THE DEVELOPMENT OF SCIENCE AND TECHNOLOGY IN THE CARTBI
POSSIBILITIES AND PROBLEMS

A Paper Prepared for the

International Studies Association Meeting

Washington, DC

(aren 1985

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§ CENTER FOR ENERGY AND ENVIRONMENT RESEARCH

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THE DEVELOPMENT OF SCIENCE AND TECHNOLOGY IN THE CARIBBEAN:
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Ву
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THE DEVELOPMENT OF SCIENCE AND TECHNOLOGY IN THE CARIBBEAN:

and

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The mobilizing of science and technology fer development in the

Caribbean is proving to be agonizingly slow. Although reliable infor-

mation on research and development expenditures and research personnel

js not available

whelmingly Gependent on imported science and technology?. Efforts to

foster indigenous capabilities are at very different stages from country to

country but their impacts are still limited. While rapid progress has been

made in a number of countries science

the region and each of the member states remains over

nd technology remain marginal and

Preceriously institutionalized,

There is no accepted and uniform definition of the Caribbean nor

eed there be, We define the region as consisting of the islands of the Caribbean Archipelago and the cultursly related countries of Belize, Guyana, Suriname and French Guyana with the majority of their popula~tions living on the Caribbean Sea. This provides in 1984 a region consisting of 30 million people in 22 independent and non-independent countries speaking English, French, Spanish, and a variety of dislects

and Creole languages. It is in this region that scientific and technological excharges have existed for several decades and where « rudimen= tery regional S\$ & T network is beginning to take shape. The five

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Central American republics and Panama operate essentially in another S & T framework although the Caribbean has much to learn from the impressive experience of Costa Rica.*

Our emphasis is on the development of indigenous capabilities for research, development, demonstration, adaptation and diffusion of science

and technology (R,D,D,A, and 0). The rescarch to development cycle is further disaggregated in this definition to indicate the entire process and

the stages at which Caribbean countries may participate. Thus most

basic research and much applied research will continue to be imported but the region has a role to play in demonstration, adaptation, and diffusion. Indigenous capabilities are broadly defined to include research by multi~rational corporations or other non-regional actors provided that it is carried out in the Caribbean and is of relevance to regional needs.> Our peoples.

ties of the Caribe

interest is in the human resource capabi

Science and technology are used to make weapons, medicine, food, knowledge and many other items. Trasleoffs ané contradictions between equity and efficiency goals, ecological and economic growth objectives, are Persistent in the region." Currently indigenous S\$ 6 T is so limited that

it makes a minim

contribution to any of these objectives, even in Cuba which tries harder than anyone else In the region. There is almost no military research in the region but there is atso not enough of any other research to contribute significantly to economic growth, The evolution of indigenous capebilities can be meusured i severct ways including publi

tions and citations in internationally circulating

journals, patents and

copyrights, RED expenditures, cost-benefit analysis of research projects, quality of lite indices, and air and sea pollution counts. Economic analysis suggests that one fourth to one half of economic growth in countries such as Brazil and the United States can be attributed to science and technology. The work of economist Nathan Rosenberg and others under-Hines the importance of shop-fleor innovation, learning by doing, in the Provess of economic growth.® The scanty evidence indicates that the Caribbean has little formal or Informa! shop-floor RED.

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History of Caribbean Science and Technoloay

There is 2 long uneven history of science and technology in the Caribbean which remains to be documented. Science for several centuries

was the prerogative of learned amateurs; botanists, naturalists, phy: cians and others, Technology was mostly imported and lightly adapted.

Rarely was either institutionalized. A majer Spanish scien

Ic expedition

was based in Cubs from 1795-1798 but neither the University of Havana or any other 19th century Caribbean university or academic academy

found a secure place for science.®

The first significant Caribbean adaptations of science and technology ?occurred in the late 19th and early 20th century with the introductions of the steam engine, raliway and control of yellow fever and other mosquitoborne diseases. The striking cececases in mortality in Cuba, Puerto Rico and the West Indies after 1900 were based on applied research, demonstration and diffusion. These successes contributed to the establishment in the 1920's of modest agricultural, tropical medicine and public health research facilities.

In general the Caribbean colonial heritage in science and technology came late, was oriented towards production of export crops, and failed to provide career opportunities for local scientists. Secondary and university education retained its humanities and law bias and remained Predominant numbers throughout the colonial period. Rigid race and class statified societies failed to diffuse popular knowledge of science and technology,

The drive towards indigenous science and technology capabi

ities has.

roots in Caribbean pol

ical nationalism, It is an expression of the desire
to reduce political and economic devendency, to provide outlets for natio~
nal creativity, and to generate econumic growth which is subject to natio:
nal direction. Caribbean Developrient Bank (CDH) President William

Demis declared that "what Third World countries need is a vast increase
in expenditure on Research and Development which would enable them 10
utilize their own domestic raw materials and ultimately to produce and

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export products based on their own resources or their own designs styles. Even more important, technological innovation in Third World countries is required to develop efficient labour-intensive techniques of The two themes of indigenous R 6 D for new exports and for appropriate technologies were linked to the desire to alter the terms

production.

of technology transfer:

Beginning in Cubs in the 1960's and reaching by the mic 1960's most of the region has been the concern for national science an technology policies, planning and institutions, The concept that science and tech nology required government force-feeding as well as regulation was promoted by several

mission for Latin America. This concept was fortified by the energy

ted Nations agencies, especially the Economic Com-

crisis of the 1970's and the felt need of governments to respond with

coherent national energy policies. Conferences, seminars and workshops

spread the message to politicians, civil servants and researchers. All independent Caribbean governments were asked to present national science and technology plans at the 1979 UN Conference on Science, Technology and Development. Most complied ond for many it was their

first attempt at a policy statement.

The new government awareness of possible roles for science and

technology has not been accompanied by privete sector or academic par' cipation or much public support, Scientific communities within the Caribbean hove vestly extended their format ond informal contacts over two decades but their principal ties are still outside the region. Lacking Internal funding, adequate equipment, competitive salaries, technicians, and. information services, most Caribbean national scientific communities are loosely structured end organized. At the regional level their ties are Still embryonic. The pressure for mobilizing science and technology has come from the politicians rather than the scientists. It has come from the frustrations of energy imports, mussive external debts, limited markets for traditional exports, and popular deniands. It 1s often derived from @ naive belief that science and technology once mobilized could provide responses to urgent short-term problems. At the 1983 first meeting of

Caribbean: ministers responsible for science and technology one politicians:

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remarked "I cannot go beck to my Government and say that all we have

produced is another report."
The promise of a mobilized science and technolegy can only be reat
ited if and when indigenous infrastructures come inte being. This
requires years of effort st improving and evtending ihe teaching of
science in the schools, popular science and technoloay education programs
for adults, the estabtishment of critical masse: of well-funded and sup-
i and outside the region,
ported researchers effectively networked with
and agreement on research priorities. There are few shortcuts without
an infrastructure and no shortcuts to is achievement although its size
will vary. A quick review of national efforts \ date conveys the stete of

existing infrastructures and research progren **Notiones Filorts** Cuba has invested in the sist Impressive science and technology infrasteucture in the Caribbean but it does not work well. Adopting since 1965 the highly centralized Suviei mode! of science and technology planning and even the Soviet system of pre anc post-doctoral degrees, Cubs has @ pool of researchers, institutes, science information and documentation systems, priorities and plans, pufications and meetings but to administers the dozen limited resutts.'? the Cuban Acadeiy of Science major institutes snc universities are relegated te training and some applied research, Enterprises lack authority and funds to engage in

shop-floor adaptation and innovation, and earning by doing suffers."

The Central Institutes work to rigid plans and have poor links with:

ies. The persistent problems of Soviet S&T

producers end univer:

appear magnified on a Caribbean island, The choice of priorities with R £ D funding directed at sugar mechanization and use of byproducts is also questionable. Cuba is the only Caribbean country with a policy and an infrastructure but S & T are not contributing te economic growth or to reducing dependency. Irunically the major Cuban equity gains in exten ding education, health and other services have been through management

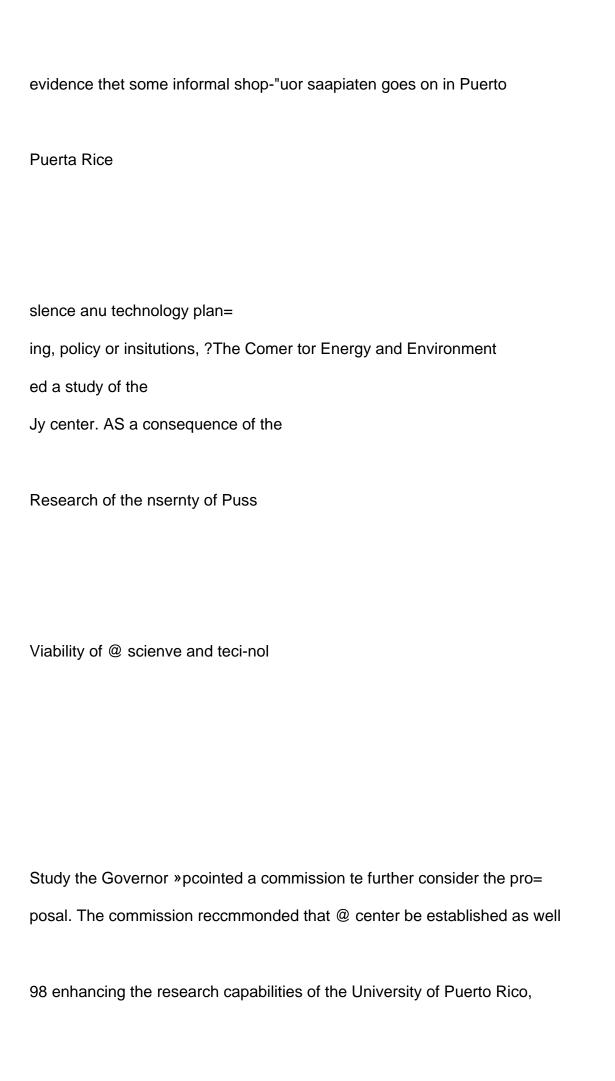
and investment not R 6 D.

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Puerto Rico ha a science anc technology irestructure in search of

2 policy, Next to Cuba it

Fesearch spending in the region. 1S feoerai government agencies sup-



and growing emphasis on the needs of the stati entrepreneurs. As of
this writing, the r2pori has not been officicly acknowledged, in part became of 8 chance ie Governors, The plas sould involve the use of
fiscal incentives to mot onal firms Kored in Puerto Rico to
ate om
Substantially increase thor local R & D efforts, It would be the first
attempt in the Caribbean to establicn institutionetized university-private
sector links for research, crawing wn US exper

The Dominican Republic has tromentad acct highly uneven research in agriculture, alternative energy systems, fishectes and other areas.)

