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Overview on Natural Resources for Food and Agriculture in the Wider Caribbean Region

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the Food and Agriculture Organization of the United Nations*



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OVERVIEW ON THE STATE OF RENEWABLE NATURAL
RESOURCES FOR FOOD AND AGRICULTURE
IN THE
WIDER CARIBBEAN^{1/}

1/ Report prepared by FAO at the request and with the financial assistance of UNEP/ECLA.

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TABLE OF CONTENTS

	<u>Page</u>
INTRODUCTION	1
WATER RESOURCES	
1. The Resources	2
2. Use of Water and Its Attendent Problems	3
<u>Recommendations</u>	5
SOIL RESOURCES AND AGRICULTURAL LAND USE	
Major Soil Constraints	7
Erosion Problems	7
Salinization	8
Water-logging	8
Soil Resource Utilization - Agriculture	8
Land Tenure	9
Types of Agriculture	11
<u>Recommendations</u>	13
PASTURE	
1. The Resource	14
2. Utilization of the Resources	16
3. Problems	17
<u>Recommendations</u>	17
FORESTRY	
1. Forestry Resources	18
2. Deforestation	18
<u>Recommendations</u>	22
WILDLIFE	23
GENETIC RESOURCES	
1. Forest Genetic Resources	25
2. Plant Genetic Resources	26
3. Animal Genetic Resources	28
<u>Recommendations</u>	29
FISHERY RESOURCES	
Introduction	29
1. Marine Fisheries	30
2. Coastal and Inland Fisheries	33
3. Major Environmental Problems Related to Fisheries	
Development	35
<u>Recommendations</u>	37
<u>CONCLUSIONS</u>	39

LIST OF TABLES

	<u>Page</u>
1. Areas of Irrigated Lands in Central America	4
2. Soils of the Caribbean Area	6
3. Categorization of Soil Conditions	7
4. Land Use within the Sub-Regions (1977)	10
5. Distribution of Farm Sizes in Selected Areas	11
6. Sub-Regional Distribution of Land under Permanent Pasture	14
7. Regional Distribution of Tropical Forest 1975, 1980, 2000	19
8. Examples of Deforestation which has occurred in the Region	20
9. Annual Average Deforestation and Afforestation Rates for Major Sub-Regions of the Caribbean	20
10. Production from Forests 1966 - 1976	21
11. Spatial Distribution of the Continental Shelf Areas	30-31
12. Live Weight Fish Potential for the Maritime Waters	32
13. Demersal and Pelagic Potential in Areas with more than 200 m depth in kg/ha	32
14. Research and other Formalized Activities Related to Fisheries in the Region	34
15. Estimation of major sewage and other organic waste emissions to the Caribbean Sea and Gulf of Mexico	36
16. Types of pollutants to be expected from certain industrial activities	37

OVERVIEW ON THE STATE OF RENEWABLE NATURAL RESOURCES
BASIC FOR FOOD AND AGRICULTURE
IN THE WIDER CARIBBEAN*

INTRODUCTION

This overview on the state of renewable resources basic for agriculture and food production in the Wider Caribbean is one of several sectorial overviews prepared by different specialized agencies of the United Nations and other international organizations, within the framework of the Caribbean Environment Project (CEP) a joint UNEP/ECLA understanding which has for main task to elaborate an Action Plan for Sound Environmental Management in the Wider Caribbean Area.

The territorial coverage of the Wider Caribbean as defined by the CEP contains: all countries of Central America; Mexico; Colombia, Venezuela, Guyana, Surinam and French Guyana; all the islands of the Lesser and Greater Antilles; and the Bahamas and Turks and Caicos. In addition, the gulf Coast states of the USA also fall within the CEP definition. The marine coverage of the Wider Caribbean comprises the Gulf of Mexico and the Caribbean Sea plus the continental platform (maximum depth of 200 m) of those territories with Atlantic coastlines.

This overview addresses three main aspects regarding the Region's natural resources: firstly the present state of the natural resource base with respect to the various subsectors of agriculture, forestry and fisheries are outlined; secondly an attempt has been made to determine the potential of the resource, related to usage, and the reasons for the present state; and finally recommendations for action needed to enable the resources to be used rationally for sustainable productivity.

The report is presented with separate sections dealing with the following resources: water, soils, agriculture, forestry, savannahs, territorial wildlife, genetic resources and fisheries.

In general, the statistical information and discussions have been presented sub-regionally. The sub-regions were chosen according to environmental similarities and geographical proximity. The grouping are as follows:

- i. Central America and Mexico;
- ii. Colombia and Venezuela;
- iii. Guyana, Surinam and Trinidad and Tobago^{1/};

* Draft report prepared by FAO within the framework of its Environment Programme Coordinating Unit in collaboration with all FAO Divisions concerned in Agriculture, Forestry and Fishery Departments through a Consultant, Mr. Hernan Contreras Manfredi.

1/ Technically the Guyana region of Venezuela which incorporates the Orinocco delta should be included in this sub-region. However the data on Venezuela does not enable this region to be differentiated satisfactorily from the rest of Venezuela.

- iv. The Greater Antilles from Cuba to Puerto Rico; and
- v. The Lesser Antilles from the Virgin Islands to Grenada and incorporating Barbados.

Attention is drawn to the ecologic fragility of many of the systems and the interconnections between the natural resource base and man's ability to utilize them to his needs on a sustained manner. It is therefore considered imperative that all aspects of planning and development, should take into consideration the above mentioned interrelations.

WATER RESOURCES

This section deals with the more general aspects of water resources and their utilization in the Région. Detailed sectoral usage is dealt with in the individual sections of the Overview.

In the FAO report on "The State of Food and Agriculture 1977", it is reported that only 2 percent of the world's total estimated water resources is in a fresh liquid state, 98 percent of which is groundwater. It has been further estimated that of the total precipitation, on a global basis, 7.7 percent is in the cycle as surface water and 0.4 percent is in the form of groundwater. Although small in percentage terms however, the quantity of fresh water available is very large. The main problem relates to its distribution and location.

1. The Resource

Data on this resource within the Region tends to be rather "scanty" and heterogeneous, and as such does not lend itself to satisfactory tabulation.

Climatically, although the entire Region lies within the tropics (2° to 30° N of the equator), there are substantial macro and micro-climatic variations due to topography and orientation with respect to the prevailing north-easterly winds. Even comparatively small islands such as Jamaica show marked differences from one area to another; thus on the N.E. coast and over the Blue Mountain range, annual precipitation averages 7 600 mm whereas it is but 760 mm on the S.W. coasts, giving an inland-wide reported annual average of 2 000 mm. Such large variations even for a small island illustrate the lack of meaning attributable to national average rainfall figures.

Nevertheless, the following broad climatic zones, with reference to rainfall and temperature, can be identified within the Region:

Humid tropics - found along most of the coastlines of Central America, Eastern Venezuela, the Guyanas and the majority of the Islands, as well as in the tropical rainforests below an altitude of 1 000 m. Here average annual rainfall is heavy (in excess of 2 000 mm) although there are distinct wet and dry seasons with the majority of precipitation occurring during a six to seven-month period.

Sub-humid tropics - with much lower rainfall are to be found in several inland areas of Central America, along the Northern coast of Colombia and Venezuela and some of the natural savannah areas of those two countries, as well as Barbados, the Netherland Antilles, Antigua, Southern Haiti and Southern Jamaica. In these areas rainfall is between 1 000 mm and 1 500 mm on average;

Semi-arid and arid areas occur in a few locations in the Region, such as Northern Venezuela and North Eastern Colombia. However, by far the largest area occurs in Mexico. In these regions rainfall averages less than 700 mm, but precipitation is highly unpredictable and can vary by as much as 40 percent from one year to the next.

Nevertheless, as a generalization it can be said that the Region does not suffer from serious water deficiency (defined by annual rainfall in mm minus annual evapotranspiration in mm).

As far as surface water is concerned, the Region contains a few very large rivers such as the Essequibo in Guyana, Orinocco in Venezuela, Magdalena in Colombia and the Rio Grande between Mexico and the USA. There are also numerous rivers and streams, draining the Region (see Map) although some of the small islands have very few streams. Barbados, for example, has no surface rivers. The total water discharge to the Wider Caribbean marine environment has been estimated as $2.8 \times 10^3 \text{ km}^3$ (including the US Gulf coast).

In addition there should be large stocks of underground water resources although their total extent is as yet undetermined.

Hence one may conclude that the Region certainly possesses the water resources needed to meet its total requirements. However this needs to be properly assessed and evaluated.

2. Use of Water and Its Attendant Problems

The major interrelated problems concerning the use of resource are: location, annual distribution and the cost of infrastructural development.

a) Locational problems

Although it has been stated in Section 1 that the Region possesses sufficient water resources to cover its needs, the location is very often remote from where it is most required. The overwhelming majority of the fresh water discharged to the sea is carried by comparatively few rivers remote from much of the agricultural and other human activities which require it.

At the same time a few of the smaller rivers, whose waters can be and are effectively used are suffering increasingly from sedimentation and to some extent to localized pollution problems occasioned by mainly industrial upstream activities.

The problems of many of the Lesser Antilles is that due to their small size, and often mountainous topography, the residence time of surplus precipitation is extremely short, thereby reducing its accessibility.

In Jamaica, the locational problem revolves around the fact that the heaviest rains, fall on the opposite side of the mountain divide to where much of the population and agricultural lands are located.

As a consequence most of the islands have to depend on the water supplies from underground sources. The present knowledge of the potential of these resources is not known; in general groundwater resources have limitations to satisfy the need of agricultural and other usage. For example Barbados, with an average population density of more than six persons per hectare, has to obtain most of its water from underground sources.

b) Annual distribution

The uneven distribution of rainfall throughout the year is another major constraint relating to its use for agricultural and other purposes.

The majority of the agricultural lands in the Region receive annually a total rainfall in excess of that required by the crops for satisfactory growth. However, as pointed out earlier most of the precipitation occurs during a five to seven month-period.

For example, in Honduras (which is representative of most of the Caribbean coastal regions of Central America), 90 percent of the yearly rainfall occurs during the six-month wet period. A similar situation occurs in Trinidad and Tobago where, even very close to small rivers, grass stops growing and begins to turn brown within a month of the onset of the dry season. Optimum irrigation requirements during this period for food and crops have been estimated at between 25 mm and 30 mm per week in Trinidad and Tobago.

