WISICA the degree of direct focus and commitment required to ensure that Sea Island Cotton growing becomes a major crop in the Caribbean crop menu just like sugar-cane, bananas and citrus is assured. This will surely be achieved if the research and the delivery of its results and other assistance to growers is as extensive and unifocused as in the case with sugar cane.

WISICA has these responsibilities already assigned to it by its Articles of Association and the opportunity to make it function as prescribed, will bring to the cotton industry the additional benefit accruing from the superior prices which the addition of the WISICA Trade Mark automatically brings to any item to which it is attached. Without the Trade Mark, Sea Island Cotton is just another long staple cotton fibre. The new organisational and management arrangements for the promotion protection, control and use of the Trade Mark will ensure that its existence is never challenged again or the name Sea Island used on anything but genuine West Indian Sea Island Cotton.

Cardi, because of the role it has played in the development of agriculture in the region can be of great assistance to WISICA in realising the important goal of developing an integrated Sea Island Cotton Industry, helping WISICA to establish quickly those linkages at the national, regional and international level with Research and Development institutions.

7.7 Training Component

The project will afford substantial opportunities for he job training of the core team in the course of its implementation. The international professionals will work closely with counterparts where they exist and impart - considerable substantive skills and procedural techniques.

There exist in the Cotton Development units of the various ministries, a core of trained professionals who can effectively fill some of the international staffing requirements (long and short term technical assistance) of the project. However, some are lacking in training in specific technical aspects of cotton production. Accordingly, we recommend that the project include both formal training and short-term seminars and workshops.

Formal training should include providing MSc level educations for at least five professionals. The substantive content of such

training should focus on providing Masters degrees in areas such as cotton breeding, agronomy, and plant protection.

Short-term courses, workshops and seminars should focus on specialty topics that strengthen the capacity of professionals to grasp the specialized skills in cotton production. The bulk of the workshop should, however, be tailored towards the training of cotton farmers. Each year, as the work plan is prepared, farmer training need can be addressed and the requisite workshops planned.

7.8 Sustainability

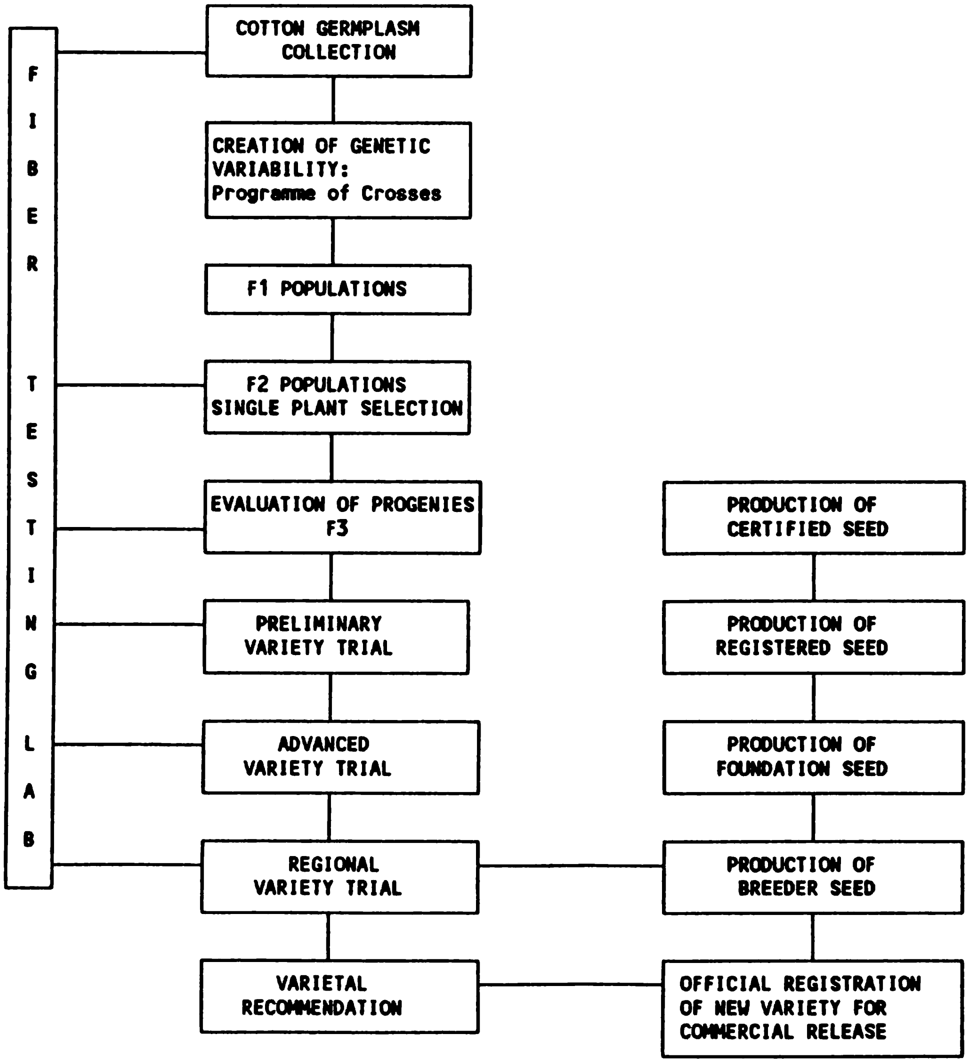
It is recommended that the project be launched as a ten (10) year project and receive an initial tranche for five years of approximately US$2.4 million for the EEC under Lome IV Regional agricultural allocation. The issues and constraints facing the cotton industry require this time frame for adequate resolution. The project will require the commitments of fiscal as well as human resources on the part of the four participating countries for the foreseeable future. It must be emphasized that the projected level of governmental support is marginally above the present levels of effort being provided by most of the participating countries. Other important areas such as land use, zoning, tenure policy reform, must be addressed if the project is to have the desired impact. To the extent that substantial increases in cotton production occur, and royalties are earned and collected, the project would have assisted in putting in place a process that is self sustaining.

