



Caribbean Agricultural Research and Development Institute



CARDI's contribution to agricultural research and development, food production and reduction of poverty and hunger



Belize

Country Highlights

Count 2008 ights

CARDI

Improving Lives Through Agricultural Research

BELIZE

COUNTRY HIGHLIGHTS REPORT 2008



SEPTEMBER 2009

CARIBBEAN AGRICULTURAL RESEARCH AND DEVELOPMENT INSTITUTE
CENTRAL FARM, WESTERN HIGHWAY, CAYO DISTRICT
BELIZE

TABLE OF CONTENTS

	Page
List of Acronyms and Abbreviations	ii
Message from the Country Representative	1
Review and Update of Agricultural and Rural Sectors	3
Implementation of the MTP, 2008/2010	5
Highlights of Workprogramme 2008	5
Strategic Axis 1: Development of Sustainable Industries	6
Strategic Axis 2: Development of Strategic Linkages	16
Strategic Axis 3: Institutional Strengthening	17
Staff Members	19

LIST OF ACRONYMS AND ABBREVIATIONS

ASR	Asian Soybean Rust
BAHA	Belize Agricultural Health Authority
BMDC	Belize Marketing and Development Corporation
BOPA	Belize Organic Producers Association
BSI	Belize Sugar Industry
CARDI	Caribbean Agricultural Research and Development Institute
CGA	Citrus Growers Association
CIMMYT	International Maize and Wheat Improvement Center
CREI	Citrus Research and Education Institute
CTV	Citrus Tristeza Virus
CUN	Critical Use Nomination
DBM	Diamondback Moth
DFC	Development Finance Corporation
EM	Effective Microorganisms™
FAO	Food and Agriculture Organization
IAEA	International Atomic Energy Agency
IFPRI	International Food Policy Research Institute
IICA	Inter-American Institute for Cooperation on Agriculture
IPM	Integrated Pest Management
LSD	Least Significant Difference
MAF	Ministry of Agriculture and Fisheries
MBTOC QSC	Methyl Bromide Technical Options Committee Quarantine, Structure and Commodities
MOU	Memorandum of Understanding
MTP	Medium Term Plan
NCCARD	National Coordinating Committee for Agricultural Research and Development
PCB	Pesticides Control Board
R&D	Research and Development
RKB	Red kidney bean
TEAP	Technology and Economic Assessment Panel
TGL	Trunk girdling lava
UNEP	United Nations Environment Programme
WTO	World Trade Organization
WWF	World Wildlife Fund

MESSAGE FROM THE COUNTRY REPRESENTATIVE

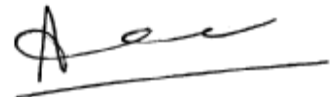
The food and financial crisis of 2008 developed from different underlying causes, but they are becoming intertwined in complex ways through their implications for financial and economic stability, food security, food sovereignty, and political security. Over the past two years, the price of nearly every agricultural commodity increased sharply, creating a food price bubble. At their peaks in the second quarter of 2008, world prices of wheat and corn, for example, were three times higher than at the beginning of 2003, and the price of rice was five times higher. In the past few months, the economic slowdown and favourable weather conditions have pushed the prices of major cereals down by about 40 per cent, but they remain high compared with three years ago. A reduction of food prices is not evident in Belize, but this short-term price relief is insufficient to ensure that the poor have access to adequate amounts of nutritious food. These crises pose challenges and opportunities for agriculture. After decades of underinvestment in the agricultural sector, high food prices have provided some incentives for policy-makers, farmers, and investors to increase agricultural productivity. Investments should be made in agricultural research and development (R&D), rural infrastructure, rural institution, and information and sharing. A recent study by IFPRI shows that if investments in public agricultural research doubled from US Dollar (USD) 5 to 10 billion from 2008 to 2013, agricultural output would increase significantly.

CARDI has been playing its role in the current food security and sovereignty crises being experienced, especially through its research in corn and bean varieties. The CARDI cereal and grain legume crop research and development programme is aimed at improving the production and marketing of cereal grains in Belize by focusing on the annual evaluation of corn and bean varieties to identify ones that perform better than the ones that are currently being planted, the identification of appropriate IPM practices for improved quality and quantity of yields, the production and marketing of quality seed of selected varieties to meet the seed demand of small and medium sized producers and the development of handling and storage systems to reduce post-harvest losses at the small farm level. In 2008, greater focus was placed on bean varietal trials than in previous years.

