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IMPACT AND AMELIORATION OF SEDIMENT AND AGRO-CHEMICAL POLLUTION IN CARIBBEAN COASTAL WATERS

Review of Soil Management and Farming Practices, Including the Use of Agro-Chemicals In The Caribbean, With Particular Reference To St Lucia And Jamaica

APRIL 2003

CARDI

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EXECUTIVE SUMMARY

- This review discusses farming practices, soil management and use of agro-chemicals in Jamaica and St Lucia. It provides information to build on other research relating to the impact and amelioration of sediment and agro-chemical pollution in Caribbean coastal waters.

- This research has focused on two watersheds in Jamaica (Rio Cobre and Wag Water) and three watersheds in St Lucia (Soufriere, Roseau and Praslin/Mamiku) as representative watersheds within the two countries. General farming practices have been described and then each watershed has been characterised according to literature and survey results from 150 farms in Jamaica and 150 farms in St Lucia.

- Farming practices in relation to soil conservation in Jamaica is then reviewed. The progress of conservation projects over the years beginning in the 1940s and continuing to the present is recorded, and it is evident that there is an increasing number of projects focusing on soil conservation and reducing impacts of farming, and use of agro-chemicals, on the environment.

- The role of increasing population numbers, particularly in Jamaica, on soil degradation is also highlighted, as well as the need for a total development orientation to soil conservation, where erosion control measures must be considered in relation to people development.

- The trade policy and philosophy for agriculture development in Jamaica is then discussed. The agricultural trade policy, which outlines the Government philosophy and support to the trade process is detailed along with the supporting legislation specifically the Government Anti-dumping and Safeguards legislation.

- The international agreements which impact on the process of trade among Caribbean nations are then outlined with important issues to Jamaica and St Lucian agricultural trade emphasised. It is clear that international agreements should have a heavy influence on agricultural land practices and their influence on marine pollution.

- The report concludes with the results of the farm surveys carried out in Jamaica and St Lucia. The important findings from these two surveys are highlighted and results show that the effect of the use of agro-chemicals on the overall environment were not well known or recognised by a sizeable number of farmers. Recommendations are also made of possible areas of intervention on farms in the two islands.

ACRONYMS

ACP	African Caribbean and Pacific States
CARDI	Caribbean Agricultural Research and Development Institute
CARIBCAN	Caribbean/Canada Trade Agreement
CARICOM	Caribbean Community
CBI	Caribbean Basin Initiative
CMS	Centre for Marine Sciences
DOC	Department of Chemistry
EPA	Economic Partnership Agreement
EU	European Union
FAO	Food and Agricultural Organisation of the United Nations
FTAA	Free Trade Areas of the Americas
GATT	General Agreement on Tariffs and Trade
GSP	Generalised System of Preference
GTZ	German Agency for Technical Cooperation
HASP	Hillside Agricultural Support Project
ICENS	International Centre for Nuclear Sciences
ICPP	International Convention for Phyto-sanitary Protection
IDRC	International Development Research Centre
IICA	Inter-American Institute for Co-operation on Agriculture
IRDP	Integrated Rural Development Programme
IOE	International Office of Epizootics
JADF	Jamaica Agricultural Development Foundation
JAPHIS	Jamaica Animal and Plant Health Inspection System
JARP	Jamaica Agricultural Research Programme
LDC	Less Developed countries
MAL	Ministry of Agriculture and Lands
MDC	More Developed Countries
MFN	Most Favoured Nation
MOA	Ministry of Agriculture
MOU	Memorandum of Understanding
MRAG	Marine Resources Assessment Group
NGO	Non-Government Organisation
NPI	Natural Products Institute
SPS	Sanitary and Phyto-sanitary measures
STATIN	Statistical Institute of Jamaica
UNDP	United Nations Development Programme
USAID	United States Agency for International Development
UWI	University of the West Indies
WTO	World Trade Organisation
WGSPM	Working Group on Sanitary and Phyto-Sanitary Measures

1 BACKGROUND

This report contributes to a three-year research project *Impact and amelioration of sedimentation and agro-chemicals in Caribbean coastal waters* which is funded by DFID's NRSP LWI programme (R7668). It follows on from an earlier LWI project *Review of the impacts of pollution by sediments and agro-chemicals of tropical coastal waters with reference to the Caribbean region* (R7111). The present project is managed and conducted by two organisations: the University of York, responsible for the sedimentation aspects of the project; and MRAG Ltd, responsible for agro-chemical components of the project. Agro-chemical related activities are undertaken in St Lucia and Jamaica. The project commenced in June 2000 and ends in July 2003, with the publication of guidelines for best management practices for agro-chemical management.

This review of soil management and farming practices is the work of the Caribbean Agricultural Research and Development Institute at the University of the West Indies, Mona, Jamaica. Comments and insight have been received from a number of project partners[1] and these have contributed to the final report. The document aims to provide an understanding of soil management and farming practices with particular emphasis on the use of agro-chemicals[2] in St Lucia and Jamaica, and the wider Caribbean. This information will contribute to the wider project objective of a broader technical understanding of the extent in which agro-chemicals are applied and impacting the environment in two representative countries in the Caribbean. St Lucia has been selected as a detailed case study, including thorough investigation of the fate of agro-chemicals in the environment. Jamaica has been chosen to provide a contrasting example of intensive agricultural land use on a large Caribbean Island. Agro-chemical inputs will be estimated there from importation data and literature review and differences in appropriate best management practices explored.

In late 2000, the Centre of Marine Sciences (CMS) in the Department of Life Sciences at UWI signed a Memorandum of Understanding (MOU) with The University of York/MRAG Ltd. This MOU outlined the basis for collaboration between UWI and the University of York/MRAG Ltd on various aspects of the project "Impact and Amelioration of Sediment and Agro-chemical Pollution on Caribbean Coastal Waters." The MOU envisaged a group at UWI consisting of representatives from CMS, and other Departments/Institutes on campus including the Department of Chemistry (DOC), the Natural Products Institute (NPI) and the Caribbean Agricultural Research and Development Institute (CARDI). The representative from CMS was designated the coordinator of this group. In the list of activities which the UWI group was given in the MOU, CARDI was made responsible for the carrying out all tasks relating to a review of soil management and farming practices, including the use of agro-chemicals in the Caribbean, with particular reference to St Lucia and Jamaica and produce a technical report. This review contains the phased outputs as follows:

i. Characterization and quantification of farming units;
ii. Identification of target crops for further study;
iii. Literature review;
iv. Appraisal of existing national legislation, national/international policy measures and potential future impacts (e.g. EU banana agreements);
v. Interviews with key informants in Government, NGO's and the agricultural industry;
vi. Preparation of draft questionnaires for St Lucia and Jamaica; and
vii. Structured questionnaires for farmers in St Lucia and Jamaica and subsequent analysis;
viii. Compiled review document.

[1] Jamaica: UWI, CCAM; St Lucia: MAFF, CEHI, UK: MRAG Ltd.

[2] For the purpose of the current project, the term agro-chemical includes pesticides and fertilisers used in agriculture.

2 INTRODUCTION

Jamaica has a total land area of 11,424 km^2 and 80% of this is a configuration of mountains ranging between 300m and 2100m in elevation. This gives rises to watershed areas comprising of sloping lands, the steepness of which in most cases is greater than 20%. There are 33 watershed areas in the island, each is drained by a major river and its tributaries and comprising land areas extending from the hills to the sea (IICA, 1998).

Decades of improper land use have contributed significantly to some 18-20% or approximately 200,000ha of these lands being seriously eroded, with an average annual soil loss of between 150 to 200 tons per ha (IICA, 1998). As a consequence, there is a high level of siltation in streams and rivers, and this is adversely affecting marine life, ports, wharves, other forms of wildlife, water supplies and agricultural production (IICA, 1998).

In agriculture, large quantities of the macro-nutrients nitrogen and phosphorus (Lindsay et al., 1996) as well as chemical pesticides are utilized. As much of Jamaica's agriculture is practiced on steep slopes, transport of these materials to the aquatic environment by sediment and runoff is highly probable (Lindsay et al., 1996). The practice of surface/broadcast application exacerbates this problem. This, combined with the highly erosive rainfall experienced in Jamaica, makes transport of these materials to the aquatic environment by runoff and sediments highly likely, and may result in a shift in the natural balance.

The principal nitrate pathway to the aquatic environment is leaching by heavy rainfall or irrigation water through the soil profile into the water table. A secondary pathway is surface runoff which is the principal pathway for phosphate loss as leaching of phosphates is insignificant due to binding to soil particles. Chemical pesticides are likely to utilize both pathways, with surface runoff being the principal one.

The impact of the use of fertilizer and chemical pesticides on the environment has not been studied in detail in Jamaica. However, previous studies on nutrient levels in runoff waters have identified areas in the island with unacceptably high levels of nitrates and phosphates (Lindsay et al., 1996). Whether or not the use of inorganic fertilizers contributes to these unacceptable levels cannot be conclusively stated at present as information on this topic is inadequate. The overall study will complement previous work in this area and allow for a qualified statement on the impact of the use of inorganic fertilizers and chemical pesticides on the environment

3 CHARACTERISATION AND QUANTIFICATION OF FARMING UNITS

3.1 Farming units in Jamaica

Data from STATIN (1996) indicate that there are a total of 407,434 ha of land available for farming in a total of 187,791 holdings or farming units, including landless farmers. 152,791ha or 38% of the total area is in larger parcels of over 200ha each and this is operated by 205 farming units or a mere 0.11% of the total farming units (fig. 3.1).

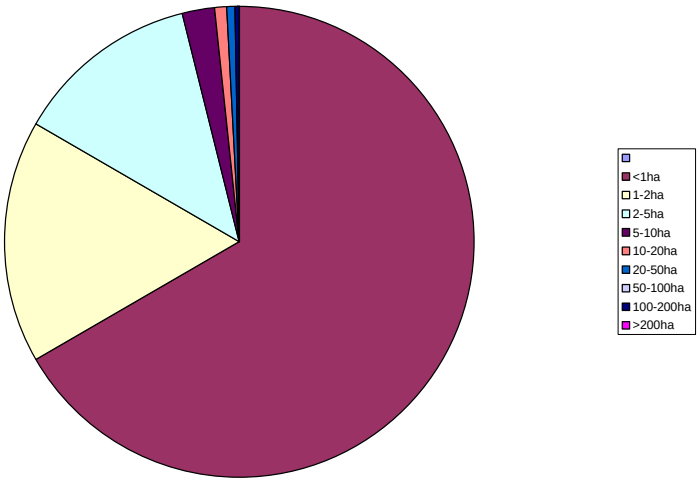


Figure 3-1: Percentage number of holdings in relation to size of holdings in Jamaica

The data also indicates that at the other end of the land holding spectrum, there is 171,653ha in farm holdings of less than 1ha to 10ha (fig. 3.2). This represents 42% of the available farming area. This area is operated by 170,033 farming units or 90% of the total farming units (fig 3.3).

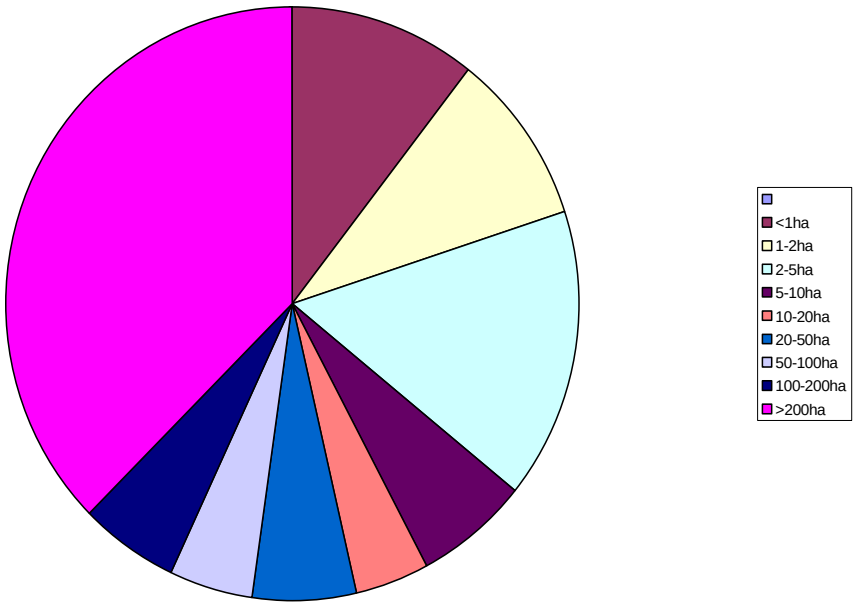
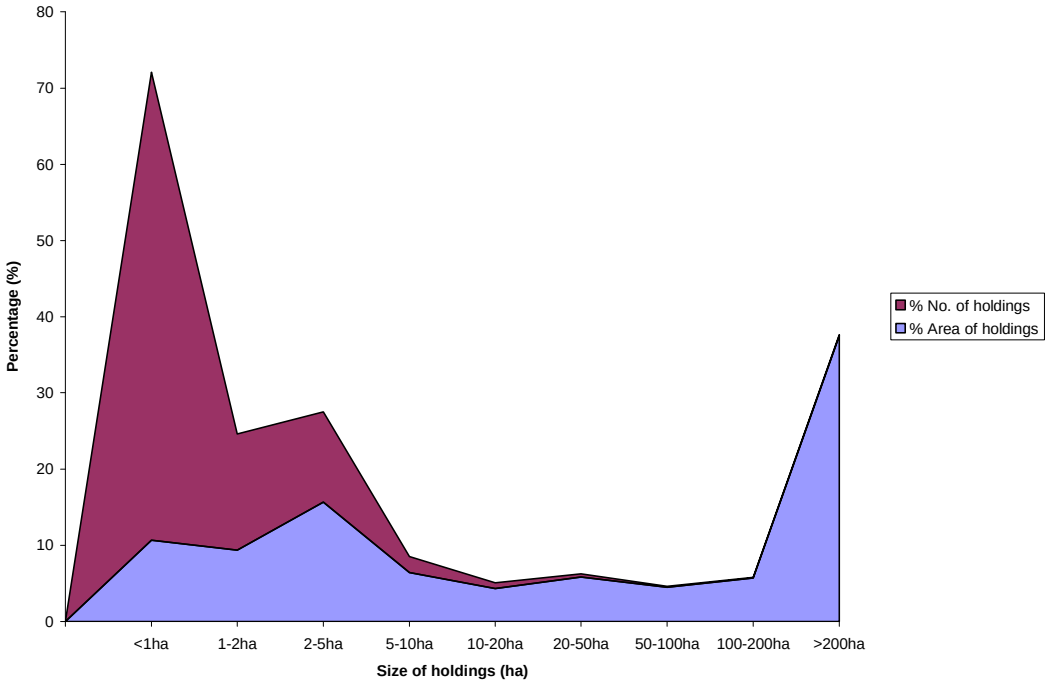


Figure 3-2: Percentage area of holdings in relation to size of holdings

This means that there are both the small holdings, which are likely to put extreme



pressure on the land area and the larger holdings that must be looked at in terms of their management of the soil and environment.

Figure 3-3: Percentage number of holdings and area of holdings in relation to size of holdings

Data from STATIN (1996) also indicate that there are a total of 130,509 ha under permanent crops in the island, no data was provided from this source for the area under annual crops (Table 3.1). The data also indicate that 53,294ha or 41% of the total area is under sugar cane. The other crops of importance are banana, coconut, citrus and coffee, but none of these occupy more than 10% of the areas under permanent crops.

3.2 Farming Units in the Selected watersheds

The watersheds selected are the Rio Cobre and Wag Water watersheds. These two watersheds are fairly representative of the typical Jamaican watershed which has been influenced by improper management mainly due to the activities of an increasing population.

3.1.1 Rio Cobre Watershed

The Rio Cobre watershed, with a total land area of 63,000 ha, occupies most of the parish of St Catherine and a small area of the south western section of St Mary (fig. 3.4). The main tributaries of the Rio Cobre are the Rio Pedro, Rio Magno and the Rio D'Oro (fig. 3.5).

The upper sections of the Rio Pedro and the Rio D'Oro flow through areas with relatively low agricultural activity. Yams , vegetables and cocoa are the major crops grown. Sand mining is a major activity along the Rio Pedro. Both rivers border the Tulloch Estate, a large estate near Bog Walk where sugar cane and bananas are grown. This area is flat and is subject to periodic flooding by the river. This watershed has a fair cover of permanent crops and natural forest in sections. However over reaping natural forest for fence posts and timber have aided degradation of the watershed leading to rapid stream flow (Bockaire, 1994).

The 1996 Agricultural Census (STATIN, 1996) has indicated that St Catherine has 19139 ha in permanent crop production. No data is available for the area under annual crops. Of the permanent crops sugar cane occupies the highest acreage of 8007 ha with citrus, mainly orange having the second highest of 3691ha. There are also large areas of bananas, cocoa and coffee in the watershed (Table 2).

Bockarie (1994) gives data on the farming units in the Rio Cobre watershed and this indicates that the highest number of farmers are in bananas and cocoa (Table 3). So that although there are larger areas under sugar cane and citrus there are actually much more farming units in bananas and cocoa. These four crops, sugar cane, citrus, banana and cocoa, are therefore the ones of most importance in this watershed.