Government ministers, parastatal cormeration:nen-profit foundations, and the universities compete for far too few revcarehers, technicians, and funds. Efforts at coordination through scienc ane iecanology offices in shave faltered. Each RG

wsly guard its turf, ?The Netional Energy Policy

the Presidency and prv-sise

D unit seeks. to jc

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Commission was established in 1979 and has launched several research
Programs but with little coordination or coherence. If Cuba is overcentralized then the Dominican Republic has spread scarce resources too

thinly and widely. It has particularly segiected investment in science education, science for adults, and science information systems. One Fesult is that it is still basically dependent on overseas graduate study in the sciences and engineering in spite of huge increases in undergraduate student enrollment,

Haiti has for its 5 million population the weakest science infrastruc~ture in the region. Three decades of brain

Haitian researchers abroad than within the country. A handful of foreign

drain have resulted in more

funded projects in agriculture, alternative energy, and refores~
tation through fast-growing species go on but without an infrastructure.
High turnover, low se
and other probler
policies are reduced to empty words in the absence of an infrastructure

Ss, poor networking, no information systems,

Quickly frustrate researchers. National plans and

oF serious efforts to creste one. Since most Haitian receive less than 3 years of formal education, one must begit with elementary science concepts imparted by audio-visual, radio and other means in Creole rather than French which is net understood.

One of the few hopeful elements in the Haitian picture is the remarkable informal earning by doing of Haitian entrepreneurs in producing local components for assembly plant

Joseph Grunwald of the Brookings

Institution recently conducted a study comparing backwards linkages in assembly plants in several countries. Ke found that Haiti's record was outstanding, taking advantage of low-cost labor, and tax and other Incentives to replace imported with local components for baseballs and other products. !#

The French Antilles and Guyana and the Netherlands Antilles still ely on metropolitan countries for most of their science, technology and institutions. This results in excellent marine biology, tropical forestry

and other centers manned by European scientists. Applied research on

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local problems has had though to wait the organization recently of local universities and research institutes

The Caribbean independent mainland states of Belize, Suriname and Guyana share low population densities, large tracts of undeveloped territory, and the possibilities of unexploited natural resource. Their re Search efforts and policies are at similar stages of seeking the funds, Personnel and organization to carry out comprehensive natural resource

Surveys. Government ministries, parastatal organizations, and universi~sk and donors operate on

2 project by project basis. Guyana with its predominant public sector has gone furthest in national science anc technology policy and planning but has little ability to implement. Geiize and Suriname are mostly

ties and technical colleges are unequal to the t

Groping to improve extremely weak intrasteuctures

The smailer Leeward and Windwar Islands lack policy, planning, Institutions, researchers, and research. Scattered projects are externally funded and implemented, often on alternative energy, with minimal loca! Participation. The exception are the appropriate technology centers Promoted by the Caribbean Council of Churches but their record of adaptation and diffusion of results is spotiy. There has been little consideration of what constitutes appropriate science and technology infrastructure for these islands and too much emphasis on policy and institutions which are appropriate

Perhaps the emphasis in the smaller islancs of the Eastern Caribbean should be on science education and popular science for adults. Long-Gistance teaching by radio and satelite, computer and audiovisual tech=nologies can all be used to raise indigenous capabilities without costly formal instruction. Research should be underiaken at the request of and With the full participation of locals even if his means a slower research timetabl

There is an enormous contrast between the R & D capabilities of Trinidad and Tobago and those of the rest of the Eastern Caribbean.

Housing a University of the West Inciws campus, the Caribbean Industrial

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Research Center serving the private sector, » branch of the Caribbean Agricultural Research Development Institute, and various government ministry efforts, Trinidad has @ working if inadequate infrastructure.

The government decision to invest oil revenues in joint venture industriat export projects in petrochemicals has also improved local information and documentation capabilities. Trinidad has and should continue to provide advice on technology and technology transfer to the Eastern Caribbean,

Like Puerto Rico, Trinided has at infrastructure in search of a policy. This is reflected in the discussions over a strategy of joint ventures and technology

Proposed National institute of Higher Education. Research, Science and Technology. Small-scale scattered applied research efforts in 2 number of areas including agriculture and marine iology have limited impact.

insfers, industrial impert substitution, and the

Attention is needed to science education and information to improve and extend the infrastructure.

Barbados has relied on informal and formal networks to achieve coheent if modest performance. It benefits from the tocation in the country
of the Caribbean Development Bank, the nesdquarters of the Caribbean
Meteorological Institute and other regional organizations with technical
capabilities, including the local campus of the University of the West
I dissemination of

work on biogas digesters, solar heaters, and egro-industry. It has also

Indies. It has achieved some success with commerci

recently surveyed its research, researchers, and spending and has baseline data generally absent elsewhere. The role played by universal Hiteracy, public awareness of S & T, and informal public-private sector linkages has given Barbados an edge, The question may be whether to continue with effective gradual efforts or to attempt more rigorous and concentrated priorities and performance?

Jamaica hes had a topsy-turvy experience with science and technology: in recent years including 2 stark exodus of professionals and technicians. In the 1970's, and a drastic switch from emphasis on controlling the transfer of technology to encouraging uncontrolled transfers. There have also been numerous changes in per sonnel in institutions responsible for

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staffed.

Science and technology. What has continued is a basic and applied re-Search capability at the Jamaica campus of UWI: especially at the Medical Schoo! and the Caribbean Food and Nutrition Research Institute; @ tradi~tion of government research in agriculture as well as private efforts, and some scattered energy. fisheries, and other R & D. A key problem is too many small, uncoordinated research efforts underfunded and under

Jamaica has severe infrastructure and policy problems. It must Provide competitive saisries and working environments which probably means regrouping researchers in groups of minimum efficient size. Cooperation between public anc: private sector is essential Hf research is to be adapted and diffused. Consi¢eration of fiscal incentives for R & D is

Felevant in an economy

Ippled for lack of foreign exchange.

The College of Science and Technology has a useful role to play in

working with the private sector to foster shop-floor innovation and trai ing. A national policy and plan may be appropriate for Jamaica if the process is open and participstory including the increasingly organized

scientific community.

These thumbnail sketches of national efforts are partial, subject to change, and arbitrary. They do iruicate the enormous range of science and technology experiences and approaches within the region, and the basic obstacles to regionat cooperation. Such cooperation of present consists of the Caritbean Community (CARICOM) nations whose relations focus on politics and trade also includes, UM!, CMi, CDB, the Caribbean

Examination Council, and 2 number of nc gevernmental professionat

associations. At the regional eve! the Association of Caribbean
Universities und Research Centers (UNICA) founded in 1967 has continued
2 low-profile program of conferences, workshops and exchanges of infor
mation and has discussed possible joint research projects. Its membership,
includes universities throughout the Caribbean, as well as Colombia,
Venezuel

fexico, and the US, but Cuba has not joined.

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?The Commonwesith Ceriteven has uttempied several regional science and technology projects ond proposed others. Using US funding, the Caribbean Development Bank and thy CAPICOM Secretariat have spent \$7 energy research, The

milion over five years on snalicisione alt +s

CB also operates » Technolusical Cons taney Seviee fr the Eastern

Caribbean. The Orga

scale subregional p*2ject

and the technica! com

the political level supeors w 4

wieldy to find att

shes had several small-
ICG Secretseiet jacks the authority
nate ?hese slots. CARICOM at
NS and un-
NS and un-
Instead the focus since 1973 fas room ot wwe Cartobean-wide level
With the initiative coming hom ECLA»
such as OF. Dennis Irvine, vice? hance:
and a f
individuals

hniversiry of Guyana.
These efforts produced in ak) thy intergevernmentst Caribean Councit
of Science and Te
CARICOM states pics Cubs, che Dewinica Ru
Nethertands Anritics
wlvg, (CEST). oS memboreni includes most of the
bbiic, Maiti, end even the
possible ne cinaeper emt Assouiate Member, It
Is the widest Caribbeces qoverrmenta: grouping for science ever except
for the Wor!
to the colonial pores, Nowaver,

their dues, tack o
fon ECLA for Secrevriat se-views. 2
that was confined
War 11 ano postwar Caribtean Comm
ere £034 members have net pal
ane wcernm ?Ussing has rontinues: reliance
Comemye: peeLcipaiion ond tterest

Is markediy uneven. There is suraement ony suacitic "coordinating
advisory, and impionentatrs sow the oooh rne inntiat work
Program calls for a req} wat of national S 6 T
capabilities, ana vines information yd exch
the CCST with such a diverse members
to afford benefits te atl if at «awe! cone Gonominator
we activities. Like UNICA,
likely

» os settled fer activi



support of rescarch centers

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except in the Commonwealth Caribbean, The ciiemnma is that without much more extensive regiorai cooperation mary Curinbean countries will be shut out of science and technology.