It should also be noted that if the recommendation that a re-organised WISICA Inc be the implementing agency is approved, the level of money available from royalty and licensing payments would increase to 75%. Therefore, there is absolutely no doubt that the research programme can be maintained for as long as cotton is one of the region's agricultural crops. Additional funds from Royalty payments will become available for other purposes once the Mark is properly registered in appropriate destinations and a continuous publicity programme is in place.

Consideration might be given to the utilisation of any available money to set up a 'venture capital' fund to assist persons involved in the industry to become involved in processes utilising cotton or its by-products.

A strong recommendation is made for an early start to the cotton breeding and pest management programme. To this end, governments of the other producing countries might wish to join the Government of Barbados in soliciting for a period of not less than two (2) years the services of Mr. Guy Pauly of IRCT-CIRAD and the official of the National Resources Institute involved in the Pest Management Programme in Barbados. Efforts should however be made to secure the services of these experts for the initial five (5) year period of the project.

ANNEX 1
GENETIC IMPROVEMENT AND SEED PRODUCTION SCHEME



ANNEX 2
SEED MULTIPLICATION AND CERTIFICATION STANDARDS

1. TOLERATED NUMBER OF OFF-TYPE PLANTS PER ACRE

Off-Type Plant Description	Seed Class: Breeder	Foundation	Registered	Certified
Other variety of the same and/or morphological off-type plants	None	None	2	5
Other Cotton Species	None	None	None	None

2. STANDARDS FOR SEED QUALITY

Factors	Breeder	Foundation	Registered	Certified
Min. % pure seed (whatever is the seed origin)	98	98	98	97
Max. % inert matter (trash)	2	2	2	3
% Other crops (seed)	None	None	None	None
% germination (minimum)	80	80	80	75
Maximum moisture content	10	10	10	10
Other Cotton Species	None	None	None	None

ANNEX 3

Assumptions Used in the Economic Analysis

1. The life of the project is estimated at 10 years.

2. The analysis is based on 1990 constant prices.

3. The new lands bought under cultivation are assumed to be presently owned by farmers.

4. Traded goods have been valued at their appropriate border prices. Sea Island Cotton market price has been put at US$5.50 per lb cotton lint.

5. Local costs have been adjusted by a Standard Conversion Factor (SCF) of 0.80; skilled labour has been valued at its market price and unskilled labour has been shadow priced at 0.60.

6. All transfer prices have been taken into account and the appropriate adjustments made.

7. Cultivation of new lands will commence in the second year of the project.

8. The farmers cost of production is presented in one model for all countries in Table 4.6. The crop yields are based on assumption that improved agronomic techniques, including more effective pest control methods are practiced, and improved genetic materials are utilized in the production process. Incremental production on existing cultivation assumes 10%, 20%, 35% and 50% of total incremental production in project years 2, 3, 4, and 5 respectively. The without project scenario is based on information provided by the Ministries of Agriculture of participating countries.