The demographics of the watershed are not easily available, mainly because the administrative units are not consistent with the units or areas that form part of the Rio Cobre drainage basin. For example, the Rio Cobre drainage basin covers areas which are administered by the parishes of St Mary and St Catherine and include hundreds of electoral districts. The demographic data is only available for electoral districts. The process of determining which electoral district falls within the watershed has not yet been done. There is however, data from the constituencies which are part of the watershed and this is given in Table 3.4

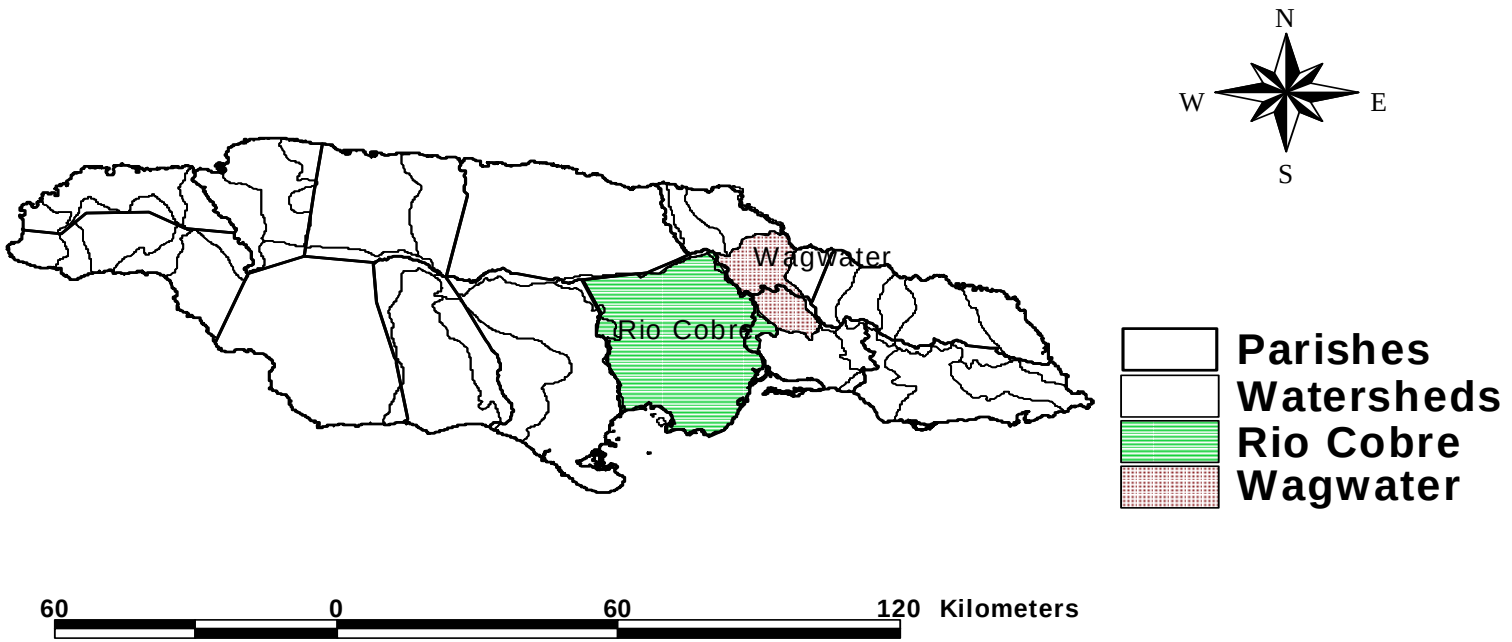


Figure 3-4: Location of Wag Water and Rio Cobre Watersheds

Table 3-1 Total permanent crops by size of holdings

Size Holdings	Avocado	Banana	Coco a	Coconut	Coffee	Grapefruit	Orange	Ortanique	Mango	Pimento	Plantain	Sugar cane	Other crops
< 1ha	258	3540	1039	875	1815	160	744	34	866	301	1318	1936	906
1-2 ha	140	2659	1541	968	2088	132	823	34	465	292	1113	2501	573
2-5 ha	196	3721	2499	2205	2924	185	1446	61	609	747	1435	4519	1187
5-10 ha	56	1064	737	1005	954	56	519	61	258	387	309	1599	185
10-20 ha	38	531	312	822	538	44	352	36	124	229	169	1022	117
20-50 ha	37	619	300	1190	635	22	524	43	104	517	113	2136	118
50-100 ha	11	625	114	1416	439	10	572	28	25	293	51	1449	166
100-200 ha	13	318	263	1550	591	10	789	51	233	588	7	2596	80
>200 ha	10	3003	221	3852	823	98	4492	482	575	1707	66	35536	619
Total area	759	16080	7026	13883	10807	717	10261	830	3259	5061	4581	53294	3951

Table 3-2: Permanent crops by size of holdings in St Catherine

Size Holdings	Avocado	Banana	Coco a	Coconut	Coffee	Grapefruit	Orange	Ortanique	Mango	Pimento	Plantain	Sugar cane	Other crops
< 1ha	49	425	221	133	211	18	174	3	123	29	185	185	147
1-2 ha	23	376	354	131	299	18	212	2	69	32	168	258	129
2-5 ha	33	498	556	238	535	28	328	5	111	70	199	410	208
5-10 ha	10	126	130	98	126	9	156	6	45	28	44	117	50
10-20 ha	5	55	61	55	74	9	100	2	14	14	17	82	31
20-50 ha	2	32	38	62	22	2	57	0	22	7	9	73	21
50-100 ha	0	12	4	76	21	0	220	4	3	0	5	134	1
100-200 ha	0	3	0	35	3	1	380	0	146	0	0	388	21
>200 ha	0	141	2	86	29	41	1909	7	4	21	0	6360	78
Total area	122	1668	1366	914	1320	126	3536	29	537	201	627	8007	686

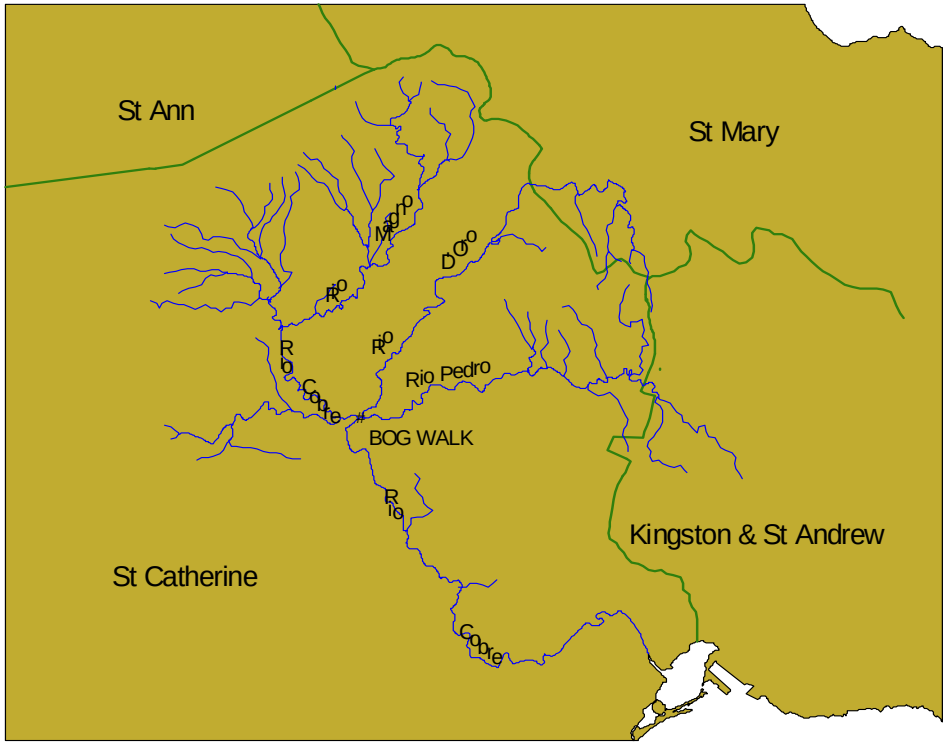


Figure 3-5: Map of the Rio Cobre basin

Table 3-3: Differences in cropping pattern for number of farmers growing the crop by farm size in the Rio Cobre Watershed

Crop	Farm size (ha)				Total	Percent
	Tiny	Small	Medium	Large		
	<0.9	0.9<2.3	2.3<4.5	>4.5		
Annual	50	85	48	25	208	4.77
Avocado	5	21	26	19	71	1.63
Banana	199	255	148	76	678	15.55
Citrus	15	40	33	38	126	2.89
Cocoa	194	255	159	83	691	15.85
Coconut	43	104	81	46	274	6.29
Coffee	34	88	73	57	252	5.78
Fallow	34	79	47	28	188	4.31
Lumber	8	44	38	27	117	2.68
Mango	28	73	47	38	186	4.27
Other crops	26	54	29	23	132	3.03
Other trees	64	111	66	40	281	6.45
Pasture	7	32	44	47	130	2.98
Pimento	14	37	33	31	115	2.64
Plantain	27	44	32	17	120	2.75
Ruin	81	173	109	77	440	10.09
Sugar	17	51	37	20	125	2.87
Yam	55	89	53	28	225	5.16
Total	901	1635	1103	720	4359	100.00

Table 3-4: Number of farmers their gender and size of holdings in the Rio Cobre Watershed

Constituency	Number of Farmers by gender				Size of Holdings (ha)			
	Male	Female	NS	Total	<0.9	0.9<2.3	3.3<4.5	>4.5
St Catherine (NE)	2219	678	14	2911	1720	597	200	104
St Catherine (NW)	3392	904	18	4314	2183	1213	493	184
St Catherine (WC)	3176	905	32	4115	2247	993	349	131
St Catherine (EC)	2544	729	22	3295	1967	699	204	105
St Catherine (SE)	1536	613	15	2164	988	408	205	131
St Catherine (WR)	145	37	2	184	60	9	9	9
St Catherine (S)	114	42	20	176	60	9		38
Total	13128	3908	123	17159	9225	3928	1460	702

3.1.2 Wag Water River Watershed

Wag Water River watershed has a total land area of 24,800 ha and is located in North west St Andrew and South St Mary (Fig. 3.4). The watershed is drained primarily by the Wag Water River and its main tributaries, the Flint and Ginger Rivers (Fig 3.6). It is on

this river that the Hermitage dam is located at a site much nearer to the Grand ridge where the watershed begins. This source of potable water also augments the Kingston Metropolitan area supplies. Slopes vary from very steep in the upper reaches through moderate to small acreage of flat lands along the river nearing its entry into the sea.

The watershed presently has an estimated 45% permanent cover. A wide range of cropping systems are in evidence from forestry (planted and natural), permanent crops of cocoa, coffee, fruit and food trees, semi-permanent crops, bananas, pineapples, sugarcane and various food crops.

A cocoa fermentry and a chocolate factory sited in the area make the growing of cocoa a profitable venture. Commercial banana plantations along the major river valleys contribute to the range of productive enterprises. Soil types are highly erodible and there is a tendency to over exploit for food crop establishment. Consequently soil loss is high (Cunningham, 1993) and where deposited in the river, sandmining results.

The majority of land owners are small farmers who for the most part reside on their holdings. Because of the proximity of this area to Kingston housing development appears to be expanding to accommodate persons who work in the city.

The reaping of timber trees from individual holdings by sawmillers in recent years, with very little replacement has robbed the area of some of its natural cover (Cunningham, 1993). Short drought periods now have grave consequences for the farmers who depend on rainfall for the various crops.

The 1996 Agricultural Census (STATIN, 1996) has indicated that St Mary has 15,061ha in permanent crop production while St Andrew has 3514 ha. No data is available for the area under annual crops. In St Mary the major crops in order of total area under production are banana, coconut and cocoa. In St Andrew the major crop is coffee which covers nearly 50% of the total permanent crop area. Banana and cocoa are the other two crops of importance based on acreage.

Data on annual crops, available from the RADA Office in St Andrew for one area, Temple Hall, which falls in the watershed is given in Table 3.7. The data indicate that the more important annual crops in the district are vegetables and ground provisions with callaloo and yam being the significant crops in the respective groups.

As the Rio Cobre watershed and for the same reasons, information on the population of farmers and the farming units are not yet available. Data from the constituencies that fall within the watershed are presented in Table 3.8.

Table 3-5: Permanent crops by size of holdings in St Mary

Size Holdings	Avocado	Banana	Coca	Coconut	Coffee	Grapefruit	Orange	Ortanique	Mango	Pimento	Plantain	Sugar cane	Other crops
< 1ha	15	450	232	168	47	20	24	1	41	32	278	72	56
1-2 ha	15	453	363	205	72	8	23	0	39	38	251	88	42
2-5 ha	26	685	881	552	176	20	76	3	88	144	411	121	339
5-10 ha	10	307	323	278	73	9	49	32	63	100	27	28	0
10-20 ha	7	142	136	175	49	6	37	1	14	33	58	16	12
20-50 ha	7	264	220	413	92	8	145	1	17	121	61	68	17
50-100 ha	1	392	71	594	55	1	116	0	1	60	22	83	2
100-200 ha	0	165	257	484	17	5	245	43	1	62	2	0	0
>200 ha	0	714	161	536	18	39	192	20	109	497	16	0	106
Total area	81	3572	2644	3405	599	116	907	101	373	1087	1126	476	574

Table 3-6: Permanent crops by size of holdings in St Andrew

Size Holdings	Avocado	Banana	Coca	Coconut	Coffee	Grapefruit	Orange	Ortanique	Mango	Pimento	Plantain	Sugar cane	Other crops
< 1ha	8	392	74	21	413	9	9	0	29	14	47	27	53
1-2 ha	5	121	83	13	370	5	7	0	18	9	36	16	39
2-5 ha	8	109	91	20	338	8	10	1	16	12	36	20	36
5-10 ha	1	45	49	20	126	1	6	2	10	6	37	5	16
10-20 ha	1	6	6	13	90	1	1	10	7	13	2	1	3
20-50 ha	1	6	3	2	209	1	7	0	1	1	0	0	0
50-100 ha	0	2	0	76	69	0	0	0	0	0	0	0	0
100-200 ha	1	0	0	0	134	0	0	0	0	0	0	0	0
>200 ha	0	0	0	0	0	0	0	0	0	0	0	0	0
Total area	25	681	306	165	1749	25	40	13	81	55	158	69	147

Table 3-7: Annual crop production statistics in the Temple Hall area of the Wag Water watershed

Crop	Area (ha)			
	Target	Planted to date	Reaped for the year	Currently growing
Pulses	17.7	27.1	22.7	10.8
Vegetables	60.4	112.8	100.7	32.4
Condiments	11.9	13.9	13.7	7.0
Fruits	7.7	4.9	4.0	7.8
Cereals	39.2	37.9	55.7	17.4
Ground Provision	58.0	61.9	57.6	57.8
Total	194.9	258.5	254.4	133.2

Table 3-8: Number of farmers their gender and size of holdings in the Wag Water watershed

Constituency	Number of Farmers by gender				Size of Holdings (ha)			
	Male	Female	NS	Total	<0.9	0.9<2.3	3.3<4.5	>4.5
St Andrew (WR)	2066	449	17	2532	1651	538	155	57
St Mary (SE)	2300	627	47	2974	1927	1143	526	177
St Catherine (EC)	94	34		131	90	19	7	3
Total	4460	1110	64	5637	3668	1700	688	337

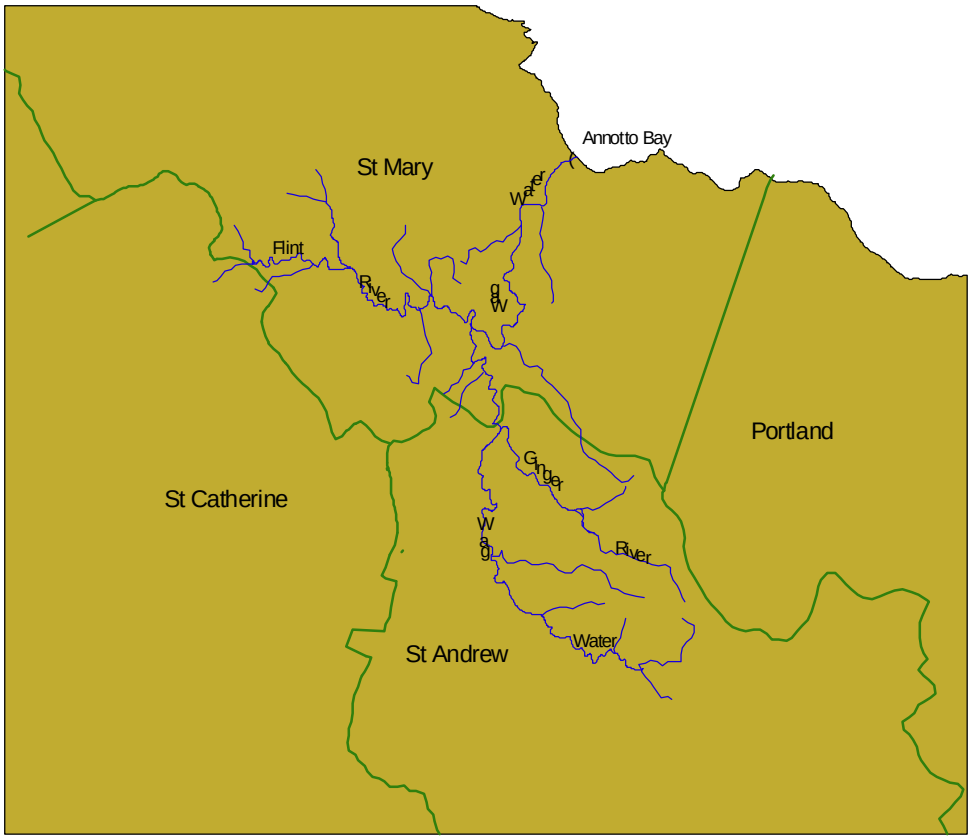


Figure 3-6 Map of the Wag Water basin

4 IDENTIFICATION OF TARGET CROPS FOR FURTHER STUDY

From the data obtained for the two watersheds and consultation with the agricultural staff in the areas, the crops of importance are sugar cane, citrus, banana, coffee, yams and mixed vegetables in the Rio Cobre watershed. While in the Wag Water River watershed they are coffee, banana and plantain, yams, hot pepper and mixed vegetables.

The larger holdings would be predominated by monocrop system of the more permanent crops of sugar cane, citrus, banana, plantain and coffee. While the smaller holdings consist of a multiple crop system which will have some permanent crops but can be defined by more cash crops such as hot peppers, yam and mixed vegetables.

The target crops selected for further study in the two watersheds are given below. In an effort to obtain adequate coverage of all the crop types identified, the survey will be stratified in large holdings and small holdings.

Table 4-1 Selected target crops for the two watersheds

Rio Cobre	Wag Water
Bananas Citrus Coffee Mixed Vegetables Sugar cane Yams	Bananas Coffee Hot Pepper Mixed Vegetables Yams

5 OUTLINE OF EXISTING KNOWLEDGE OF FARMING PRACTICES AND SOIL CONSERVATION TECHNIQUES

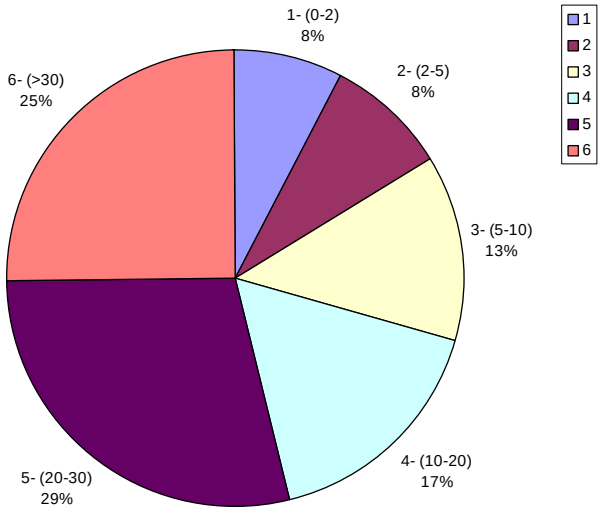
Farming practices are developed based on the physical characteristics present in the particular location. For this reason farming systems are often characterised by the physical parameters of the area. E.g. Farming systems for the humid lowlands of the tropics or farming systems for the semi-arid tropics (Ruthenberg, 1980). It means therefore that any discussion on the farming practices and soil conservation techniques employed in Jamaica must be prefaced by an understanding of the unique conditions that pertain to the island. This presentation seeks to briefly describe the physical characteristics of the island which influences the farming system and practices and also to review important aspects of the resulting farming system particularly in relation to its ability to sustain agricultural production and maintain the integrity of the environment.

5.1 Land area and topography

Jamaica has a total land area of 11,424 km^2. The greatest length of the island is 146 miles, its greatest width is 80.8 km and its least width is 35.6 km (Henry, 1978). The principal range of mountains run east to west with the rivers flowing north and south. Approximately 80% of the land area is a configuration of mountains ranging between 300m and 2100m in elevation (Henry, 1978). This gives rise to watershed areas comprised of sloping lands the steepness of which, in most cases, is greater than 10%. Figure 5.1 gives the percentage of land in various slope categories (1-6).