Sector *y Secta-

?The present state and prosprcts for S £ T in the region need to aso be examined by secio-s, Table! provides available information on

current national and research spencing, a cure reliable guide than policy statements. There is striking convergence and an apparent basis for further regional cooperation, Our discussie attests to highlight the

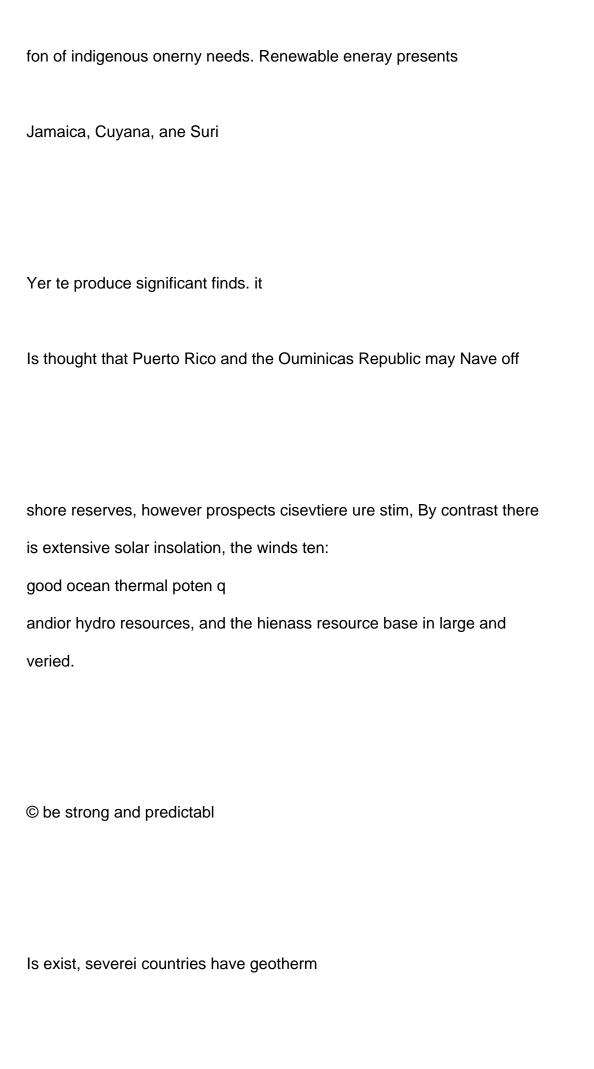
research sector

issues in each key
Alternative
nersy Research
The Caribbeen is 90 percent deperctent on imported oil at present to
fuel its energy needs (Trinided a6 Tobago 1s the only oil and gas
exporter, Barbados and St. Vincer produce some oll and gas). Yet the
Caribbean and other sub-tropics

isons hove energy energy advontages

not necessarily shared by other

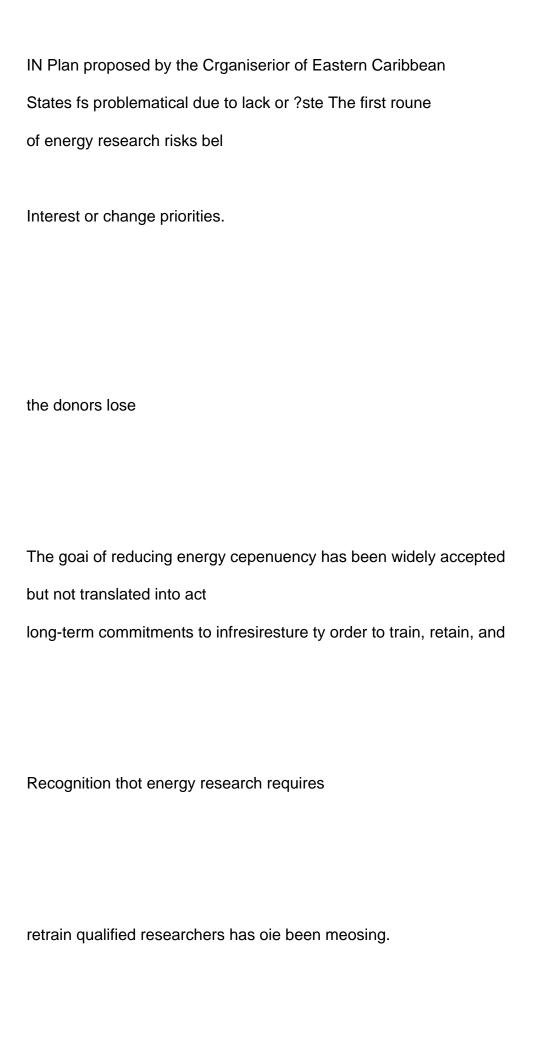
developing couniries. The energy op
© of particular interest. 17
portunities associated with coustat activ
It is widely recognize that the Cariobenn oossesses 9 wide array of
energy resources which may bs exptest
large propor
the greatest opportunities. Recent oli ano gas expiorations in Cuba,
provide from 2 small to a



Page Break
There is disagreenent over the appropt
ment, demonstration, application and diffusion: focusing on renewable
16
feness of research, develop
energy. Some analysts faver a wide range of research programs.
Other come up with priorities and propose ther development by external
Sources Using economically snc technically proven technologies and doner-imposed regional, subregions? ane rationa: energy policies.'?

The track reccre of enerey ve:
arch In the region is mixed to date.
Table IV presents 2 ?engthly ¥st ct donors, projects, and sectors which
includes foreign goveranent rations, private foun-
dations, and others. Sere guvernmeris have respended by organizing
their owes nutio
and elsewnere.
'at poley offices az in chs Pew iniean Republic, Puerto Rico
In spite of this vetivity and wierest, there has been relatively tittle
actual energy reseorch in the region. fhe Carter for Energy and Envir-
fonment Research in Puerto Ricu hes been the single most active research

center, working on «
Industrial hot water, orean ¢
?ergy ?rom sugar cane. solar air conditioning.
wal eneray and other technologies.
Because of changing US government privrities the Center has hac to
curtail much of its work. The CL has theses o variety of research,
including a passibe solar water heater program in Harbades, It too has,
Fun into funding constraints un tulure energy research. The Regional
Energy Acti



	scussions of internation:
rei	iional_ and nationat planning, policy,
	and cooperation skip the specifice ered to sustain energy research.
	oject by project episodic fundiny rakes it difficult to develop those
Ve	ery indigenous research capabilitie. that are needed.
	Page Break
Αg	gricuiture and Forest
Ex	port crops such as suger ant se
lar	nd cotton have provided the
his	storically most effective examples, nf Carinbean public and private sector
res	search linkages. Discoureging markets and prices for traditional ex-
	orts present new challenges to 2 erst-cuionts! research structure.

There ere advoca!
Sof now sms on non-traditional
export crops such as fruit trees for whose praiucts new markets may exit
The empnasis is pleced on commerci
lization and marketing.
Others maintain that research sheuie taows on jew-ces:, labor-intensive

technologies et the discosition of smull tarmers with litte credit or formal
education. Then there are those whs a-gue or sgru-industry research to
adapt known dairy, poultry, sheep und 915, animal fedder and other
conditions to Carivtieas commercias a crt
sre and joud processing. The
emphasis here is on
rigultural evennsion, mechanization, and technology
ricultural excension, mechanization, and technology
transfer with the goat of reducing present extremely high food imports.
-
The debate over research approaches and ysats divides governments,
ministries of agriculture, researchers, university faculties of egriculture
ministries of agriculture, researchers, university faculties of egricuture,
ministries of agriculture, researchers, university faculties of egricuture, external donors wi

others. If even occurs in Cube where the smal 4 outyields the state
cach country due to
remaining private sector is cenieg res
farms." It is @ debate with 9 citterer the different prevati
systems of land cenure, extent of rural migration,

and other factors. For iistance Pucrto ?tes fw opted for agro-industry,

Fesearch in @ society where few spoilhetiors cwmain; Haiti is overwheimingly rurat und smelt farmer and comesteates on labor-intensive

Fesearch. The debste is furth rated by the possible use of sugar

for fuel and its econemics,

The problem is thet at the national level the resources are lacking to effectively pursue several agricultural raseoveh strategies at the same time. A World Bank study of dev.

has Indicated! the diseconomies

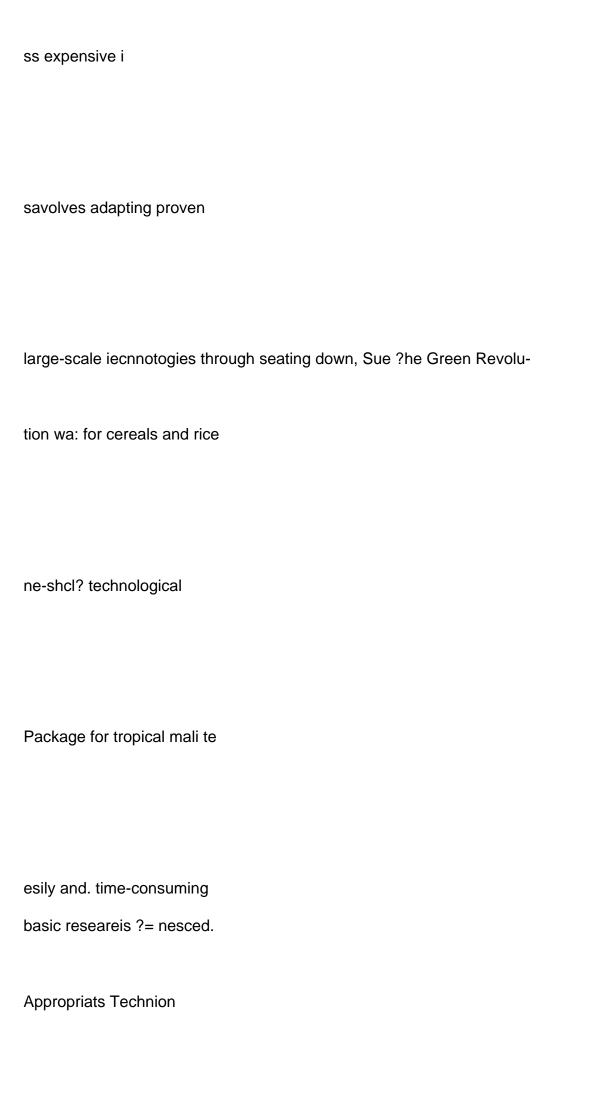
ping country agricultural research

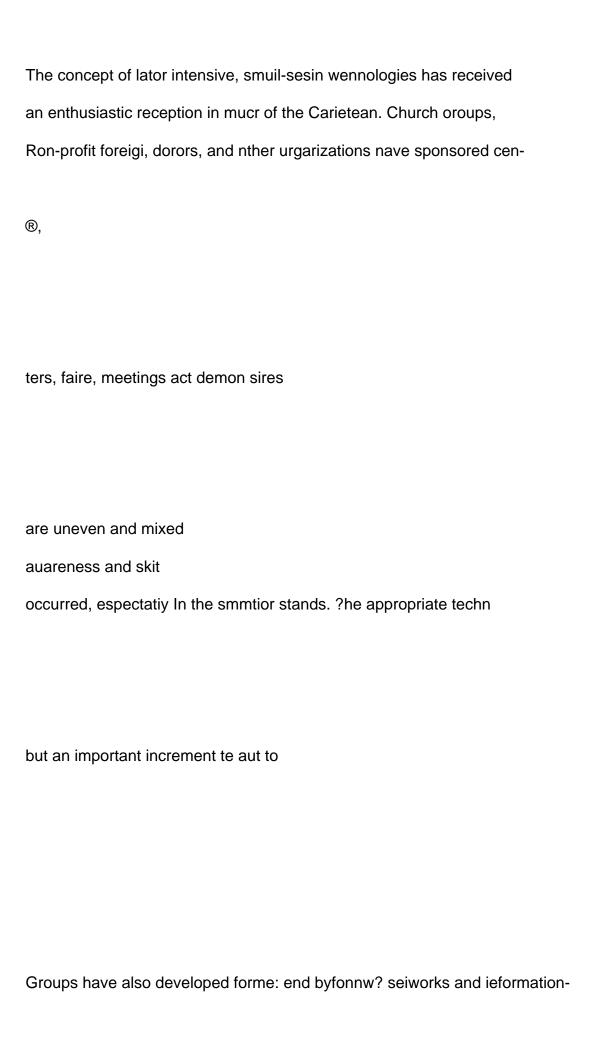
cele from we few and isclated re-

Searchers. Work on new crops an

traditional crops such as sugar and
bananas must be carries) out at the wubsegional or regional level for the
Page Break
smaller countries. Giver, 2 regional division of research labor it might be
Possible to follow seers. researc: tives simultanensly but this is @
long-term goal.
Reluctantly aepears that rese
Fe veciswns need to be forced
Adusiry. A sntier although tess painful
? and fast-growi
Species for -eforestetinn in peasant societics. Halt and the Eastern

