GENERAL
LC/CAR/G.660
18 October 2001
ORIGINAL: ENGLISH

NEW TECHNOLOGIES IN AGRICULTURE

NEW TECHNOLOGIES IN AGRICULTURE

Introduction

At the twentieth meeting of the Standing Committee of Ministers Responsible for Agriculture under the heading "Technology Generation, Validation and Transfer", the discussions centered around the formation of yet another institution – PROCICARIBE - to *"integrate and coordinate all the agricultural research and development organizations throughout the Caribbean involved in technology development, export market development and the garnering of funds in support thereof"* It is interesting to note that the above in total or parts were already the mandate of the Caribbean Agricultural Research and Development Institute (CARDI) and the Inter-American Institute for Cooperation on Agriculture (IICA). The Caribbean Council for Science and Technology (CCST) also had the area of coordination and promotion of technology as its mandate. Another network will thus be formed with the same basic weaknesses inherent in the very institutions that contributed to the network functions.

The point is made to highlight some of the fundamental problems associated with technology generation, adaptation and transfer in the subregion. It is not that there is no work being done. However, the volume of work done at the universities and other institutions is small. The fundamental problem is that the work being done does not appear in the mainstream of activities and is therefore not reported. In addition, in spite of the existence of numerous bodies entrusted with a coordinating function, there can be very little coordination, since there is very little information sharing.

Linkages

Generation, validation and transfer of new technologies in the agricultural sector therefore, remain elusive except in the agricultural sector in which extension officers make a contribution. The need to develop linkages between the agricultural sector and other sectors, especially the tourism sector, has long been recognized. It has also been established that agro-processing could play an important part in the revitalization of the agricultural sector. The problems and reasons for the absence of linkages may lie in the fact that the technological needs for revitalization has not been adequately addressed. This may also be because Caribbean agriculture is essentially characterised by a dual production, marketing and allocation process in which traditional non-food export crops and large enterprises are favoured at the expense of the domestic sector. This situation has resulted in a regional food import bill in excess of US$ 1 billion per annum. (See Table 4). This duality results in an undercapitalized small farm sector, unequal distribution of land and low levels of food security.[1]

New technologies in agriculture

The raging debate now engaging the scientific and community is centred on the role and efficacy of foods derived from Genetically Modified Organisms (GMOs). Scientific and technological advances in genetics, cytogenetics, microbial genetics, microbiology, microtechniques, cell physiology and material science have unlocked the secrets of action,

[1] Dr. L. Harlan davis, PLANLAC: Principal ideas and proposals for action. Proceedings of the seminar PLANLAC and the media. April 18, 1991, Port of Spain, Trinidad and Tobago.

reaction and expression of genes, the proteins and the activities that they control. Whereas these technologies were initially viewed as beneficial to humans, especially in the areas of health, the agricultural sector has also benefited tremendously from these new discoveries.

Micro-propagation, of course, is not new in agriculture. As far back as the 1950s vegetative propagation of plants was a well established practice in the region, with leaf cuttings replacing stem cutting as rooting material in cocoa, coffee and other plants, which itself replaced the seed. These smaller cuttings were then replaced by tissue culture that allowed for rapid multiplication of plantlets as planting material. The advantage of tissue culture over these earlier forms of propagation lies in the fact that not only can the planting materials be replicated quickly, but also the properties of these materials can be fixed and assured. Properties such as resistance to diseases, responses to fertilizer application and other growing conditions and product quality can be predetermined and fixed. It is that property of the technology that makes it so useful in the agricultural sector. The banana industry, especially in the French Caribbean islands, has benefited from this technology though its use is not as widespread as in the Windward Islands.

