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

NEW TECHNOLOGIES IN AGRICULTURE

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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