between smaitnatders and sare:
decision fies etween research os commercial forest
Caribbean must -heose agricultural and fers
of the Caribbs
industry research is
?efor pecsamis white the
Ge facte opts ?or
ncustry. Ironically agro-





sharing: an important iesson for he scicatilie conmenity. While its tetat
economic contribution may be tinitee spprocrinie tectnmacy efforts in the
Fegion are & welcome sigs of self tetiar
they may be extended * crafts, cost
recycling, ana small ind
Where local interest merits
Kechnoiagies, eiatertals
ries.
Eevironmer ial Scienre:
The Cariobean cunsists of denssiy populated nighiy fragile human and

Organic ecosystems subject to pendiic numcanes, esechovakes and wat
made disusters such as vit spills. The caviroumental sciences ore recent
Page Break
arrivals in the region although there is a distinguished recorc of academic
lad, Jamaica, Barbados,
ronmental concepts has been
research in marine biology in Puerto Rico, Tr:
Curacao, and elsewhere. Recognition of en
stressed by UNEP. UNESCO with its Man and the tisphere research
Program, and by the n«
tion. Ecological problems have also received! some attention from the
Caribbean Tourism Center in Barbados establishet by the Caribbean Hotel
and Tourism Axsociations.

n-governmental Caribbean Conservation Associe~

The growth versus pollution debate of the 1960's and 1970's has a different context in the Caribbean. Polition in « closed island ecosystem threatens survival in a way that it does not" Calcutla or Mexico City.

There has been growins

demand for applied researciy on short-term agement and nicg. There are political

Problems of harbor pollution, oit-sptils, cossta! zone me beach and san eres'n af demands for resesich to improve ?ishing practices and yields, reduce imports ai

nd generate employment.

Unfortunately increased interest ia ecological research has not been matched by 2 strengthening and vevision of e=vironmental science infra~ structures. Technicians are despcrately surce making fisheries sod marine extension jrourams unrealistic. Research centers lack critical masses of researchers and adequate information services with a consedence in Caribbean archaeo-

ten through collaboration

quent loss of staff. tmaportant work has bee

logy. marine biology

between local and better-equipped tu-elgn

c! other elds but

serchers, The small islands

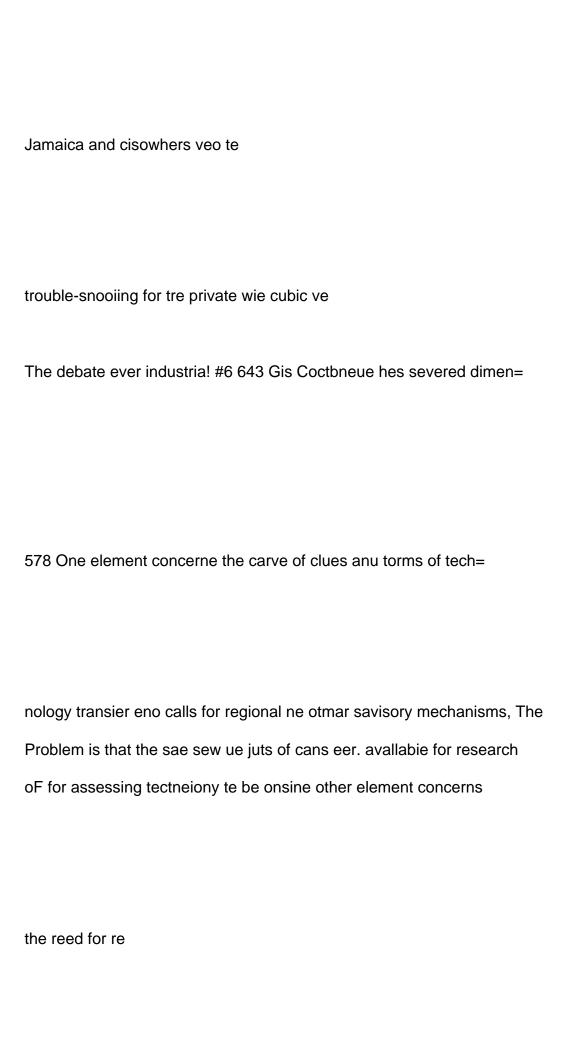
have become particularly dependent on donors tor assistance with their
regional cooperation
immediately runs into the short-term needs of many countries versus the
Multiple ecoiogical peiblems. ine possibiii
long-term commitment of building infrastructure,
Climatology and seismology are :he two disciplines in which Caribbean
applied research and international oasic research interests have been
bridged. The Caribbeon Meteorological institute collects weather data for
the Eastern Caribbean and uses satellite dat
ings. Its cooperation and thet of other Caribbean
for forecasting and hurri-
cane and storm wars

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ational weather services with i agencies to mirker'y Inpraved regio-
date. Simiariy inter= carinbean nes waded to
nal forecasting capabi'ities whi sectin
rational oceanogrenhic and seismic s
asic research know.ecige
history.?9

basic research by nreviding
basic research interes! The prine
J0b training of Caribbesy vesrerchees.
recs fe and planetary climatic
rees to and planetary climatic
The lesson is taal the Gartonesn cen pacticibate in fiesterate
applied to
comes fron, tive onthe

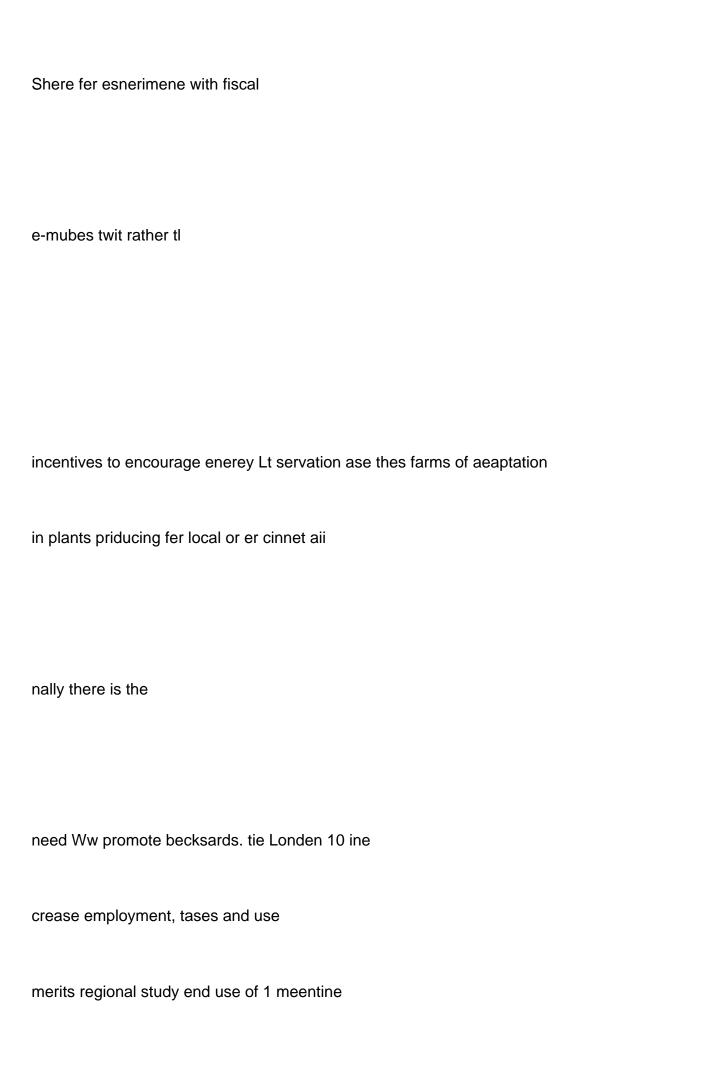
?There is very Hits formal ine stri Carihbean and an

unknown but presumat yt
eo amnitnt af inten chop-tlocy adaptation,
Cuba is the sole exception AK is seer oo wiur) Soviet and
pean capita: go attoots at * \noort-substitution
including designing here technology
transfer is largely unvegulates exept for leraigs esctange constraints,
ne Dotwucun Renublie, Trinidad,
st Euro-
Industrial techeciowy in
mation cons ne cansuiting, and some



ional desige oley Ganebtities or new export
ook of available man
industries such os petrachem«.
Power suggests tha: ths cost
at the expense of other @ ¢ 0)
locai adaptation is fidust
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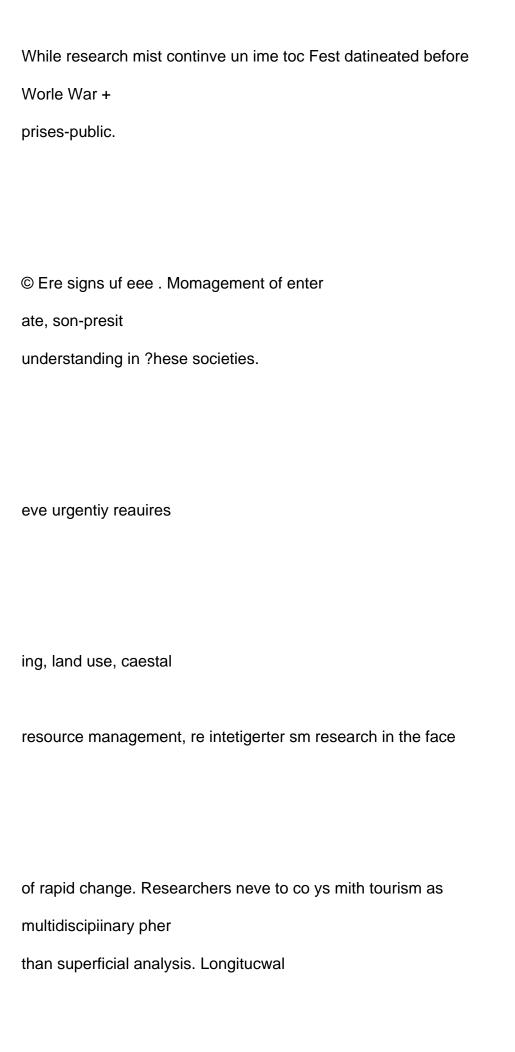
There has been more than \$0 years ef suis schularship in the social sciences ier the Caribbean. much of ab secouars. Tes face and class, kinuship and gence, A>! bs the New World, the Plantation economy, emigration and otrers boue oes competently studied widely diffused