The ability to manipulate the properties of plants and other species is viewed with misgivings and is responsible for the concern with regard to GMOs. It is not that modifications have not taken place in the past. Gene manipulation that brought about the new varieties of wheat and corn, for example, during the "green revolution" of the 1960s did not provoke the debate now sparked by GMOs. This is so because the variations arising from the manipulations took place over a long period of time through selective crossing and breeding that occur naturally in populations. Even before the green revolution, selection of characteristics and manipulation of types were being undertaken. For example, it is not generally known that the North American apple so common on Caribbean streets, particularly at Christmas, is not the original fruit. The buffalypso, new varieties of pigeon peas and sorrel, as well as new varieties of cashew[2] that bear fruit within six to nine months are all the result of work done by regional researchers.

Irrigation also represents another area of new technology in the agricultural sector. It has long been demonstrated that sprinkler irrigation is not only wasteful and inefficient but also harmful to some crops. Flooding or furrow irrigation has not been demonstrated to be any more suitable for crop physiology or more efficient in water conservation and, particularly in small farms can cause erosion. Research into these problems has developed new methods of irrigation, notably drip irrigation, that addresses the problems of water-use efficiency, water pressure, soil modification and in addition facilitates increased uptake of fertilizer by the plants. The design of the technology takes into consideration the existence of a finite supply of water resources, the need to monitor micro-environments that do not promote the growth of harmful insects and pests, and the need to lower the cost of production by creating efficiencies in the application of inputs. The range of application is wide, from a simple system to a more one that can require initial capital injection that may be beyond the reach of small farmers.

In the animal sector new technologies are also being introduced. Artificial insemination and bloodless castration are used throughout the region. However, the debate over GMOs also has implications for that sector. Cloning is now possible and raises issues of ethics and of animal gene variability loss that is vital to the preservation of biodiversity. New hormonal applications

[2] The new cashew variety comes from Brazil

and treatments can increase growth rates, reduce the incidence of disease and enhance the appearance and nutritive values of meat and fish products, as well as increase shelf life. Gene splicing can be used to treat a number of animal health problems and new techniques in aquaculture, veterinary and animal science have helped increase the livestock and fish populations. Genetic manipulations have helped develop breeds of animals that are more suitable to local conditions. These new advances are, however, not without risks, as is evidenced by the outbreak of "mad cow disease", which was triggered by the use of infected products in the animal feed. The new technologies in the plant sector have also benefited the livestock sector as new varieties of grass, augmented by new irrigation technologies, have produced feeds for animals resulting in improved quality meat.

The role of energy in economic development

No country or productive sector has developed without an adequate and reliable supply of energy. Table 1 highlights the energy consumption per capita of selected countries. It may be used to compare the consumption rates of the more developed economies with those of less developed economies as exists in the Caribbean. To a great extent the urban-rural divide that exists in most societies is delineated by energy supply. With particular reference to agriculture, the slow pace of development and diversification in the rural areas can be attributed to the lack of energy (electrical) to enable the utilization of machinery and equipment. It is therefore very common for raw materials to be transported from rural to urban areas for processing. An adequate water supply is also a vital requirement at the processing stage and whereas sources can usually be found in the rural areas, without proper treatment, they may not meet the required standards needed for processing. The slow pace of diversification as well as the high cost of production of agri-products may be attributed to both the lack of a reliable source of energy and good water quality at farm gate.

Table 1
Energy consumption per capita

Economy	Kg of oil equivalent		Avg. annual % growth
	1980	1996	1980 - 1996
Canada	7,848	7,880	0.3
Costa Rica	669	657	0.7
Haiti	392	268	-2.8
Jamaica	1,115	1,465	2.3
New Zealand	2,972	4,388	2.9
Panama	957	853	-0.3
Papua New Guinea	-	-	-
Singapore	2,653	7,835	8.1
United States of America	7,973	8,051	0.4
Latin America & the Caribbean[3]	1,062	1,163	2.4

Source – World Development Report 1999/2000: Selected development indicators

[3] Represents the average for the region.