Interference with, or destruction of, the forest in the water-shed areas, has served to intensify the water problem in many parts of the Region, since many streams and small rivers which used to maintain satisfactory flows suitable for small scale irrigation, now virtually dry up in the dry season.

Given this rainfall pattern, agricultural production can only be increased through supplementary irrigation.

However, only small areas of agricultural lands in the Region are irrigated. Nevertheless, there was a 36 percent increase in irrigated lands between 1970 and 1975 in five Central American countries as shown in Table 1.

Table 1

Country	Areas of Irrigated Lands in Central America		
	1970	1975 (\$increase)	Comments
Costa Rica	62 693	65 740 (4.9)	Includes 12 065 ha coffee, 18 049 ha pasture
El Salvador	20 074	26 146 (30.3)	Includes 7 844 ha pasture
Guatemala	19 110	36 653 (91.8)	Includes 5 865 ha pasture
Honduras	49 800	54 000 (8.4)	Includes 3 000 ha pasture
Nicaragua	43 287	63 882 (47.6)	Includes 9 582 ha pasture
TOTAL	194 964	264 421 (35.6)	

On the other hand, the opposite problem is encountered during the wet season. Low lying areas, plains, valleys and coastal areas often suffer from flooding and water-logging.

c) High cost of infrastructural development

In order to improve accessibility to water resource and to regulate its use between the seasons, large infrastructural developments are required involving impoundment, distribution, drainage and irrigation. Generally, these operations require very large capital expenditures. For example, a

water supply project in Trinidad, (population 1 million) to provide an additional 60 million gallons of potable water per day, is costing that country more than US\$ 200M. In Guyana, a drainage and irrigation scheme involving 171 thousand hectares of coastal agricultural lands is costing nearly US\$ 500 per hectare.

Because of the expenditure involved, irrigation schemes are often developed primarily for the more lucrative, large-scale, export-oriented agricultural crops with only marginal allocations for domestic food crops. This is a serious handicap for the expansion and development of local food production within the Region.

This situation does not necessarily arise from national agricultural policies, it is partly a result of the lack of domestic financial resources needed to implement drainage/irrigation schemes. The countries are forced to turn to the international finance market for loans, which naturally are granted only on the basis of returns on investment and ability to debt in foreign exchange. Thus, countries whose foreign exchange earnings are almost totally dependent on agricultural exports, are in effect caught in a vicious circle.

Finally, one should recognize that although statistics are not available, small-scale irrigation is practised (albeit unscientifically) by large numbers of small farmers throughout the Region. These systems, developed through individual (or collective) effort, represent a significant, unaccounted, financial contribution to the Region. It is possible that some form of coordinated central organization and minimal financial and technological assistance could prove to be of great value in raising agricultural productivity.

RECOMMENDATIONS

Based on the foregoing broad review on the state of water resources in the Wider Caribbean, the following are few general recommendations:

- i. Of crucial importance for planning and rational utilization is the availability of satisfactory data. Regional data is insufficient and heterogeneous; it does not reflect the real irrigation, industrial and other needs. It is therefore suggested that where possible, existing data should be refined and further data collection should be conducted; this would need strengthening development of monitoring stations.
- ii. Studies on the soil-water-plant relationships in the different agro-ecological zones of the Region should be fostered.
- iii. In areas of potential irrigation water logging and salinity problems should be addressed; there is very little information on this subject for the Caribbean.
- iv. The dynamics of watershed and their management is of critical importance for water resources availability. The dynamics must be understood so that corrective action should be taken wherever necessary, and satisfactory management practices developed.
- v. Existing small-scale irrigation practices in the Region should be reviewed with a view to determining their potential for improvement, expansion for food crop production.
- vi. The possibility of the use of micro- or mini-dams, should be fully investigated for multiple purpose use, such as: irrigation, river flow regulation, power generation, etc.

SOIL RESOURCES AND AGRICULTURAL LAND USE

The soil resources of the region are described in Volumes III and part of Volume IV of the FAO/UNESCO Soil Map of the World, published in 1975 and 1971, respectively. Table 1 gives a broad summary of the extents of the different soils of the greater Caribbean Region. The wide differences in the distribution of soils between Mexico and Central America plus the Antilles on one side and the Caribbean countries of South America on the other, are mostly related to soil parent material and climate.

The widespread occurrence of Andosols in Mexico and Central America is a consequence of the large number of active volcanoes in that part of the Region; in the South American Caribbean, Andosols are only found in Colombia. The occurrence of Rendzinas is restricted to limestone parent materials in seasonally dry climates and this combination is more frequently found in Mexico and certain parts of Central America and the Antilles than in the Caribbean countries of South America. Dominating soils over large surfaces in these latter countries are the Acrisols and Ferralsols, above all in the extensive upper Amazon and Orinocco river basins.

Table 2

<u>Soils of the Caribbean Area</u>			
	<u>Mexico, Central America, Antilles</u>	<u>Colombia, Venezuela, Guyana, Surinam, Fr. Guyana</u>	<u>Total</u>
.....in 1 000 hectares			
Fluvisols	3 137	12 440	15 577
Gleysols	6 347	21 994	28 341
Regosols	13 554	4 756	18 310
Lithsols	24 660	22 271	46 931
Arensols	-	4 349	4 349
Rendzinas	13 550	251	13 801
Andosols	19 532	3 365	22 897
Vertisols	16 311	3 728	20 039
Kastanozems	36 005	1 038	37 043
Phaeozems	1 086	-	1 086
Cambisols	30 810	14 405	45 215
Luvisols	30 265	5 602	35 867
Podzols	-	1 080	1 080
Planosols	1 525	2 598	4 123
Aerisols	21 307	53 231	74 538
Nitosols	10 790	13 123	23 913
Ferrasols	651	67 286	67 937
Histosols	2 492	2 028	4 520
Solonchaks	242	1 450	1 692
Solonetz	-	315	315
Yermosols	24 636	541	25 177
Xerosols	14 975	2 903	17 878

Major Soil Constraints

Major constraints, related to the nature of soils, are: lack of natural fertility, erosion (and erosion hazard), salinization, water logging, physical/chemical degradation and shallowness. Constraints related to climate and soil, are drought and permafrost. All these constraints put more or less serious limitations on agricultural land use and land use potential.

The percentage distribution of land areas affected by these constraints is given in Table 3.

Table 3

Categorization of Soil Conditions

	Drought	Mineral stress	Shallow depth	Excess water	Perma frost	No serious limitations
Central America	32	16	17	10	0	25
South America	17	47	11	10	0	15
World	28	23	22	20	6	11

Note: Figures are percentages of land with indicated conditions.

From Table 3 it can be seen that Central America has a comparatively high proportion of its soils with no serious limitations for agricultural use.

Erosion Problems

One of the most serious problems affecting the soils of the Region is erosion, both in terms of already eroded lands and (in terms of) high risk of increased erosion.

In general terms, it can be established that the soils derived from metamorphic, igneous and highly diogenized sedimentary rocks, which are the most prone to erosion. For the Caribbean, Table 3 shows that the most vulnerable areas are the Greater Antilles and parts of Venezuela, Colombia, the Guyanas and Trinidad-Tobago.

The volcanic soils (of Central America, the Lesser Antilles and the Andean Region of Colombia and Venezuela), due to high permeability, are far less erosion prone.

Because of their characteristics and gentler slopes, alluvial soils also present fewer erosion risks.

The relationship between rainfall intensity and velocity of water infiltration is little understood and requires intensive study in order to maximize soil use.

Apart from soil degradation, an example of the costly effects of erosion is the high siltation rate of the Archicaya Dam in Colombia. Only after 21 months of its completion the capacity of the dam reservoir was reduced by one quarter due to siltation; ten years after, the reservoir was filled at three-quarters of its capacity by sediments.

Salinization

Salinization is a comparatively minor problem at present in the Region, with an estimated 0.7 percent of the total land surface of Central America being affected. These are primarily restricted to Mexico, where the Solouchaks and Solonetz are highly susceptible. In the rest of the Region the problem occurs in a few areas such as Falcon and Zara, in Venezuela and some places of the coastal zones with a semi-arid climate.

Water-logging

Excess water is not found in extensive areas of the Region, and is mainly a problem associated with river deltas, plains and some savannahs and coastal basins. The soils involved are Gleysols, Fluorisols, Planisols and Vertisols. The main countries affected by this problem are Guyana, Surinam and French Guiana, and the Orinocco delta of Venezuela.

Soil Resource Utilization - Agriculture

The total land area of the Region is 517 525 hectares of which 9.7 percent is classified as arable and permanently cultivated, 22.7 percent is under permanent pasture, 50.3 is used for forestry and 17.3 is miscellaneous.

Table 4 gives a sub-regional breakdown of the land use for 1977. Since 1964 there have been some significant changes. For example: arable and permanently cultivated land increased by 4 million hectares (8.6%), while land for miscellaneous uses, such as urban, industrial and road construction as well as waste lands, increased by 7.5 million hectares (9.1%).

The Table 4 is not indicative of potentially suitable arable lands, nor does it indicate in any way soils which are being used for unsuitable purposes, or soils which have been degraded through inappropriate cultivation practices.

For example: it has been estimated that Panama has 1 million hectares of eroded soils; in Venezuela the figure is 10 million hectares; while in Panama 77 percent of that country's surface shows accelerated erosion.

Also in Mexico and Guatemala, the traditional cultivation of maize in inappropriate areas using inadequate technologies is still carried on even though crop yields are very poor.

On the other hand, experiments in Mexico have shown that through certain techniques, such as organic fertilization soil fertility can be greatly enhanced and that by using this technique, drained swamps can be made productive.

There are also areas, at present under cattle, as well as some forested lands whose soils are suitable for sustained agriculture. Thus by a re-allocation, present arable land availability can be increased.

Some of the soil use problems relate to arable land availability. Table 4 for example shows that the total land per capita of the Lesser Antilles is only 0.44 hectares and that arable land amounts to a mere 0.13 hectares. These figures indicate great pressure on the land from the population from all development activities. In the Greater Antilles, although the figures are more than double those of the Lesser Antilles (0.93 and 0.27) respectively, are still very low. Despite this general lack of arable land availability a significant proportion is under permanent export crops, such as sugar cane, bananas, coffee and cocoa. In Trinidad and Tobago for example (with a per capita availability of 0.14), one-third of the arable land is under sugar-cane and much of the remainder is under constant urban encroachment.