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There are a number of social science nsear. centers in the region,

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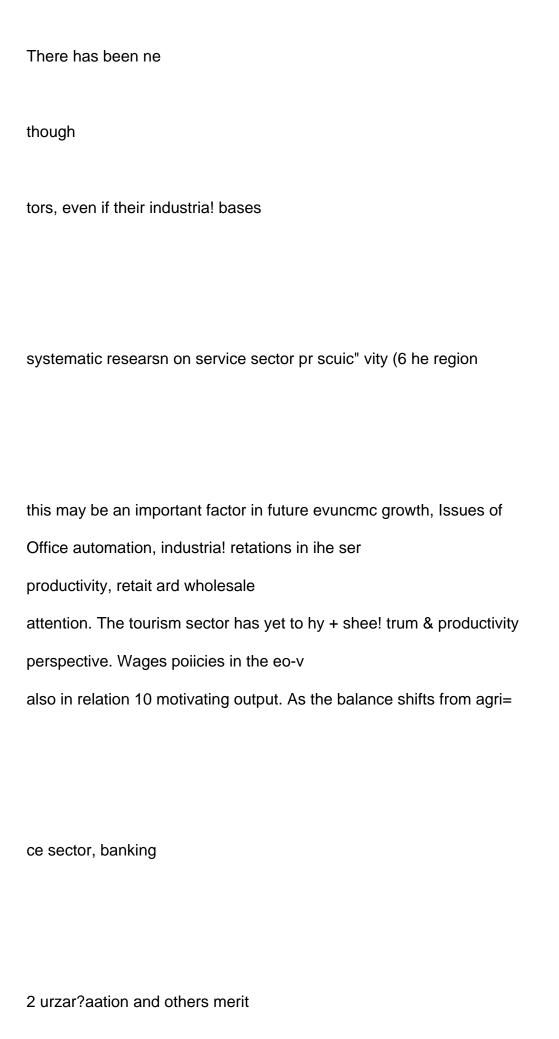
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have played a tending rele need ty pane Jejerests and eupirical data bases
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The Caribbean strength lies in opp sed ecaity such as drug trials,
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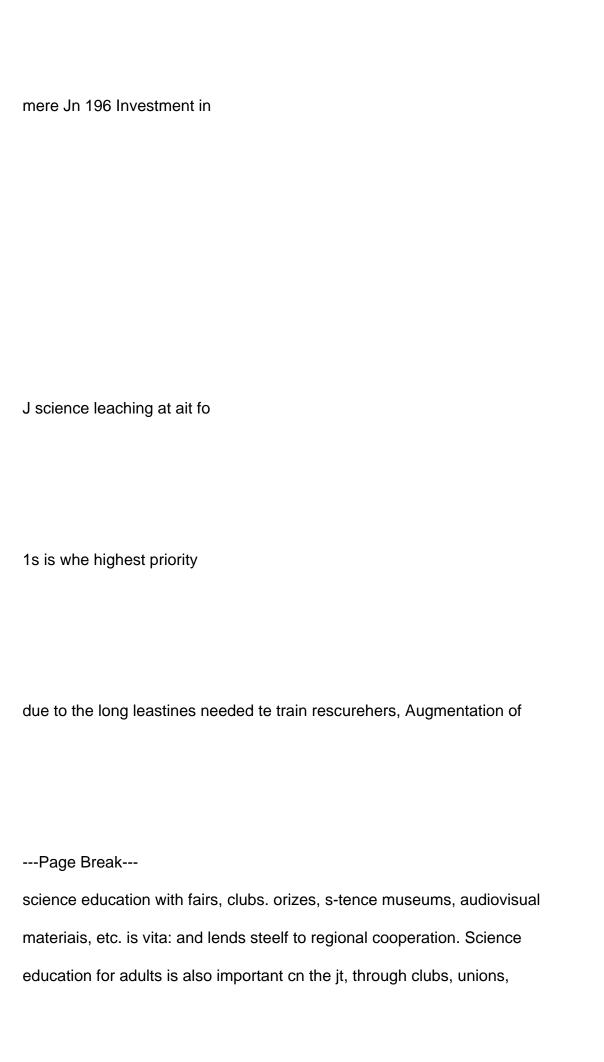
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clans based medicine 1s stot foanibie.
sherces amd there gee important
gains from regional shoring of jnfer slice ane comparative research,
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Natural Resour'=

Several Caribbean countries such 26 Guyane Relize, Suriname and

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of computers in the
The Caribbean for two aees
existing numbers of researchers anti in geverxt counteles such as Haith
there are fewer 1
science education as
(es nas barely oven able to replace its



and other organizations. The qual shuils be auginented job-related Knowledge and skills rather than a vague awereness of the importance of science, Audiovisual and computer 7 the jet training should be at~tempted.

Numerous studies ave shown that researchers emigrate due to frus~ tation with local worsing conditions end saiuries a well as foreign opportunities.?° The Cariobean has tne acvertexe of geographic proxi mity to mejor research centers ard pessinie on-line communications. Keeping good researcivers ip he region requires providing them with frequent keep-up access to major cee

we data bases and over

seas communications, and centers with ?eric: masses" sufficient to

Permit stimulating exchanges. Hanafuis of soma researchers scattered

around the region are not productive. Ades
formation systems and
telecommunications are > sine qua non of effeci2 Caribbean R & D; not
luxuries. The alter
emigrate.
tive is to conunue to ser some of the best people
Research Priorities
Covered tiets of possible Coribbean response mismities have been mut
Several tists of possible Caribbean research priorities have been put
SP goal uf buliding indige~ nous research capabilities. It acoues ior highest priority to insite
research on problems unique te the
research on problems unique te the
together?! Gurs is derived from th ton
fon where trarsterable technologies

Will pot work or must be adapted. Re~enadie energy systems and ageiculture and appropriate technology ?it vais criterion. So does research fon Caribbean ecosystems. Investments in information science, improved telecommunication and science educetion ave nevdad to make any R&D

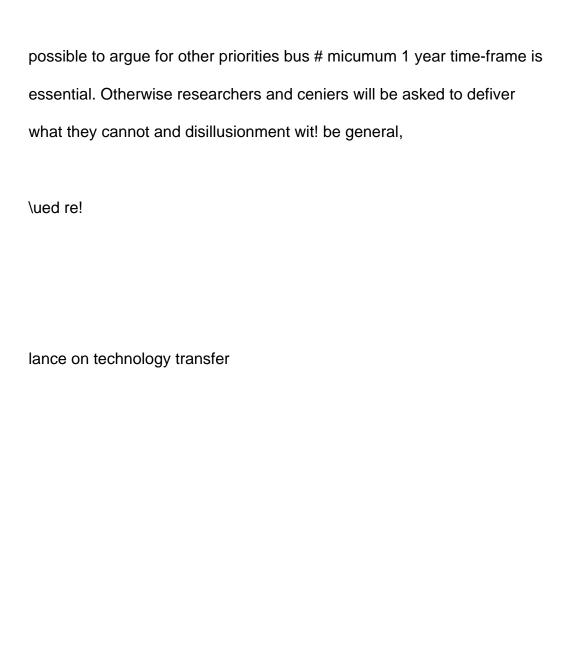
Program possible. including our st require infrastructure buildups and cannot premise economic results. before the 1950's. We do not believe that there are short-cuts in the 1» must be nourished

yestions. The priorities we propose

Caribbean. Science ani) Technology in the re

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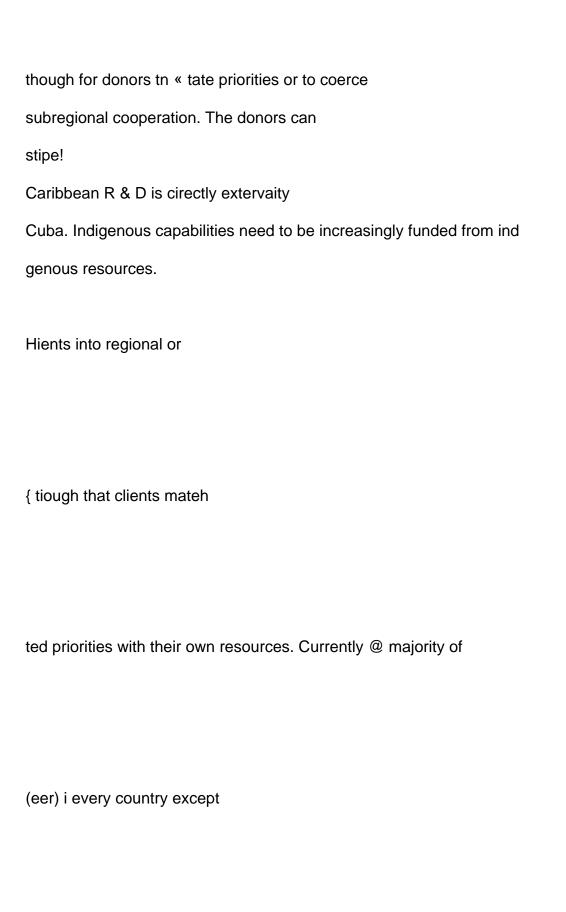
before It can deliver. Short-term crash projects lead nowhere since local capabilities are not ateres. Cont cannot deal with sectors where in sit ?search has not substitute, it ts