CARDI wishes to acknowledge with appreciation the collaboration and strong support readily given at all times by the Government of Belize. The Minister of Agriculture and Fisheries, Hon. Rene Montero provided his full support, and the Ministry of Agriculture and Fisheries (MAF) continued to be our main partner. The Institute is especially grateful to the Chief Executive Officer in the Ministry of Agriculture and Fisheries, Mr Gabino Canto, for his support in addressing many of the agricultural research and development problems of Belize and the Region.

Mr. Eugene Waight, Chief Agricultural Officer; Mrs. Francine Magloire, Director of Projects; Mr. Ricardo Thompson, Coordinator of Extension; Mr Neville McAndrew, Director of Research and Development and Mr. Manual Trujillo, Coordinator of Crops; and their staff in the MAF continued to provide help and collaboration.

Our gratitude is also extended to the many persons and organizations, including participating farmers, whose support, cooperation and kind wishes enabled us to successfully execute our work programme in 2008.

A handwritten signature in black ink, appearing to read 'Anil K. Sinha', written over a horizontal line.

ANIL K. SINHA
CARDI Representative, Belize

16 March 2009

REVIEW AND UPDATE OF AGRICULTURAL AND RURAL SECTORS

Agriculture has been an important industry, particularly the production of export crops such as sugarcane, bananas, and citrus fruits, which represent more than 80% of agricultural production value. Belize has approximately 107,242 ha (265,000 acres) of farmland (roughly 5% of the total land area), of which 59,084 ha (146,000 acres) are used for crops and 48,158 ha (119,000 acres) for pasture (Green, 2007). In addition to plantation and export crops, thousands of small farmers rely on agricultural production to sustain their livelihoods and provide for their families. There are over 11,000 farmers in Belize, 75% of which are small farmers with holdings less than 4 ha (10 acres). The main crops for domestic consumption are rice, corn, and red kidney beans, although the domestic agricultural base has become increasingly diversified in recent years to include significant areas of onions, hot peppers, cabbage, and other crops.

The expansion and improvement of agriculture is one of the principal aims of national development planning. The Department of Agriculture of the Ministry of Agriculture and Fisheries maintains an Extension Service with officers posted in all districts. Agricultural research is conducted at the Central Farm Research Station into a variety of tropical crops, livestock and pasture. Agricultural research is also done by other non-governmental bodies, such as the Caribbean Agricultural Research and Development Institute (CARDI) and the Taiwanese Mission, within the country. The Ministry provides mechanical services while

Belize Agricultural Health Authority (BAHA) provides veterinary and quarantine services to farmers. Other government services include the Belize Marketing and Development Corporation (BMDC), which operates in the buying and selling of producers' rice from the Toledo District, and the Development Finance Corporation (DFC) and Small Farmers and Business Bank offer credit to farmers, among others.

During 2008, Belize's agriculture export earnings remained stagnant at BZ\$ 334.60 million due to decreases in sugar, citrus, shrimp and papaya exports. Export growth was higher for banana, non-shrimp fisheries products and red kidney beans/blackeye peas. The October flood, caused by Tropical Storm number 16, resulted in a significant drop in production of basic grains. The notable exception was sorghum, output of which rose by 55.9% to 10.7 million kg (23.6 million pound) as farmers substituted it for yellow corn and soybean, thereby increasing the area under its cultivation from 2,880 to 5,392 ha (7,116 to 13,325 acres). Annual production of corn, the grain hardest hit by the floods, declined by 17.7% to 36.4 million kg (80.0 million pounds), with harvested acreage and average yield per acre down by 10.9% and 7.9%, respectively (Annual Report 2008, Central Bank of Belize). Low yields and acreage due to the adverse weather conditions also contributed to a 35.0% reduction in rice output, while that of soybean plummeted by 93.5% to 0.05 million pounds as acreage shrank from 196.3 ha (485 acres) to 18.2 ha (45 acres) with the switch by farmers to sorghum. Bean production registered a 1.0% decline to 7 million kg (15.4 million pounds).