New technologies in the energy sector

With the exception of Trinidad and Tobago the small Caribbean countries are all heavily dependent on imported fossil fuel to meet their energy needs. There are, however, ample sources of renewable energy supplies that can be harnessed to meet those needs, though the policy considerations of the utilization of these technologies have not gained favour in the region. There are some efforts by private individuals, primarily at the University of the West Indies (UWI), to promote renewable energy use, and a few entrepreneurs have taken up the challenge, especially in the development of solar energy projects. However, the utilities, the major providers of energy in the region, have generally shied away from renewable energy use. There is the exception to this in the few cases of those providers who operate hydro-power plants, that are unfortunately affected by lack of sufficient water flow due to deforestation and the concomitant reduction of surface water. Table 2 provides details on energy consumption in the Caribbean.

Table 2
Primary Energy Consumption in the Caribbean 1999

Country	Total (quadrillion btu)	Petroleum	Natural Gas	Coal	Other
Antigua & Barbuda	0.006	100%	-	-	-
Bahamas	0.048	100%	-	-	-
Barbados	0.020	95%	5%	-	-
Cuba	0.386	93%	5%	1%	1%
Dominica	0.002	78%	-	-	22%
Dominican Republic	0.195	92%	-	3%	5%
Grenada	0.002	100%	-	-	-
Guadeloupe	0.025	100%	-	-	-
Haiti	0.022	85%	-	-	14%
Jamaica	0.156	96%	-	1%	1%
Saint Lucia	0.003	100%	-	-	-
Saint Vincent & the Grenadines	0.002	90%	-	-	10%
Trinidad and Tobago	0.400	12%	88%	-	-
Average	**0.097**	**87.77%**	**6.77%**	**0.08%**	**0.77%**

Source: Caribbean Fact Sheet. Department of Energy, USA

Of the new technologies available it would appear that hydro, solar, wind and biomass would most benefit the agricultural sector in the region although each may be site and activity specific. At present, only Cuba (0.4 billion kWh) and Jamaica (0.7 billion kWh) have significant amounts of power generated from geothermal, solar, wind, wood and waste electric sources. The Dominican Republic was the largest producer of hydroelectricity in 1999. The level of 0.9 billion kWh was greater than the combined output of Cuba, Haiti, Jamaica and Puerto Rico. It should also be noted that in 1999, the Caribbean was the destination for about 2.3 percent of solar thermal collectors exported by the United States. Table 3 shows the Installed Capacity of electricity generated from renewable sources in Caribbean countries during 1999. The net generation is shown for purposes of comparison.

Table 3

Country	1/1/99 Installed Capacity (million kW)	1999 estimated net generation (billion kWh)
Antigua & Barbuda	0.03	0.1
Bahamas	0.40	1.47
Barbados	0.17	0.72
Cuba	4.34	14.36
Dominica	0.02	0.06
Dominican Republic	2.20	7.29
Grenada	0.03	0.12
Guadeloupe	0.42	1.30
Haiti	0.24	0.67
Jamaica	1.19	6.53
Saint Lucia	0.02	0.09
Saint Vincent & the Grenadines	0.01	0.08
Trinidad and Tobago	1.25	4.90
Total	**10.422**	**38.15**

Source: Caribbean Fact Sheet. Department of Energy, USA

The nature of Caribbean agriculture

For the most part, Caribbean agriculture, with the exception of that of Belize, Guyana, Suriname and to a lesser extent Antigua and Barbuda, Barbados and Trinidad and Tobago, is restricted to mainly cultivation on hillsides and without irrigation. While in these above-mentioned countries a relatively high percent agricultural activity is on flat land, most of the activities are in primary production, with the exception of major rum industries that are based around sugarcane production. The major crops, sugarcane and bananas, differ markedly, in that sugarcane is a seasonal crop whereas bananas can be harvested year round. Other tree crops such as coffee, cocoa, coconuts and nutmeg are perennials. Unfortunately, presently crops are affected by depressed market conditions and the state of agriculture in the region is not as healthy as it could be. The region also produces an abundance of fruits and vegetables, but because of high production costs, unreliability of supply and an acquisition of foreign tastes by the population, there is high competition from imported fruits and vegetables. Table 4 offers a comparison of the value of total agricultural imports and exports in selected Caribbean countries for the year 1999.