Approecty

Donors to Caribbean science and technokay have their individual agenda end constituer cess to coordinate mjor government donars. An indication of broad funding tevels for several years in advance wouse nelp, ft is undesirable

les. The World Sank fos sought with some suc~



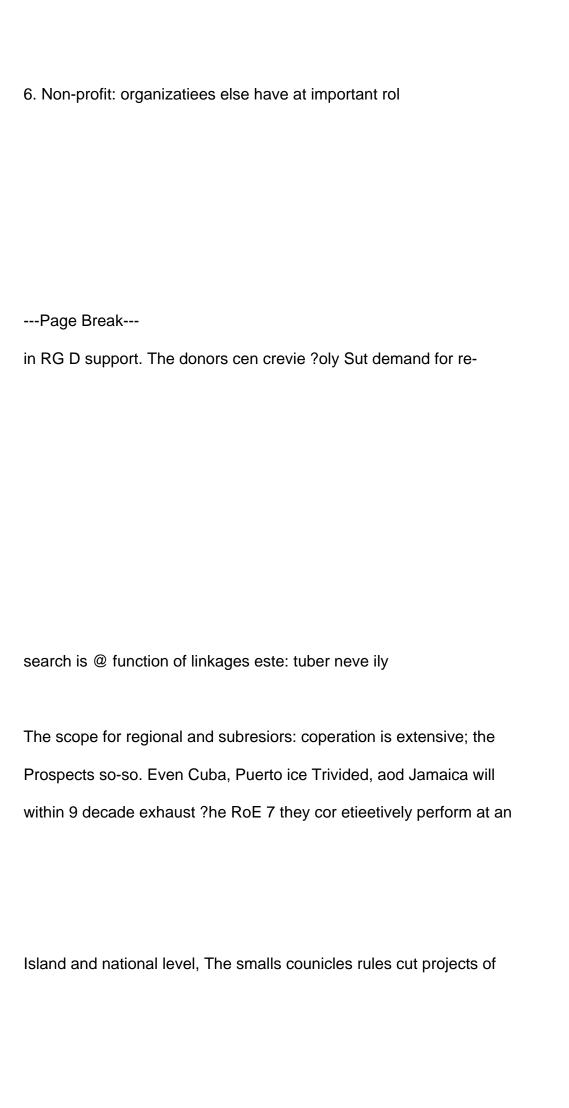
Most R&D in the Cartbbean wilt curtinue ?¢ be carried out at the national level, whaiever the sources of fun Funding needs te be restructured to fac

tele user-researc! incentives can

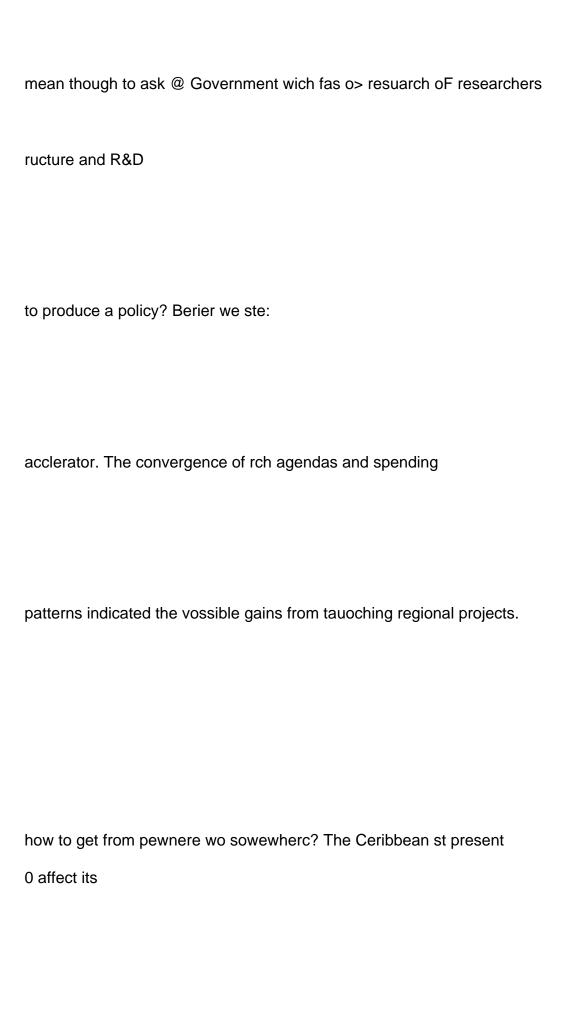
be tried to induce the tourist sector te (un! soar energy: agro~industry to support university work, etc, Fhe seli-imposed segregation of re=

Searchers and possible users must be forcefully bechen-down or no diffusion will occur, Where National councils of science and technology &

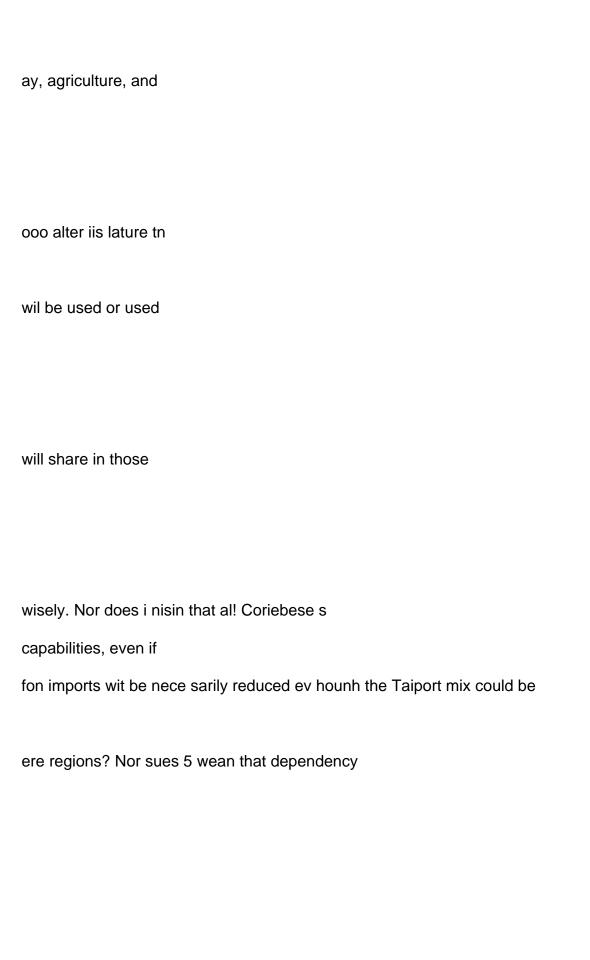
there should be broad participation of trade wrinnists, farmers groups,	
teachers, etc. The snaliness of those societies chould be an asset for	
research diffusion end vot a liability. Public -ector corporations like the	
electric utilities should have set asicie # & D fancis to be used for con~	
sector. Linkages shoulé	
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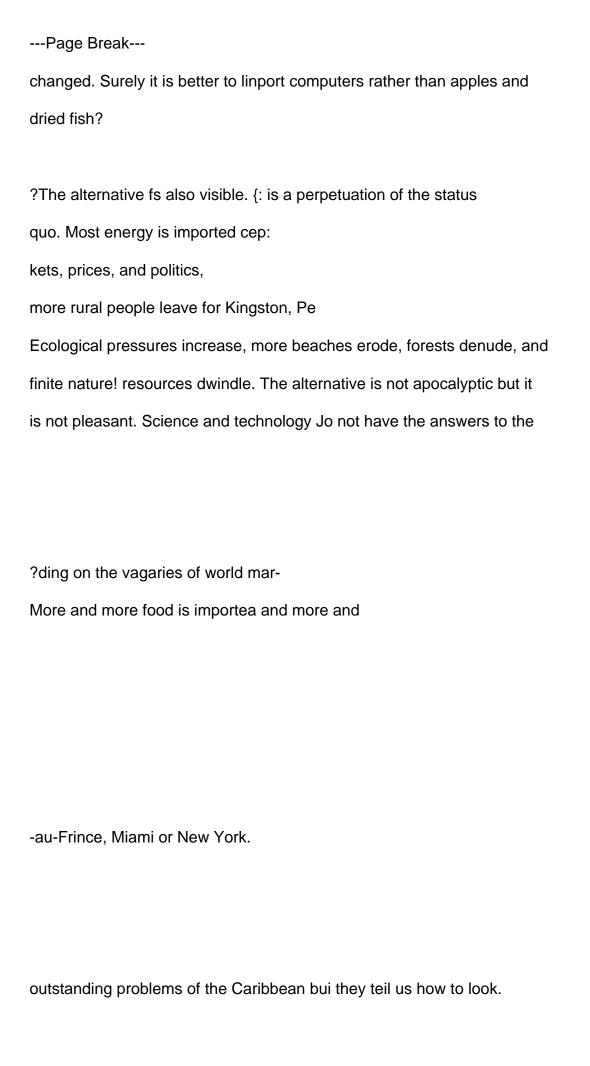


most interest te the most ad wens rai cooperative as between
Puerto Rico and the Dominican Republic or Cues ant Jamaica as in the
1970's may be more geruanising OLt van ales BE Untwancedt
1 te momentum in
T to Momentum III
Donor and interna! support ?snes :
Support of ragional ecoperation e nieeds to be @ step ahead from
conferences ane sti*voys to carefully eusigne! shared research. {1 is the
true thai dasetine data is unavana! les and tnat science
and technology peticie: sre it wristent. What does it



does rot have sufficient svlance ane toons ies	
own future, Compare ?his te india wich wonstrate, adapt,	
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oped the abitity to increasingly oo	
exports. It is possible for the Caribbea wi tir 4 decade to have	the
Indigenous capabi	
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Caribbean Science and eersatogy Principat Regionat ond vernatior 2) Organizations
Association of Isiand marine Coordinates marine seen
105 ot the Ceriboear, {AMMLC) 8 informatia ex: ances
Appropriate Technoiosy tnternadions? agency

US government funding
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cy of Overseas Develop-
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Council of Churcies
?os based promoter of his support from? Caribbean
Caribbean Associstion © Chambers Commurce an ingustey (CAIC)
Private sector promoting improved ferns
Caribbean Agricultural Research ond

Trinicad base
pment fnstitute (CARDI)
Caribbean Food and Nutrition .ns?'tute (CRN) Located ip Jamaica and
attached to the University of West indies Mecivat School,
Caribbean Economic Community (CARICOM, Seer 'aciat based in Guyana
Coordinates alternatives energy ane rected 2 rejects
Caribbean Industriai Mesearen ins:
industria? technology research svn «
Trinidad government

Conference of Canbbuan sud Lab Aweneun Ministers Reponsible for
Science und Tecrnoiogy (CASTALA.). UNESCO Group scheduled to meet
in 1985,

Caribbean Appropriaie Technology Soutre (CATC), Established in Barbados-1981.