Production of vegetables, root crops and plantains was mixed. While output of onions, squash, okra, sweet pepper,

pumpkin, carrots, tomatoes, coco yams and sweet potatoes rose, decreases were recorded for lettuce, cauliflower, celery, cassava, ginger, yam and yampi. Plantain output surged by 143.6%, with increases of 13.0% in acreage and a more than doubling in yields.

Notwithstanding some floods loss in small animals, livestock production did well overall. Cattle dressed weight increased by 19.1% to 3.8 million kg (8.4 million pounds) in response to strong, internal demand. Pig dressed weights grew by 10.4% to 8.9 million kg (19.6 million pounds), while that of poultry declined by 25.9% to 12.6 million kg (27.8 million pounds) as high feed costs prompted processors to grow smaller chickens. An additional problem was presented to the industry by the emergence of poultry Newcastle disease that may have been borne by flood waters from Guatemala. Milk output rose by 7.9% to 3 million kg (6.6 million pounds) and egg production also increased by 14.4%. In contrast, honey yields declined by 38.0% to 45,000 kg (100,000 pounds).

Annual marine production fell by 11.4% as a fall-off in farmed shrimp overshadowed a higher conch catch and significant increases in tilapia and Cobia fish.

The Ministry of Agriculture and Fisheries was instrumental in the introduction of protected covered structure to produce off-season vegetables. California Red earthworms were re-introduced for organic vegetable production. Forty farmers and three Extension Officers attended the BEJO Vegetable Seed Company Field Day in Guatemala with the purpose of learning the latest technology developed by the company. One low-cost potato storage facility was built to demonstrate to farmers an appropriate technology to store potato for

seed and human consumption. Two rice variety trials were established to evaluate tolerance level to *Spinki* mite, which was recorded for the first time in Belize in the latter half of 2007.

CARDI Belize specializes in research and development on cereals and grain legumes, mainly corn, soybean, peanut, red peas and cowpeas. Additionally, CARDI Belize is involved in the production of nucleus and commercial seeds of hot peppers. It also maintains and manages germplasm banks of the cereals and grain legumes, as well as vegetables that can be accessed by the Region to aid in the recovery of food production after natural disaster.

The focus of the Citrus Growers Association's (CGA) Citrus Research & Education Institute (CREI) is to work with citrus growers and others to develop, implement and share technology that leads to sustainable citrus farming systems. The extension unit continued with the practice of responding to grower's requests for field visits in addition to organized farmer field trips to the CREI rootstock trial. There was an increase in the demand for budwood and plants to the industry. Eighteen varieties of citrus, new to Belize, were imported to increase the range of variety types available to growers. The programme to test budwood multiplication blocks in the industry for citrus tristeza virus (CTV) revealed that around one percent of the multiplication blocks trees had become infected with CTV. Those trees were destroyed. An industry-wide survey was conducted to identify signs of four devastating citrus diseases - citrus canker, citrus leprosis, citrus variegated chlorosis and huanglongbing (citrus greening) - that are present in the Region but not in Belize. There was no evidence of those diseases in Belize. A technical support grant was

obtained from the International Atomic Energy Authority (IAEA) for the Mexican Fruit Fly Project and work began to collect fruit-fly population data in the South Stann Creek areas of the citrus industry. Collaboration with World Wildlife Fund (WWF) continued with the project to develop better weed management practices for the industry.

IICA supported and facilitated the implementation of the Agro-Plan 2003-2015 through the establishment of a monitoring mechanism for agriculture and rural life in order to identify trends, threats, critical emerging issues and opportunities. IICA continued to provide logistical support for Belize's participation at the World Trade Organization (WTO)/Sanitary and Phytosanitary fora. Through the technical support from the IICA Canada Office and IICA Headquarters, an expert in Avian Influenza visited Belize to share the Canadian experience with members of the Belize Poultry Association, BAHA and governmental officials.

The Belize Sugar Industry (BSI) and the Belize Sugar Industry Control Board are providing research and technical support to sugarcane producers. BSI has continued to evaluate varieties for high yield and disease resistance, pest and disease management.