Diversification efforts in the agricultural sector have not been successful for a number of reasons. With the exception of Guyana, Suriname and Belize land size is a critical factor for the support of large multi-crop cultivating. Even when the amount of land available for use land is not a prohibiting factor, the agronomy of the new crops and the general knowledge of these crops are lacking. Another problem is the lack of institutions to support research and development either with respect to established crops or those that might be introduced. This is more a problem of finance rather than manpower and apply to both small and large States of the region.

Table 4
Value of total agricultural imports and exports 1999

Country	Agricultural Products Total Imports (000 US $)	Agricultural Products Total Exports (000 US $)
Antigua & Barbuda	30,205	410
Bahamas	224,345	83,321
Barbados	165,179	75,923
Aruba	72,409	12,927
Cuba	545,160	676,380
Dominica	27,584	22,108
Dominican Republic	543,313	332,094
Grenada	30,766	20,459
Haiti	297,393	22,575
Jamaica	403,288	294,359
Montserrat	5,152	19
Netherland Antilles	180,509	16,367
Saint Kitts and Nevis	20,581	10,178
Saint Lucia	66,887	38,114
Saint Vincent & the Grenadines	28,379	37,235
Trinidad and Tobago	307,313	221,262
Br. Virgin Islands	8,013	16

Source: Food and Agriculture Organisation (FAO) Database. Copyright FAO 1990-1998

The agricultural sector in the Caribbean is based on primary production. Primary produce, including fruits dominates agricultural activity and diversification projects have tended to address alternative crops rather than increase products from the crops grown. There is some activity in agro-processing but it remains small in comparison to total activity. It has been suggested that the lack of institutions and funding for research and development may be a critical factor in this lack of value added activities. One cannot, however, discount the taste preferences for imported food items by the general population. For example, although banana ketchup is readily available on the local market, few people buy it preferring instead tomato ketchup, not realizing that banana puree makes up a large proportion of the tomato ketchup base. The local sweet potato is as good a product for baking, but the preference is for what is called "English" or "Irish" potato. In fact, most Caribbean countries are attempting to grow the "English" potato instead of using the sweet potato or breadfruit, another acceptable substitute. Slavery, which is responsible for inhabiting the region has undoubtedly left an indelible mark on the taste of the population and, by extension, may have contributed to the lack of development of agro-processing in the region.

Because the emphasis has been on primary production technological development in the agricultural sector has been slow, with new initiatives taking place in the crop agronomy and, to a lesser extent, in post-harvest research. Thus, for the banana industry in the Windward Islands, a research arm of Windward Islands Banana Growers (WINBAN) was established to do work on propagation and cultivation technologies, with funding from member countries and the European Union. Work done by WINBAN has resulted in the introduction of new varieties, improved fertilizer application, weed and pest control regimes, as well as quality control programmes.

On the other hand, the Produce Chemist Laboratories, established during the 1970s in most Eastern Caribbean countries to promote agro-industrial research, have been left virtually untouched and woefully short of financial and manpower resources. Agro-processing and post-harvest technologies have been left to the imagination of farmers and to a number of small entities who provide assistance to small business. However, except for the Bureaux of Standards, which are often under-staffed, there is no recognized institution that can conduct research and provide information and technology to small business on a sustained basis in the smaller States. Notwithstanding the existence of some laboratories and other institutions in Guyana, Jamaica and Trinidad and Tobago, these have not been overly successful in transforming the agricultural sector, primarily due to lack of long-term programming and appropriate funding levels. There are, however, a number of hot sauces, jams, jellies, and even wine produced in the Caribbean, but few have been able to meet international standards so as to be able to compete either in the regional market or globally. There is also the perennial discussion on the sustained availability of raw materials or the scale of operations for economic considerations. However, with appropriate technological interventions as well as the identification of strategic niche markets, both these problems can be overcome, as has been done in other parts of the world, including Costa Rica.