9. The cost associated with post-harvest handling of cotton are the 1990/91 cost of ginning of cotton and the baling and delivery of the cotton lint to the port. The analysis assumes that, although those costs will be reduced per kilogram, as the volume of production increases, the 1990/91 costs are maintained throughout for conservatism. Details are presented in Annex 4.

10. The farmgate price on the farm model is the price paid to the farmers by the Ministries of Agriculture (CCII in the case of Barbados).

11. The economic benefits are the value of the output at the f.o.b. prices.

12. Net incremental benefits from the projects are generated from new lands in production and the improved quality and increased quantity of output from the existing lands.

ANNEX 4
ECONOMIC PRICE AND MARKETING COSTS OF COTTON LINT
(US$/LB LINT)

ITEM	Antigua	Barbados	Montserrat	St. Kitts/Nevis	Average
F.O.B. Price	5.5	5.5		5.5	5.5
Farmers Price	3.96	4.83		3.63	4.14
Marketing Expenses					0.635
Ginning and Baling					0.044
Marketing Commission					0.028
Handling of Bales					0.044
Loading of Bales					0.011
Inspection Fee					0.002
Transportation of Ginnery					0.003
Transportation to Wharf					0.001
Bank Charges					0.002
Marketing Services					0.500

ANNEX 5
ROYALTY AVAILABLE FOR RESEARCH AND DEVELOPMENT
(US$)

ITEMS	PROJECTED YEARS									
	1	2	3	4	5	6	7	8	9	10
1. Cotton Lint Exported (lbs)	343890	518100	878150	1327050	1911750	2418000	2767500	3070500	3300750	3531000
2. Yarn Produced (Lint x 0.7) (lbs)	240725	362670	614705	929935	1338255	1692600	1937250	2149350	2310525	2471700
3. Royalty ($1.70/lb yarn) ($)	409230	616540	1045000	1580890	2274980	2877420	3293325	3653895	3927890	4201890
4. Research and Development Allocation (15% of Total Royalty)	61385	92480	156750	237135	341250	431615	494000	548085	589185	630285

ANNEX 5
ROYALTY AVAILABLE FOR RESEARCH AND DEVELOPMENT
(US$)

ITEMS	PROJECTED YEARS									
	1	2	3	4	5	6	7	8	9	10
1. Cotton Lint Exported (lbs)	343890	518100	878150	1327050	1911750	2418000	2767500	3070500	3300750	3531000
2. Yarn Produced (Lint x 0.7) (lbs)	240725	362670	614705	929935	1338255	1692600	1937250	2149350	2310525	2471700
3. Royalty ($1.70/lb yarn) ($)	409230	616540	1045000	1580890	2274980	2877420	3293325	3653895	3927890	4201890
4. Research and Development Allocation (15% of Total Royalty)	61385	92480	156750	237135	341250	431615	494000	548085	589185	630285

ANNEX 6A
SENSITIVITY ANALYSIS I
(Assumption)
US$4.00 per lb Cotton Lint Assumed

ITEM	PROJECT YEARS									
	1	2	3	4	5	6	7	8	9	10
1. Project Benefits										
1.1 Sales Revenue										
Antigua	0	77400	352400	992400	1922400	2813400	3461400	3947400	4352400	4757400
Barbados	0	588000	1680000	2730000	3990000	5040000	5670000	6300000	6720000	7140000
Montserrat	0	13200	48000	108000	192000	240000	288000	312000	336000	360000
St. Kitts/Nevis	0	18240	35040	102240	167040	203040	275040	347040	419040	491040
Incremental Project Benefit	0	696840	2115440	3932640	6271440	8296440	9694440	10906440	11827440	12748440
2. Project Cost										
2.1 Capital Cost (R&D)										
General Project Administration	158000	158000	158000	158000	158000	158000	158000	158000	158000	158000
Technical Assistance	1022000	1022000	1022000	1007000	1007000	1007000	1007000	1007000	1007000	1007000
Travel and Per Diem	120000	120000	120000	120000	120000	120000	120000	120000	120000	120000
Materials and Equipment	296000	19000	19000	19000	19000	248000	19000	19000	19000	19000
Contingencies	198000	143000	143000	141000	141000	187000	141000	141000	141000	141000
Sub-Total Capital Cost	1794000	1462000	1462000	1445000	1445000	1720000	1445000	1445000	1445000	1445000
2.2 Production Cost										
Labour	0	349770	810800	1280020	1841990	2463970	2922275	3315105	3626100	3937090
Services	0	24060	56510	89530	129085	172860	205115	232765	254650	276540
Materials	0	234330	513940	762200	1081085	1434030	1694095	1917005	2093480	2269950
Sub-Total Production Cost	0	608160	1381250	2131750	3052160	4070860	4821485	5464875	5974230	6483580
2.3 Maintenance and Other Cost	0	51665	160280	294950	470360	622235	727085	817985	887060	956135
2.4 Marketing Cost	0	109355	339255	624310	995590	1317060	1538990	1731400	1877610	2023815
TOTAL INCREMENTAL COST	1794000	2231180	3342785	4496010	5963110	7730155	8532560	9459260	10183900	10908530
NET INCREMENTAL BENEFITS	-1794000	-1534340	-1227345	-563370	308330	566285	1161880	1447180	1643540	1839910