IMPLEMENTATION OF CARDI'S MEDIUM TERM PLAN 2008/2010

CARDI's current work programme has been guided by CARDI's Medium-Term Plan (MTP) 2008-2010. The 2008-2010 MTP and annual work programmes are organized

around three *Strategic Axes*: Strategic Axis 1 – Development of Sustainable Industries, Strategic Axis 2 – Development of Strategic Linkages and Strategic Axis 3 – Institutional Strengthening. These Strategic Axes are the first tier of the hierarchical framework of the MTP and, accordingly, provide the foundation upon which the portfolio is constructed. They are distinctly separate but interdependent Strategic Axes and drive the Institute's initiatives in the conduct of its mandate. As a consequence, each Strategic Axis is described by goals, objectives, activities and expected results at the institutional level. The Country work programmes take their cue from these institutional framework elements.

HIGHLIGHTS OF WORKPROGRAMME 2008

CARDI's workprogramme for 2008 spanned two cropping seasons, the November/December 2007 planted crop which was harvested in March/April 2008, and the June/July 2008 planted crop and harvested in September/October 2008. One notable feature of 2008 was that the precipitation recorded for most of the months - except July, August and November 2008 - at Central Farm, Cayo District was way above the ten-year average precipitation for 1994-2004 (Figure 1).

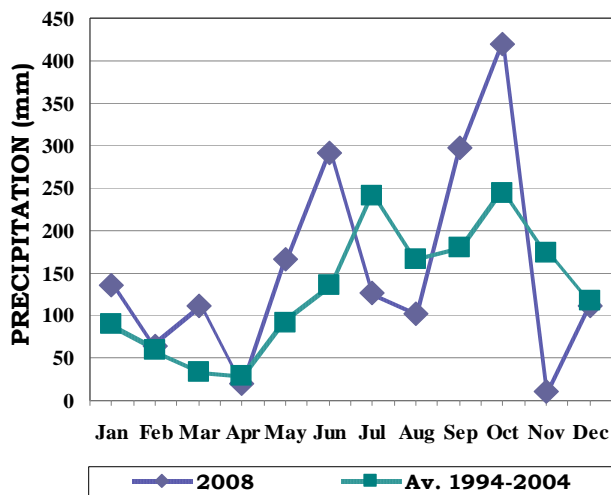


Figure 1. Monthly and mean monthly precipitation (mm) precipitation recorded at Central Farm, Cayo District for 2008 and 1994-2004, respectively

There was difficulty in the planting of crops, especially corn in June 2008. During the months of September and especially October 2008, the abnormally high precipitation resulted in the flooding of rivers and creeks of the entire country. There were severe damages to crops along the river banks in the Cayo, Belize and Orange Walk districts. Crop production was adversely affected by flooding in 2008.

Strategic Axis 1: Development of Sustainable Industries

CARDI's activities are driven by Strategic Axis 1, which expresses the core functional elements of the Institute's mandate and is directly linked to food production and use. Strategic Axis 1 comprises two Focal Areas viz, 'Science, Technology and Innovation' and 'Natural Resource Management'. The successful execution of the work programme in Strategic Axis 1 would result in CARDI contributing to (1) increased regional food security, food supply / food sovereignty and

agro-industrialization and (2) sustaining the environment under which food production occurs and sustaining post-disaster food supply.

Commodity Development – Crops

The objective of the Commodity Development Programme is to increase productivity and sustainability in the agricultural sector through the generation and transfer of market driven technology products and services to food production industries.

1. Characterize and evaluate developed/improved varieties and landraces for productivity and value added products.

Five sets of corn (*Zea mays* L.) germplasm were acquired from CIMMYT, Mexico for evaluation in Belize. Only four sets of trials were planted in July 2008 at Central Farm due to space limitation. Elite Tropical Late Yellow Normal & QPM Hybrid Trial was comprised of 30 entries. White corn Varietal Trial (08EVT12-25) was comprised of 16 entries. Advance Tropical Three-Way crosses White Normal and QPM Late (08TTWCL-22) was comprised of 18 entries and Elite Tropical Late White Normal and QPM Hybrid Trial (08CHTTW-25) had 36 entries. A local supplier, Prosser Fertilizer and Agrochemical, provided 17 entries of Yellow/White corn hybrids for evaluation and were planted in a hybrid evaluation trial in July 2008 at Central Farm. The supplier also provided the fertilizers and agrochemicals for this trial as needed. These trials were affected by prolonged floods at the maturity of corn crop. However, corn was harvested from those plants which were still standing after the flood. Data were

collected and analyzed with adjustments for the number of plants harvested. There were significant differences among entries in the adjusted grain weight per plot, with a few entries showing promising results for further evaluation (Tables 1 to 5).