Other problems encountered in introducing post harvest technology in agriculture are the availability and reliability of such infra-structural outlays as water supply and energy. No serious consideration can be given in relation to the erection of plants and factories without either of these elements. The presence and availability of these in the urban areas and their absence in rural areas where the crops are grown tend to increase the cost of production. Produce must be transported from the rural areas to the urban areas for processing, a factor that makes the finished product cost non-competitive.

Renewable energy technologies that can close the gap

Though the majority of Caribbean households are supplied by electricity, there are still a large number of homes without access to electricity, in most cases because of the high cost of providing the service. With the energy needs of the region primarily met by non-renewable sources it is unlikely that costs will decrease or that major rural electrification programmes will become so cost-effective that the energy component in any production process in the rural areas will allow it to be competitive. That being the situation, a case can be made for the introduction of energy technologies that are more convenient and adaptable to the rural setting. The problem remains, though, that unless the electricity utility itself begins to factor in those new technologies into its mainstream generation programme, it is not likely that it will relinquish the monopoly presently held, into the hands of private concerns.

Over the past ten years a number of institutions have taken up the responsibility of providing information, training and pilot projects to introduce these new technologies to the region. In this regard, the promotional work of the Caribbean Solar Energy Society has been successful in persuading some governments to grant concessions to manufacturers and users of solar water heaters. Unfortunately, the Society has not been successful in encouraging the utilities to take a broader view of energy security in the Caribbean by reducing their dependency on imported hydrocarbons and incorporating sources of solar, wind and geothermal into the energy equation.

Ironically the three above-mentioned sources of renewable energy are all in use in the region but on islands of limited agricultural activity. A geothermal plant is in operation in Guadeloupe, a wind farm is operating in Curaçao and a solar system has been established in St. Johns in the US Virgin Islands. From the perspective of cost, these installations have not proven to be more expensive than conventional energy sources though, their technological challenges and reliability needs to be mastered. Because the emphasis is placed on meeting the energy needs of the urban sector, new technologies that can improve the prospect of rural areas for industrialization and also increase crop production have not been given serious consideration.

It is a recognized fact that the annual yield of most of the crops grown in the region can be increased through irrigation. However, since the majority of those crops are grown on farms that are not close to electricity sources, though close to water sources, traditional diesel pumps for irrigation continue to be the norm, with all the problems inherent in providing fuel on a continuous basis. Even where electrical power is available for the pumps, the cost of electricity increases production costs to the point where local produce becomes more expensive than their imported counterparts. It is not being argued that the introduction of renewable energy by itself will reduce production costs. What is being suggested is that a ready source of energy in rural areas will generate activities both within and outside the agricultural activities that can increase farm income and therefore improve the efficiency of the sector. This aspect is often overlooked in the analysis of the agricultural sector when compared to the tourism sector in the Caribbean. In our analysis we tend to remove manufacturing activities from the agricultural sector even when they are by-products of agricultural activities. Available technologies and their possible applications are highlighted below.

Solar/thermal

Technological advances in this area of renewable energy have improved since their introduction. More efficient solar cells resulting in the need for fewer panels makes this technology more cost effective and efficient than 20 years ago. Research on the life-span of the cells has also removed the need for frequent replacement and advances in material science have contributed to the overall improvement of this as an energy source. As a result, greater efficiencies are being achieved with smaller units which continue to reduce the unit cost, making it competitive in operations using conventional energy sources. With these improved factors solar systems can be used in the agricultural sector to:

(a) Provide the energy for pumping water for irrigation;
(b) Reduce the time needed to dry crops and allow the drying process to take place even under some adverse conditions thereby controlling the drying process and the resultant end product; and
(c) Manipulate the environmental and/or physiological processes that can affect productivity in some plants and animals.