Category 1 - 0-2°
Category 2 - 2-5°
Category 3 - 5-10°
Category 4 - 10-20°
Category 5 - 20-30°
Category 6 - > 30°

Figure 5-1: Percentage of total land area distributed into various slope categories



There are 33 watershed areas in the island, each is drained by a major river and its tributaries and comprise land areas extending from the hills to the sea (IICA, 1988). The overall implication is that most of the agriculture is carried out on sloping lands, most of which are prone to erosion. In this regard, Jamaica farming systems are mainly hillside farming systems.

5.2 Soil Series

Baker (1978) describes six soil series found in the hilly areas of Jamaica based on their unique parent materials. These are

1. Soils derived from hard limestone. These are red, brown and yellow coloured soils occurring mostly above 100m. e.g. St Ann clay and Chudleigh clay loam.

2. Soils derived from soft limestone. These are mostly marls and rubbly limestone material. They are usually very shallow and contain an abundance of free lime. E.g. Carron Hall clay and Killancholly clay.

3. Soils derived from shale material. These vary in composition. They are usually bedded and weather easily to form soils which are rich in potash. These soils are susceptible to land slipping and erosion. E.g. Belfield clay and Llandewey clay loam.

4. Soils derived from purple conglomerates. These are like land marbles cemented together to form a giant stone. The soils developed are purple in colour. E.g. Cuffy gully gravelly sandy loam.

5. Soils derived from tuffs and other conglomerates. These are mainly clays, usually very acid and low in fertility. E.g. Wirefence clay loam and Wait-a-bit clay.

6. Soils derived from granite and porphyry. These soils are usually shallow and low in fertility. They consist mainly of shattered rock and physically weathered materials. These erode very easily. E.g. Flint River sandy loam and Valda gravelly sandy loam.

In addition, there are two soil series associated with the coastal areas of the island these are:

1. Recent alluvial soils, which occur on the flood plains, along the banks and at the mouth of the main river streams. These soils vary in texture from sands and loam to clay loam and are in general, the most fertile soils in the island. E.g. Agulta sandy loam and Caymanas clay loam.

2. Older alluvial soils, which occur mainly in the plains of St Catherine and Clarendon. These soils are generally heavier in texture, acid or highly acid compared to the recent alluvial soils and in many areas are alkaline. E.g. Churchenpen clay and Bodles clay loam.

5.3 Climate and Rainfall

The minimum daily temperature values over a 30-year period varied between 12.4 and 18.8°C, whereas maximum temperatures varied between 31.1 and 31.6°C. Monthly potential evapo-transpiration values ranged between 77 mm and 158 mm. Low rainfall acts as a limiting factor on plant growth for different periods in various

parts of the island. Rainfall ranges from a low of 1400mm in the drier parishes to 2200mm in the wetter ones, and is concentrated in two distinct periods from May-July and September to November. The dry season is considered to be during the period December-January. Most of the drier areas have six critically droughty months whilst the rest of the areas have three or more months of droughty conditions (CARDI, 1999). This means that unless irrigation is available there is in most years a six month cropping season in the wettest part of the island.

Like most tropical countries Jamaica has many high intensity rainfall events. Arrangements of the mountain range relative to the trade winds favours high rainfall on the northern side of the island. High intensity rainfall also accompanies hurricanes that are not infrequent occurrences (Wilson, 2001). Rainfall intensity of 100 mm in one hour has been reported in the Rio Grand watershed. In recent years, rains in Portland (Wilson, 2001) were recorded with a rainfall of over 1200mm over a 24 hour period. These intensities are too high for the infiltration rates of most soils and the resulting runoff erodes soils (Wilson, 2001).

5.4 Agricultural systems

There are three distinct farming systems which can be identified on the island as follows: (Baker,1978):

1. The Estate or plantation system, which involves the production of export crops mainly sugar cane, bananas, citrus, coconuts, or beef for the local markets. In this sector, agriculture tends to be on the extensive rather than on the intensive basis and occupies some of the best farm lands of the country.

2. Medium scale farming, which is practised on farms between 25-100 acres. These farms are normally engaged in a wide range of enterprises mainly dairying, pig poultry, banana, sugar cane, citrus, cocoa, coffee, pimento, coconuts, vegetables, legumes and other crops. These farms cover various slope ranges, and are generally fairly cognisant of the need to preserve the very steep slopes by maintaining them in natural vegetation.

3. Small scale farming, practised on farms below 25 acres in size and located mainly in the hills of the country, is mainly concerned with the production of food crops for the domestic market. Crops such as coffee, cocoa, pimento, citrus, bananas, sugar cane, ginger, tumeric, kola nut, mango, avocado, ackee, etc. are grown for the export market. On these small farms, other fruits such as breadfruit, soursop, naseberry, sweetsop, guava, pineapple etc. are also produced in large quantities. Additional enterprises are dairying, pig, poultry and goat rearing.

In the first two systems, most of the crops are grown in monoculture, or a combination of two, but on the smaller holdings only crops such as sugar cane, yams, vegetables and legumes are grown in monoculture. The general pattern is to have a wide variety of crops growing on the same piece of land. Since the harvesting period varies, this method will enable the farmer to reap all year.

6 HILLSIDE FARMING SYSTEM

As already indicated, 80% of the land area of Jamaica is on hillsides. When this is combined with a mean annual rainfall which ranges between 1400mm in the drier parishes to 2200mm in the wetter ones, and which is concentrated in two distinct periods, it provides a serious soil erosion hazard when these hillsides are disturbed in any way.

Hillsides are disturbed for all kinds of human development projects, including housing, roads, forestry and agriculture. Of these, the most severe damage to hillsides comes through its continuous use for the production of short term food crops.

Some of the agricultural practices which accelerate soil erosion on hillsides are (Lindsay and Douglas, 1993):

1. Removal of trees, bushes and grass prior to cultivation.
2. Cultivation up and down the slope.
3. Poor plant stand and exposed soil areas
4. Overstocking of animals which results in bare patches
5. Burning of vegetation

6.1 Soil Loss

Preliminary soil loss estimates under average conditions as estimated by Sheng (1973) is given in Table 6.1.

Table 6-1: Estimate of erosion rates under different land use in the non-limestone upland watershed of Jamaica.

	Dense forest	Cultivation	Various kinds of terraces	Bare soil
Soil loss (ton/acre/year)	2-5	40-60	6-16	150-250

Based on an experiment conducted on Wirefence clay loam on a 30% slope under yam production, Sheng (1973) showed that soil loss could be significantly reduced by soil conservation practices (Table 6.2).

Table 6-2 Soil loss reduction effected by selected soil conservation measures. (SHENG, 1973A)

Treatments	Control (local practices)	Hillside ditch with yam on hills	Hillside ditch and contour mounds	Bench terraces	Remarks
Total	384.75	111.19	76.26	50.05	43 months
Annual mean	53.74	15.53	10.65	6.99	
Percent of control	100	29	20	13	
Total depth lost	1.5	0.45	0.31	0.20	Inches. I acre inch equals 277.250 lb
Mean annual depth inch	0.43	0.13	0.09	0.06	

Bench terrace the most expensive and most unlikely to be used by small farmers gave the best results, but unfortunately the conditions of the experiment did not facilitate determination of significance.

6.2 The effect of soil erosion

Land degradation has been a major concern resulting from accelerated erosion. Fertile top soil has been washed off resulting in lowered soil productivity. The amount of soil lost is based on estimates as there have not been long term studies of soil erosion. This erosion has resulted in the abandonment of large tracks of steep lands. Some commentators in the past, as reported by Eyre (1992) have put forward the theory that many former coffee estates were abandoned due to severe erosion resulting from poor land management.

The pollution of water resources due to pesticides, other agro-chemicals and soil sediments is a growing concern. Hill (1987) reported the presence of crop protection pesticides in water samples. Sediments transported in water continue to accumulate in the municipal dams and the main harbour. It has been suggested that both the Mona and hermitage dams have lost significant storage capacity due to silt deposits.

Reduction in water yields for domestic and industrial uses is also a critical current issue (Lindsay and Douglas, 1993). The deforestation of many of the watersheds in the island coincides with increased demands for water for the rapidly increasing urban population. Water restrictions are a norm in many areas of the capital. The shortage of water is in contrast to the frequent flash floods in these areas. The high sediment load often renders the runoff useless due to its siltation potential and the high cost of treatment for provision of potable water.

6.3 Soil conservation technologies

Management of hillsides for the growth of short-term food crops requires the use of some form of soil conservation. These generally fall into two categories

- Engineering structures, such as the heavy earth movement associated with the building of terraces, stone barriers and walls, gully plugs etc.

- Cultural practices, which encompasses protecting the soil through prudent soil and vegetative management during crop production.

Some of the many soil conservation technologies tested in or suggested for use in Jamaica are (Wilson, 2001):

(i) Engineering structures

- Terraces: these give good erosion control but are believed to be too expensive for the resource poor farmer that occupies the vulnerable hillsides. Terraces are also difficult to maintain and are incompatible with some livestock enterprises.
- Contour trenches: These give good erosion control but are difficult to construct. They require technologies to which small farmers are not accustomed. Maintenance is expensive especially where livestock enterprises are a component of the farming system.
- Contour ridges: These also require special equipment and maintenance are also very expensive. In addition, should the ridges fail, the escaping water would severely damage the land below.
- Contour bunds: These are similar to contour ridges, but are more stable and easier to maintain.

(ii) Cultural practices

- Contour hedge rows or alley cropping: This biological technique is inexpensive to establish but with some hedge rows species maintenance can be labour intensive and expensive, however plant nutrients gained from trimmings may compensate for the cost of trimming.

- Grass barrier: The use of vetiver grass as a contour barrier for soil erosion control has been used in Jamaica for many years. Its effectiveness in erosion control has been verified but farmers complain about its tendency to spread into crop areas.

- Organic mulch: traditional use of grass mulch is a common and successful practice in the southern region of the St Elizabeth parish, but it has not caught on elsewhere in the country. However harvesting, transporting and applying the dried Guinea grass is expensive and this limits its use to high return crops.

- In-situ mulch: This is the use of the residue of a herbaceous legume as mulch and is still to be introduced to and evaluated in Jamaica.

7 A REVIEW OF SOIL CONSERVATION PROJECTS IN JAMAICA

7.1 The history of soil conservation in Jamaica

The problems of soil erosion and land slides that Jamaica would face were first highlighted in 1492 by Christopher Columbus, whom in describing the country to the Queen of Spain presented it as a piece of crushed paper (Wilson, 2001). The slopes his model depicted were obviously too steep for farming as was known then and therefore this was not a land for farming. Consequently the Spanish occupation of Jamaica was slow. However, when the British came in 1655 no one informed them of the difficult terrain that made up the beautiful island. They learned this for themselves and confined their farming activities to the flat land near the coast. However, they showed no restraint in giving the steep hillsides to their ex-slaves when slavery was abolished in 1836. For the next 100 years, the peasant farmers (the ex slaves) ravaged the slopes as they used inappropriate technologies to exploit marginal lands. Although the British observed the resulting degradation, they did nothing until 1944 just about the time power was being handed over to locals. The problem was highlighted and funds provided to initiate soil conservation programs.

There are reports of soil erosion problems and the need for soil conservation since the 1930's. They repeatedly pointed to the increasing problems and the threats they pose to the ecosystem. Steele (1954) and Rockie (1956) have presented reports on the need for land use planning and soil conservation. Resulting from several proposals, two pilot projects, Yallahs Valley Land Authority and Christiana Area Land Authority were established to control land management in the associated watersheds. In these pilot areas, structures such as bench terraces and contour/storm drains and the use of strip cropping and hedgerows of grasses and other perennials were installed. A watershed commission with support staff was also established and the main watersheds in Jamaica were declared for protection and rehabilitation. A major approach adopted was the establishment of tree crops for watershed stability. The first attempt to measure soil loss in a degraded watershed was done in the James Hill area of Clarendon.

A comprehensive soil conservation project, with assistance from FAO and UNDP, was started in 1968. This project assisted in the measurement of soil loss and runoff from experimental plots (Sheng and Michaelson, 1973). Pilot demonstration areas were established as well as the training of hundreds of soil conservation personnel. Based on the systems developed by the UNDP, a Second Integrated Rural Development Programme (IRDP) was established in Central Jamaica. These projects have been dismal failures partly due to the high cost of establishment and maintenance.

The Inter-American Institute for Co-operation on Agriculture (IICA, 1981) also conducted research on non- structural techniques in the production of annual crops on sloping lands. IICA has also been associated with the USAID funded Hillside Agricultural Project through a sub-project (HASP) in St Catherine. Here soil loss is to be monitored by a recently improved tree crop establishment system on selected farms. Until recently a Hope River Project monitored water yields from the Hope River in conjunction with UWI. The project also implemented a series of structures and biological measures for erosion control.

There have also been two projects funded by JARP (JADF) on the use of biological methods (perennial hedgerows) for erosion control and improved soil management in bauxite and other soils in Central Jamaica (Lindsay, 1992). These studies have been

done in conjunction with MOA, CARDI and UWI. The UWI Botany Department, in conjunction with the University of Wales, has also been involved in monitoring runoff and sediments from watersheds in the Cinchoma area of St Andrew. Finally several statutory bodies routinely monitor water quality throughout the country. Annex 1 gives a list of projects which have been carried out in hillside management.

The review of the literature has shown that of the many soil conservation projects that have been done in Jamaica there have been few success stories. A common discord running through these reports is the top down approach which lacks adequate farmer participation in the selection/modification of the various soil and water management techniques. Soil conservation by means of enforced policies is also a non starter. Several workers have noted, from a summary of successful projects, that conservation is likely to be most effective where it is conducted with the active cooperation of farmers, in their own interests, and integrated with other measures for overall agricultural improvement. This approach fits well into the farming systems approach which has been articulated by the Hillside Agricultural Project (HAP). Recent summaries by Blusian (1982), Young (1986), Moldenhauer et al. (1988), and Shaxon 1989 have emphasised the need for the participatory approach to designing and implementing soil conservation projects. There has also been overwhelming support of the trend towards a reduction in the emphasis on soil conservation in isolation and towards the integration of such practices into the farming practices for a particular location. Improved systems of agricultural development include hillside management, conservation farming, integrated land use or sustainable farming. According to Young 1986 the referred approach should include the following components:

i) Reduce the emphasis on soil conservation as an isolated measure, it should be part of integrated methods of land use improvement;
ii) Utilize simple methods, that are within the capacity of farmers to establish and maintain;
iii) Provide external support for sound traditional farming practices;
iv) Training of local extension services is vital, and in many cases needs to be greatly improved; and
v) Soil conservation requires that participating farmers respect and support the measures which have been proven to have an overall positive impact on the farming and livelihood of the people.

It has also been noted in the literature review that there are misgivings as to the efficacy of vegetative/biological methods in erosion control in tropical countries. This has been due in part to improper establishment and maintenance. Although effective natural terraces have been noted in several countries including St Vincent and Kenya, there is still apprehension as to the effectiveness of these barriers in erosion control. For example Young (1986) has suggested that firm knowledge of the effects of agroforestry practices on erosion is sparse. On the basis of existing data he contends that the probable effects may be summarised as follows: the practice can control erosion, through the combined effects of checking runoff, providing a soil litter cover, maintaining soil organic matter, and through progressive transformation into terraces.

Notwithstanding the limitations cited above the experience in Jamaica with engineering structures such as bench terraces have been dismal. Blustain (1982) has summarised several reasons for the lack of success of engineering structures in Jamaica. In the final analysis however proper soil erosion control can be achieved through the integration of selected engineering and biological control measures

7.2 The role of human activities in soil erosion

In Jamaica at present, the most important local factor affecting soil erosion and landslides is the human density and activities (Wilson, 2001). This is due to their need for shelter and other infrastructure such as roads that cover the soil and concentrate water before releasing it down the slopes. Increasing human population density is most important, as negative effects associated with human activity seem to increase exponentially with population density. Many watersheds such as the Great River watershed are degrading due to the uncontrolled squatting by persons seeking employment in nearby Montego Bay who in turn seek shelter in the nearby watershed. They increase the impermeable surface and hence runoff volume. In addition their waste and excrement contribute to pollution. Roads that are required for their movements increase slope gradients and the potential for landslides. Cultivation disturbs soil and exposes the structure to raindrop impact that breaks down soil structure into particles that are easily removed in runoff. There is evidence that an increase in soil erosion and especially landslides are associated with human population density and that environmental degradation will accelerate as more people move into vulnerable locations. Distributing human population to prevent high density in fragile areas is a conservation measure that is not receiving serious consideration.

8 APPRAISAL OF EXISTING NATIONAL LEGISLATION, NATIONAL/INTERNATIONAL POLICY MEASURES AND POTENTIAL FUTURE IMPACTS

The national legislation, national/international policy measures which are related to international trade in agriculture are not separate from those for trade in other products. A detailed discussion of all the measures is therefore virtually impossible. In this presentation, the Jamaica export trade policy in agriculture is first highlighted. This is followed by a brief review of the more pertinent legislative measures. The national and international trade agreements with which the country is involved in are then discussed. In conclusion, important trade issues in agriculture which can affect future markets are highlighted.

8.1 Export Trade policy

An increase in exports from the agricultural sector is pivotal to Government's Plan for the development of the economy. As part of its export policy, the Government will, therefore, ensure the provision of information services to assist the private sector. The Government will also work to ensure the preservation of the reputation of Jamaica through strict grading and quality control. It will also be the policy of Government to use diplomatic channels to ensure that Jamaica's exports are treated fairly in foreign markets, and to work with regional exporters in an attempt to maintain preferential markets in Europe for as long as the political basis for such preferences exist. In the meantime, the Government will endeavour to ensure that existing quotas are filled and that the framework is in place to identify and exploit new opportunities, including those that are non-traditional and value-added.

In addition to the above measures the Government is committed to devising new and effective strategies to improve export regulations and to meet international requirements. One such strategy is the creation of a 'one-stop' facility, which will provide for a smoother and quicker passage for highly perishable products to the overseas importer. This programme is intended to enhance the operation of the United States Development of Agriculture's Pre-clearance Programme, which allows produce to be cleared by U.S. Inspectors in Jamaica, thus removing the need to do so in the United States.

In the Veterinary Division, a modern Residue Testing Laboratory has been established for certifying the export of conch, fish and dairy products particularly, to the European Union. This laboratory will also play an increasing role in the monitoring of imported meat products.

The Government recognizes that the application of Sanitary and Phytosanitary (SPS) measures in agricultural Trade will take on added significance as a result of agreements in the various trade fora to remove tariff barriers and other non-tariff measures in import transactions involving Agricultural and fish products.

Developing countries and in particular Jamaica, which are participants in the WTO; the Free Trade Areas of the Americas (FTAA); CARICOM as well as, other bilateral arrangements, face the urgent task of revamping and upgrading the existing SPS System in order to bring it in harmony with those of its trading partners.