The other major subregions, have what can be described as an adequate capita arable land availability, in Central America and Mexico, agricultural activity is fairly well developed. However, again much of the best soils are used to grow export oriented crops such as coffee, sugar, cotton, bananas, cocoa and beef. The magnitude of the operations can be estimated from "The State of Food and Agriculture 1977 (FAO) which reports that between 1971 and 1975 Latin America's share of World Agricultural Trade was approximately 13 percent and that 65 percent of their trade was in coffee, sugar, bananas, beef and cotton.

At the same time the Region showed a continually increasing foreign dependence on edible oils, cereals and dairy produce. Cereals dependency increased from 6 percent (1955-60) to 46 percent (1965-70) and 60 percent (1971 to 75) of total food imports.

These large export-oriented systems in addition to causing soil problems through monocultural practices, generally lead to increasing marginalization of a large section of the farming community. Thus land tenure is seen as another major problem relating to soil utilization and agricultural practices.

Land tenure

Table 5 shows the farm-size distribution in selected parts of the Region.

Table 4

Land Use within the Sub-Regions (1977)

SUB-REGION		Arable & Permanently Cultivated	Permanent Pasture	Forestry	Other Uses	Total
Lesser Antilles	Area	227 445	80 184	173 475	289 896	771 000
	Percentage	29.5	10.4	22.5	37.6	100.0
	Per Capita	0.13	0.05	0.10	0.17	0.44
Greater Antilles	Area	6 093 874	5 292 526	2 973 146	6 726 454	21 086 000
	Percentage	28.9	25.1	14.1	31.9	100.0
	Per Capita	0.27	0.23	0.13	0.30	0.93
Colombia and Venezuela	Area	10 459 897	34 251 033	124 903 461	35 841 609	205 096 000
	Percentage	5.1	16.7	60.9	17.3	100.0
	Per Capita	0.29	0.95	3.47	0.98	5.68
Central America Mexico and Panama	Area	32 538 315	75 418 265	99 380 590	44 897 830	252 235 000
	Percentage	12.9	29.9	39.4	17.8	100.0
	Per Capita	0.44	1.02	1.34	0.61	3.41
Guyana, Surinam Trinidad and Tobago	Area	1 035 099	2 415 231	32 778 135	2 188 535	38 337 000
	Percentage	2.7	6.3	85.5	5.5	100.0
	Per Capita	0.43	1.00	13.62	0.91	15.93
TOTAL	Area	50 354 630	117 457 259	260 208 807	89 504 324	517 525 000
	Percentage	9.7	22.7	50.3	17.3	100.0
	Per Capita	0.37	0.86	1.91	0.66	3.81

Source: FAO Production Yearbook 1977.

Table 5
Distribution of farm sizes in selected areas

Area	Percentage with given farm size in hectares								
	0.5	2	4	10	20	40	80	200	
Lesser Antilles*	36.5	27.5	6.6	4.6	2.3	1.1	0.6	0.5	←0.3→
Guyana	←37.96	35.41	2.3	4.63					
Honduras		67.5		15	30.0		150	2.5	→
Haiti	←71→	1.3	28.6	0.4					→
Dominican Rep.			15.34		39.68	50	20.47	100	500
								21.23	2000
									←1.25→

* In addition there are 20 percent with no established plot.

Note: In Colombia and Venezuela farm sizes tend to be concentrated at both ends, with many very small holdings as well as holdings in excess of 1 000 ha.

Thus it can be seen that small holdings constitute a significant proportion of the total number of farms in many of the countries. It should, at the same time, be noted that the figures in Table 5 do not indicate the total area cultivated under the different farm sizes. It is however generally accepted that the total acreage under farms of a given size in the Caribbean, follow the reverse distribution. That is to say, most of the good agricultural land is occupied by a small number of large farms.

As a consequence, the small farmers and peasants (many of whom barely exist at a subsistence level), are forced onto marginal lands which very quickly undergo the process of erosion and degradation of the types previously described. This aspect is dealt with in more detail in the next sub-section.

Types of Agriculture

The main types of agricultural practices obtaining in the Region can be described as: migratory agriculture; small-scale sedentary agriculture; and large-scale sedentary agriculture.

Shifting Cultivation

This type of agriculture is practiced by indigenous Indian groups in Central America, Panama, Colombia, Venezuela and the Guyanas, mainly in the humid-tropical forests. Their plots are generally small (a quarter to one half of a hectare) and are located on flat land or gently slopes. Once abandoned, the land generally reverts back to natural forest and the damage can generally be labelled as "minor temporary disarrangement of the forest structure".

Migratory agriculture is also, generally, non-degrading when practiced on very permeable volcanic soils.

This activity which has been carried on for centuries can be justified by the minimal subsistence requirements of some of the highly marginal rural populations.

Improvements, however, can be made by encouraging the utilization of wood and the biomass as byproducts of deforestation. This form of agriculture can also be improved by incorporating elementary fertilization practices in order to make it more environmentally sound and more beneficial to man.

Destructive migratory practices are carried on in the Andean zones of the Region. Here the motivation comes mainly from the basic drive for subsistence and the physiological need for food. Highly erodible soils with slope of up to 70 percent are subjected to slash and burn and intensive cropping with virtually no external inputs, until erosion and general degradation renders the land virtually useless. As an example, in Honduras 2 197 800 ha of land, suitable only for forests are estimated to be under this type of activity, and further deforestation for the same purpose is still underway. This is also a problem in many of the islands.

Small-Scale Sedentary Agriculture

Small-scale sedentary agriculture is practiced throughout the Region with varying degrees of organization and environmental effects. In the Lesser Antilles, for example, there is a diversity of crops with no particularly large farms (this is the case in Grenada). There is however the problem of inadequate agriculture infrastructure and financing, so that farming techniques are lacking in inputs, communications and marketing. Also, in many instances, farming is carried out on marginal lands, not because of marginalization caused by land tenure problems, but because of totally inadequate land resources.

Attempts to solve some of the problems of intra-territorial soil resources have been made, particularly within the context of CARICOM (a Caribbean Common Market association of the English-speaking Caribbean Countries) whereby the smaller islands have been allocated the production of vegetables and tuber plants suited to their soils and the larger territories have been allocated the industrial and grain crops. Within this Caribbean (CARICOM) food plan, soya beans and corn (and cattle production) has been planned for Guyana, Belize, Trinidad and Tobago, Jamaica and St. Kitts. The concept is to reduce regional food imports through collaborative effort.

Nevertheless, small scale farming within the Region, even where there is a reasonable amount of good agricultural land, tends to be at a subsistence level. Such is the case in Trinidad and Tobago. In those countries the problem is related to the afore-mentioned land tenure problem. In Haiti it has been estimated that there are about 650 000 such dwellers.

Small scale subsistence farming even not practiced on highly arable soils is generally associated with the problem of non-existent or minimal inputs - either through lack of education or, more normally, lack of ability to purchase the needed inputs.

Although in some cases productivity is good, there is generally a lack of the much needed infrastructure in terms of storage facilities and technologies, marketing and distribution services. Added to that there exists the perennial problems of the lack of access to credit and technology which made the development of environmentally sound small-scale technology almost impossible.

Large-Scale Sedentary Agriculture

This activity characterizes much of the agriculture practiced in the Region, much of it is related to export-oriented crops or beef production. Under this type of system, it is often found that the resource is underutilized. This is

the case with some of the savannahs. However, more usually, large-scale farming is associated with very high levels of inputs in terms of chemicals and machinery. When these inputs become excessive they are, of course, environmentally degrading (as well as wasteful).

Large-scale farming, particularly related to cattle-grazing is very of the prime mover of wind erosion and accelerated desertification.

Synopsis of the Problems Related to the Soil Resources and their Use for Agriculture

The major problem in the Region is that agricultural activity utilizes part of the soils which are totally unsuitable. This has led to considerable erosion and soil degradation. The problem has arisen partly because of the land tenure situation in which the bulk of the farmers are forced on to marginal lands because the best lands are occupied by comparatively few farms, and in some cases, particularly in the smaller islands, there is insufficient suitable land even if the land tenure system is satisfactory.

On the other hand, large-scale farming is often characterized by under-utilization of the resources or by excessive inputs.

Both types, in the continental sub-regions have also been constantly modifying the agricultural frontiers by removing the protective forest cover.

Finally, it should be emphasized that mere redistribution of land cannot and does not solve the problems of misuse of the resource. For land reform to be truly effective it must be carried out simultaneously with education programmes, and mechanisms must be found for the farmers to have access to credit and technology. An additional related problem for the small farmer is the lack of adequate storage facilities, transport and access to markets.

RECOMMENDATIONS

It is generally recognized throughout the Region that land use planning is of paramount importance. The basic problem is not so much the development of the plans, but rather it is the implementation which has proven to be an almost impossible task. That this is so, is in large part a socio-economic problem. It cannot be expected that all of the highly erodible and eroded soils be immediately cleared of people. However, methods for preventing the continuing process can be developed. In this context, the following recommendations are made:

- i. Projects should be established to determine the best (and simple) technologies which can be used in the short to medium term, by farmers on highly erodible or already eroded soils, in order to allow continual cropping. The farmers should then be provided with maximum assistance to enable them to implement the new methods;
- ii. Educational programmes should be developed for training farmers in the principles and technologies of soil conservation and agricultural ecosystems;
- iii. Basic studies into soil, water, vegetation relationships should be conducted on all the frontiers for which there is a lack of knowledge. Only by this means can the best use of the land be determined;

- iv. Before land reform programmes are mounted, it is imperative that educational programmes are developed and that mechanisms for credit, technology, marketing, transport and storage accessibility are carefully organized and tested;
- v. In some cases, traditional agricultural practices have evolved over centuries and are in harmony with the environment. A study of all of these practices should be undertaken to determine whether any of them should be incorporated into the formal sector.

PASTURES

1. The Resource

Official statistics show that the total area of land under permanent pasture in the Region was 117 457 239 hectares in 1977 (22.7 percent of the total land area). Table 6 below shows the sub-regional distribution of these lands.

Table 6 - Sub-regional Distribution of Land under Permanent Pasture

Sub-region	Hectares	Percentage of total land in the sub-region	Percentage of pasture land in the Region
Lesser Antilles	80 184	10.4	0.01
Greater Antilles	5 292 526	25.1	4.51
Colombia and Venezuela	34 251 033	16.7	29.20
Central America, Mexico and Panama	75 418 265	29.9	64.22
The Guyanas, Trinidad and Tobago	2 415 231	6.3	2.06
TOTAL	117 457 259	22.7	100.00

The statistics also indicate that during the past ten years, there has been a reduction of 1 500 000 hectares.