With respect to (a) there are now pumps that are designed to operate on solar panels that can pump water into a holding tank for distribution either by gravity fed drip irrigation or furrows into the field. The advantage of such a system is that it will bring water conservation measures immediately into consideration, since it has been shown that water is wasted through the use of sprinkler irrigation where pressure is not a factor. An added benefit is that, once installed, the system is almost maintenance free. It removes the need for refueling in the case of fuel pumps making it environment-friendly.

Wind

Research in material science has greatly improved technologies for wind turbines and for increasing the efficiency and life-span of generators. In the older turbines it was necessary to inspect and service on a regular basis and problems associated with rusting and metal fatigue were experienced. New generation turbines have dealt with these problems and it is now possible to have larger turbines of about 500-1000kwatt with 15- year maintenance-free warranties.

Overcoming these problems, of course, does not obviate the need for information on wind direction, speed, availability, patterns and other factors. While the intensity and frequency of sunlight is fairly predictable, this is not the case with wind. Extensive tests must be conducted to determine the suitability of sites. Another limitation refers to the fact that the turbines have to be mounted on turrets, which are exposed and therefore subject to the adverse effects of hurricanes, especially in the tropics. These are two serious limitations of wind energy but once overcome, wind as a source of energy can be as cost effective and environmentally friendly as solar energy. Unlike the solar systems, wind energy can be used in large-scale irrigation as well as on the small-scale irrigation projects in the energy sector. In addition, because more energy is produced,.wind energy can be used for agro-processing activities and for household use. In that respect, when, of course, climatic conditions are favourable, wind energy projects can promote multiple aspects of community development.

Biomass

Biomass is a by-product of agricultural activity, that can also provide energy to the agricultural sector. The technology is directed to the utilization of waste to generate gas for household use, primarily for cooking. The technology also exists for the generation of electricity from other plant products. However, unless plant farms are established specifically for that purpose the use of that technology, under existing conditions of farming would create more environmental problems instead of contributing to increased agricultural productivity. Such a programme would require a high level of investment, management and commitment on the part of the farmers and it is unlikely that these can be achieved under the present situation of agriculture in the region. Early attempts at bio-gas technology have failed in the region precisely because of these problems, and the poor state of the forests in Haiti is a result of the indiscriminate and unplanned use of trees for the supply of cooking fuel.

Bio-gas technology, however, can be used in conjunction with other technologies on the farm especially on animal farms where the need for sanitation is urgent and where the system can provide a clean source of fuel using the waste from the animals and plant materials. However, further research is needed to develop smaller digesters and systems to meet the needs of the small peasant farmers if the use of the technology is to be enhanced.

The applicability of these energy sources to the small farm situations in the region will require a change not only in the farming methods employed, but also in the approach to farming and the concept of the farming communities in the region. The technologies would be more useful if used at the community level. With the cost of installation probably beyond the reach of the average farmer, a new cooperative and collaborative spirit will have to be nurtured and developed at the community level in order make capital use of these new technologies. Table 5 sets out to compare production costs at new plants by energy resource.

Table 5
Production cost per kilowatt hour of energy resources[4]

Power Plant Technology	$/kWh
Pulverised sub-bituminous coal	$0.037
Natural gas combined cycle turbine	$0.040
Pulverised bituminous coal	$0.041
Wind turbine – Class 7 winds	$0.042
Wind turbine – Class 5 winds	$0.061
Wood waste boiler	$0.088
Geothermal	$0.093
Municipal solid waste	$0.118
Solar thermal	$0.210
Photovoltaic	$0.270

Source: Resources Data International, Inc.

Caribbean agriculture in the future

Caribbean agriculture, if it is to be a contributing sector to regional development, will have to, inter alia:

(a) Radically transform itself to place more emphasis on agro-processing;
(b) Adopt a more integrated approach to pest control and management;
(c) Reduce post harvest losses;
(d) Reduce the use of inorganic fertilizers and promote the use of organic manure;
(e) develop and utilize soil enhancing crops, on a larger scale.