In seeking to address this problem the Government will be guided by the Agreement on Sanitary and Phytosanitary Measures of the World Trade Organization (WTO), as

well as the recommendations of the Working Group on Sanitary and Phytosanitary Measures (WGSPM) of the Free Trade Areas of the Americas.

The Government, through the Ministry of Agriculture, has already initiated several steps which are part of an overall strategy for improving export regulations and sanitary and phytosanitary considerations in particular. These efforts include:

1. The promulgation of two pieces of legislation

    - Aquaculture, Inland and Marine Products and By-Products (Inspection, Licensing and Export) Act, 1999;
    - Meat and Meat Products and Meat By-Products (Inspection and Export) Act 1998;

2. the Establishment of Export "one-stop" Preclearance Centres at Norman Manley International and Sangster International Airports, respectively;

3. the establishment of a Residue Testing Laboratory in the Veterinary Division of the Ministry of Agriculture; and

4. participation in international agencies such as:

    - CODEX Alimentarius;
    - International Office for Epizootics (IOE); and
    - International Convention for Phytosanitary Protection (ICPP).

The Government will also seek to further strengthen the system through the following mechanisms:

1. the development of the umbrella organization, the Jamaica Animal and Plant Health Inspection System (JAPHIS) to administer the country's SPS Programme;

2. the attachment of International Standards to make the system consistent with the Agreement on Sanitary and Phytosanitary measures in the WTO;

3. development of normative practices in the areas of Animal Health, Vegetable Sanitation, and Food Safety;

4. the harmonization of the procedures for Control Inspection approval, Certification, Mutual recognition, and Risk Analysis, among other things with those of its trading partners;

5. the strengthening of the infrastructural and operational capacity of the system in order for it to comply with the new rules and to establish conditions of equivalence with trading partners; and

6. the overhauling of the legal framework and the development of regulations including Bio-Safety regulations to operate the system.

In addition, the Ministry of Agriculture will collaborate with scientific organizations such as, the International Centre for Nuclear Sciences (ICENS) in order to improve the analytical services to support a modern agricultural health and food safety system. Support is also being provided through the Agricultural Support Services

Project, which is designed to enhance the competitiveness of Jamaican agriculture in domestic and foreign markets, by strengthening critical capacities for the efficient delivery of Agricultural Support Services including irrigation, strategic marketing information, and research and extension services. Funding assistance amounting to US$22 million, of a total of US$31 million.

8.2 Important National Legislation

Many pieces of legislation are in effect to regulate the process of trade in agricultural products. These include the more traditional plant quarantine regulations which pertain to the importation of certain commodities into the country in relation to plant and animal health consideration. Related to this is the Agricultural Product Act which ensures that only the highest quality, pest free produce is exported from the country through the operations of a Produce Inspection Unit of the Ministry of Agriculture.

But in the new climate of a liberalised trading, the Government of Jamaica has embarked on a programme to explore and adopt, where necessary, WTO consistent trade remedies that provide flexibility in defending local production. The Customs Duties (Dumping and Subsidies) Act is one such trade remedy and the Safeguards Act is another.

8.2.1The Custom Duties (Dumping and Subsidies) Act

In July 1999, the Customs Duties (Dumping and Subsidies) Act was enacted by Parliament. The Act implements the provisions of the World Trade Organization's agreement on the implementation of article VI of the GATT 1994 (Antidumping), and the agreement on Subsidies and Countervailing Measures. The act confers on the statutory body called the Antidumping and Subsidies Commission (ADASC) the mandate to conduct dumping and subsidies investigations.

Dumping occurs when goods are exported to Jamaica (*export price*) at a price that is below the normal value. The "*normal value*" is usually the price at which the goods are sold for consumption in the country of export. The *Dumping Margin* is the difference between the export price and the normal value price.

Dumping is not a prohibited practice under international trade agreements – but remedial action is permitted under our act where it is proven that dumping of imported goods has caused or threatens to cause material injury to a Jamaican industry that produces *like goods.*

Remedies allowed by the act are "anti-dumping duties" and "undertakings". Anti-dumping duties are duties imposed, by the Commission, on imported goods to offset the effects of dumping. The amount of the duty is usually the amount of the dumping margin, and the duration of the duty imposition is normally for a period of five years. An undertaking is an agreement signed by the Exporter promising to the Jamaican importers in order to eliminate the dumping margin.

A subsidy is any financial assistance (or income or price support) paid by a foreign government that directly or indirectly benefits an exporter. If the subsidy on the imported goods causes or threatens to cause material injury to a Jamaican industry that produces like goods a remedy is available.

The remedy provided to counter a subsidy is called a "*countervailing duty*". The amount is usually equal to the actual subsidy amount, and the duration of the duty imposition is usually for a period of five years.

For these remedies to be obtained, the affected domestic industry must file a complaint with the Commission. However, the Commission cannot initiate an investigation unless it receives a *properly documented* complaint. A properly documented complaint is one that documents the essential areas and contains evidence sufficient to support the claims made. The essential areas are: that goods have been dumped or subsidized and have caused or is likely to cause material injury to the domestic production of the industry concerned. A complaint that contains mere allegations is not considered properly documented, and will have to be returned to the complainant. Material injury may be supported by evidence of the effect of dumped imports on domestic prices and the impact on domestic producers of like goods. Impact factors include relevant economic factors and indices including decline in sales, market share, profits, output, productivity, return on investments, and utilization of capacity, to name a few.

If the Commission finds that the complaint is properly documented, it will initiate an investigation, and a public notice will be inserted in the Jamaica Gazette and a daily newspaper.

The Act stipulates that the Commission must complete an investigation within 305 days.

8.2.2 The Safeguard Act

The Safeguard Act seeks to permit the temporary restriction of imports that threaten local production and also seeks to ensure that such restrictions are applied in a manner consistent with Jamaica's obligations as a member of the World Trade Organisation.

Safeguards are temporary trade measures applied by a Government on an emergency basis against a surge in imports of a particular good. These imports must be deemed to be causing (or threatening to cause) serious injury to domestic production. It should be further noted that these imports may be fair imports (that is imports that are not dumped or subsidised).

Safeguards are permitted by the World Trade Organisation (WTO) and the Agreement on Safeguards forms a part of the WTO Multilateral Agreements on Trade in Goods.

It is intended that the safeguard legislation, once enacted, will reduce Jamaica's vulnerability to import surges of products that compete with local production. Grave problems are created for local producers when the market becomes inundated with imports priced at a fraction of domestic production costs. Even though these imports may be 'fair' and 'temporary' in nature, the surge is oftentimes of a scale that can permanently ruin the local production base.

Drafting of the Safeguard Act, required a close eye on the WTO rules and procedures, as a safeguard action can be challenged by a supplying country and that country may seek compensatory tariff reductions or seek retaliatory measures.

Drafting of the legislation therefore required collaboration with countries that already have the legislation enacted and in use. These included the United States, the EU, Canada and New Zealand. Regulations from other developing countries such as Chile, Egypt and Turkey have also been useful.

9 AGREEMENTS IN THE CARIBBEAN RELATED TO INTERNATIONAL AGRICULTURAL TRADE

There are various agreements which regulate trade in agricultural products among countries of CARICOM and between CARICOM and various other countries. These agreements are important to this report in that Jamaica is one of the higher exporters of agricultural products from the CARICOM Region.

These Agreements are as follows:-

(i) The emerging CARICOM Single Market;

(ii) Existing Bilateral agreements:

(a) The CARICOM /Columbia Agreement;

(b) The CARICOM/Venezuela Agreement;

(c) The CARICOM/Dominican Republic;

(d) The CARICOM/Cuba Agreement;

(e) The CARIBCAN.

(iii) Existing Multilateral agreements:

(a) The Caribbean Basin Initiative

(b) The Cotonou Agreement.

All these agreements are being implemented under the rules of the World Trade Organisation, which is *de facto* governing body for International trade.

9.1 The CARICOM Single Market - Caribbean Free Trade Agreement

The CARICOM Single Market is intended to be an overall arrangement among Member States of the Caribbean community (CARICOM) which deals with a number of areas of cooperation. Included in these areas is the issue of Free Trade. The Caribbean Free Trade Agreement as part of the CARICOM Single Market addresses the removal of licensing requirements for CARICOM goods and unauthorised application of trade measures and practices by Member States. The main stipulation relates to ensuring that these goods are authenticated as originating in the Caribbean according to the Rules of Origin. At the present stage of implementation Member States are being urged to make every effort to remove existing import duties, requirement for licences and the application of other discriminatory practices. The CARICOM Secretariat is in the process of conducting a study to inventory all unauthorised restrictions to trade in the Region.

9.2 CARICOM-Colombia Agreement on Trade, Economic and Technical Co-operation

The Caribbean Community concluded an Agreement on Trade & Investment with Colombia on July 24, 1994.

The fundamental objective of this Agreement is to strengthen the trade and economic relations and technical cooperation between the Parties through:

(i) The promotion and expansion of the sale of goods originating in CARICOM and Colombia with particular emphasis on exports from CARICOM States in the early stages of the implementation of this Agreement;

(ii) The promotion and protection of investments aimed at taking advantage of the opportunities offered by the markets of the Parties and strengthening their competitiveness in the international market;

(iii) The facilitation of the creation and operation of regional joint ventures;

(iv) The development of technical and scientific cooperation activities which may be agreed upon between the Parties;

(v) The promotion of private sector activities, including business exchanges between the Parties

The crux of the Agreement is that Colombia will grant unilateral preferential duty free access to selected CARICOM goods for a period of three years. Beginning in the fourth year of the Agreement, selected Colombian products will receive similar treatment in CARICOM markets, except in the LDC's.

The product coverage includes agricultural products including processed fish, cut flowers, spice and condiments.

9.3 CARICOM/Venezuela Agreement on Trade, Economic and Technical Cooperation

This Agreement was signed on 13 October 1992 between the Caribbean Community and Venezuela. The fundamental objective of this Agreement is to strengthen the economic and trade relations between the Parties through:

(i) The promotion and expansion of the sale of goods originating in CARICOM through, inter alia, oneway dutyfree access to the Venezuelan market;

(ii) The stimulation of investments aimed at taking advantage of the markets of the Parties and strengthening their competitiveness in world trade;

(iii) The facilitation of the creation and operation of regional joint ventures; and

(iv) The encouragement of mechanisms for the promotion and protection of investments by nationals of the Parties.

9.4 The CARICOM/Dominican Republic Trade Agreement

The Agreement Establishing the Free Trade Area between the Caribbean Community and the Dominican Republic was signed in Santo Domingo between the Caribbean Community and the Dominican Republic on 22 August 1988.

The fundamental objective of the Agreement is to strengthen the commercial and economic relations between the parties through, *inter alia:*

(i) The promotion and expansion of the sale of goods originating in the territories of the Parties through, *inter alia,* free access to the markets of the Parties, elimination of non-tariff barriers to trade, and the establishment of a system of Rules of Origin, Customs Cooperation and the Harmonisation of Technical. Sanitary and Phyto-Sanitary Procedures;

(ii) The promotion of the active participation of private economic agents with a view to deepening and broadening the economic relations between the Parties, and the strengthening of their competitiveness; and

(iii) The promotion and development of cooperative activities in the following areas: agriculture, mining, industry, construction, tourism, transportation, telecommunications, banking, insurance, capital markets, professional services and science and technology.

A Protocol implementing the Free Trade Arrangement was also signed on 28 April 2000. Under the Protocol, the LDC's of CARICOM shall not be required to extend to any imports from the Dominican Republic entering into their territory, treatment other than the MFN rate of duty up to the year 2005. It also allows for a list of selected agricultural products which would normally be traded duty free, to be subject to the MFN rate in times of glut. Further, schedules indicating the periods in the first year of implementation during which the signatory MDC's and the Dominican Republic may apply MFN rate of duty to the various selected products, were exchanged between the Parties. The Schedules for the selected agricultural products for CARICOM MDCs will also provide some protection for the CARICOM LDCs.

9.5 The CARICOM/Cuba Agreement

The Trade and Economic Cooperation Agreement between the Caribbean Community and the Government of the Republic of Cuba was signed in Canouan, St. Vincent and the Grenadines on 5 July 2000.

The objective of this Agreement is the strengthening of the commercial and economic relations between the Parties through, *inter alia*:

(i) The promotion and expansion of trade in goods and services originating in the territories of the Parties by means of, *inter alia,* free access to the markets of the Parties, elimination of non-tariff barriers to trade, and the establishment of a system of Rules of Origin, and the Harmonisation of Technical. Sanitary and Phyto-Sanitary Measures;

(ii) The establishment of financial arrangements to facilitate the progressive development of two-way trade between the parties;

(iii) The provision of facilities for the establishment of joint ventures and other forms of economic cooperation activities; and

(iv) The development of mechanisms that promote and protect the investments made by nationals of the Parties.

A Protocol implementing the Agreement was also signed on 15 June 2001. It was noted that imports from Cuba into the LDCs of CARICOM will face duties set down in the National Customs Tariffs of the LDCs.

Article 21 of the Protocol provides that in order to avoid the adverse impact on the demand for local products resulting in serious losses to producers/farmers that with respect to the agricultural products listed in Annex V which are being accorded duty free treatment, that they may apply the MFN rate of duty during the periods identified in the said Annex V.

9.6 The CARIBBEAN/CANADA (CARIBCAN) Agreement.

In June 1986, CARIBCAN, a programme for trade, investment and industrial cooperation for the Commonwealth Caribbean region came into effect. CARIBCAN's main feature was the unilateral extension by Canada of preferential duty-free access to the Canadian market for a wide range of imports from Commonwealth Caribbean countries. Its basic objectives were to enhance Commonwealth Caribbean existing trade and export earnings; improve the trade and economic development prospects for the region; promote new investment opportunities; and encourage enhanced economic integration and cooperation within the region.

The products excluded from duty-free treatment under CARIBCAN include textiles and clothing, footwear, luggage and handbags, leather garments, lubricating oils and methanol, which are subject to MFN treatment.

There is no time limit attached to CARIBCAN. However, because granting duty-free access for imports from the Commonwealth Caribbean conflicts with Canadian obligations under the GATT, a waiver for Canada that permits the duty-free provisions of CARIBCAN had to be sought. This waiver was granted up to 1998 at which time Canada had to seek an extension.

In January 2001, at the Sixth CARICOM/Canada Summit held in Jamaica, agreement was reached to commence negotiations to develop a more mature CARICOM/Canada arrangement which is expected to preserve the gains of CARIBCAN, while seeking to broaden access for CARICOM goods to the Canadian market.

9.7 THE CARIBBEAN BASIN INITIATIVE (CBI)

The CBI, essentially a programme of legislative and administrative measures devised by the USA with the objective of stimulating economic development in Central America and the Caribbean mainly through private sector initiatives, was launched in 1994. It provided, *inter alia,* for duty free entry of certain articles from eligible countries into the USA for an initial period of 12 years. An allocation of US$350 million was to be provided to countries which were particularly hard-hit economically and significant tax incentives were offered to US firms investing in CBI beneficiary countries. In addition a programme of technical assistance and training was to be provided for the private sector in these countries.

Guyana was the only then CARICOM country to be excluded from the arrangement which had 22 beneficiary countries.

While the range of products eligible for duty-free treatment was very broad there were many specific exclusions. Eligible products, however, had to conform to rules or origin criteria which required that :

(a) an article must be grown, produced or manufactured in a beneficiary country;

(b) at least 35% of the value must be the cost of direct processing in one or more CBI-eligible country; and

(c) US materials may comprise up to 15% of the 35% mentioned in (b) above.

Those products specifically excluded included: textiles and apparel; canned tuna; petroleum and petroleum products; footwear; work gloves made of leather, rubber or plastic; luggage, handbags; certain leather apparel; and watch and watch parts (if any material originated in a communist country). Sugar, syrups and molasses, beef and veal were also excluded unless a "stable food-production plan" was submitted by each country concerned.

Under the CBI the CARICOM region fared worse than the Central American countries. With regard both to total US imports and to CBI-eligible goods, the trade of CARICOM countries increased in the first year of the CBI but moved downwards in each of the subsequent years. By 1987 the decline was approximately 25% compared with 1983. In the smaller CARICOM islands, trade increased having started from very low levels, while those with larger volumes have generally experienced declines, with Jamaica being the sole exception. The difference with regard to Jamaica was due to its higher levels of trade in non-CBI goods. Trinidad and Tobago saw its exports decline drastically, given that petroleum products were exempted from the CBI.

The CBI contributed to progress in diversifying into manufacturing, tourism and financial and tourism services. However, a significant portion of the income for CBI beneficiary countries was earned from the sale of commodities. Therefore difficulties resulting from the long-term decline in terms of trade for commodities negatively affected their economies in spite of the noble objectives of the CBI.

9.8 The Cotonou Agreement:

The European Community and its Member States signed a new Partnership Agreement with the African, Caribbean and Pacific (ACP) States in Cotonou, Benin, on 23 June, 2000. This Agreement replaces the Lomé Convention, which has provided the structure for trade and cooperation between the EU and the ACP since 1975. The Agreement is valid for a period of 20 years, subject to revision every 5 years.

The ACP-EC agreement provides a framework for supporting the mutually reinforcing effects of trade cooperation and development aid. The EC and the ACP States have agreed on a process to establish new trading arrangements that will pursue trade liberalisation between the parties and formulate provisions in trade-related matters.
The objectives of economic and trade cooperation are:

(i) To promote smooth and gradual integration of ACP economies into the world economy;

(ii) To enhance production, supply and trading capacities;

(iii) To create new trade dynamics and foster investment;

(iv) To ensure full conformity with WTO provisions;

The Procedures which are applied under this Agreement are to:

(i) Introduce a new trading arrangement after a preparatory period;

(ii) Maintain the present regime during the preparatory period (2000 – 2008 at the latest);

(iii) Liberalise in parallel, starting in 2000, almost all imports from all LDCs, on the basis of GSP;

(iv) Maintain protocols on sugar and on beef and veal, but review these protocols in the framework of negotiations for new trading arrangements;

(v) Start formal negotiations on economic partnership agreements (EPAs) by September 2002 at the latest;

(vi) Assess, in 2004, situation of non-LDC ACP countries not in a position to enter into EPAs and examine alternative possibilities;

(vii) Assess, in 2006, progress in negotiation of EPAs;

(viii) Have new trading arrangements to enter into force by 1 January 2008 at the latest;

(ix) Start the liberalisation of trade by 2008, at the latest, during a transitional period of at least 12 years.

9.9 World Trade Organisation

The World Trade Organization (WTO) is the only global international organization dealing with the rules of trade between nations. At the heart of the system — known as the multilateral trading system — are the WTO's agreements, negotiated and signed by a large majority of the world's trading nations, and ratified in their parliaments. The agreements were negotiated and signed by governments but their purpose is to help producers of goods and services, exporters, and importers conduct their business.

These agreements are the legal ground-rules for international commerce. Essentially, they are contracts, guaranteeing member countries important trade rights. They also bind governments to keep their trade policies within agreed limits to everybody's benefit.