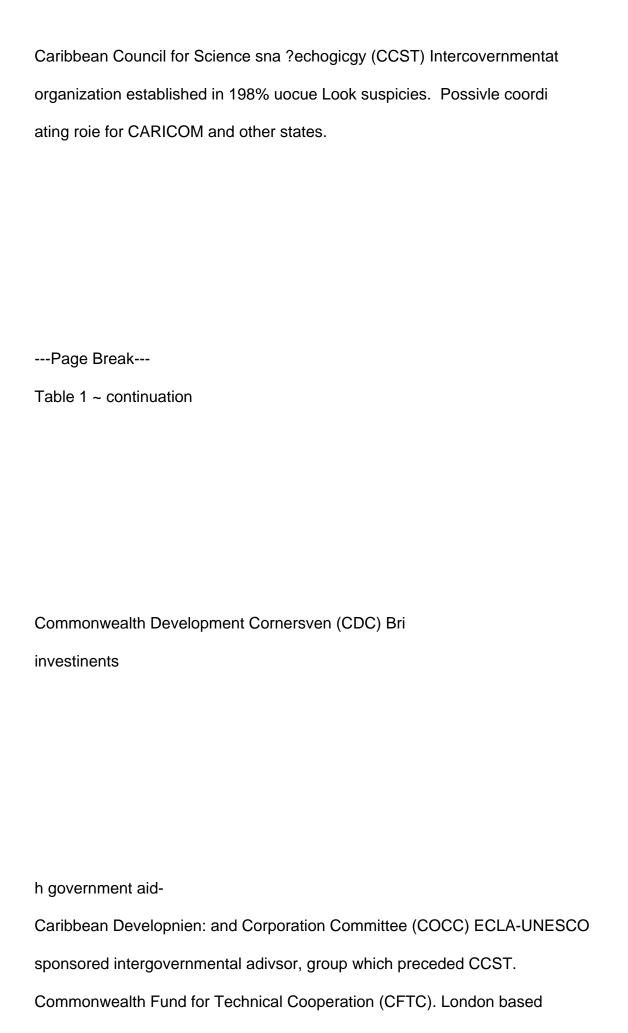
Caribbean Conservetions Associa" CAL Barbados based non-profit

group concerned with ?cology a at sctoration,

Caribbean Devetopnent Bank

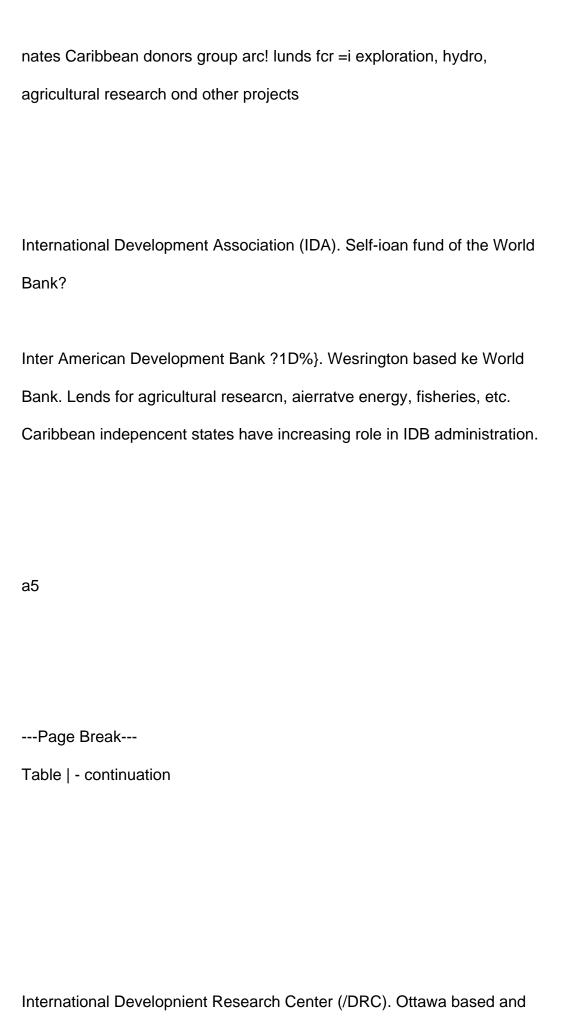
in Barbados; funus ul! rnative

Energy Unit based



Caribbean Croup for Cooperation in Eecinemie Levelopment (CGCED)
World Bank sponscred club of darors active in energy and other projects
Canadian International Development (CLA), Supports agriculture, fishe-
ies end other research
Caribbean Meteorological institute
CARICOM ares fier dat
Gurbados based; serves
project. Works closely
Commonwealth Science Council (CSC). Londen based. Funds surveys and conferences.
Caribbean Technology Paticy Siuoie
the University of the West Indies
IDRC in Canada to puis a seri
(TPS), Joint research project of
the University of Guyana funded by





Canadian governmet funded autonomous supporter of small-scale technology and other projects. Funds CTPS study.

Inter American institute for Agricultura! Cooperation (IICA). Based in Costa Rica and ifilsted with the OAS. Holds Caribbean workshop on ruit trees

Intergovernmental _ Ocesnographic _Cummission of the __ Caribbean. GOCARIBE). UNESCO affiliated advisory group for marine science research,

Japanese investment and Consulting Agency (JICA). Donor agency

Latin American Scholarship Program at American Universities (LASPAU)

Graduate ard. post-graduate education of UWI, Dominican Republic and others Organization of American States. Science and Technology Division in Washington sponsors Caribbean science and technology policy seminars and funds siratimscale vesearen projects.

Organisation of Eastern: Caribbean States (OECS). Secretariat in St. Lucia coordinates technical ausistence for ember states.

Latin American Organization for Energy Development (OLADE). Based in
Ecuador; conducts workshops and surveys in tive Caribbean

Pan American Health Grganization/World Health Organization (PAHO/WHO).

Coordinates health data, surveys end training

Rockefeller Brothers Fund (RBF). Based in New York funding Caribbean alternative energy projects

United Nations Centre for Science, Technology and Development (UNCSTD). "New York based follow-up to the 1979 Vienna Conference. Conducts surveys.

United Nations Conference on Trade anid Devetonment (UNCTAD). Geneva based promoter of regiona: electronics and phirnaceuticals. projects

United Nations Development Program (UNDP). New York based funder of small-scale energy, fisheries and other projects

Economic Commission for Latin America (ECLA). Caribbean

region office in Trinidad is Secretariat for CCST. Promotes regional role.

United Nations Environmental Program (NEP). Nairobi based with Caribbean plan of action emphasizing eil sills, coastal management.

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Table | ~ continuation

United Nations Edveational, Scientific, and Cultural Organization
(UNESCO). Based in Paris with representative in Jamaica. Promotes
science end technology policy and planning, marine science research and
Caribbean participation in global Man and Biosphere (MAB) research

United Nations Industrie! Development Orgavization (UNIDO). Based in Austria. Promotes Caribbean technology transfer studies, small industry

United Nations taterin Fund for Science and Technology (UNIFST). Based in New York as follow-up to 1979 UNCSTD conference. Limited funds for

CCST secretariat, meetings.

U.S. Agency for International Development (USAID). Funds alternative enersy, age, Fisheries and other research, national and regional.

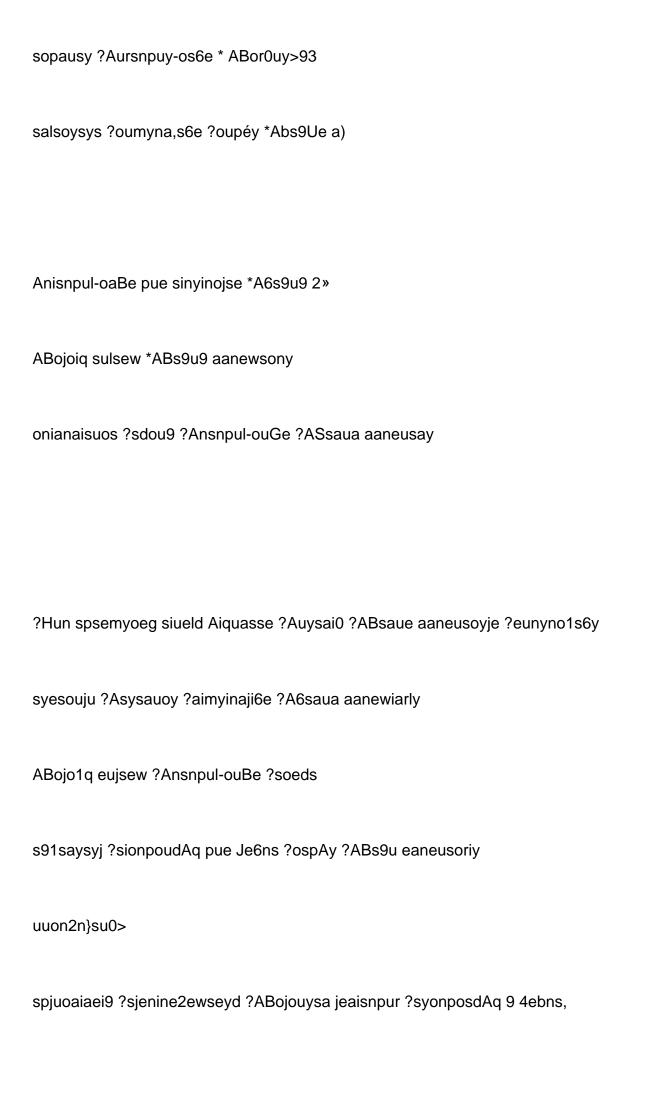
University of the West indies (UWi). Applied and basic research in agriculture, natural sciences, marine biology, Institute of Social and Economic Research and other folds. Campuses ih Bartado:. Jamaica, and Trinidad. Long-distance science teaching project and other extension activities for smetter island:

Volunteers in Technical Assistance (VITA). Washington based non-profit clearing house for appropriate technology information

Association of Caribbean Universities (UNICA). Groups public and private universities and research institutes. Menbership extends to Colom