ANNEX 6A
SENSITIVITY ANALYSIS I
(Assumption)
US$4.00 per lb Cotton Lint Assumed

ITEM	PROJECT YEARS 1	2	3	4	5	6	7	8	9	10
1. Project Benefits										
1.1 Sales Revenue										
Antigua	0	77400	352400	992400	1922400	2813400	3461400	3947400	4352400	4757400
Barbados	0	588000	1680000	2730000	3990000	5040000	5670000	6300000	6720000	7140000
Montserrat	0	13200	48000	108000	192000	240000	288000	312000	336000	360000
St. Kitts/Nevis	0	18240	35040	102240	167040	203040	275040	347040	419040	491040
Incremental Project Benefit	0	696840	2115440	3932640	6271440	8296440	9694440	10906440	11827440	12748440
2. Project Cost										
2.1 Capital Cost (R&D)										
General Project Administration	158000	158000	158000	158000	158000	158000	158000	158000	158000	158000
Technical Assistance	1022000	1022000	1022000	1007000	1007000	1007000	1007000	1007000	1007000	1007000
Travel and Per Diem	120000	120000	120000	120000	120000	120000	120000	120000	120000	120000
Materials and Equipment	296000	19000	19000	19000	19000	248000	19000	19000	19000	19000
Contingencies	198000	143000	143000	141000	141000	187000	141000	141000	141000	141000
Sub-Total Capital Cost	1794000	1462000	1462000	1445000	1445000	1720000	1445000	1445000	1445000	1445000
2.2 Production Cost										
Labour	0	349770	810800	1280020	1841990	2463970	2922275	3315105	3626100	3937090
Services	0	24060	56510	89530	129085	172860	205115	232765	254650	276540
Materials	0	234330	513940	762200	1081085	1434030	1694095	1917005	2093480	2269950
Sub-Total Production Cost	0	608160	1381250	2131750	3052160	4070860	4821485	5464875	5974230	6483580
2.3 Maintenance and Other Cost	0	51665	160280	294950	470360	622235	727085	817985	887060	956135
2.4 Marketing Cost	0	109355	339255	624310	995590	1317060	1538990	1731400	1877610	2023815
TOTAL INCREMENTAL COST	1794000	2231180	3342785	4496010	5963110	7730155	8532560	9459260	10183900	10908530
NET INCREMENTAL BENEFITS	-1794000	-1534340	-1227345	-563370	308330	566285	1161880	1447180	1643540	1839910

ANNEX 6B
SENSITIVITY ANALYSIS I
US$4.00 per lb Cotton Lint Assumed

ITEM	PROJECT YEARS									
	1	2	3	4	5	6	7	8	9	10
1. Project Benefits	0	696840	2115400	3932640	6271440	8295440	9694440	10906440	11827440	12748440
2. Project Cost	179400	2231180	3342785	4496010	5963110	7730155	8532560	9459260	10183900	10908530
3. Net Farm Benefit (1-2)	-1794000	-1534340	-1227385	-563370	308330	565285	1161880	1447180	1643540	1839910
4. Discount Factor (12%)	0.893	0.797	0.712	0.636	0.567	0.507	0.452	0.404	0.361	0.322
5. Present Value Benefit (4x1)	0	555380	1506160	2501160	3555910	4205790	4381890	4406200	4269710	4105000
6. Present Value cost (4x2)	1602042	1778251	2380063	2859462	3381083	3919189	3856717	3821541	3676388	3512547
7. Net Present Value (4x3)	-1602042	-1222869	-873898	-358303	174823	286600	525170	584661	593318	592451