The figures presented above, by no means indicate that all suitable land is under permanent pasture nor indeed that all land under permanent pasture is most suited to that purpose. For example in the section dealing with forestry, it was pointed out that some 2 million hectares of forest lands were being used for cattle rearing.

Probably the highest proportion of natural pasture lands in the Region are to be found in the "Llanos" of Venezuela and Colombia but it should be realized that this area is not homogeneous and in fact exhibits great territorial variation with diverse savannahs.

In general terms, the Region's pasture lands are located in three main climatic zones namely: humid tropical (below 1 000 m), with high temperatures, rainfall and humidity; dry-tropical (below 1 000 m); and non-tropical (above 1 000 m).

According to Horrell (1972) most of the pastures of Central America are man-made and a large percentage of the area is covered mostly with introduced grasses (predominantly from Africa).

In Central America also (excluding Mexico) two-thirds of the pasture lands are below 1 000 m. Horrell estimates that a large future expansion of pasture is possible in the year-round humid Atlantic zone. In general, these pastoral soils are considered to be of low fertility (most severe in Panama), particularly deficient in phosphorous and sulphure.

In the sub-region formed by Colombia and Venezuela, large areas of natural and man-made pasture occur throughout most of the countries. Statistics for Venezuela, for example show the following:^{1/}

	Total	Llanos Occid.	Llanos Oriente	Lago	Guayana	Remanente
Area of natural pasture - million hectares	13.90	5.17	4.06	0.10	2.33	2.24
Other pastures million hectares...	2.54	0.14	0.45	0.78	0.51	1.37
TOTAL.....	16.44	5.31	4.51	0.88	2.84	3.61

Thus the Llanos account for 66 percent of the total natural pasture lands and the natural pasture lands account for 84.5 percent of total pastures.

As with the case in Central America, the Insular Caribbean also has little natural grassland. Also, particularly in the Lesser Antilles, competition for scarce agricultural land militates against the use of agricultural land for permanent pasture. Hence the figure of 10.4 percent shown in Table 6 is just over one quarter of the total land under arable land and permanent pasture. The corresponding ratios for the other sub-regions are: Greater Antilles - 0.46; Colombia and Venezuela - 0.76; Central America and Mexico - 0.70; and the Guyanas plus Trinidad and Tobago - 0.70.

Thus in summary, the following may be said about the pasture resources of the Region. In Central America, and to a lesser extent in the Greater Antilles, cattle rearing is carried out by allowing the animals to forage freely; in both sub-regions the major portion of the pasture lands are man-made and are covered by introduced grasses.

In Venezuela and Colombia, as well as the Guyanas, the majority of livestock rearing is carried out in natural grass lands.

In the Lesser Antilles, due to scarcity of land, small scale livestock rearing is carried out, but in many instances, forage is cut and conveyed to penned animals.

^{1/} FAO (1971) "Recursos forrajeros de Venezuela".

2. Utilization of the Resource

In general, the pastures throughout the region are used for the direct foraging of animals, mainly beef cattle and dairy cows. Some sheep and goats are also grazed on the pastures but this is fairly minor in comparison. Stocking rates (animals per hectare) vary tremendously through the Region and even within a given country; thus for Venezuela, an FAO report (1971 op cit) gives the following values for 1967:

	<u>Llanos</u> <u>Occid.</u>	<u>Llanos</u> <u>Oriente</u>	<u>Lago</u>	<u>Guayana</u>
Animals/ha.....	0.37	0.39	1.12	0.17

In Central America reports an average stocking rate of one animal per hectare (Horrell).

These stocking rates do not in themselves indicate extensive use (under-utilization) or intensive use of the resource, since climatic conditions, soil fertility and use of inputs inter alia dictate optimal stocking rate.

That under-utilization and over-utilization of the resource do take place however is evidenced by a surplus of fodder, in the first case, and scarcity followed by poor or negative animal productivity and/or soil degradation in the second instance.

A significant amount of research on cattle rearing has been carried out in the Region and is still ongoing. The main thrust, with the object of raising productivity has been in the following areas: improved pasture management and fertilization techniques; feeding trials with crop residues from sugar cane, sugar cane tops, banana plants, root vegetables and molasses - this line of research has been pursued particularly by the island countries; agronomic studies relating to cereals and legumes production such as maize and soybean for animal feedstock; and animal crossbreeding and optimal stocking rates.

Data in general is scarce with regard to stocking rates and pasture fertilization (Horrell). However, some examples may serve to illustrate the productivity of some of the pastures.

At Gualaca (9 months wet season 4 000 mm rainfall) it was found that the application of 300 kg/ha of N (with added P & K) raised dry matter production of the pasture nearly five-fold. The stocking rate could then be raised from the unfertilized rate of 1 cow and 1 calf per hectare. Similar experiments showed that the daily weight gain of young cattle could be more than doubled (in some cases approaching treble) while at the same time doubling the stocking rate.

Based on studies in Central America, it has been shown that in general the savannahs are over-exploited at present in terms of their potential using fertilizers.

In the Llanos Orientales (Venezuela) on the other hand, indications are that in an average, these lands could sustain 2 heads of cattle per hectare, that is nearly 5 times the present average.

3. Problems

The main problems associated with the utilization of this resource may be summarized as follows:

- i. Under-utilization of grassland resources for feed; this is particularly the case for the Llanos of Colombia and Venezuela. Under-utilization is not a problem as such for the land; but it is rather a waste of the resource potential for producing more animal protein, in a region where the population is generally protein deficient;
- ii. Overgrazing: in general this problem is associated with small farms, particularly in Central America and the Insular Caribbean. For example, of a total estimated cattle population of 7.5 million in Central America in 1965, 45 percent were located on holdings of less than 50 ha (Horrell). Overgrazing leads to soil erosion (water and/or windborne), and degradation;
- iii. Poor soil fertility: this is a particular problem in Central America and the Guyanas. Much of the soil fertility problem is associated with the humid tropical areas where the man-made pastures are subjected to intense rainfall which very quickly leaches the nutrients from the soil. This lack of soil fertility in turn leads to poor beef productivity; and
- iv. Water deficiency/surplus: this is a problem caused by the annual distribution of rainfall. Many areas have prolonged dry spells (5-6 months) followed by equally long wet spells. During the dry spells, many pastures dry-up and can only sustain very small numbers of animals. On the other hand, during the wet spells, flooding is often a problem, particularly on the plains. And as yet unexplained observation in Central America, is that even without flooding, lowered animal production occurs during period of continuous rain. It would also appear that as yet no satisfactory method of storing surplus (wet-season) fodder for use in the dry season, has been found for the humid tropics.

RECOMMENDATIONS

Basically arising out of the aforementioned problems, the following broad recommendations are suggested:

- i. The ongoing research as outlined in section 2 (page 16) should be properly coordinated in order to maximise the benefits for the Region as a whole and to minimise unnecessary duplication of effort; Central America possesses a network of Government stations under a whole range of various ecological zones. The research results obtained in these institutions should be made available to other institutions having similar ecological conditions.
- ii. Close attention should be paid to those lands which have proven to be particularly unsuitable for cattle rearing. Studies should be carried out into the most suitable use of these lands as a precursor to their reallocation; and
- iii. The possibility of utilizing other sources of protein such as wild animals (deer for example) should be investigated. Yields from such animals may prove to be far superior to cattle rearing.

FORESTRY

This section presents a summary of the forestry resources of the Region and discusses the fairly rapid disappearance of much of the forest and the problems which are thereby created. In addition there are short subsections on the commercial exploitation of the resource and some social aspects. Finally, based on the general analysis of the present trends some recommendations for action are presented.

1. Forestry Resources

The total area under forest in the Wider Caribbean has been estimated as 221 120 000 ha in 1975 (just under 45 percent of the total land area). Table 7 shows a subregional breakdown, according to the type of forest, for 1975 together with projections for the years 1980 and 2000.

The figures of Table 7 do not of course indicate the total forest potential of the region. To do so would be an extremely difficult task. It is not even possible to say that those areas which were originally covered by forest are still potentially suitable since in many cases man's activities have so changed the characteristics of the soils that it may be almost impossible to return the land to forest.

Thus there are "potential" forest areas such as Barbados which was once completely forested and which now has no forest. Similarly it has been reported that some 2 197 800 ha of forest lands in Honduras are at present under agricultural crops. However, it does not always follow that a reallocation of land resources is necessarily bad, provided that all the consequences of such re-allocation are considered fully.

It is common to find in the literature a subdivision of the forest resources into two categories, namely: productive and non-productive. These titles can be very misleading if not properly understood. They in fact apply to commercial timber operations. Non-productive forest however in many instances performs essential services such as water shed protection, soil stabilization and/or wild life breeding grounds and habitats. In addition, they may be used for the preservation of genetic species or for the growth of specialized herbs, etc. Hence, on no account should it be assumed that non-productive forest implies that their land may automatically be put to alternative use.

In relation to genetic resources, it should be mentioned that the Caribbean Region produces coniferous seeds for all the tropical areas of the world.

2. Deforestation

Deforestation is one of the most serious development related problems common to almost every country in the Region. Deforestation is both planned (organized agricultural expansion programmes, site clearance, etc.) and unplanned (mainly through forest-fires and shifting agriculture).

It should be noted that afforestation and forestation is projected to be only 2 percent of deforestation according to present trends.

According to FAO land-use statistics, the total area of forest lands for the region was 260 280 807 ha. These indicated a reduction of 10 million ha since 1966 (i.e. 1 million per year). That the process is accelerating is indicated by the present estimate of 1 785 000 ha annually shown in Table 9 (This area is equivalent to almost twice the total land area of Jamaica).