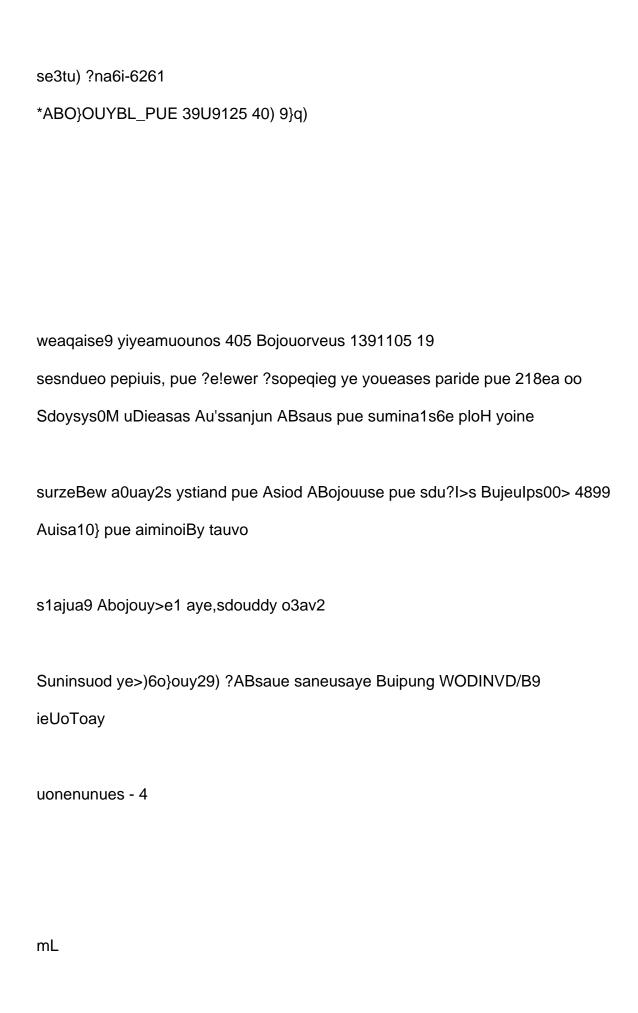
Venezuela, Mexico, and the U.S. Holds workshops on agricultural

and energy research, curriculum, and other exchanges,
World Intetiectual Property Organization (WIPO). Paris based and
Promoting new patent, copyright and related organization in the region.
Opposes UNIDO.
World Meteorotogicat Organization. UN agency responsible for data collec~
ton
This list is not exheuutive and requires updating. It includes the prin«
pal non-national organizations invelved in Caribbean science and technolo-
oy.
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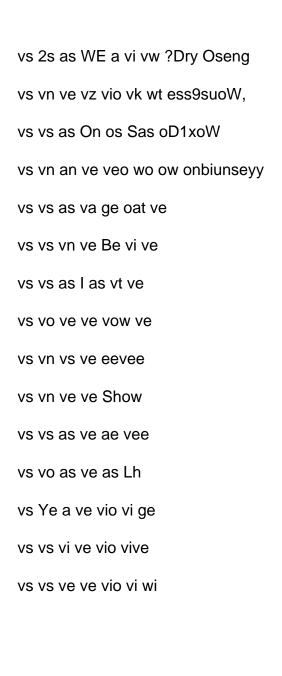


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TABLE IV

SUMMARY OF ENERGY PRUJECTS IN THE REGION

Caribbean. The following is @ list of their main activities. The purpose is to serve as 2 project checklist, which may be updated with final cata

A number of international and regional organizations are active in the

regarding the investment and staius of the individual projects and with

information regarding projects to come. The projects listed include those

executed, under execution, under preparation, planned, or suggested.

Eneroy Donor/Exe- Recipient

Subsector _cuting agency Activity country

oi Venezucial
?
Inancing oil supply Barbados, Jamaica,
ico Domincar? Republic
Trinidod/ Financing cil supply CAR!COM countries

8 Tobago

UNDP/IERU, on regional Bahamas, Barbados,

Canade ion prorotion Dominica Republic,

Grenada, Guyana,

Haiti, Jamaica,

Surhiame

IBRD Oil exploration

promotion fencing

1B Onshore olf expio- ?? Cuyana, Jamaica

ration lending

IDB Offshore seismic Regional

Surveys lending

UNDP/CDB! Assistance ?or fiets ? arbados

Ibe operation and expic

ration

1B Seismic survey of Barbados

fossil tucls

UNDP Gas development Borbadtos

EDC Canady LPG provessi Berbedos

Solid coe Peat survey Betize

mineral
fuels OLAvE, Lignite development Haiti
Germany investigation
Peat development Jamaica
Lignite devetopment
1
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Table IV ~ continuation
Electricity
Hydro
UK,
Trinidad
© Tobago

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IBRD		
Eximbank		
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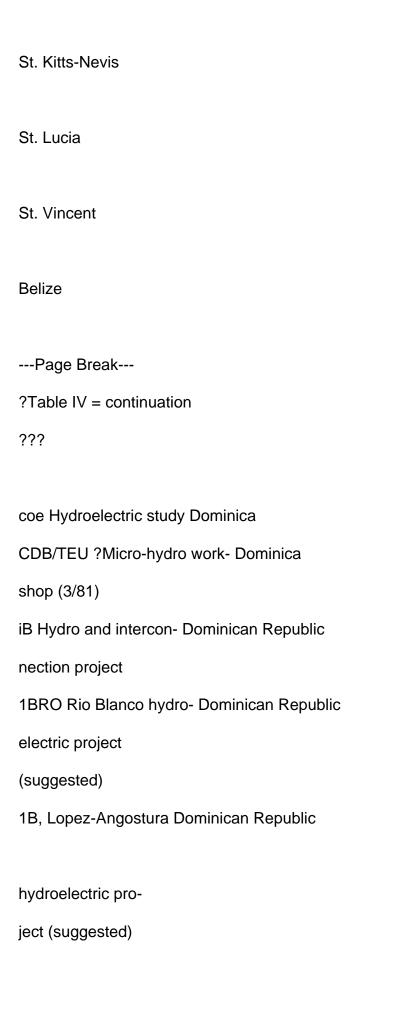
Restoration of
existing power
plant
Technical assis
tance for electri-
city development
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grading
First power project
Electricity rehabi~
litation
Generation expansion
Generation expansion
Acquiring the elec

First power project:		
sector strenghening		
Power development		
Power development		
Rural electrifica~		
tion		
Generation expansion		
Generation develop-:		
ment; transmission		
development		
Generation expansion		
Improvement of elec		
tricity supply		
hydro project		

tric utility

Tariff study

Antigua		
Antigua		
Antigua		
Barbados		
Dominica		
Dominican Republic		
Dominican Republic		
Dominican Republic		
Grenada		
Guyana		
Haiti		
Jamaica		
Jamaica		
Monserrat		



Venezuela Hydroelectric master Dominican Republic
plan
Venezuela Hydrological resource Grenada
assessment
OLADE Micro-hydro identi- Grenada
fication
1B La Chapelie hydro Haiti
Project feasibility
study
Sweden Hydro development Jamaica
1B Hydro development Jamaica
IDB Mini-hydro develop- Monserrat
ment
COB, BDD Hydro development St.Vincent.
IDB, IBRD Kabalebo hydro Suriname
Netherlands project
Belgium Micro-hydrp. Suriname
Geothermal Belgium Preliminary geo- Dominica
thermal study
OLADE Regional geo- Regional
thermal study
one

Table IV - continuation **USAID** Geothermal develop- Monserrat ment HEB Geothermal assessment St. Lucia Renewable Alternative energy CARICOM, Dominican. energy technologies Republic, ?Guyana, (general) Jamaica OAS Regional research Dominica center (suggested) UNDP/UNIDO Industrial applica~ Jamaica tion of renewable energy technologies: alternative energy Gemonstration center IDB Assessment of non- Jamaica ?conventional energy 1BRD Recycling of tube oil Jamaica EDF Alternative energy Jamaica demonstration units

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cos Demonstration faci- St. Lucla
tity
Renewable CIDA, COB Bagasse burning Barbados
energy studies
(biomass)
1B Pitot generator Barbados
coe Prefeasibility vege- Domi
table waste boiler
Brazil Technical assistance, Guyana
ethanol production
usaiD Utilization of rice Guyana
husks
IBRD Gasification of wood Guyana
waste; oil-to-charcoal
conversion of alumina
kilns
oe
Page Break
Table IV ~ continuation
SSS

1DB Utilization of wood Guyana

waste
USAID, IDB Reforestation Haiti
IDA
usain Appropriate techno- Haiti
logy center (charcoal)
1B Charcoal project Jamaica
cos Biogas production St. Vincent
from arrowroot
Renewable UN Interim Wind generators Antigua
energy fund
(wind)
Rockefeller Wind generators Antigua
Fund
coe Wind power system St. Lucia
cos Wind power system St. Vincent
Renewable COB Blogas digestors Barbados
energy
(biogas)
OLADE Biogas unit com- Grenada
parison
?ons Biogas study Haiti
Biogas demonstration Jamaica
unit. (suggested)

EDF Biogas plant St. Vincent **OLADE** Biogas study Suriname Renewable USAID/CDB_ Solar component in CARICOM, Dominican energy the regional program? Republic, ?Guyana, (solar) Jamaica Solar air condi~ Barbados toning USAID/CDB Solar collector Barbados manufacturing ---Page Break---Table IV ~ continuation IDB Research program for Dominican Republic solar USAID/OLADESolar system manufac~ Haiti ?turing OLADE Solar drying and ?Suriname heating

Institution USAID/CDB Regional project for CARICOM, Dominican,

buildis renewable energy and Republic, ?Guyana,

?organization institution building Jamaica,

18RD Energy conservation Barbados

Program

coe Energy development Dominica

plan

cos Technical assistance Dominica Republic

in energy rationalize-

tion |

we Planning and develop- Dominican Republic

ing energy resources

unP Fromulating national Grenada

energy policy

uk Energy conservation Jamaica

program

CARICOM? Energy assessemnt Monserrat

of the tourism sector

CARICOM? Technical assistance St. Lucia

for energy planning

The Soviet Union is funding oil exploration and a feasibility study for a
Commercial Nuclear Reactor in Cuba. France and Cuba have collaborate:
on @ bagasse to paper factory.
United Nations Development Programme, June 1, 1982 - Coordination of
Energy Policy in the Caribbea
J. Vardi: (UNDP Consultant)
Interciencia, InterNews Section, 1979-89, Caracas
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Footnotes
?The authors acknowledge the assistance and hospitality of the Center for
Energy and Environment Research in the preparation of this paper. The
views expressed are solely those of the authors.

1. Cuban R & D was estimated at 74 million pesos in 1977 with 948 Cu-
ban. Jamaican R & D was estimated at J\$52.6 million? in 1980-81.
Barbados R & D was estimated at \$558,000 in 1960.
There has been no regional survey of R & D and research manpower
using a uniform methodology.
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"Some Facts and Many Impressions of Science and Technology in Coste
Rica"
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Fopean Space Center in French Guyana,? It is peripheral to the
region.
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Caribbean,
20.
"Efficiency vs. Equity, Economic Policy Options in the
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CARICOM," p.282-336.
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