The goal is to improve the welfare of the peoples of the member countries.
Over three-quarters of WTO members are developing or least-developed countries. Special provisions for these members are included in all the WTO agreements

The special provisions include:

(i) longer time periods for implementing agreements and commitments;

(ii) measures to increase trading opportunities for these countries;

(iii) provisions requiring all WTO members to safeguard the trade interests of developing countries;

(iv) and support to help developing countries build the infrastructure for WTO work, handle disputes, and implement technical standards.

In 1997, a high level meeting on trade initiatives and technical assistance for least-developed countries brought their concerns to centre stage.

The meeting involved six intergovernmental agencies and resulted in an “integrated framework” to help least-developed countries increase their ability to trade, and some additional preferential market access agreements.

A Committee on Trade and Development, assisted by a sub-committee on least-developed countries, looks at the special needs of developing countries. Its responsibility includes implementation of the agreements, technical cooperation, and the increased participation of developing countries in the global trading system.

The WTO organizes around 100 technical cooperation missions to developing countries annually. It holds on average three trade policy courses each year in Geneva for government officials. Regional seminars are held regularly in all regions of the world with special emphasis on African countries. Training courses are also organized in Geneva for officials from countries in transition from central planning to market economies.

In 1997/98, the WTO set up reference centres in almost 40 trade ministries in capitals of least-developed countries, providing computers and internet access to enable ministry officials to keep abreast of events in the WTO in Geneva through online access to the WTO’s immense database of official documents and other material.

10 IMPORTANT INTERNATIONAL AND REGIONAL TRADE ISSUES IN AGRICULTURE

Jamaica has been committed to trade reform for a significant period. The WTO agreement on Agriculture introduces a programme of reform for the global agricultural sector. The programme aims at reducing tariffs, domestic support and export subsidies applied by all member countries, as well as the introduction of disciplines in the area of quantitative restrictions. The WTO agreements on Sanitary, and Phytosanitary measures also introduce new rules governing the standards required for agricultural products traded internationally, as well as for products traded in the domestic market.

In the Free Trade Area of the Americas, Jamaica and other participating states are seeking to remove tariffs and non-tariff barriers to trade in the Americas by the year 2005. Under this process, special provisions are being negotiated to ensure that the agricultural sector in the smaller economies is not overwhelmed and eroded by precipitate or indiscriminate marketing opening. This is important in order to build the supply side capabilities of the sector and to take advantage of improvements in market access.

The Government recognizes that the trade policy has a major role to play in the development of a competitive agricultural sector, while also recognizing the need to protect the sector from non-competitive elements of the trade system.

The Government's agricultural trade policy, therefore, provides for the setting of import duties, in accordance with regional and international agreements, and the negotiation of trade agreements to provide for an expansion of the export markets for Jamaican products. It also provides for the development and implementation of anti-dumping legislation, and for taking action against other forms of predatory pricing.

Additionally, the Government intends to take full advantage of the rules governing trade in services arising out of the various bilateral, multilateral, regional and hemispheric agreements. These rules relate to market access conditions, rights of establishment of Service Providers, arrangements governing intellectual property and access to technology, as well as rules of competition and laws and regulations governing standards, particularly those related to plants, animals and food products.

Negotiations for alternative trade arrangements to the Lome Trade Regime (Cotonou agreement to the end of 2001) are due to commence in September 2002. In these negotiations, Jamaica will seek to preserve favourable access terms and conditions for its main agricultural exports. Similarly, the Government will pay special attention to rules governing access to and protection of technology, including plant varieties and agricultural commodities indigenous to Jamaica, as well as knowledge-based products as these are important driving forces in international production and trade in agriculture.

The Government will continue to build competitiveness in the agricultural sector and to explore more thoroughly the options under the WTO and if necessary, to attempt to negotiate new options which will assist the sector to complete the adjustments to liberalization.

There is a body of agreements and provisions under the WTO that can be utilized legitimately by member states as a short term remedy for some of the problems local producers face in adjusting to the trade liberalization phenomenon. These include:

The special safeguard provisions in the agreement on agriculture which permit a country to impose additional duties on imports in the event of significant import surges;

The agreement on anti-dumping practices which permits a Government to increase anti-dumping duties in the event that a product has been proven on investigation to be dumped;

The agreement on subsidies and counter-veiling measures, which permits the imposition of duties on subsidized products; and

The agreement on safeguards which allows a country to protect its industry from injury from imports.

Other provisions of relevance which will be explored include special safeguards for development purposes, which can be imposed by developing countries:-

Safeguards invoked on the basis of balance of payment problems;
The possibility of legitimately introducing a system of variable levies and supply management for certain crops e.g. vegetables.
Stricter use of SPS standards, as well as other technical standards for imports would also be necessary.
The Government also recognizes that several of the trade remedies that can be applied under the WTO are limited in scope and time application, and would, therefore, need to be applied along with measures to assist in making local food production more competitive in the longer term.

Other related issues in:
The selection and application of appropriate trade measures or remedies on a timely basis requires that the trade monitoring, evaluation and imposition capabilities of the country be strengthened to ensure effective coordination between the various parties and or organizations; and in order to increase duties it is necessary to make determinations, which can be proven before the WTO. These include data on ability to supply the domestic market, prices and the level of employment in the industry.
In light of the above, the Government intends to take appropriate action particularly with respect to the most sensitive items affected by importation. In this regard, the Ministry of Agriculture will continue to work with sub-sector groups and has set up a joint Committee with the Bureau of Standards to discuss the establishment of standards for 16 sensitive agricultural items falling under the Food Crop sub-sector which includes five items of exotic fruits and vegetables.
The Government has also updated Jamaica’s Anti-Dumping Legislation in order to make it consistent with the WTO's requirements. Jamaica’s new Bill provides for the establishment of an Anti-Dumping and Subsidies Commission and includes the imposition of Anti-Dumping and Countervailing duties on dumped or subsidized goods, as well as requirements and procedures to be followed in the conduct of investigations.

11 FARM SURVEY IN JAMAICA

A survey of a representative sample of large and small farms in two watersheds, Rio Cobre and Wag Water was carried out to determine the farming practices which were carried out in these watersheds and the possible effects on the environment. This presentation reports on some preliminary results of this survey.

11.1 Methodology

A survey of a representative sample of large and small farms in two watersheds, Rio Cobre and Wag Water was carried out over the period December 2001 and March 2002. The survey instrument consisted of a questionnaire of 54 questions which sought to garner information on the farmer, the farm size and location as well as details of the agronomic and other practices. The objectives of the survey were:

- To identify farming practices for select crops in the Rio Cobre and Wag Water River watersheds.
- To document important information on fertilizer and pesticide usage of both small and large farmers in the Rio Cobre and Wag Water river watersheds.
- To determine possible areas of fertilizer and pesticide abuse in the two watersheds.
- To identify possible areas of intervention to improve the efficiency of fertilizer and pesticide use in the watersheds.
- To identify possible alternatives to the use of fertilizers and pesticides in the watersheds.
- To determine the health risks related to pesticide use in the watersheds.
- To identify probable areas of pollution in the watersheds.

The survey was carried out by extension officers of the Rural Agricultural Development Authority (RADA) of the Ministry of Agriculture, Jamaica, operating in the district as they were more acquainted with and more likely to have the confidence of the farmers. A total of 149 farms were surveyed in the two watersheds. The completed survey forms were sent to the biometrics section of CARDI headquarters in Trinidad for statistical analysis.

11.2 Description of watersheds

11.2.1The Rio Cobre watershed

The Rio Cobre watershed, with a total land area of 63,000 ha, occupies most of the parish of St Catherine and a small area of the south western section of St Mary. The Rio Cobre river is fed by four tributaries which meet in the upper section above Bogwalk:

- Rio Pedro – tributary from the west
- Rio D'oro
- Rio Cobre – important pollution from bauxite pollution
- Rio Magno

The upper sections of the Rio Pedro and the Rio D'Oro flow through areas with relatively low agricultural activity. Yams, vegetables and cocoa are the major crops grown. Sand mining is a major activity along the Rio Pedro. Both rivers border the Tulloch Estate, a large estate near Bog Walk where sugar cane and bananas are grown. This area is flat and is subject to periodic flooding by the river. This watershed has a fair cover of permanent crops and natural forest in sections. However over reaping natural forest for fence posts and timber have aided degradation of the watershed leading to rapid stream flow (Bockaire, 1994).

In the Rio Cobre watershed, most of the underlying rocks are permeable and this gives rise to underlying stream flows. These rivers are often intermittent which is typical of Jamaican rivers. The upper section of the watershed has steeper slopes, while the lower sections (e.g., Bogwalk) have gentler slopes. Soils also change moving through the watershed, from clays in upper valleys to alluvial and loam further downstream.
Larger estates are located in Bogwalk and lower areas of the watershed. These large farms are primarily monocrop systems. Small farmers are mainly engaged in mixed crops in the upper watershed.
In the smaller farms, the dominant soil conservation systems practiced are terracing and contour farming. The main crops are; yam, cocoa, assorted vegetables, red peas, sweet potatoes, bananas and pineapples. For those areas with really steep hillsides, tree crops would be first choice. However, the farmer has limited resources (i.e., small piece of land), and therefore has to maximise the yield from his/her plot. They are advised by RADA to use strip cropping, for example planting red pea borders around plots of yam.
The main crops produced in sections of the Rio Cobre watershed are as follows:

Riversdale
Yam – most dominant in Riversdale and priority Gungo peas
Red peas
Monocropping with sweet potato.

Ewarton
Chiefly vegetables – callaloo (mono), Pak Choi and cassava (mono)
Tree crops (citrus dominant, little coffee, some cocoa)
Main concerns are soil conservation issues as well as pesticide use (for vegetable cultivation).
There is better agricultural management of citrus and coffee with respect to soil conversation. These crops are also grown on the lower slopes so soil erosion is not a major issue. The main concern with tree crops (i.e. citrus and coffee) is the heavy use of herbicides.

Guy's Hill
Main crops are Irish potato, vegetables, plantain, coffee, banana, pumpkin, tomato, hot and sweet peppers and cabbage.
The main issues here are deforestation and heavy pesticide use on vegetable crops. There is a low percentage of forest and tree crops in the Guy's Hill area.
Because of the high permeability of the substrate, the Rio Cobre has the potential for groundwater contamination. Most rivers are recharged with groundwater and this should be a concern for RADA, as there is heavy weedicide use, especially from large plantations.

11.2.2 Wag Water River watershed
Wag Water River watershed has a total land area of 24,800 ha and is located in North west St Andrew and South St Mary (fig. 3.4). The watershed is drained primarily by the Wag Water River and its main tributaries, the Flint and Ginger Rivers (Fig 3.6). It is on this river that the Hermitage dam is located at a site much nearer to the Grand ridge where the watershed begins. This source of potable water also augments the Kingston Metropolitan area supplies. Slopes vary from very steep in the upper reaches through moderate to small acreage of flat lands along the river nearing its entry into the sea.

This watershed encompasses St Mary and St Andrew, and runs from upper St

Andrew to Annotto Bay. The main tributaries of the watershed are important in that they feed the Hermitage Dam, which provides drinking water for Kingston. This dam is fed by Ginger River and Flint River.

The watershed presently has an estimated 45% permanent cover. A wide range of cropping systems are in evidence from forestry (planted and natural), permanent crops of cocoa, coffee, fruit and food trees, semi-permanent crops, bananas, pineapples, sugarcane and various food crops.

A cocoa fermentry and a chocolate factory sited in the area make the growing of cocoa a profitable venture. Commercial banana plantations along the major river valleys contribute to the range of productive enterprises. Soil types are highly erodible and there is a tendency to over exploit for food crop establishment. Consequently soil loss is high (Cunningham, 1993) and where deposited in the river, sandmining results.

The majority of land owners are small farmers who for the most part reside on their holdings. Because of the proximity of this area to Kingston housing development appear to be expanding to accommodate persons who work in the city.

The reaping of timber trees from individual holdings by sawmillers in recent years, with very little replacement has robbed the area of some of its natural cover (Cunningham, 1993). Short drought periods now have grave consequences for the farmers who depend on rainfall for the various crops.

St Andrew: Temple Hall

Main crops produced in this area of the watershed are coffee, yam and vegetables. The main concern is therefore the impact of pesticides from coffee cultivation. The issue of poor or inadequate soil management practices in the district was noted.

There is a problem of high nitrogen levels on coffee plantations. The extension officers are now encouraging the farmers to change to mixed fertiliser grades (with lower N).

Other considerations in this district are the impacts of logging, e.g. the cutting of young yam trees for yam sticks. There are also several logging operations.

There are many natural springs in the Wag Water area and there are some bottling water operations. Sewage contamination (farm and household) is also an issue.

Salisbury Plain

The predominant crops grown in this district are yam, vegetables, some coffee and tree crops. Main concerns are associated with vegetable cultivation due to high pesticide use on cabbage, tomato, Pak Choi, callaloo and string bean (mainly cabbage, tomato and Pak Choi). Cucumber is also grown in this locale.

There are however increasing incidents of household and farm waste entering the rivers including drums, plastics and Styrofoam containers. In addition, there are pig farms and some chicken pens adjacent to the Wag Water River, as well as, factories and coffee processing plants. The concern raised was that these activities often pollute the river directly (e.g. pens are washed and the waste is shunted directly into the rivers with no pre-treatment).

There was a suggestion to encourage farmers to integrate the use of chicken/pig waste into their farming systems. There were reports of some farmers with good systems in this area.

Castleton
The main crops found here are coffee (major concern), plantain, yam, cocoa and banana. Mixed cropping of plantain and yam is primarily found in Castleton.
Yam is cultivated using contour farming so this does not cause an erosion problem; coffee cultivation is the major culprit of soil erosion. Vegetables are also cultivated in Castleton, including Pak Choi and cabbage. Concern was also raised regarding pesticide use for these vegetables. Additionally, many of the vegetable plots are located along the banks of the Wag Water River.

Broad Leaf district
The main concern raised by an extension officer was the illegal dumping of solid waste, farm waste and livestock on the banks of the river (e.g., pigpen wastes).

Highgate
Flint River and Robins Bay area have large plantation farming systems, e.g., Green Castle Estate cultivates papaya, scotch bonnet pepper, banana, coconut and breadfruit.
The main concern at this location is the impact of pesticide used by the large banana estates (also aerial spraying). The area is also prone to landslides.
Drains have been cut through the fields of the St Mary Banana Estates, which discharge directly into the Wag Water.

Flint River
The main crops grown here are cocoa, pineapple (barriers) and ginger.
The main concern is soil management. There are steep slopes found in this area.

11.3 Jamaica Survey Results

11.3.1 Farm Profile

The total number of farms surveyed was 149, with 96 from the larger Rio Cobre watershed and 53 from Wag Water. Of these 149 farms 57 were classified as large farms (>5.0 ha) while the other 92 were considered small farms. These farms covered the parishes of St Andrew (28) St Mary (32) and St Catherine (89).
Of the large farms only 26 of the 57 or 46% of the farms had specific main crops. The breakdown of the main crops on these farms are given below in table 11.1

Table 11-1: Breakdown of main crop types on the large farms

Crop Type	No. of farms	% of farms
Banana	5	19.2
Coffee	3	11.5
Citrus	12	46.2
Sugar cane	3	11.5
Coconut	1	3.8
Citrus/Sugar cane	2	7.7
Total	26	

Citrus was the predominant crop in the large farms with about 50% of the farms growing this commodity.

11.3.2 Land Tenure

Most of the lands being farmed (60%) were owned by the farmer. This land tenure system did not vary very much, although the farms were split into a number of parcels. Table 11.2 gives the land tenure of the first parcel of the farms surveyed. Other parcels of land on which farming operations were carried out by the farmers followed a similar trend of land tenure.

Table 11-2: Land tenure system on the farms surveyed

Type of Tenure	No. of farms	% of farms
Own	87	60.4
	8	5.6
Lease	21	14.6
Family land	5	3.5
Rented	7	4.9
Freehold	15	10.4
Government owned	1	0.7
Total	144	

11.3.3 The farmers' profile

The age range of the farmers is given in Table 11.3. This indicates that the majority of farmers (>80%) were over the age of 40 and more than 50% were over the age of fifty. This is the case because farming has become and occupation which people turn to later in life.

Table 11-3: Age range of farmers in the survey

Age of farmer	No. of farmers in range	% farmers
< 20 years	1	0.7
20-30 years	4	2.7
31-40 years	24	16.1
41-50 years	26	17.4
51-60 years	32	21.5
61-70 years	35	23.5
> 70 years	27	18.1
	149	

In addition the majority of farmers was only educated to the primary level (Table 11.4). The indications are that these farmers were likely to be fixed in their ways and unwilling to change practices easily.

Table 11-4: Level of education of the farmer

Level of Education	Frequency	% of farmers
Primary	77	51.7
Secondary	37	24.8
Tertiary	23	15.4
Other	12	8.1
Total	149	

11.3.4 Soil, rainfall and irrigation on farm

The main soil type on the farm was described as loam. This is universally accepted to be the most ideal type of soil. Table 11.5 gives a breakdown of the soil descriptions made of the soil on the farms surveyed.

Table 11-5: Description of the soils on the farms surveyed

Soil Type	No. of farms	% of farms
Clay	39	26.2
Sand	13	8.7
Loam	81	54.4
Sandy loam	10	6.7
Clay loam	5	3.4
Clayey sand	1	0.7
Total	149	100%

Only 11 farms (7.4%) indicated that rainfall was adequate for their farming operations at all times of the year. Another 43 farms indicated that rainfall was adequate for most of the time. A total of 94 farms (63.5%) indicated that rainfall was not adequate for all the needs of the farm and there was a need for irrigation (Table 11.6).

Table 11-6: Adequacy of rainfall for farming purposes

	No. of farms	% of farms
All the time	11	7.4
Most times	43	29.1
Some times	86	58.1
Never	8	5.4
	148	100%

Sources of water for use during the dry season varied widely with springs, domestic supply and private tanks being the most widespread. Surprisingly, 48 farms (32.7%) had no source of water for use on farms during the dry season (Table 11.7).

Table 11-7: Sources of water during the dry season

Source of water	No. of farms	% of farms
Piped (domestic supply)	18	12.3
Private tank	10	6.8
Spring	39	26.5
None	48	32.7
Other	24	16.3
Piped, spring	2	1.4
Private tank, spring	1	0.7
Piped, private tank	3	2.0
Piped, river	1	0.7
Private tank, well	1	0.7
	147	100

Table 11.8 gives the various methods of irrigation employed by farms during the periods of inadequate rainfall. A large portion of farms (50%) used manual methods (buckets/watering cans) to get water into the soil.

Table 11-8: Method of irrigation used on farms

Irrigation method	No. of farms	% of farms
Sprinkler irrigation	7	4.9
Bucket/watering can	72	50.0
None	49	34.0
Other	13	9.0
Drip irrigation, bucket/watering can	1	0.7
Sprinkler irrigation, bucket/watering can	1	0.7
Bucket/watering can, other (water hose)	1	0.7
Total	144	100

60 farms (40.3%) indicated that they practiced mulching on their farms compared to 89 farms (59.7%) which did not. The reasons advanced for not mulching varied widely and are given in Table 11.9. The main reason expressed by 17.8% of the respondents was that mulching was likely to help the build up of pests in and around the soil. Mulching and other soil water conservation methods are likely to be useful practices for all of the farms.