Table 7

- Regional Distribution of Tropical Forest 1975, 1980, 2000 (Thousands of ha)

Sub-region	Year	Hard Woods		Soft Woods	Total
		Dense	Open		
Central America and Mexico	1975	57353 (25.9)	14631 (6.6)	24361 (11.0)	96345 (43.6)
	1980	55857	(1)	23203	(1)
	2000	51370	(1)	19430	(1)
CARICOM: Belize, Guyana Jamaica, Trinidad and Tobago.	1975	19741 (8.9)	146 (0.07)	428 (0.2)	20315 (9.2)
	1980	19709	(1)	424	(1)
	2000	19580	(1)	410	(1)
Other Caribbean Countries: Bahamas, Cuba, Dominican Republic, Guadeloupe, Haiti, Martinique, Surinam.	1975	23832 (10.8)	4 (0.0)	1098 (0.5)	24934 (11.3)
	1980	23758	(1)	1045	(1)
	2000	23490	(1)	860	(1)
Colombia and Venezuela	1975	75426 (34.1)	4100 (1.9)	0 (0.0)	79526 (36.0)
	1980	70176	(1)	0	70176 (1)
	2000	59920	(1)	0 (0.0)	59920 (1)
<u>T O T A L</u>	1975	176352 (79.8)	18881 (8.5)	25887 (11.7)	221120 (100.0)
	1980	169500		24672	194172 (1)
	2000	154366		20700	175066 (1)

() = percentage of total forest cover in the entire region
 Figures may not add to exactly 100.0 due to rounding off.

(1) not estimated

The FAO annual production yearbook points out that not all of the data on land use are reliable because of definitional and data collection problems. As a particular example, the case of tree felling permits issued in Venezuela may be cited. That country reportedly issued an average of 28 489 such permits annually between 1963 and 1973 covering a total area of 2 721 517 ha. In addition to that forest lost due to illegal action and forest fires should be added. According to official figures the total area deforested during that period was about 2 500 000 ha.

Nor does the pressure on forests appear to be decreasing. Partly through lack of education but mainly social and economic reasons, individuals burn and misuse the resource. Worse still they often provoks extensive fires which have far greater ecological consequences.

For the world in general it has been estimated that the annual destruction of tropical humid forest ranges from 1.5 percent to 2.0 percent. Specifically in relation to the Wider Caribbean, the following Table 8 gives some examples, while Table 9 gives estimates of annual deforestation for the period 1975 to 1980 for the major sub-regions.

Table 8 - Examples of Deforestation which has occurred in the Region

Location	Level of deforestation
Barbados	total
Mexico	400 000 hectares per annum
Colombia	800 000 hectares per annum
Venezuela	250 000 hectares per annum
Panama (Azucero Penninsula)	92 000 hectares (1954-1972) 2.4% per year

Table 9 - Annual average deforestation and afforestation rates for major sub-regions of the Caribbean

Sub-region	Afforestation	Deforestation
 Thousands of ha	
Central America and Mexico	4	700
CARICOM	1	10
Other Caribbean countries	9	25
Colombia and Venezuela	20	1 050
<u>T O T A L</u>	34	1 785

The effects of deforestation

Apart from the diminution of the resource potential, the most serious consequences are erosion and the disturbance of the hydrologic equilibrium. The former, leads to destruction of the soil characteristics and fertility, and in hilly or mountainous areas encourages landslides. The latter affects the surface water supply of the river basins, leading to: extremely exaggerated differences in river flow between seasons; reduction of underground aquifer recharge; sedimentation of rivers, estuaries, swamps and coastal areas; and increased incidences of flash flooding. Also, because of changed surface-air moisture equilibria and the reduction in evapotranspiration changes in microclimates occur, and in severe cases of deforestation major scale climatic changes can occur, leading to serious drought and/or desertification. The effects of some of these on agriculture and fisheries are addressed in the appropriate sections of this overview.

The effects of deforestation in the humid tropics are quite different to those in the temperate regions of the world. The former are, in general, subject to far higher annual rainfall and this precipitation is also much more intense for greater periods of time. For example, at Choco in Colombia rainfall averages 8 000 mm per year; in Cuba, hurricane Flora reportedly caused extensive damage in the deforested areas, yet insignificant losses were reported in the virgin forest areas; a similar situation obtained in Honduras when hurricane Fiji struck that country.

Another significant problem associated with deforestation relates to the fact that, in the tropics in general and in the humid tropics in particular, the nutrient cycle is very rapid. Most nutrients are found in the first few centimetres of soil and in the vegetation itself. Consequently, total elimination of the forest biomass means that the majority of the nutrients are lost from the ecosystems and a poor soil is left. This can create serious obstacles to reforestation efforts if the two activities are not undertaken at the same time.

Wood for Energy

The general production trends for forest products are shown below in Table 10.

Table 10
Production from Forests 1966 - 1976

Countries	T o t a l		W o o d	
	1966	1976	1966	1976
Mexico	12.9	14.8	9.2	8.2
Central America	16.2	21.1	13.8	17.1
Colombia	24.9	23.0	22.0	20.0
Venezuela	6.3	8	5.8	7.3
Greater Antilles	7.5	7.6	6.8	7.0
Lesser Antilles	0.2	0.1	0.1	0.0
	68.0	74.6	57.7	59.6
	Million m ³			

From this table it can be deduced that the average annual increase in production over the 11-year period was 0.97 percent overall and 0.33 percent for firewood. The latter account for 84.8 percent of the total in 1966 falling to 79.8 percent ten years later. From these figures it would therefore appear that although the Region is highly dependent on petroleum as its major commercial energy source, firewood still plays a significant role and possibly is a prime mover of deforestation.

From the point of view of the present energy problem faced by the Region, firewood and charcoal already play a significant role (estimated at 80 percent of domestic energy use). It is very likely that several countries will turn their attention increasingly towards their forest to seek (at least partial) solutions to their deficiency in alternative indigenous energy sources. Adequate forest management can produce biomass for direct or indirect combustion (i.e. alcohol-distillation processes).

Present annual percapita consumption in the region (including use for energy) is 0.77 m^3 . If consumption were doubled, natural management of the resource could cover total needs and would leave ample margin for export since, theoretically, minimum annual production of the productive forest surpasses 500 million m^3 per year (i.e. about 3 m^3 per capita).

Some social aspects

One of the prime movers of deforestation in much of the region has a strongly rooted social genesis. This is the migratory agricultural worker whose method of clearing land is the slash and burn technology. In this case forest utilization (or destruction) is carried out by persons who, for various reasons are culturally and socially marginal to society at large and who must extract a bare subsistence given the social and economic structure which condition their existence.

On the other hand, the burning of forests and other methods of clearing, is also caused by faulty, planning (or lack of implementation of planning), land distribution or lack of appreciation of, or misuse of resources. In some cases it results from simple short-term pecuniary greed.

On the part of governments, much deforestation is carried out in order to extract mineral resources, to shift rapidly increasing, almost uncontrollable urban populations, and/or to increase agricultural land urgently needed to feed their growing populations. However these activities are often carried out without the correct methods for cultivation or other development (such as for example those used by pre-Colombian Indian populations), sometimes with expensive, if not disastrous consequences.

Finally, it should be mentioned that forests do have certain aesthetic and psychophysiologic functions in relation to man. The social function of the forest as habitat for man cannot be destroyed without serious effects on the quality of life. It is often said that a poor or hungry man cannot appreciate the beauty of the forests; however, remove all the trees forever from his view and it is certain that he will suffer, since very often they are the only form of beauty in his otherwise ugly and painful life.

RECOMMENDATIONS

Generally speaking there is a lack of concerted and integrated planning in the region encompassing forest utilization and general development. This

is particularly so in so far as incorporation of peasants and the marginal sectors of the society are concerned.

Based on the foregoing review of the state of forestry resources, the following recommendations for action are proposed:

1. as a first priority, it is imperative that integrated multidisciplinary planning be applied to the total land area for differential utilization: forestry, agriculture, meat production, urban and industrial use, silvi-pastoral use, resource protection, recreation use and others; under a total ecological perspective;
2. once determined, the final forested land reserves must be maintained in a deforestation-reforestation equilibrium. Hence the development of management plans becomes crucial. Since such activities normally require constant feed-back regional co-operation and free, frequent information exchange is seen as key to successful rapid implementation;
3. to this end, the integration and strengthening of forestry research institutions in the region is seen as essential;
4. since forest resources are renewable, they can play a crucial role in alleviating some of the region's energy problems. However, development of the forests for energy purposes will require some research, careful integrated silvi-culture and efficient sophisticated management. Here also, the countries of the region should pod their resources;
5. finally, conservation awareness, écologic culture, ecological planning and the problems of forest utilization by those on the fringes of society are partly problems of education. All forms of educational media should be developed and used to educate the public at large on the importance of their forests to their descendents well being.

WILDLIFE

Under the present report, this resource will mainly consider wild fauna but also flora and micro-organisms when related to the genetic resources or genetic heritage.

The state of the resource has been scarcely studied and evaluated as such. Most of the present knowledge is based on traditional taxonomical and biological research, which unfortunately does not provide a reasonable base for management or evaluation of its actual or potential benefits.

Wildlife, however, and its present status is mainly related to areas or land commonly considered as marginal from the productive point of view, even though they may cover nearly half of the total terrestrial surface of the Region under study and much greater when coastal areas are considered.

Tropical ecosystems have the greatest diversity of species and the Caribbean area follows this pattern even though the pressure on the fragile nature habitat is rapidly increasing.

The great diversity of wildlife, its uneven distribution and nearly unknown number and structure makes it difficult to evaluate its real productivity in economic and social terms.

A number of wild plant and animal species which are being currently used for food and feed, for traditional medicine, or as hides and skins, trophies, pets and raw material for tanning cosmetics, drugs production, local handicraft products, oil, building, etc. are not normally considered in current production statistics.

Some of the not less important do not even come into the market channels but are collected and consumed directly by the farmers and indigenous populations which in their absence would normally starve (if currently fed on statistically considered products).

It is well known that hunters in Central America have preferences for some animals as for example deers (venades), puma tiger (tigrillo), monkeys, danta or tapir, doves, partridges, etc., and that some of them are now forbidden as they are endangered, for example, jaguar, manati, quetzal, caiman. However, it is still impossible to have an accurate estimation of numbers of kills or figures on the total trade. Studies developed in Brazil which could be extrapolated to the region under consideration indicate normal consumption even in restaurants of turtle, agouti, deer, armadillo, paca, wild duck, capybara, tapir and peccary.

Present exports are mainly of living specimens of monkeys, tropical fish, birds, normally used for laboratory tests and pets. Hides and skins of caimans, snakes, wildcats, tigers and other are exported for leather handicrafts and trophies.

The amount of degradation of the resource is difficult to estimate, but it is considered that 40 percent of the global vertebrate extinction has occurred in the Caribbean.