Caribbean agriculture must be linked to food production and food security, therefore, the necessary research in home economics, food preparation, nutrition and agri-business must be undertaken with a view to satisfy the tastes of the various sectors of the population, rich and poor, foreign and local. It must also establish linkages with the tourism industry to take advantage of the higher earnings associated with this sector, as well as reduce the food import bill of the region.

In order to bring about that transformation, the traditional precepts of agricultural production for export purposes must be replaced by the new concept of processed products for export. Only pointed injections of technology can bring about that transformation and the application of renewable energy to agriculture can play an important role in that process. Policies must be established to provide for independent producers of energy when the national grid does cater to the needs of farmers. Incentives must be provided to persons and institutions interested in doing research, especially on product development and transformation. Such incentives can take the form of tax holidays, or tax credits.

For Caribbean agriculture to contribute significantly to development, it must be able to *inter alia,* satisfy the food and nutrition needs of the region, as well as export excess produce. Previous agricultural policy has not been that direction. Agriculture in the Caribbean has always been regarded an export activity for the generation of foreign exchange and agricultural policy

[4] For comparison purposes only. Does not represent existing or depreciated plants. Includes $0.15/kWh United States federal subsidy for renewables.

has been developed to support that objective. Thus, when another activity is perceived to be able to provide foreign exchange to the region, policy is quickly changed to favour that new enterprise at the expense of agriculture. Such is the situation in the region that agriculture has to compete with tourism, with export processing zones or electronic assembly plants for scarce State resources and the attention of policy makers. A more rational policy would have been for agriculture to provide the platform for manufacturing to and complement the resources that these other activities could bring to the State. This would require a view of agriculture that places it at the centre of economic activity whose first and foremost responsibility would be the provision of food and fibre to the population. In that context the necessary research and development for product transformation, for post harvest research and for marketing of products could be undertaken, as is done for tourism.

It is interesting to note that in the developed countries domestic farm policy takes precedence over international policy, macroeconomic policy and resource policy. In fact, in one country it has been noted that domestic farm policy is the bread and butter of agricultural and food policy. Seen in that context, a more holistic approach to planning for the sector would, of necessity, be the norm. Concerns for nutrition, healthcare, farm amenities and for the farm family to adequately house, feed and educate itself would drive the policy agenda. This is where technology would be an important component of farm policy. The emphasis would be on farm income rather than on commodity prices. Therefore, the total operations of the farm and the total products that can be derived from them in order to increase income would drive the research agenda for new products and the capturing of the upscale market products.

A serious deficiency in Caribbean agriculture is the lack of research and technology institutions that are mandated and supported by public funds to carry out research and development work. Most ministries of agriculture in the region are under funded with the larger percentage of their funding allocated to salaries and maintenance. The Produce Chemist Laboratories in the Organisation of Eastern Caribbean States (OECS), Caribbean Agricultural Research Institute (CARIRI) in Trinidad and Tobago, the Scientific Research Council (SRC) in Jamaica and the Institute of Agriculture, Science and Technology (IAST) in Guyana have as their mandates the undertaking of research and development. However, these institutions are under funded and under staffed. Some effort is being undertaken at the University of the West Indies, but the University projects itself more as a teaching institution rather than as a generator of knowledge and products. That may be so because, too of funding problems. For example, there is no division of Home Economics at the University and the work being done in agro-processing is not under the aegis of the Department of Agriculture of the University. This is, of course, the complete opposite of what obtains in developed or even some developing countries where university research work sets the pace for development. The State Colleges and Agriculture and Manufacturing (A&M) universities play that role in the individual States of the United States of America, and the Institute of Food Technology and Applied Sciences in Costa Rica plays a similar role.

Another weak component of agriculture in the region is the extension service. With a weak research and development base to support extension and with extension concentrating on the agronomy/cultivation of the export crop, much of the time is spent advising on production technologies which, of course, do not change quickly. Extension work is not seen as necessary for the promotion of the development of the farm family. Instead it is seen as a necessity for the production of the crop. There is no link between food and nutrition, between marketing and post-harvest concerns and between crop production and cost accounting and book keeping. Farm

management and family income management have no complementarity under the present extension ethos. That disjointed approach to the farm and the farm family is a serious threat to modernization and to the sustainability of agriculture in the region.