Table 11-9: Reasons expressed by farmers for not using the practice of mulching

Reasons for not mulching	No. of farms	% of farms
None	2	4.4
Adequate rainfall	4	8.9
Crops do not require mulch	7	15.6
Cover quite adequate	4	8.9
Don't know about practice	7	15.6
To prevent build up of slugs	8	17.8
Grass, brush burnt	1	2.2
Land is fertile	1	2.2
Not necessary for citrus	5	11.1
Not necessary	3	6.7
Time consuming	1	2.2
Drought does not last for long period	1	2.2
Not practical or economical	1	2.2
	45	100

11.3.5 Soil erosion on farm

Table 11.10 gives the main land slope types on the farms surveyed. The majority of the farms (>90%) are on moderate to steep slopes, indicating a high propensity to erosion.

Table 11-10: Main slope types on farm

Slope type	No. of farms	% of farms
Gentle <5	11	7.5
Moderate 5-15	79	54.1
Steep 15-30	43	29.5
Very steep >30	13	8.9
	146	

Eighty-two farmers or 55% of those surveyed, thought they were losing soil by erosion. This soil erosion was manifested in various observed soil characteristics as indicated in Table 11.11.

Table 11-11: Observed effects of soil erosion on farm

Observed effects	No. of farms	% of farms
Soil lost fertility	28	18.8
More stones visible	29	19.5
Rills and gullies on the land	46	30.9
Other	9	6.0

Despite this however farmers were not willing to adopt the conservation methods recommended. Table 11.12 gives the soil conservation methods being carried out by farmers. The main methods in use are planting along the contour and using drains and trenches to divert water from farms or to move water down the slopes. The main methods recommended, which include various forms of barriers, were not in widespread use and the use of vegetable hedgerows was very limited. Erosion of these soils is therefore likely to continue unless stringent efforts are made to change farmers' practices in this regard.

Table 11-12: Conservation methods employed

Soil Conservation method	No. farmers	% of farmers
Terracing	14	9.4
Contouring	44	29.5
Drains/trenches	71	47.7
Stone barriers	14	9.4
Grass barriers	26	17.4
Bamboo/log barriers	25	16.8
Hedgerows	5	3.4
None	31	20.8

One method of improving the situation is by increasing the tree cover on farms. At present >60% of farms have less than 50% tree cover (Table 11.13) and 63% of the farmers indicated a willingness to plant more trees on their farm. The implications here are that the trees must have some commercial value.

Table 11-13: Percentage tree cover on farm

Tree cover (%)	No. of farms	% of farms
0- 10	25	16.8
10-20	30	20.1
20-50	45	30.2
50-100	49	32.9
	149	

11.3.6 Use of agro-chemicals

The use of agro-chemicals particularly fertilizers and pesticides was quite widespread on farms. One hundred and twenty-seven farms (85.2%) used chemical fertilizers or some sort of manure. This is despite the fact that very few farms (<20%) had done soil tests so that fertilizers were not being applied by virtue of recommendations based on soil properties. In terms of pest and disease control, a number of pest species and diseases were indicated for the various crops and in 87% of the cases

chemical control methods were carried out. In the case of weeds the main means of control was mechanical and only in 26% of the cases was chemical control used.
The main reasons for using agro-chemicals are indicated in Table 11.14. Seventy percent (70%) of the farmers felt that agro-chemicals increased their yields while 46% felt it improved the appearance of the produce.

Table 11-14: Reasons for using agro-chemicals

Reasons	No. of farms	% of farms
Increased yields	105	70.5
Improved appearance of produce	69	46.3
Other	6	4.0

In addition 102 farmers indicated that they would purchase more fertilizers if they had the resources, while 75 farmers (50.3%) indicated that they would purchase more pesticides if they had the resources. 103 farmers (69.1%) felt that more fertilizers or pesticides would give them better results in their farming efforts.
In response to the question of whether there were affordable alternatives to agro-chemicals, 109 farmers (73.2%) felt that there were, but only 77 farmers (51.7%) were willing to use alternatives to chemical fertilizers and a mere 20 farmers (13.4%) were willing to use alternatives to chemical pesticides.

11.3.7 Sanitation and safety

The sanitary and safe use of agro-chemicals on farms to reduce pollution and risk to health was also assessed in the survey. Table 11.15 indicates the methods of disposal of excess chemicals by farmers after use. A large proportion of farmers (48.8%) stored the excess chemicals for future use, while another 33% either buried or applied the excess chemicals to the soil.

Table 11-15: Methods of disposing excess agro-chemicals

Disposal Method	No. of farms	% of farms
Bury	16	12.8
Apply to soil	26	20.8
Store for future use	61	48.8
Other	19	15.2
Bury, store for future use	1	0.8
Apply to soil, store for future use	1	0.8
Store for future use,other	1	0.8
Total	125	100

One hundred and fifteen farms (77.2%) indicated that they cleaned their chemical applicator after every use. The washings from these cleanings were disposed of as shown in table 11.16. Again applying to the soil and burying were the more popular methods and these were employed by 93% of the respondents (Table 11.16).

Table 11-16: Methods of disposing washings from applicators

Disposal method	No. of farms	% of farms
Bury	21	17.1
Wash down stream	2	1.6
Apply to soil	93	75.6
Other	6	4.9
Apply to soil, other	1	0.8
Total	123	100

The disposal of pesticide containers was mainly by burning (43%) but a significant 25% buried these containers in the soil (Table 11.17).

Table 11-17: Methods of disposing pesticide containers

Disposal method	No. of farms	% of farms
Bury	32	25.2
Burn	55	43.3
Put in household garbage	11	8.7
Other	15	11.8
	113	????

In terms of personal safety 44% of the respondents indicated that they wore protective clothing while spraying agro-chemicals, while 38.3% wore their regular clothing. Most farmers (70%) wore boots when applying chemicals, but less, approximately 46% wore hats, gloves or respirators (Table 11.18).

Table 11-18: Use of protective clothing while spraying agro-chemicals on farm

Clothing used	No. of farms	% of farms
Regular clothing	57	38.3
Protective suit	66	44.3
Goggles	53	35.6
Hat	71	47.7
Gloves	68	45.6
Boots	104	69.8
Respirator	69	46.3
Other	4	2.7

A large proportion of farmers (48%) indicated that their interval between spraying and harvesting of produce was 1- 2 weeks. An almost similar number, 46%, indicated that their interval was over two weeks, while only 7 farms (5.6%) harvested crops 1 day to 1 week after spraying pesticides (Table 11.19).

Table 11-19: Interval between spraying and harvesting of crop

Interval	No. of farms	% of farms
1day – 1 week	7	5.6
1 week-2 weeks	60	48.0
> 2 weeks	58	46.4
Total	125	100

One hundred and two respondents (78%) indicated that they applied pesticide to produce to be used in the home, while 22% indicated that produce for home use was not sprayed. One hundred and thirty-two respondents (92.3%) indicated that they were not aware of any case of illness on their farm due to pesticide use, while 7 respondents indicated that they had experienced cases of illness due to pesticide use on their farm. Twelve respondents (8.5%) indicated that they have known of persons who have become ill from pesticide use, while the remaining 91.5% had not.

11.3.8 Effects of farming practices and agro-chemicals on the environment

The response of farmers to the question on the effect of their farming practices and use of agro-chemicals on the environment is given in Table 11.20. In general about 50% of the farmers felt that farming practices and pesticide use were affecting the environment off the farm, while a little less than 20% felt they were not and about 30% did not know. As regards chemical fertilizers only 55 farmers (36.9%) felt their use was having an adverse effect on the environment, while an almost equal number, 50 farmers (33.6%) felt they were not and 40 farmers (26.8%) did not know.

Table 11-20: The effect of farming practices and agro-chemical use on the environment

Agronomic practices	Affects the environment		Has no effect		Don't know	
	No of farms	% of farms	No of farms	% of farms	No of farms	% of farms
Fertilizer use	55	36.9	50	33.6	40	26.8
Pesticide use	78	52.3	-	-	-	-
Other farming practices	74	49.7	28	18.8	43	28.9
Agro-chemical use	72	48.3	29	19.5	47	31.5

These responses indicate that farmer training on the effect of poor farming practices and excess use of agro-chemicals on the environment may be necessary and can be fruitful.

11.3.9 Comparison of farming practices on large and small farms

In the survey, there were 57 large farms (> 5.0ha) and 92 small farms. Owing to this great disparity in the number of large and small farmers it was not possible to do a direct comparison of the farming practices on the two sizes of farms. What was done was to make a similar analysis of some of the important practices on the small farms as well as the large farms.

In general, it was found that large farms tended to have main crops and not a mixture of several crops being grown at the same time as is the case on small farms. The practices on the large farms were therefore more uniform and related to the requirements of the crop rather than the actual size of the farm. On the small farms with many more crops, the practices varied for each crop. This difference in the basic operations of the two sizes of farms tended to complicate the analysis. An example will be very instructive in relaying this finding.

Table 11.21 gives the levels of mulching and use of chemical fertilizers practiced on large farms in relation to four main crops as well as on all the farms. Table 11.22 gives similar data for small farms in relation to nine crops as well as on all farms.

Table 11-21: Levels of mulching and fertilizer use on large farms in relation to crops grown

Crop	Selected farming practices			
	Mulch	No- Mulch	Fertilizer	No-Fertilizer
Citrus	2	21	21	1
Cocoa	1	15	7	9
Coffee	1	7	8	1
Yam	5	10	12	2
Total	9	53	48	13

Table 11-22: Levels of mulching and fertilizer use on small farms in relation to crops grown

Crop	Selected farming practices			
	Mulch	No- Mulch	Fertilizer	No-Fertilizer
Bananas	4	37	13	28
Citrus	0	5	2	3
Cocoa	1	15	4	12
Coconuts	2	8	1	9
Coffee	3	9	11	1
Pineapple	0	7	4	3
Plantain	2	28	8	22
Sugar cane	1	11	2	10
Yam	20	34	33	21
Total	23	154	78	109

Mulching varied from 6.3 % in cocoa farms to 33.3% in yam farms, but averaged 14.5% on all large farms. A similar analysis on small farms showed that mulching ranged from 0% in citrus and pineapple farms to 37.0% in yam farms. The overall level of mulch use on all farms was 13%. The level recorded for both sizes of farms is quite similar and the conclusion can be made that the level of mulching on large and small farms is similar.

Chemical fertilizer use ranged from 95.5% on citrus farms to 43.8% on cocoa farms, with an overall average of 78.7% on the large farms. For chemical fertilizer use in small farms this ranged from a high of 91.6% in coffee farms to 10% in coconut farms. The overall level of fertilizer use on all farms was 41.7%. Following the same argument as above, the conclusion here could be that there is a much higher use of fertilizers on the large farms compared to the small farms.

Both conclusions could however be wrong, because the practices were related more to the crop than the size of farm. In the overall analysis of all farms surveyed, 60 farms or 40.3% of farms surveyed indicated that they practiced mulching. A similar analysis for fertilizer use indicated that 85.2% of all the farms surveyed use chemical fertilizers.

The use of the particular management practice was more related to the crop and the benefits perceived to be derived from the practice than the actual size of farm.

From the limited analyses done, it is felt that there are no wide variations in practices between large and small farms to indicate any major differences from the results recorded for all farms in the body of the report.

11.4 Conclusion

The results coming out of this survey are very interesting and highlight some important factors pertaining to the management of hillside farms while preserving the aquatic, coastal and marine environment off the farm. In particular, the survey indicates that soil management, in terms of fertilizer application, is in no way related to soil properties as less than 20% of the farms had done soil testing. This may be an important area for intervention, to ensure excess fertilizers are not being applied to the soil. In addition, although the majority of farms were on moderate to steep slopes, and indicated that there were signs of erosion on these farms, just over 40% indicated there were serious steps being made to control erosion. Recommended soil conservation practices, particularly the use of vegetable hedgerows, were not in frequent use. In terms of pesticide use, there was extensive use of chemicals for pest and disease management. Chemical weed control was however limited. It was also widely felt that agro-chemical use enhanced the profitability of the farm and more agro-chemicals would be used if the resources were available. This attitude of the

farmers was quite startling, and when coupled with the fact that the majority of farmers (>80%) were over 40 years old (due to farming being a later life occupation), indicated a major challenge to significantly change their practices. Only about a third of the farmers felt their practices on the hillside would adversely affect the environment off the farm, and a significant number did not have an opinion on this matter. This could therefore be a major area for farmer training.

12 FARM SURVEY IN ST LUCIA

12.1 Introduction

St. Lucia located at latitude 13 50' N and longitude 60 59' W, is the second largest of the Windward Islands with an area of 620 km^2. The island is 42 km long and 22 km wide with a very irregular, steep terrain especially in its interior, which rises to a height of 950 m. The island boasts very fertile volcanic soils but, due mainly to topographic constraints only 28% (17,360 ha) of the total land area has been classified as suitable for agriculture.

St Lucia has a tropical climate strongly influenced by its broken, rugged topography. Rainfall increases and temperature decreases with altitude, and the western side of the island experiences higher rainfall. Annual rainfall averages about 1600mm in the northern and southern extremities of the island to about 3500mm in the higher altitudes. The island experiences distinct rainy and dry seasons: the rainy season extends from June to December while February to April are the driest months.

The island is subdivided into 37 water catchments or river basins from which a number of perennial streams emanate. These streams ultimately lead to the sea, and are reported to have a lot of aquatic life, particularly crayfish.

Over the period 1985-1995, agriculture accounted for 13 percent of the GDP of the island, this has declined now owing to the declining markets for banana, but agriculture is still important to the livelihood of the rural population. Farming is carried out in watersheds which consist of steep highlands as well as flat valleys. Water courses provide drainage for these agricultural lands and therefore carry any soil sediments from erosion or excess agro-chemicals applied to the soils. Little is known about the amount of soil erosion and agro-chemical use on these farms, and neither has the pollution from these activities been investigated.

In early 2002, a survey of a representative sample of large and small farms in three watersheds, Rousseau, Praslin and Soufriere was carried out to determine the farming practices which were carried out in these watersheds and the possible effects on the environment. This report details the results of this survey.

12.2 Description of watersheds surveyed

12.2.1 Rousseau

Roseau is a watershed with high rainfall (2000- 2500mm per annum) and isolated on the western side of St Lucia. The watershed is 49.1km^2 (total acreage of 4500ha) from the East Forest Reserve to Mont Gimie Central, down the Venus/Anse la Raye ridge to Roseau and the Landelac Sarrot ridge toMarigot. It has a total farming area of approximately 2000ha.

There is an estimated 1245 farms with the majority (1200) being considered small farms of 2ha and less. There are 35 medium sized farms of 2-10ha and 10 large farms over 10ha. The large farms grow bananas and tree crops on flat to sloping (15-20^o slope) lands, while the medium sized and small farms grow bananas, tree crops, food crops and root crops on sloping (15-30^o slope) lands. The smaller farms tend to be on the steeper lands.

The general farming practices for the Roseau valley are summarized in Table 12.1

Table 12-1 General farming practices in the Roseau watershed

Land preparation	Manual
Planting methods	Manual
Irrigation methods	Rainfed – about 95% of farmers do not irrigate their crops.
Soil and water conservation	Manual, including contour and graded drains, mulching (some farmers practice this to maintain moisture) and contour planting and spot tillage. In the interior, dense

	rainforest around the Roseau dam and high precipitation cause soil moisture to last well into the dry season. There is wide variation of soil type, therefore water retention levels vary (6" to bedrock in Roseau).
Soil fertility management:	Fertilizer and chemical application
Pest and disease management	Major pests and diseases are leafspot (in bananas), diamond-back moth, white flies, rodents and man (praedial larceny). Pests/diseases are managed through chemical control (aerial spraying and manual application with knapsack sprayers).
Weed management:	Major weeds are water grass, paragrass, wildslip/tendance and creepers/vines. These are controlled using manually applied chemicals and cutlassing in some crops, e.g., dasheen.
List of pesticides	WEEDICIDES: Talent, Replane, Gramoxil, Gramoxone, Round Up, TouchDown INSECTICIDES: Benlate, Cupravit, Banrot, Captan
Harvesting methods	Manual
Post-harvest operations	Chemicals used are Ridomyl, Fungaflor and Allum
Marketing	Crops sold through local and central markets, through the Marketing Board, TQ, Charles and export markets to the US (non-traditional crops).

The Praslin/Mamiku watershed includes the rivers of Praslin/Riviere Galet des Trois Islet (11.0km²) and Mamiku/Patience (16.0km²) which is bordered by forested ridges either side of Mamiku valley. Main towns/villages are Mamiku, Mon Repos, Patience, La

12.2.2 Pointe and Praslin.

This watershed has an estimated 127 farms with the majority (80) being small farms (< 2ha). There are 47 medium sized farms (2-10ha) and 10 large farms (> 10ha). The large farms grow bananas, coconuts, citrus and cashew trees, on the upper and mid levels of the water shed, while the medium sized and small farms grow bananas, coconuts, breadfruit and cashew trees, vegetables, hot pepper, corn and root crops on all levels of the water shed.

The general farming practices for the Praslin valley are summarized in Table 2.2.

Table 12-2 General farming practices in the Praslin watershed

Land preparation	Clearing (manual and use of cutlass) Tillage (manual and use of garden fork)
Planting methods	Manual
Irrigation methods	Rainfed except for 4 farmers (1 upper watershed, 3 lower watershed using gravity, pump and buckets)
Soil and water conservation	Graded and contoured drains, mulch, tree planting (contoured), trash barriers
Soil fertility management:	Pen manure (in vegetables): NPK fertilizer (16:8:24 +2MgO and urea 46%N)
Pest and disease management	Leaf spot control – chemical and manual. Nematodes and stem borer control of chemicals. Thrips – chemical Mosiac virus – burn (manual)
Weed management:	Foul Foot milk weed, Tet-Meg, watergrass, Vines,

	TiCoco, Nut grass – manual cutlass and hoe
List of pesticides	Talent, Gramoxone, Touch Down, Gramocil, Reglone
Harvesting methods	Manual
Post-harvest operations	Manual
Marketing	Local and export

12.2.3 Soufriere

The Soufriere watershed is surrounded by ridges either side and encompasses the villages of Zenon, Cressland, Diamond, Esperance, Fond St Jacques, Toraille, Belvedere, Migny, Soufriere, Mini and St Phillip. There are four estates: Ruby, Diamond, Soufriere and La Perle. In addition to impacts on sedimentation by volcanic action, it was pointed out that there is mining for pumice in the upper catchments (Fond St Jacques).

This watershed has over 210 farms with the majority (>200) being small farms (< 2ha). There are 5 medium sized farms (2-10ha) and 4 large farms (> 10ha) or estates which have already been mentioned. The large farms grow coconuts, breadfruit, avocado and mango trees, on the mid and lower levels of the watershed, while the medium sized farms grow coconuts, avocado, cocoa and citrus on the middle level of the watershed and small farms grow dasheen and yams on the upper and mid levels of the watershed.

The general farming practices for the Soufriere valley are summarized in Table 12.3.