Some countries have already developed areas suitable for wildlife ranches oriented towards direct production as in the case of Cuba for caimans or other for conservation purposes. Some other for pure protection purposes. Costa Rica, Venezuela, Panama, have good example of national parks or others related areas in which wildlife is under protection. Other alternatives for conservation could be found under the UNESCO network of Biosphere Reserves, which up to now has nearly no implementation in the Region.

The pressure on the natural habitat due to deforestation, establishment of agricultural areas, sometimes in insuited lands, the excessive use of pesticides or other sources of soil and water pollution combined with uncontrolled hunting are the main causes of wildlife resources degradation.

The fact that from 40 000 marine turtle hatching on the Gulf of Mexico in 1947, only 700 were found in 1976 and 450 in 1977 could be used as an indicator of a current situation.

In El Salvador the white-tailed deer, wild rabbit (conejo de montes) and the spider monkey have already disappeared. All of them were currently used as part of the farmers animal protein intake.

In 1973 more than 46 major vertebrates were considered as endangered or diminished in the Region, and there is no reason to believe that the situation has improved.

During the last decade many studies and projects have been implemented for the management and conservation of natural habitats and wildlife in the Region.

With the contribution of UN Specialized Organizations such as FAO and UNESCO, the UNDP or NCO's as the Rockefeller Brothers Foundation (RBF), the International Union for Conservation of Nature and Natural Resources, the World Wildlife Fund and the contribution of universities and research institutes from the region and from other countries, different activities have been developed.

There is urgent need, however, to continue ecological studies on habitats and species oriented towards productivity and management. At the same time, formulation and enforcement of adequate legislations should be encouraged together with the necessary development of an adequate administrative capacity.

The need for training should be evaluated in order to create the necessary structure for it or to arrange for sufficient external training. On this subject OAS and UNEP have been working recently in collaboration with other institutions and organizations.

The evaluation of the actual and potential productivity of wildlife, including its genetic heritage value, should be initiated for fauna and flora in order to give adequate indications to planners and decisions makers.

GENETIC RESOURCES

In this section, genetic resources are considered under four sub-headings, namely: forest resources; phythogenetic resources and animal genetic resources.

1. Forest Genetic Resources

The main interest in the Caribbean Region is focussed on the conifers, and in particular, the pine tree species (Pinus Caribea and Pinus Oocarpa), which are of great importance to world forestry. Consequently, the preservation of their genetic values carries much responsibility.

In the past 20 to 30 years much of the natural pine forest of Central America have been destroyed, and much of those which still exist are in danger of extinction.

The pine has been widely acclaimed as a useful species due to the fact that it accepts low fertility soils and maintains highly productive growth. The Pinus Oocarpa for example, can grow on slopes and on thin soils that are generally improductive for agriculture or other forest growth.

Since there is great diversity within a given species -whether between different populations or between individuals in a given population - selection and preservation of seeds constitutes an urgent measure, which should be undertaken. Preservation should preferably be in situ. If that is not possible, the ex situ preservation should be carried out. Ex situ

preservation can be achieved in two ways: seeds can be transported to other similar areas in order to establish well managed, carefully protected small plantations, or seeds can be kept in cold storage under special conditions of light and humidity, thus enabling the seeds to maintain their fertility for up a century.

In that respect, an 'FAO/UNEP forest genetic resource conservation project has been working, with some of the countries of the Region through FAO, to set up small-controlled specialized plantations in areas suitable for the established species or for those which must be preserved.

For this purpose priorities among species have been determined with respect to their economic and industrial importance and to the future resource potential. Priorities range from 1 to 3 where:

1. species in immediate demand;
2. species of industrial importance but with less priority than 1;
3. species of potential future interest.

So far the project has established a priority rating for some 40 species.

In Mexico, the I.N.I.F. is in charge of feed supply and has established several regional centres and six research stations. The Table below lists some of the species which they have been working with.

<u>Species</u>	<u>Comments</u>
Pinus Pseudostrobus, Pinus Oocarpa, Pinus Patula	Distributed seeds internally and to other countries
Pinus Strobus (Chiapensis Variety) Picea (5 000 ha destroyed by fire), Pseudotsuga Flanbante	Protection of these endangered species
Doorcorea Comprila, Atriplea Spp and other similar	Fodder species
Eucalyptus Calmaduldensis, Euca- lyptus Citriodora and similar	Medicinal species

In the British Caribbean, the United Kingdom, through their Ministry for Overseas Development, has continued with genetic research on other pine species.

Finally, it should be pointed out that the number of useful forest species (apart from pine), that could be similarly areated is very large. Also, many are probably lost to man without ever having been studied.

2. Plant Genetic Resources

The Wider Caribbean includes includes one of Vavilov's origin centres, that is, Mexico and Central America. According to that author "A very considerable part of cultivated plant resources originates in this region...". The number of important cultivated species which have originated in that area is 45 according to Dressler, and 66 according to Vavilov. The number of autoctonous seed plants in the Region is estimated to be 10 000. Annex 1 shows a list of the more important autoctonous species for agricultural use in the Region.

The factors responsible for the almost unlimited variability of present germoplasm are, inter alia: the great ecologic diversity of the Region, the number of islands, and eight centuries of agricultural tradition, including European influence since the sixteenth century.

The Present Situation

The replacement of an autoctonous species - particularly within recent times - by homogenous or even homocigotic commercial varieties for the more important crops has greatly eroded the agricultural genetic resource base of the Region.

The value of the autoctonous species now in danger stems from their local adaptability and their resistance to pests and diseases indigenous to the Region. These characteristics give them pre-eminence as raw material for the generation of plants that are even better adapted to the Region's ecosystems.

Many efforts have been made to collect and preserve those species or varieties which are now in danger of extinction. In Annex II a list is presented covering most of the national (or regional) institutions, which maintain collections of regional germoplasm of agricultural interest. Unfortunately, these collections represent only a very small part of the phyto-genetic variability which is being lost to man.

Also, the condition of the materials collected are not always the best, and the great majority of germoplasm banks in the Region or kept under the ambient conditions of humidity and temperature, factors which rapidly affect the germination ability of seeds, adversely.

An additional problem is the scarcity of adequately trained personnel. This further reduces the efficacy of investments made.

From the agro-botanic point of view, the Region may be divided into three main sub-regions, having their own distinctive characteristics. These three sub-divisions are delineated below together with the recommendations made at a joint OAS/CATIE meeting in 1973 with respect to the need for special attention because of variability and/or degree of genetic erosion.

- 1) The Isthmian Area Comprising Southern Mexico (Federal States of Veracruz and Oaxaca) to Panama
 - a) The highlands of Guatemala and adjacent ones in Mexico, particularly those on the Pacific watershed;
 - b) The Atlantic coast from Belize to Alumirante, the Honduran coastline as one of the last known areas;
 - c) Pacific coast from Nicoya in Costa Rica to Panama;
 - d) Chirripo and Talamanca range highlands, between Costa Rica and Panama;
 - e) Mountainous Region of Nicaragua (Matagalpa) to the San Juan and Sarapigni valleys;
- 2) The Continental Area, which Includes the Caribbean Watersheds of Colombia and Venezuela
 - a) Santa Marta Sierra and adjacent lands;

- b) The Goajira;
 - c) Sierra of Merida;
 - d) Lower Orinocco Basin, from Apure to Guainia, Atabapo and Cariguiari rivers;
 - e) Lands adjacent to the Gulf of Paria;
- 3) The Island Archipelage
- a) Trinidad and Tobago;
 - b) Guadeloupe;
 - c) Cuba;
 - d) Dominican Republic and Haiti.

Among the more important species, the following can be mentioned:

a) Autoctonous

Zea, Phaseolus, Gossypium, Theobring, Capsicum, Cucunbita, Ipomoca, Duorcorca, Maribot, Solanum, Persea, Carica, Annona, Agane, Xanthosoma, Cridosculus, tropical fruits and palm trees;

b) Imported from which there are ecotypes that have evolved in the Region, and which should be preserved

Cajanus, Helianthus, Arachis, Margijeras, Cocos, Sorghum, Pyrus, Prunus, Coffea, Muso, Saccharum, Citrus, fodder and forest types.

Annex II contains reference bibliography which can be used to broaden this information on the present situation relating to the phythogenetic resources of the Region.

3. Animal Genetic Resources

One of the problems in this area related to the development and use of the "creole" porcine, bovine, caprine, poultry, guinea pigs, rabbits and others. These low productive, rustic animals have the great advantage of excellent adaptation to the environment and of well developed resistance to some endemic diseases. Furthermore, they can be raised without the need of complicated technical knowledge.

For the peasant farmer, they represent a valuable possibility from the genetic viewpoint. These animals constitute a valuable reserve as potential genetic resource to be used in cross-breeding and in implementing resistance to other species or breeds that are more vulnerable to some diseases. In summary, their application to genetic and zootechnic research is very wide.

Unfortunately, the "creole" species or breeds tend to disappear to be a very reduced and standardized number of breeds.

The evaluation and conservation of these resources are necessary tasks for the Region and require the compilation of antecedents, location of material of genetic interest and the support of governments for a better understanding of the topics involved.

Some of the Region's varieties can be cited as examples: "creole" cows with the characteristics of the Zebu variety do not have any cicuerisa; the Barbados Black Belly sheep; the sheep of the Virgin Islands; the Pelibuey sheep of Cuba, Mexico and the Dominican Republic; and the Colombian African Sheep.

RECCOMENDATIONS

- i. The promotion of interchange of information and material between the different organizations working on all aspects of genetic resources;
- ii. Regional courses on the collection, maintenance, evaluation and documentation of genetic resources should be given;
- iii. Research into the physiological factors that limit the viability of seeds from certain critical species, should be instituted;
- iv. New expeditions should be mounted to collect germoplasms, especially, in those areas previously mentioned in the review;
- v. The establishment of regional germoplasm banks and/or the improvement of those already in existence, through the installation of humidity and temperature control chambers, should be vigorously pursued.

FISHERY RESOURCES

Introduction

Fish protein forms a significant part of the protein intake of the people of the Region, as well as in the national economies. This can be seen from Table 11, which gives the production, imports, exports and consumption of fish for each country in 1977.