(a) Economic Benefit/Cost Ratio at Discount Rate of 12%
Economic Benefit = $29,487,200
Economic Cost = $30,787,283
Benefit/Cost Ratio = 0.958

(b) Net Present Value (NPV) of Project at Discount Rate of 12%
NPV = US$1,300,083

(c) Economic Internal Rate of Return (EIRR) of the project = 5.2%

ANNEX 7A
SENSITIVITY ANALYSIS II
50% Shortfall in New Lands Under Cultivation

ITEM	PROJECT YEARS									
	1	2	3	4	5	6	7	8	9	10
1. Project Benefits										
1.1 Sales Revenue										
Antigua	0	53210	242280	682280	1321650	1934210	2379710	2713840	2992280	3270710
Barbados	0	404250	1155000	1876880	2743130	3465000	3898130	4331250	4620000	4908750
Montserrat	0	9080	33000	74250	132000	165000	198000	214500	231000	247500
St. Kitts/Nevis	0	12540	38940	70290	114840	139950	189090	238590	288090	337590
Incremental Project Benefit	0	479080	1469220	2703700	4311620	5704160	6664930	7498180	8131370	8764550
2. Project Cost										
2.1 Capital Cost (R&D)										
General Project Administration	158000	158000	158000	158000	158000	158000	158000	158000	158000	158000
Technical Assistance	1022000	1022000	1022000	1007000	1007000	1007000	1007000	1007000	1007000	1007000
Travel and Per Diem	120000	120000	120000	120000	120000	120000	120000	120000	120000	120000
Materials and Equipment	296000	19000	19000	19000	19000	248000	19000	19000	19000	19000
Contingencies	198000	143000	143000	141000	141000	187000	141000	141000	141000	141000
Sub-Total Capital Cost	1794000	1462000	1462000	1445000	1445000	1720000	1445000	1445000	1445000	1445000
2.2 Production Cost										
Labour	0	174890	405400	640010	921000	1231990	1461140	1657550	1813050	1968550
Services	0	12030	28260	44770	64540	86430	102560	116380	127330	138270
Materials	0	117170	256970	381100	540540	717020	847050	958500	1046740	1134980
Sub-Total Production Cost	0	304090	690630	1065880	1526080	2035440	2410750	2732430	2987120	3241800
2.3 Maintenance and Other Cost	0	25830	80140	147480	235180	311120	363540	408990	443530	478070
2.4 Marketing Cost	0	54680	169630	312160	497800	685530	769500	865700	938805	1011910
TOTAL INCREMENTAL COST	1794000	1846600	2402400	2970520	3704060	4752090	4988790	5452120	5814455	6176780
NET INCREMENTAL BENEFITS	-1794000	-1367520	-933180	-266820	607560	952070	1676140	2046060	2316915	2587770

ANNEX 7B
SENSITIVITY ANALYSIS II
50% Shortfall in new lands under cultivation

ITEM	PROJECT YEARS									
	1	2	3	4	5	6	7	8	9	10
1. Project Benefits	0	479080	1469220	2703700	4311620	5704160	6664930	7498180	8131370	8764550
2. Project Cost	1794000	1846600	2402400	2970520	3704060	4752090	4988790	5452120	5814455	6176780
3. Net Farm Benefit (1-2)	-1794000	-1367520	-933180	-266820	607560	952070	1676140	2046060	2316915	2587770
4. Discount Factor (12%)	0.893	0.797	0.712	0.636	0.567	0.507	0.452	0.404	0.361	0.322
5. Present Value Benefit (4x1)	0	381830	1046080	1719550	2444690	2892010	3012550	3029260	2935420	2822190
6. Present Value cost (4x2)	1602042	1471740	1710509	1889251	2100202	2409310	2254933	2202657	2099018	1988923
7. Net Present Value (4x3)	-1602042	-1089913	-664424	-169698	344486	482699	757615	826608	836406	833262

(a) Economic Benefit/Cost Ratio at Discount Rate of 12%
Economic Benefit = $20,283,580
Economic Cost = $19,728,585
Benefit/Cost Ratio = 1.03

(b) Net Present Value (NPV) of Project at Discount Rate of 12%
NPV = US$554,999

(c) Economic Internal Rate of Return (EIRR) of the project is 14.5%

FECHA DE DEVOLUCION