12.3 Methodology

A survey of a representative sample of large and small farms in three watersheds, Rouseau, Praslin and Soufriere was carried out over the period July 2001 and June 2002. The survey instrument consisted of a questionnaire of 56 questions which sought to garner information on the farmer, the farm size and location as well as details of the agronomic and other practices. The objectives of the survey were:

- To identify farming practices for crop production in the Rouseau, Praslin and Soufriere watersheds.
- To document important information on fertilizer and pesticide usage of both small and large farmers in the Rouseau, Praslin and Soufriere watersheds.
- To determine possible areas of fertilizer and pesticide abuse in the two watersheds.
- To identify possible areas of intervention to improve the efficiency of fertilizer and pesticide use in the watersheds.
- To identify possible alternatives to the use of fertilizers and pesticide in the watersheds.
- To determine the health risks related to pesticide use in the watersheds.
- To identify probable areas of pollution in the watersheds

The survey was carried out by extension officers, of the Ministry of Agriculture Forestry and Fisheries (MAFF) of St Lucia, operating in the districts as they were more acquainted with and more likely to have the confidence of the farmers. A total of 150 farms were surveyed in the three watersheds. The completed survey forms were sent to the biometrics section of CARDI headquarters in Trinidad for statistical analysis.

Table 12-3 General farming practices in the Soufriere watershed

	Large Estate	Medium	Small
Land preparation	Nil	Minimum	Manual/minimum tillage
Planting methods		Transplanting	Transplanting
Irrigation methods	None/rained	None/rained	None/rained
Soil and water conservation	Drainage/stone barriers	Minimum	Minimum (trash barriers)
Soil fertility management:	Very little	Inorganic	Inorganic/organic
Pest and disease management	Limited to rat poison	Minimum	Chemical control in vegetables
Weed management:	Under cocoa	Gramoxone	Manual, Gramoxone, Touchdown
List of pesticides	Pesticides: Tambo, Xantari, No Moult, Lanate, Dipel,Agree and Admire Weedicides: Gramoxone, Touchdown, Talent Fungicides: Cipravit Blue, Kocide, Benlate, Banrot Fertilisers: NPK (16:8:24 + 4 MgO; 12:12:17)		
Harvesting methods	Manual	Manual	Manual
Post-harvest operations	Cocoa (polishing)	Cocoa (polishing)	Nil
Marketing	Local, export	Local	Local

12.4 St Lucia Survey Results

12.4.1 Farm Profile

A total of 150 farms were surveyed in the three watersheds. The breakdown of the number of farms surveyed in each watershed is given in Table 12.4. The majority of farms surveyed were from the Rouseau watershed as this was the largest and most significant watershed in terms of agricultural production.

Table 12-4: Breakdown of farms surveyed in each of the three watersheds

Watershed	No. of farms	% of farms
Roseau	80	52.7
Praslin	30	20.7
Soufriere	40	26.7
Total	150	100.0

Of the 150 farms surveyed, 23 (15%) were over 5.0ha and were considered large farms. The remaining 127 farms were below 5.0ha and were considered small farms. Table 12.5 gives the land tenure of the main parcel of land on the farms surveyed. The survey indicated that 60 farms were on lands fully owned by the farmer, while another 43 (28.7%) were on land owned by the family.

Table 12-5: Land tenure of the main parcels of land on the farms surveyed

Type of Tenure	Frequency	Percentage
Own	60	40.0
Rent free	22	14.7
Lease	5	3.3
Family land	43	28.7
Rented	5	3.3
Government owned	1	0.7
Share crop	6	4.0
Total	144	

The main crops grown on the farms are given in Table 12.6. Root crops were the most popular crops and were found to be the main crop group on 58 farms (38.7%). This was closely followed by bananas which was the main crop on 56 farms (37.3%). However because bananas were grown on the larger farms, the total area under bananas in the three watersheds was expected to be much higher than that under root crops. Other crops of importance in the watersheds were mixed vegetables and tree crops.

Table 12-6: Main crops grown on the farms surveyed

Crop Type	No. of farms	% of farms
Banana	56	37.3
Mixed vegetables	12	8.0
Root crops	58	38.7
Tree crops	8	5.3
Ornamentals	1	0.7
Banana/mixed vegetables	1	0.7
Banana/Root crops	5	3.3
Mixed vegetables/root crops	6	4.0
Mixed vegetables/tree crops	1	0.7
Ornamentals/citrus	2	1.3
Total	150	100%

12.4.2 Farmers' Profile

Table 12.7 gives the gender of the farmers in the survey. The majority of farmers, 126, were male, while 24 farms were run by females. There was no indication of the role played by women on the farms which were recorded as being managed by men or vice versa.

Table 12-7: Gender breakdown of the farmers surveyed

Gender	No. of farmers	% of farmers
Male	126	84.0
Female	24	16.0
Total	150	100.0

The age range of the farmers in the survey is given in Table 12.8. The farmer population could be considered as being balanced with an almost equal amount of young and old farmers making up about 47% of the population and the majority 53% being middle age. There were 36 farmers (24%) below the age of 40 and they were considered to be young. Another 79 farmers were between 40 and 60 years old and

these were considered to be middle age. The remaining 34 farmers were over 60 and were put in the old category.

Table 12-8: Age of farmers in the survey

Age of farmer	No. of farmers in range	% farmers
20-30 years	3	2.0
31-40 years	33	22.0
41-50 years	43	28.7
51-60 years	36	24.0
61-70 years	24	16.0
> 70 years	10	6.7
	149	

Table 12.9 gives the level of education of the farmers in the survey. The majority of farmers, 141, (94%) had at least primary level education. There were only 8 farmers with no education.

Table 12-9: Level of education of the farmer

Level of Education	Frequency	% of farmers
None	8	5.3
Primary	114	76.0
Secondary	16	10.7
Tertiary	11	7.3
Other	1	0.7
Total	150	100

12.4.3 Soil water management on farm

Table 12.10 gives the soil types which were reported on the farms surveyed. The most prevalent type of soil on 91 (54.4%) of the farms surveyed was loam. This was followed by 45 farms (26.2%) which had clay soils. Since loams are considered the most fertile type of soil the majority of farms were on good soils.

Table 12-10: Main soil types on the farms surveyed

Soil Type	Frequency	Percentage of farms
Clay	45	26.2
Sand	2	8.7
Loam	91	54.4
Sandy loam	3	6.7
Clay loam	8	3.4
Total	149	

From the available data, rainfall on the island is adequate for agriculture production. There is however, the possibility of periodic, low soil moisture conditions owing to poor distribution of this rainfall. Table 12.11 gives the sources of water for use on farms during the dry season. The indications are that 108 farms (72%) had no source of water for irrigation during the dry season. Of those farms that had a source of irrigation water, 16 farms or 66% of those practicing irrigation used manual methods of fetching buckets or watering cans. Six farms (25%) had sprinkler irrigation systems and two farms (9%) had drip irrigation systems.

Table 12-11: Sources of water for farm use during the dry season

Water source	No. of farms	% of farms
Piped	4	2.7
Private tank	1	0.7
Spring	8	5.3
None	108	72.0
Other	16	10.7

Forty-one farms or 27.3% of the farms sampled employed the use of mulch while the other 109 farms (72.7%) did not. The reasons put forward for the practice by those farmers who used mulch are given in Table 12.12. Most of the farmers responding felt that the mulch either kept the plants moist or suppressed weeds. These are considered the traditional reasons for mulching. Under the St Lucia conditions of high rainfall mulching can also be a means of erosion control. The type of mulches used are given in Table 12.13. In almost all cases these mulches incorporated grasses and leaves from the plots. There was no indication of mulches being applied from sources outside the actual plots, such as hedgerows.

Table 12-12: Reasons indicated by farmers for applying mulches

Reason for mulch use	No. of farms	% of farms
Keep plants moist	20	13.3
Suppress weed growth	3	2.0
Improve soil fertility	1	0.7
Suppress weeds	15	10.0

Table 12-13: Type of mulches used on farms

Type of mulch	No. of farms	% of farms
Grass	22	53.7
Leaves	2	4.9
Grass, leaves/trash	12	29.3
Other (manure)	1	2.4
Trash	2	4.9
Grass, trash	1	2.4
Grass, leaves Trash, sawdust	1	2.4
Total	41	100

Ninety-two farmers indicated reasons for not mulching and these are indicated in Table 12.14. There were a variety of reasons given for not applying mulches. The most frequently recorded reason (16.3%) was that the farmer never thought about (considered) the practice. Other frequently recorded reasons were that mulching was not necessary (10.9%) and the crops did not require mulching (8.7%). These latter reasons relate to the adequate rainfall which is experienced by the farmers. The use of mulch as a means of erosion control appears to be unrecognised by the farming community. This could be an important area for a training intervention.

Table 12-14: Reasons indicated by farmers for not applying mulches

Reasons for not mulching	No. of farms	% of farms
Adequate rainfall	2	2.2
Crops do not require mulching	8	8.7
Cover quite adequate	6	6.5
Don't know practices	8	8.7
To prevent build up of slugs	2	2.2
Not necessary	10	10.9
Time consuming	6	6.5
Never thought about using mulch	15	16.3
Labour intensive	9	9.8
Too costly	8	8.7
Does not produce crops during dry spell	2	2.2
Water is not a problem	1	1.1
Tree crops provide sufficient moisture	1	1.1
During field sanitation dry leaves, other plant parts form mulch	3	3.3
During detrashing leaves drop in field	1	1.1
Irrigation is conducted	1	1.1
Intend to later on	1	1.1
Don't get the right material to mulch	1	1.1
High rainfall area	1	1.1
Would require more material than can be obtained	1	1.1
Don't have any interest in it	1	1.1
Time consuming, no labour	1	1.1
Don't have the right material, costly	1	1.1
Can't pay labour, old age does not permit activity	1	1.1
Not important right now	1	1.1
Total	92	100

The more important problem in soil management appears to be due to excess rainfall and the need for effective drainage. Table 12.15 gives the methods used to counteract excess rainfall on the farms. Only 35 farms (23.3%) felt they had no need to have any special measures to counteract excess rainfall on farms. The other 115 farms used various forms of drainage to effectively remove excess water from their farms. These methods were also important in controlling soil erosion as the most adverse effect of excess rainfall on sloping land is increased soil erosion.

Table 12-15: Methods used on farm to counteract excess rainfall

Method	No. of farms	Percentage of farms
None	35	23.3
Drainage	82	54.7
Contour drains	5	3.3
Construction of drains/mulching	1	0.7
Construction, maze of drains	10	0.7
Construction of beds/bedding	3	2.0
De-silting of lateral drains	5	3.3
Digging of lateral drains	3	2.0
Total	150	

12.4.4 Soil erosion on farm

Table 12.16 gives the main land slope types on the farms surveyed. The majority of the farms 61.3% are on flat lands or gentle to moderate slopes, while 57 farms (37.3%) were on steep slopes and only one farm (0.7%) was considered to be on a very steep slope. The indications are that the majority of farms would have a moderate erosion risk which could be easily managed

Table 12-16: Main slope types on farms surveyed

Slope type	No. of farms	% of farms
Gentle <5	31	20.7
Moderate 5-15	56	37.3
Steep 15-30	56	37.3
Very steep >30	1	0.7
All types	1	0.7
Flat	5	3.3
	150	100

Another contributory factor to soil erosion besides high rainfall and sloping lands is soil cover. The methods used for land clearing on farms are given in Table 12.17. The majority of farmers used manual methods of land clearing which are normally better for soil conservation than mechanical methods.

Table 12-17: Land clearing methods used on farms surveyed

Method	No. of farms	% of farms
Cut trees/shrubs	75	50
Weed with machete	111	74
Burn trash with fire	69	46
Forking	78	52
Ploughing	39	26
Ridging	16	10.7
Other	26	17.3

From the level of slopes and the methods of land clearing reported there does not appear to be a serious erosion risk on the farms. This is substantiated by the response given to the question on the main soil problems encountered on the farm. Table 12.18 gives the major soil problems encountered on the farms surveyed. A number of soil problems were encountered by each farmer, but overall 69 farmers (46.0%) indicated that too dry soil was their major problem, while 31 farmers (20.7%) indicated that their soil was too wet. Other important soil problems recorded were low fertility, stones in the soil, soil wash and too heavy soils. Soil wash, stones in the soil, land slips and to some extent low soil fertility can all be regarded as signs of erosion but it is not clear how many individual farms have indicated these problems.

Table 12-18: Major soil problems encountered on the farms surveyed

Soil problem	No. of farms	% of farms
Soil wash	20	13.3
Soil too dry	69	46.0
Heavy soil	19	12.7
Stones in soil	23	15.3
Low fertility	28	18.7
Land slips	9	6.0
Soil too wet	31	20.7
Other	20	13.3

Table 12.19 gives the indications of soil erosion seen on the farms surveyed. Again there is no true indication of the number of individual farms recording these problems. But the overall low percentage of each of these problems on the farms, indicates that soil erosion is not a major problem despite the high rainfall conditions. This may be related to the high percentage of farms on flat land to moderate slopes.

Table 12-19: Signs of erosion on farm surveyed

Erosion indication	No. of farms	% of farms
Soil is less fertile	16	10.7
More stone is visible	19	12.7
Land taken over by gullies	36	24.0
Other	8	5.3

Table 12.20 gives the soil conservation method employed by the farms surveyed. The use of drains and trenches as a soil conservation method was indicated by 117 farms, with contour farming indicated by 29 farms. The prevalence of these simple methods and the fact that 15 farms used no form of soil conservation is a further indication that soil erosion is not considered a major problem on the majority of these farms. A small number of farms employed more effective soil conservation methods such as terracing and the erection of various physical barriers. These may be the farms which are on very steep slopes. None of these farms use vegetable hedgerows as a soil conservation tool.

Table 12-20: Soil conservation method employed on the farms surveyed

Conservation method	No. of farms	% of farms
Terracing	3	2.0
Contouring	29	19.3
Drains/trenches	117	78.0
Stone barriers	7	4.7
Grass barriers	4	2.7
Bamboo barriers	4	2.7
Hedgerows	0	-
None	15	10.0
Other	11	7.3

Tree cover on the farm is also an important means of controlling soil erosion by decreasing the energy of the raindrops on the soil. Table 12.21 gives the percentage tree crop cover on the farms surveyed. 112 farms (74.6%) had less that 50% tree cover. 102 farmers (68%) were willing to plant more trees on the farm, while 42 farmers (28%) were not.

Table 12-21: Percentage tree cover on farms surveyed

Tree cover (%)	No. of farms	% of farms
0- 10	26	17.3
10-20	39	26.0
20-50	47	31.3
50-100	37	24.7
	149	

12.4.5 Agro-chemical use

Fertilizer use on farms was quite widespread. One hundred and forty-five farmers (96.7%) used chemical fertilizers while only 5 farmers (3.3%) never used fertilizers. Thirty-one farms (20.7%) had a soil test done while the other 118 (78%) had not done any soil test. One farmer did not know if a soil test had been done. The great disparity between the number of farmers which have had a soil test done and the number using chemical fertilizers indicates that soil fertilizers are not being used in relation to soil fertility levels and may be over used.

The methods of fertilizer application are given in Table 12.22. Most farmers (80.7%) applied fertilizers to the soil surface and there was no indication, if attempts were made, to incorporate these fertilizers into the soil. Soil incorporation is essential to decrease loss of fertilizers by water runoff and volatilization.

Table 12-22: Method of fertilizer application on farms surveyed

Application method	No. of farms	% of farms
Surface	121	80.7
Surface/broadcast	3	2.0
Surface/band placement	18	12.0
Both	1	0.7
Broadcast/spray foliar	1	0.7
Total	144	

Forty-three farms (28.7%) used limestone to improve the soil pH, while the other 107 (71.3%) did not. This is despite the fact that most of the farmers (85.3%) did not know whether their soil was acidic or not. Only eight farmers knew that their soils were acidic and needed chemical amelioration with limestone (Table 12.23).

Table 12-23: Types of soil reaction on the farms surveyed

Soil reaction	No. of farms	% of farms
Alkaline	8	5.3
Acidic	8	5.3
Alkaline/acidic	1	0.7
Don't know	128	85.3
Good pH	1	0.7
	146	

In terms of pest and disease control, a number of pest species and diseases were indicated for the various crops planted in the watersheds and in 87% of the cases chemical control methods were carried out to control pests while in 67 % of the cases chemicals were used to control diseases. In the case of weeds, the main means of control was mechanical and only in 15% of the cases was chemical control used.

One hundred and four farmers (69.3%) felt that pesticide use affected the amount of money they made on the farm, 32 farmers (21.3%) felt pesticide use did not affect their income, while 13 farmers (8.7%) did not know. 125 farmers (83.3%) used pesticides because they felt it increased their yields, while 71 farmers (47.3%) felt pesticides improved the appearance of their produce (Table 12.24).

Table 12-24: Reasons for using agro-chemicals

Reason for agro-chemical use	No. of farms	% of farms
Increase yield	125	83.3
Improved appearance of produce	71	47.3
Other reason	13	8.7

In addition, 107 farmers (97.3%) indicated that they would purchase more fertilizers if they had the resources, while 86 farmers (81.9%) indicated that they would purchase more pesticides and 91 farmers (89.2%) indicated they would purchase more weedicides if they had the resources. Ninety-six farmers (80.2%) felt that more fertilizers or pesticides would give them better results in their farming efforts.

In response to the question of whether there were affordable alternatives to agro-chemicals, 137 farmers (91.3%) felt that there were, but only 13 farmers (8.8%) were willing to use alternatives to chemical fertilizers and a mere 5 farmers (3.4%) were willing to use alternatives to chemical pesticides.

12.4.6 Sanitation and safety

The sanitary and safe use of agro-chemicals on farms to reduce pollution and risk to health was also assessed in the survey. Table 12.25 indicates the methods of storage of agro-chemicals on the farm. Seventy-two farmers (52.9%) indicated that they keep their agro-chemicals in a locked shed, while another 29 farmers (21.3%) used a shed, presumably without a lock. Only one farmer stored chemicals in his house.

Table 12-25: Method of storage of agro-chemicals on farm

Location	No. of farms	% of farms
Shed	29	21.3
Locked shed	72	52.9
In the house	1	0.7
In the field	9	6.6
Other	20	14.7
Shed, in the field	2	1.5
Shed, other	1	0.7
Locked shed, in the field	1	0.7
In the house, other	1	0.7
Total	136	100

Table 12.26 indicates the methods of disposal of excess chemicals by farmers after use. A large proportion of farmers (51.2%) either buried or applied the excess chemicals to the soil, while another 26.4% stored the excess chemicals for future use.

Table 12-26: Methods of disposing excess agro-chemicals

Disposal method	No. of farms	% of farms
Bury	17	13.6
Apply to soil	47	37.6
Store for further use	33	26.4
Other	25	20.0
Bury, apply to soil	1	0.8
Bury, store for further use	1	0.8
Apply to soil, store for further use	1	0.8
Total	125	100.0

The frequency of chemical applicator cleaning is given in Table 12.27. Eighty-four farmers (63.6%) indicated that they cleaned their chemical applicators after every use, while another 25 farmers (18.9%) did so between different chemical

applications. Sixteen farmers indicated that they never cleaned their chemical applicator.