An important observation which can be made is that the per capita consumption of the smaller island inhabitants is almost two and one half times that of the Central America Countries and more than four times that of Colombia and Venezuela. This observation is important for two reasons:

- a) as shown in the other sections of this overview, the smaller islands have very limited resources for the production of land-based animal protein;
- b) much of the fish caught by the Central American Countries is extracted from the water of the Pacific Ocean.

However, they are increasingly looking to the Caribbean Sea as an added source.

1. Marine Fisheries

The Resource

The total area of maritime waters covered by the wider Caribbean, as defined in the Introduction to this overview, is 5.41×10^6 km² Table 12

shows the spatial distribution of the continental shelf areas. ^{1/} The Caribbean Sea and Gulf of Mexico together account for 78.4 percent of the total (i.e. 4.24×10^6 km²).

Table 11

Countries	Production 000 Ton	Import 000 Ton	Export 000 Ton	Available 000 Ton	Available kg/person
LESSER ANTILLES					
Antigua	800"	600"	95"	1305	16.5
Barbados	4000"	1341"	105"	5236	21.3
Dominica	500"	756"	000	1256	16.3
Grenada	3341	700"	300"	3741	37.4
Guadeloupe	9525	2604	000	12129	34
Montserrat	120"	-	-	120	8.6
Martinica	2167	4620	000	6789	19.6
Saint Lucia	2500	471"	7"	2964	29.5
St Kitts Nevis	1600	300"	000	1900	41.3
St. Vincent	581	403"	59	925	9.25
Turks & Caicos	1050"	000	400"	650	85
TOTAL	26184	11795	966	37013	25.2 media
GREATER ANTILLES					
Cuba	183282 1900*	100300"	16900"	268582	28.2
Haiti	2600 300*	2355"	139"	5116	0.9
Jamaica	10100	17702"	10"	27792	13.7
Dominican Rep.	4235 359*	9600"	717	13477	2.6
Puerto Rico	58405 357*	-	-	58762	19
TOTAL	261538 2916*	129957	17766	373729	14.6 media
COLOMBIA AND VENEZUELA					
Colombia	23670" 51437*	10939"	5250"	80796	2.8
Venezuela	144213 8021*	7900"	9000"	151134	12.1
TOTAL	227341 59458*	18839	14250	231930	

^{1/} It should be noted that the Atlantic Ocean boundaries for the Region are defined by the 100 m depth contour except for the Guyanas Region where a 200 m maximum depth contour has been used.

Cont. Table 11

Countries	Production 000 Ton	Import 000 Ton	Export 000 Ton	Available 000 Ton	Available kg/person
CENTRAL AMERICA & MEXICO					
Belize	1899" 25"	128"	806"	1246	9.6
Costa Rica	12979" 61"	2571"	2556"	13055	7.2
El Salvador	4414" 3072*	1495"	2500"	6481	1.7
Guatemala	2474 600*	1400	1900"	2574	0.5
Honduras	4369 170*	1052"	2659"	2932	1.1
Mexico	651125 18971*	16397	64500	621993	10.6
Nicaragua	18318 4043*	1483"	10772"	13072	5.6
Panama	228016	1692"	32805	196903	67.4
TOTAL	950536 26942*	26218	118498	858256	
TRINIDAD & TOBAGO, GUYANA, SURINAM & FRENCH GUYANA					
Guyana	21772	000	3805"	17967	21.1
French Guyana	1142	400"	400"	1142	19
Trinidad & Tobago	4303	3600"	742"	7161	6.3
Surinam	6076 235*	1500"	1800	5776	13.4
TOTAL	33528 235*	5500	6747	32281	
REGIONAL TOTAL	1499127	192309	128702	1562734	10.6

" Estimated values or indirectly calculated

* Catch in continental waters and aquaculture

Source: Year books of fishery statistics, FAO, 1977

Table 12 also shows the live weight fish potential for the maritime waters indicated, whereas Table 13 indicates the demersal and pelagic fish potential (in kg per ha) for water depths in excess of 200 m. The total estimated potential for the regions continental platform ranges between $2\ 945 \times 10^6$ and $4\ 490 \times 10^6$ tons, live weight.

In order to exploit the resource fully on a sustainable basis for the theoretically exploitable potential should not exceed forty-five percent of the total potential. That is, the estimated sustainable exploitable

potential is between 1.33×10^6 and 2.02×10^6 tons per annum for the continental shelf (these figures are equivalent to 8 and 12 kg per capita for a total regional population of 166 407 000 including the Gulf Coast States of the USA).

Table 12

Live Weight Fish Potential for the Maritime Waters

Place	Continental shelf area (000 km ²)	Demersal potential (000 ton)	Pelagic potential (000 ton)	Total potential (000 ton)
Caribbean	250 <u>1/</u>	From 50 to 200	From 400 to 800	From 450 to 1000
Gulf of Mexico	600 <u>1/</u>	From 1000 to 1500	1000	From 2000 to 2600
Bahamas-Cuba sector	120 <u>1/</u>	From 25 to 50	From 120 to 240	From 145 to 290
Atlantic Guyanas	200 <u>2/</u>	From 100 to 300	From 150 to 300	From 250 to 600
TOTAL	1170	From 1175 to 2050	From 1770 to 2440	From 2945 to 4490

1/ 200 m depth

2/ 100 m depth

Table 13

Demersal and Pelagic Potential in areas with more than 200 m depth in kg/ha

Place	Demersal	Pelagic	Total
Caribbean	2 - 8	16 - 32	18 to 40
Gulf of Mexico	16 - 25	16	32 to 41
Bahamas-Cuba sector	2 - 4	10 - 20	12 to 24
Atlantic Guyanas	5 - 15	7 - 15	12 to 30
Average outside continental shelf	From 18.5 to 33.5		

Exploitation

Although data are not available on the annual fish catch defined by the above boundaries, it has been established that in 1975 twenty-one percent (1.26×10^6 ton), of an estimated 6×10^6 ton potential for the Western Central Atlantic Region - which is larger than the wider Caribbean - was extracted. However, this figure does not include the considerable quantity of fish caught by shrimp trawlers (sometimes as much as 80 percent of the total catch) and which are thrown back into the sea.

Type of Fishing Activity

A cursory analysis of the types of fishing vessels used in the region demonstrates that as at present constituted, the industry is basically artisanal. This is clearly demonstrated by the combined figures extracted from available country sources and shown below.

<u>Type of Vessel</u>	<u>Number of Vessels</u>
Canoes & small vessels 7 m	27 962
Motor launches 7 - 11 m	526
Vessels 11 m	755

In terms of exploitation of the regional resource, it is unlikely that such an industrial structure would result in a situation of over-exploitation, except possibly in localized areas.

However, it is known that fishing on an industrial commercialized scale by countries from outside the region does take place within the wider Caribbean, but data relating to the extent of those operations are not available.

One practice with serious implications is the dynamiting of coral areas, particularly for the export tropical fish aquarium market. This practice is indiscriminately destructive of delicately balanced ecosystems and can result in the permanent loss of valuable breeding grounds.

Research Activities

In general very few of the countries in the region carry out research or other formalized activities related to fisheries. The following chart indicates the main activities engaged in at the national level. Colombia, Cuba, Mexico and Venezuela reportedly have the best facilities and specialized personnel, both in quantity and quality, although they have not yet attained their optimal capacity.

It should probably be stressed at this point that the majority of the countries do not have the financial (and in many instances the human) resources to maintain specialized institutions for the maritime research.

Also it would appear, that no regional network exists for the free-exchange of information between those institutions which do exist.

Some territories, notably Barbados and Honduras have benefitted from bi-lateral and international projects.

2. Coastal and Inland Fisheries

Resources and Productivity

The most significant fishery activities of the region are to be found at the Campeche Bank in the Gulf of Mexico, at the Morquito Bank in the Caribbean Sea off the coasts of Honduras and Nicaragua, in the Gulf of Paria between Venezuela and Trinidad and Tobago and the coastal waters adjacent to the Guyanas. These areas, in general correspond with the existence of mangroves, aquatic flora and coral atolls as well as to the limited existence of up-wellings and down-wellings in the region.

Table 14

Research and other Formalized Activities Related to Fisheries in the Region

	Marine Biology	Oceanography	Fishery Resources	Mangrove Waters	Aquaculture
Belize			x		
Colombia	x	x	x		
Costa Rica			x		x
Cuba	x	x			
Dominican Republic	x				
Guatemala					x
Haiti					x
Jamaica				x	
Mexico	x	x	x		x
Nicaragua				x	
Puerto Rico	x	x			
Trinidad & Tobago			x		
Venezuela	x	x	x		

In terms of the annual production of phytoplankton, the Caribbean is considered to be as productive as the Antarctic. However, because of a pronounced lack of upwellings, and due to the existence of stable thermocline, the nutrient-rich waters do not rise to the surface in spring and autumn, as is the case of temperate waters. This phenomenon results in a general low level of zooplankton and lower forms in the food chain at any given time resulting in significantly smaller populations of exploitable fishes.^{1/}

As a consequence of the above, the coastal mangroves and estuaries play a proportionately large role in primary nutrition productivity. This is amply demonstrated by the following primary carbon productivity figures.

^{1/} From IDYLL CP "The Potential for Fishery Development in the Caribbean and Adjacent Seas" - University of Rhode Island, Marine Bulletin No.1, p 5.

<u>Area</u>	<u>Primary production</u> (Grams of carbon per year per m ³)
High seas	20
East coast of Venezuela (Orinocco Basin)	350
Mangroves	1 000

Source: GULLAND op cit

The most common types of fishes caught in the coastal waters are:

- Shrimp and crawfish, mussels and squid;
- Tunas and billfishes (Skyjack, yellowfish, swordfish, Blackfin and bluefin) in fairly small quantities;
- Red-snapper, bass and hake of the coast of Venezuela

As with fishing in the high seas, coastal and inland fishing in the region is mainly artisanal in nature. It has been estimated by WECAF 1/ that the total number of persons directly employed varies between 15 000 and 18 000 in the continental waters as compared to 100 000 employed in high seas fishing.

Few or no statistics relating to inland fisheries or aquaculture in the Region, have been obtained. The former type activity is generally carried out in a small, unorganized private capacity with much of the catch being consumed by the fisherman and his family, and any remaining being sold outside of the formal commercial market. Aquaculture on the other hand, which is generally carried out on a larger, more organized scale is little developed in the Region.