From the above then it would seem that the solution to sustainable growth and development of the agricultural sector is simple. It suggests that emphasis needs to be placed on product development in the agricultural sector, equal to the corresponding emphasis that now exists on crop production. New thinking on the role of local and regional agriculture in meeting the nutritional needs of the region must inform the policy choices, rather than generation of foreign exchange from the primary product approach, now prevalent in the region. This would require the establishment or maintenance of institutions of research to transform crops into products. The farm energy needs would also be addressed and the introduction of technologies that are appropriate to the farm setting would be promoted. Hence new technologies in energy, and related farm inputs would be promoted to increase the efficiency of operations and levels of farm incomes. This new dynamism would be supported by the educational system at all levels and the corresponding linkages would be made with the other sectors such as tourism and manufacturing to promote and enhance the industrial development efforts of the region. With these supporting systems in place and a revitalization of the industry, policy makers in individual States will have greater latitude of action to meet the needs of their respective countries and to take decisions that appropriate to their constituents within the framework of regional complementarity, cooperation and collaboration. The extension service must be strengthened and integrated to be attentive to farm family issues and concerns and not only to crop or livestock production. The agricultural officer must work hand in hand with the home economics officer, the Health Officer and the Community Development Officer, each one promoting his role where and when necessary. Local farmers, too, will be able to participate in the decision-making and implementation processes, where they can appreciate and note a direct relationship between their activities, their governments policies and the income and other benefits that accrue to them in the process. This new approach will require a transformation of minds as well as that of the education system. Unless this is undertaken, the agricultural sector will contribute even less to the national and regional economies than at present, and should be a major cause for concern by policy makers.

Sources

Ahmed, Belal and Afroz, Sultana – The political economy of food and agriculture in the Caribbean. Ian Randle Publishers and James Currey Publishers. 1996.

Caribbean Food and Nutrition Institute. Annual Report 1998.

De Janvry, Alain. Dethier, Jean-Jacques. Technological Innovation in Agriculture. The political economy of its rate and bias. Consultative Group on International Agricultural Research (CGIAR). Study Paper Number 1. The World Bank. 1985

Draft summary of recommendations and conclusions of the twentieth meeting of the Standing Committee of Ministers responsible for agriculture. Belmopan, Belize. 26-29 May 1997.

Energy transition in developing countries. The World Bank. Library of Congress Cataloging in Publication data. 1983.

Hanley, Nick – Farming and the countryside. An economic analysis of external costs and benefits. CAB International. 1991.

Heduit, Michele. La filiere biogaz dans les pays en developpement. Institut de l'energie des pays ayant en commun l'usage du francais. 1993

Hodson de Jaramillo; Elizabeth, Aramendis-Ramirez, Rafael; Zuritz, Carlos A. – Procesamiento y conservacion de alimentos en America Latina y el Caribe. Volumen I. 1996

Knutson, Ronald. D, Penn, J.B., Boehm, William T – Agricultural and food policy. Prentice-Hall Inc. 1990.

Proceedings of the seminar – PLANLAC and the media. Inter-American Institute for Cooperation in Agriculture (IICA). April 18, 1991. Port of Spain, Trinidad. 1992.

Sayigh, A.A.M – Renewable Energy – Climate Change, Energy and the Environment. World Energy Renewable Congress. 11-16 September 1994, Reading, UK.

Transformation of Agriculture: Caribbean Community. Caricom Secretariat. 14 June 1996.

Wilson, Rhonda G. – Proceedings of the Caribbean high level workshop on renewable energy technologies. December 5-9, 1994. Saint Lucia.

Zuritz, Carlos A. - Procesamiento y conservacion de alimentos en America Latina y el Caribe. Volumen I. 1997