Table 12-27: Frequency of chemical applicator cleaning

	No. of farms	% of respondents
Every use	84	63.6
Between different chemical applications	25	18.9
Once per month	5	3.8
Never	16	12.1
Other	1	0.8
Every use, between different chemical applications	1	0.8
Total	132	100.0

The washings from these cleanings were disposed of as shown in Table 12.28. Again applying to the soil and burying were the more popular methods and these were employed by 71.2% of the respondents. Two farms indicated that they washed their spray applicator directly into the stream

Table 12-28: Methods of disposing washings from applicators

Disposal method	No. of farms	% of respondents
Bury	18	14.8
Wash down stream	1	0.8
Apply to soil	81	66.4
Other	20	16.4
Bury, other	1	0.8
Wash down stream, apply to soil	1	0.8
Total	122	100.0

The disposal of pesticide containers was mainly by burning (60.9%) but another 15% put the empty containers with the household garbage and 7.5% buried these containers in the soil (Table 12.29).

Table 12-29: Methods of disposing pesticide containers

Disposal method	No. of farms	% of respondents
Bury	10	7.5
Burn	81	60.9
Put in household garbage	20	15.0
Other	15	11.3
Bury, burn	2	1.5
Burn, put in household garbage	3	2.3
Burn, other	1	0.8
Burn, other	1	0.8
Total	133	100.0

In terms of personal safety 20.7% of the respondents indicated that they wore protective clothing while spraying agro-chemicals, while 53% wore their regular clothing. Most farmers (74%) wore boots when applying chemicals, but less, approximately 24% wore hats, gloves or respirators (Table 12.30).

Table 12-30: Use of protective clothing while spraying agro-chemicals on farm

Protective clothing used	No. of farms	% of farms
Regular clothes	80	53
Protective suit	31	20.7
Goggles	31	20.7
Hat	33	22.0
Gloves	31	20.7
Boots	111	74.0
Respirator	43	28.7
Other	10	6.7

Table 12.31 indicates the intervals between spraying and harvesting which are used by the farmers in the survey. Alarmingly seven farmers (6.6%) have harvested crops within a day of spraying, while another 13 farmers (12.3%) harvested within a week of harvesting. However, a large proportion of farmers (53.8%) indicated that their interval between spraying and harvesting of produce was 1- 2 weeks. Another 27.4%, indicated that their interval was over two weeks.

Table 12-31: Interval between spraying and harvesting of crop

Interval	No. of farms	% of farms
< 1 day	7	6.6
1day – 1 week	13	12.3
1 week-2 weeks	57	53.8
> 2 weeks	29	27.4
Total	106	100

Seventy-two respondents (53.7%) indicated that they applied pesticide to produce to be used in the home, while a slightly lower 46.3% indicated that produce for home use was not sprayed. One hundred and forty-seven respondents (98%) indicated that they were not aware of any case of illness on their farm due to pesticide use, while 3 respondents (2%) indicated that they had experienced cases of illness due to pesticide use on their farm. Nine respondents (6%) indicated that they have known of persons who have become ill from pesticide use, while the remaining 141 respondents (94%) had not.

12.4.7 Effects of farming practices and agro-chemicals on the environment

The response of farmers to the question on the effect of their farming practices and use of agro-chemicals on the environment is given in Table 12.32. One hundred and seven farmers (73.3%) felt that pesticide use was having an adverse effect on the environment, while 32 farmers (21.9%) did not know if there was an adverse effect and seven farmers (4.8%) felt there was no adverse effect. As regards chemical fertilizers only 62 farmers (41.6%) felt their use was having an adverse effect on the environment, while an almost equal number, 60 farmers (40.3%) did not know and 27 farmers (18.1%) felt fertilizers were not having an adverse effect on the environment. Seventy-five farmers (50%) felt that their general farming practices were having an adverse effect on the environment, 34 % did not know and 16% felt that farming practices were not affecting the environment

Table 12-32: The effect of farming practices and agro-chemical use on the environment

Agronomic practices	Affects the environment		Has no effect		Don't know	
	No of farms	% of farms	No of farms	% of farms	No of farms	% of farms
Fertilizer use	62	41.6	27	18.1	60	40.3
Pesticide use	107	73.3	7	4.8	32	21.9
Other farming practices	75	50.0	24	16.0	51	34.0

These responses indicate that farmer training on the effect of poor farming practices and excess use of agro-chemicals on the environment may be necessary and can be fruitful.

12.4.8 Comparison of farming practices on large and small farms

Of the 150 farms surveyed, 23 (15%) were over 5.0ha and were considered large farms. The remaining 127 farms were below 5.0ha and were considered small farms. In order to compare agronomic practices on large and small farms it was necessary to analyse selected practices on large farms with those on small farms. These practices are appropriately recorded in relation to the specific crop grown.

Table 12.33 gives the levels of mulching and use of chemical fertilizers practiced on small farms in relation to the 10 crops grown as well as on all the small farms. Table 12.34 gives the same data in relation to large farms. These data show that mulching varied from 23.2 % in dasheen farms to 0% in cocoa, hot pepper and pineapple farms, and averaged 16.0% on all small farms. A similar analysis on large farms showed that mulching ranged from 50.0% in tomato farms to 0% in hot pepper, pineapple and plantain farms and averaged 17.5% on all farms. The level recorded for both sizes of farms are quite similar and the conclusion can be made that the level of mulching on large and small farms are similar.

Chemical fertilizer use ranged from 100% on pineapple farms to 56.3% on cocoa farms, with an overall average of 83.9% on all small farms. For chemical fertilizer use in large farms this ranged from a high of 100% in banana, hot pepper, pineapple, plantain and tomato farms to 33% in yam farms, while the overall chemical fertilizer use was 80% on all large farms. Again the level recorded for both sizes of farms are quite similar. It appears therefore that agronomic practices varied more in relation to the type of crop being grown rather than the size of farm.

Table 12-33: Levels of mulching and fertilizer use on small farms in relation to crops grown

Crop	Selected farming practices			
	Mulch	No- Mulch	Fertilizer	No-Fertilizer
Banana	9	42	50	1
Cabbage	1	11	11	1
Cocoa	0	4	3	1
Dasheen	16	53	59	9
Hot pepper	0	3	2	1
Pineapple	0	2	2	0
Plantain	1	20	14	7
Sweet potato	0	8	5	3
Tomato	1	7	7	1
Yam	3	13	9	7
Total	31	163	162	31

Table 12.34: Levels of mulching and fertilizer use on large farms in relation to crops grown

Crop	Selected farming practices			
	Mulch	No- Mulch	Fertilizer	No-Fertilizer
Banana	2	9	11	0
Cabbage	1	2	2	1
Cocoa	1	8	6	3
Dasheen	1	4	4	1
Hot pepper	0	1	1	0
Pineapple	0	1	1	0
Plantain	0	1	1	0
Sweet potato	0	4	3	1
Tomato	1	1	2	0
Yam	1	2	1	2
Total	7	33	32	8

From the limited analyses done, it is felt that there are no wide variations in practices between large and small farms to indicate any major differences from the results recorded for all farms in the body of the report.

12.5 Conclusions

The results coming out of this survey are very instructive and bring to light some important factors pertaining to the management of farms in the upper watershed while preserving the aquatic, coastal and marine environment on the lower areas. In general farming was not done on as steep slopes as in Jamaica. In addition 20% of the farmers had soil analyses done and 11% were aware of the soil reaction (pH) of their soils. Despite these positive elements, soil management appears to be independent of soil scientific considerations. There was widespread use of chemical fertilizers and this may be an important area for intervention, to ensure excess fertilizers are not being applied to the soil.

In addition, although the majority of farms were on moderate to steep slopes (5^o – 30^o), there is a reported high rainfall level and some indication that there were signs of erosion on the farms however, there were very limited efforts made at soil conservation. Soil conservation practices, particularly the use of vegetable hedgerows may be an important recommendation for some of the farms in St Lucia.

Other chemical pesticides were also in wide use for a number of reasons including the feeling that agro-chemicals increased yields and provided a better quality of produce and hence better prices. In this regard, the principles of integrated pest management should be stressed and recommended to farmers. A third of the farmers did not know what effect their farming practices were having on the environment and this may be a further area for a training intervention.

13.0 IMPORTANT FINDINGS AND RECOMMENDATIONS FROM THE TWO SURVEYS

13.1 Findings

The surveys were conducted on two watersheds in Jamaica and three in St Lucia. There were 149 farms surveyed in Jamaica of which 57 were considered large farms being more than 5ha each. In St Lucia, 150 farms were surveyed with 23 considered as large farms. In both islands over 60% of the farms were owned by the farmer or his family. The main crops varied in the two islands with banana, citrus, cocoa, coconuts, coffee, sugar cane and yam being prevalent in Jamaica, while in St Lucia there were bananas, cocoa, mixed vegetables (cabbage, hot pepper and tomatoes) and root crops (dasheen, sweet potato and yam).

In both islands the majority of farmers were over 40 years old; this was more prevalent in Jamaica. In addition, most of the farmers only reached the primary level of education.

Soil water management on the farms differed in the two islands, mainly because the rainfall levels in the islands were different. Jamaica, with relatively low rainfall and relatively light soils, found lack of water a serious constraint and used a variety of methods to effect irrigation of the crops. Despite this, only 40% of the farms practiced mulching. In St Lucia, rainfall was higher and soils were reported on average to be heavier than those in Jamaica. The problems on this island were more related to excess soil water and drainage.

Soil erosion appears to be more of a problem in Jamaica, mainly because of the greater proportion of steep slopes being farmed. Many observed signs of erosion. In St Lucia more than half of the farms surveyed were on moderate to gentle slopes, and this lessened the erosion risk, but because of higher rainfall increased the drainage problems. On the steeper slopes in St Lucia, erosion is likely to be higher than in Jamaica. In both islands erosion control methods were poor. In St Lucia there was no mention of hedgerows as a means of erosion control. In both islands tree planting can be used to enhance soil conservation.

The use of agro-chemicals, fertilizers and pesticides was widespread on both islands. Chemical fertilizers were being used on most farms although very few had had soil chemical analyses done. This was more pronounced in Jamaica than in St Lucia.

Pest and disease control was done almost entirely by chemical applications in both islands. Farmers indicated that the use of agro-chemicals increased their yields and improved the appearance of their produce. The control of weeds was however mainly by mechanical means. In both islands the majority of farmers indicated that they would use more agro-chemicals if they had the resources.

In terms of sanitation and safety, farmers indicated that most of their excess chemicals were stored for future use, applied to the soil or buried. Although pesticides were safely kept, there is evidence from the Pesticide Control Authority that indicates that poisoning does occur in farmer homes and especially affects children. Farmers disposed of containers by burning and most used some sort of protective clothing while spraying. The interval between spraying pesticides and harvesting of crops was between 1-2 weeks in both islands, but surprisingly a small number of farmers in St Lucia indicated that this interval could be less than 1 day. A majority of farmers in both islands indicated that they sprayed crops when the produce was intended for home use. The farmers in both islands were mostly unaware of any incidences of persons being affected by chemical spraying.

The effect of the use of agro-chemicals on the overall environment was not well known or considered by a sizeable number of farmers.

13.2 Recommendations

i. Raise awareness of the benefits of Good Agricultural Practices (GAPs) (for human and environmental health) and provide farmer training in GAPs.

ii. Integrated Pest Management (IPM) systems which reduce pesticide use on crops and promote pest control by non-chemical methods should be introduced into the farming communities and recommended in both islands.

iii. More research on IPM (Integrated Pest Management) and/or IMPP (Integrated Management of Pests and Pesticides) should be conducted as a means of improved management of the use of pesticides.

iv. A comprehensive, well-developed Integrated Management of Pests and Pesticides (IMPP) programme should be designed and implemented including cost benefit analyses (i.e. organic farming vs. agro-chemical use). This programme should be at national and regional level and incorporate biological controls and prudent vegetative / farming practices. The IMPP programmes should be designed by stakeholders, including pest operators, local and regional agro-chemical importers and manufacturers, farmers, environmental groups, state bodies, the public, and the relevant university departments.

v. Socio-economic analyses, including cost-benefit analyses, should be conducted for different farming practices including options for agro-chemical use (e.g. IPM).

vi. Pesticide management procedures must be brought to the attention of the farming community and especially to children living in these farming communities as many of the agro-chemicals are stored and used in the home.

vii. Promotion of agriculture in schools to increase youth, particularly female, participation in the sector.

viii. Communications experts should be engaged for communication, education and training purposes; change-management concepts should be applied (e.g. to influence changes in: agricultural practice, storage, labelling, sale and disposal of agro-chemicals.

ix. Training courses on environmental protection and the effect of excessive use of agro-chemicals on the environment should be initiated in both islands. Further training on the environmental impacts of certain farming practices (i.e. in terms of erosion) should also be encouraged.

x. There needs to be increased soil testing on farm lands to ensure that soil chemical fertilizers are applied to overcome deficiencies in the soil and that there is no excessive use of fertilizers.

xi. The practice of mulching should be encouraged particularly in Jamaica as a means of soil and water conservation.

xii. The use of vegetative barriers (including hedge rows) for soil erosion control should be introduced to St Lucia and further encouraged in Jamaica.

xiii. Compost making and the use of organic manure should be promoted on all the farms.

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16.0 ANNEX 1: LIST OF PROJECTS UNDERTAKEN IN WATERSHED MANAGEMENT

Date	Name of Project	**Sponsoring/Executive Entities**	**Objective**	**Remarks**
1944-1947	The Farm Recovery Scheme	Ministry of Agriculture and Lands	To restore productivity of farms damaged by the hurricane of 1944	Premature interventions of scheme planned to reduce soil erosion and improve farm infrastructure. High subsidy (up to 80%) of cost.
1951-1961	• Yallahs Valley Land Authority (YVLA) • Christiana Area Land Authority (CALA)	MAL	To introduce soil conservation to farmers in the hillsides of two heavily populated areas.	Introduce expensive structures (terrace bounds, drains etc.) without imparting their importance and requirement for maintenance to the end users. Not enough properly trained staff. Grants were still regarded as handouts.
1955-1960	Farm Development Scheme			
1960------	Agricultural Development Programme (ADP)	MAL	An attempt to introduce total development to farm family	Integrated MAL extension, JAS, 4H and Social Welfare staff into one unit.
1955-1966	Farm Production Scheme	MAL	Tried to introduce total farm development	Stakeholders not ready for technological advancement. Inadequate capital and labour to cope with new techniques.
1968------	Lucea/Carbaritta Watershed Project	Watershed Commission (MAL)	To demonstrate techniques for effective farming in the watershed.	No information available.

Date	Name of Project	Sponsoring/Executive Entities	Objective	Remarks
1984-1993	On-Farm Adaptive	IDRC/IICA-MAL	• Test applicability of farming systems • Research and extension in Jamaica • To improve production and productivity in selected areas in St.Catherine	Stimulated farmers interests in new techniques, crops and livestock. Introduced livestock enterprises into communities it served.
1987-1993	Hillside Agricultural Project (HAP)	USAID/MAL	• To increase production and productivity of perennial crops • To promote watershed stabilization initial focus on the Rio Minho and Rio Cobre as expanded to all of Eastern Jamaica	While significant acreage of three crops were planted and resuscitated through use of input subsidy for maximum of 1 acre, sustainability of programme was limited as not all farmers continued initiative after subsidy ended.
1989-1993	Protected Area Resources Conservation Project (PARC)	USAID/PIOJ	• To initiate the national park system • To start two national parks	• National Park System Plan completed • National Park Trust Fund established Blue/John Crow Mountain and Montego Bay Marine Park established.
1977-1983	Second Integrated Rural Development Programme (IRDP)	MAL	To reduce soil erosion, and increase income of farmers in two sub-watershed River (Christiana) and Pinders River (Kellits)	Comprehensive methodology of providing all services (soil conservation, agricultural extension, farm credit, home economics, community development etc.

Date	Name of Project	**Sponsoring/Executive Entities**	**Objective**	**Remarks**
1989-1995	The Hope River Watershed Project	Forestry Department (MAL)	To demonstrate effective soil conservation measures	Soil erosion control structures were constructed maintenance of structure was poor.
1990-2000	National Forestry Action Plan	FAO/Forestry Department	To develop a national forestry action plan for Jamaica	Plan developed.
1991-1996	Jamaica Land Titling Project	IDB-GOJ/ Min. Agri-Min Env. & Housing	To provide titles for land settlement properties and improve facilities for land titling.	Achieve all objectives prepared more than 2000 improved facilities at Lands department. Titles Office, and Survey Dept. and linked them by fibre optic cable. Introduced the more cost effective cadastral land survey technique. 30 Staff in the above institutions received training.

Date	Name of Project	**Sponsoring/Executive Entities**	**Objective**	**Remarks**
1996-1999	Environmental Management of Watersheds: Development of Institutional Capabilities	UNDP-GOJ/NRCA-PIOJ	Improve institutional capabilities and classification of priority watersheds	National Watershed Policy drafted, and classification scheme developed.
1996-1999	Morant Yallahs Development Project (MYDP)	EU/RADA	To stimulate enterprise production through implementation of 7 components: • Technology generation • Forestry • Extension • Small livestock • Marketing • Land titling • Project management	Many targets were achieved in terms of technology reforestation, new acreages, and goat production, but project implementation showed that integrated concept of implementing too many components in one community was too complicated and stretched implementation capabilities.
1997-2000	Windows of Sustainable Models in Jamaica: The Rio Cobre Watershed	GTZ/IICA	To develop effective models for watershed management	Project duration too short for determination of impact on watershed. A model goat rearing system was developed, research. Project extended to EJASS (below).

Date	Name of Project	**Sponsoring/Executive Entities**	**Objective**	**Remarks**
On-going Projects				
1999-2002	Trees for Tomorrow	CIDA/Forestry Department	To promote production and utilization of trees	On-going
2000------	Eastern Jamaica Agricultural Support Project (EJAS)	EU/RADA	Same as MYDP	Extended to the Eastern parishes (on-going)
1998-----	Fruit Tree Crops Project	Ministry Agriculture	To develop efficient orchard management especially on marginal lands.	On-going
1995-2000	South Trelawny Environmental Association	STEA/EFJ	To demonstrate the effectiveness of trees in soil erosion control.	Techniques appeared effective but there no quantitative but there were no quantitative measurements. None target farmers adopted the technique.
2000-2006	Ridge to Reef Watershed Project	USAID/NRCA-NEPA	To initiate sustainable watershed management in two selected watersheds to the Rio Grande, and the Great River, and to focus on associated issues of policy enforcement, compliance and institutional strengthening.	Project started in 4th quarter of 2000. Employs methodology of strategic planning workshops to identify appropriate interventions.

Date	Name of Project	**Sponsoring/Executive Entities**	**Objective**	**Remarks**
2000-2003	LAMP (Land Administration Management Project)	IDB-GOJ/ Ministry of Environment	To: • Develop land titling system using 3000 parcels of land in St.Catherine in the pilot project. • Prepare integrated development plans for parish Town and Santa Cruz. • Prepare an inventory of public lands • Develop a land Information management System.	