3. Major Environmental Problems Related to Fisheries Development

To a large extent, as discussed above, the natural environmental conditions of the major part of the Caribbean Sea and Gulf of Mexico are not conducive to high fish productivity. In addition to the conditions already referred to, the temperature of the surface waters are comparatively high 26 °C to 30 °C and they are also subjected to large seasonal variations in salinity, 34.5 percent to 36.5 percent, and fluctuating turbidity. These seasonal changes are ascribed to large inflows of fresh (turbid) waters from the Amazon and Orinocco through the Eastern Caribbean, the Magdalena river through the Southern Caribbean, and the Rio Grande and Mississippi river both of which flow into the Gulf of Mexico. Indeed, much of the region lies within the humid tropics where rainfall is high (2 000 to 3 000 mm annually) and the total drainage area to the Gulf and Caribbean Sea (see map) has been estimated as 7.5 x 10⁶ km². 2/ 3/

1/ WECAF - "Review of the Status of Fishery, Research Capabilities in the WECAF Project Area".

2/ FROELICH, P.N., D.K. ATWOOD and J. POLIFKA, 1974 - "Seasonal Variations in the Salinity-Silicate Structure of the Upper Venezuela Basin, Caribbean Sea" Abstract 0158, EOS, Trans of Amer, Geophys Union 55 p 309.

3/ MARTIN J.M. and MEYBECK M. - "A Review of River Discharges in the Caribbean and Adjacent Regions" in Collected Contributions to the IOC/FAO/UNEP International Workshop on Marine Pollution in the Caribbean and Adjacent Areas - Port of Spain, Trinidad.

These conditions impose high natural stress on the marine life, particularly in inshore areas and often lead to natural fish kill 1/. As a consequence, the superimposition of anthropogenic stresses could lead to a serious reduction in the fish populations of the Region.

One of the major threats to the future development of fisheries in the Region, as a consequence is seen as contamination from land based industrial development and other activities such as human settlements and agriculture.

Although an exhaustive evaluation of the problem does not exist, an appreciation of potential harm can be obtained from a preliminary compilation on marine pollution in the Caribbean prepared by the Intergovernmental Oceanographic Commission and FAO. That information is tabulated below as Table 15.

Table 15

Estimation of major sewage and other organic waste
Emissions to the Caribbean Sea and Gulf of Mexico
 (in 000 of tons per year = BOD)

Location	Quantity	Comment
USA Gulf Coast	35	After treatment
Colombia	25	Only for coastal cities of Cartagena, Santa Marta and Barranquilla. Also 1 100 tons phosphorous.
Cuba	182.5	Substantial amount from sugar-cane processing.
Trinidad & Tobago	1.5	
Guatemala	1.4	
Panama	2.0	From city of Colon only.
Venezuela	no estimate	200 x 10 ⁶ l/day untreated sewage from Maracaibo alone. Much heavy industry located along N. coastline, contribute high organic loadings also.
Jamaica	not evaluated	Serious problems known to exist in Kingston Bay.

Source: FAO/IOC

It should be noted that major population areas on the Mexican Gulf coast are not included in the above table.

With respect to industrial effluents, the following table 16 is indicative of the potential problem.

Those types of industries and their associated pollutants are to be found concentrated in several locations within the Region such as the USA and Mexican Gulf Coast, the Maracaibo area of Venezuela and the upstream region of the Orinocco River, the Gulf of Paria region of Trinidad and Tobago, Puerto Rico, Cuba, Jamaica and along the rivers Magdalena, Sinu and Atrato in Colombia.

Table 16

Types of pollutants to be expected from certain industrial activities

Pollutants	Technological Source
Detergents, caustic soda, crude oil phenols, acids and alkalis, benzene, ethyl benzene, acetal dehyde, heavy aromatics, towene, tannic acid, chromium salts, cooling oils, deoxidizing solutions, metal oxides, wood and paper fibres, arsenic compounds, pesticides, herbicides, fungicides, hypochlorites.	Distilleries, refineries, petro-chemical industries, food processing chemical and pharmaceutical industry, tanneries, metallurgical industries, pulp and paper industry, textile industry, mining; pesticide manufacture, oil production.

Although, in general, no quantification of industrial effluents has been made, it has been estimated that the combined annual industrial waste discharge from the USA and Mexico to the Gulf of Mexico amounts to 13 million tons of dredging spoils and 700 000 tons of industrial waste.

In addition to industrial pollution, the effect of sediments carried into the sea from surface rainfall run-off from the land should be taken into account. It has been estimated for example that the Gulf of Mexico annually receives 360 million tons of sediment from natural and induced erosion. No such estimate is available for the Caribbean, but it is known that the Orinocco and Magdalena rivers carry large quantities of silt into the sea.

Sediments also contribute to the deterioration of aquatic resources of the rivers (large and small). Many rivers and streams in the Region which used to have fairly constant annual flows, now only carry water seasonally and, after heavy rainfalls, often inundate adjacent lands. In general this situation has been caused by deforestation in the water shed areas.

Increased sedimentation generates increased turbidity which reduces light penetration and affects the breathing and digestive systems of fishes. Sedimentation in coastal areas can also reduce (or even stop) growth of corals which are also breeding grounds for many fishes.

Other insidious pollutants are the biocides used in agriculture, particularly intensive agriculture such as: rice, cotton, sugar and bananas all of which are grown on a very large scale in the Caribbean. The movement of biocides through the aquatic food chain is general. The extent of the problem in the Caribbean however is not known nor has been studied.

Finally, dam construction can also cause problems by restricting migrations and changing the characteristics of the water environment.

RECOMMENDATIONS

Based on the foregoing review, six main recommendations for action with a view to protecting and developing of the aquatic food resource of the wider Caribbean Region. These are:

- i. That the development of improved fishing techniques and the enlargement of the industry should be pursued with care in order to avoid overfishing limited resources.
- ii. As a natural precursor to the above, studies on the population dynamics and breeding habits of marine species must be initiated as soon as possible. This could be achieved through the cooperation of national bodies with one another and with international bodies and projects such as IOCARIBE and WECAFC. Information and research networks between existing national institutions and where necessary these (institutions) should be strengthened, to enable them to conduct the necessary research; all countries also need to be given every assistance to enable them to maintain reliable statistics.
- iii. Given the general lack of primary productivity in the waters of the Caribbean Sea and the Gulf of Mexico and the consequent relative importance of the estuaries, mangrove swamps and coral reefs, these systems are in urgent need of in-depth studies. In addition to their productivity and the role which they play as nurseries, the pollution loading and the effects of pollution on the systems require study.
- iv. Related to recommendation (iii) there is a clear need to study the inter-relationship between fisheries industrial and urban development, agriculture and forestry.
- v. Aquaculture and mariculture have the potential to substantially increase the fish protein available in the Region. To this end, internationally sponsored research and development programmes should be developed. However, it should be noted that the successful implementation of such technologies are linked to the minimization of pollution from all activities.
- vi. Studies related to wasted resources, such as the dumping of fish associated with shrimping operations, need to be undertaken.

The Region's fishery resources are essentially a free protein source, and in the same way as for air, no national boundaries exist for fish or for water pollution. It is therefore in the interest of all the Caribbean countries to ensure that healthy stocks are maintained and that they are not killed or overfished as a result of careless or unplanned actions.

All the countries should therefore be prepared to work together in a completely regional basis to implement the above recommendations.

CONCLUSIONS

The state of renewable natural resources, in the wider Caribbean, for agriculture and food production can be summarized in terms of the following relevant problems: widespread soil erosion and degradation of soil fertility, under-utilization of local genetic resources for food and agriculture production leading to their progressive loss and/or disappearance, site specific pollution of inland and coastal water, inappropriate land tenure systems affecting the ecological and the socio-economic balance.

However, despite these problems, the Region as a whole, seems still to have the potential resources to feed its population adequately and yet paradoxically, it continues to exhibit a growing negative balance of trade in so far as agricultural commerce is concerned.

Rational and socially responsible utilization of resources in the Region calls for integral interdisciplinary, intersectoral planning in order to minimise the negative impact of actual mode of resource utilization and to maximise the benefits for the Region in particular for the rural poor. On many occasions such planning required bilateral, inter-countries or regional participation. This is particularly so with shared natural resources which occur in border areas or for resources like the waters of the Caribbean/Gulf of Mexico which must be jointly exploited by a number of the countries in the Region.

Planning must take account of the ecological and socio-economic realities of the Region concerned. It must provide for the adoption of appropriate technologies adapted to the ecological as well as socio-economic realities of the Region, including such traditional practices which have proved to be useful but needs to be further improved on the light of modern knowledge.

At the very least, planning and technologies must be oriented towards sustaining food and agricultural productivity together with preserving land, waters and other natural resources including the genetic potential of the Region. A prime objective should be a re-orientation of the solely extractive-use practices to which natural resources, including land, are subjected to at present, by striking a balance between agricultural production for export and appropriate agricultural husbandry aiming at improving the socio-economic needs of rural population and the environment.

Appropriate technologies should be adopted out within the framework of more adequate land tenure systems since minifundia is generally destructive - through resources over-exploitation, scant use of commercial inputs and inappropriate technologies - while latifundia often over exploit a particular resource and waste or under-utilize the available resources, through intensive use of commercial inputs and technologies inadequately adapted to the economic and socio-economic conditions of the countries in the Region.

As to land-use, it is of the utmost importance to develop and promote:
i) along with the use of mineral fertilizer greater emphasis on the use of organic matter, the recycling of agricultural wastes and the use of nitrogen fixing organisms; ii) integrated pest management techniques for cash and particularly for food crops.

With regard to pollution and its control, it must be emphasized that very little is known about their effects and movement through the tropical ecosystems in general and in the region in particular. Therefore, not only is it important that the phenomenon be controlled but also basic monitoring and the study of the effects of pollutants in the food and feed chain in the Region be undertaken.

Research into the Region's territorial wildlife and its relationship with the natural ecosystems, as well as the possibility of its use as a food resource, should also be undertaken.

It is also important to stress that education and training are key factors to create ecological awareness which would lead to a rational use of natural resources to increase and sustain food and agricultural production and improve the quality of life of rural poor.

Finally, a major gap to be filled up is the promotion and development of a systematic collection of data (assessment) and monitoring of natural resources which are essential for food and agriculture in order to i) improve knowledge on potential, rate of degradation/deflection of these resources and ii) develop accordingly action-oriented programmes and projects aiming at increasing agricultural productivity for the benefit of the rural poor and to enhance their quality of life and their environment.