23	CLRCY015/CLRCY016	2.840
24	CML451/CL02450 (RE)	3.423
25	CML454/CML481	2.750
26	CL02603//CML454	2.546
27	CLRCY030//CL02603	2.960
28	CML451//CML223	2.715
29	CML451//CML481	3.352
30	Local control (CARDI YC-001)	3.261
	Average LSD	0.848
	P	0.008

*Plot size = 7.7 m²

Table 1. Adjusted grain weights (kg) of Elite Tropical Late Yellow Corn Normal and QPM Hybrid Trial

Entry No.	Entry/Pedigree	Adjusted Grain weight/plot* (kg)
1	CLQRCYQ44//CLQRCYQ40	3.302
2	CLQRC4Q44//CLQRCYQ45	3.530
3	CLQRCYQ40//CLQRCYQ41	4.020
4	CLQRCYQ69//CLQRCYQ49	2.856
5	CML165/CLQRCYQ49	3.030
6	CLQRCYQ59/CLQRCYQ49	3.137
7	CLQS894Q04/CLQRCYQ49	2.546
8	(CML165XCL02450)-BX CL02450-62-1-2XCL	2.941
9	CLQRCYQ60/CML161	2.656
10	CML161XCML451- BXCML451-29-1-3XC	3.485
11	CML165/CLQRCYQ64	2.263
12	CML165XCL02450- BXCL02450-62-1-2XCL	3.347
13	CML161/CML165 (RE)	2.825
14	CLQS894Q06/CLQRCYQ47	3.108
15	CLRCY038/CL02450	2.358
16	CLRC4039/CL02450	3.024
17	CLRCY040/CL02450	3.278
18	CLRC4044/CL02450	3.064
19	CLRCY034/CL02450	3.272
20	CLRC4034/CLRCY017	4.564
21	CLRCY039/CLRCY017	3.788
22	CL02725/CLRCY016	3.263

Table 2. Adjusted grain weights (kg) of White Corn Varietal Trial

Entry No.	Entry/Pedigree	Adjusted Grain weight/plot* (kg)
1	S00TLWQAB	1.158
2	S03TLWQAB05	1.378
3	S03TLWQAB02	1.272
4	S03TLWQAB04	1.671
5	S03TLWQAB01	1.593
6	S05TLWQHGA	1.707
7	S05TLWQHGB	1.910
8	S05TLWQSEQABF2	1.526
9	S05TLWQSEQLNABF2	1.510
10	S06TLWQSEQLNABF2	1.795
11	S03TLW3B Normal	1.778
12	S03TLWBM Normal	1.247
13	S03TLWLN2 Normal	1.312
14	POZA RICA8763(RE) QPM	1.125
15	S03TLWSCB (RE) Normal	1.512
16	Local control - San Antonio	1.129
	Average LSD	0.564
	P	0.101

*Plot size = 7.7m²

Table 3. Adjusted grain weights (kg) of Advance Tropical Three-Way crosses White Corn Normal and QPM Late

Entry No.	Entry/Pedigree	Adjusted Grain weight/plot* at 13% Moisture content (kg)
1	(CML492XCML150) CML502	2.378
2	(CML503XCML-491) CLQ-RCWQ10	2.277
3	(CLQ-RCWQ48/CML491) CLQ-6315	2.859
4	(CLQ-RCWQ48/CML491)CLQ-RCWQ10	3.149
5	(CLQ-RCWQ48/CML491)CLQ-RCWQ26	3.607
6	(CLQ-6315/CML491)CML492	2.778
7	(CLQ-6315/CML-491)CLQ-RCWQ15	2.582
8	(CML144XCML159)CML176 (RE)	2.664
9	(CML448/CML476)CML449 (RE)	2.372
10	(CML269/CL02181)CML500	2.779
11	(CLRCW43/CLRCW42) CML269	3.342
12	(CLRCW40/CLRCW36)CL SPLW04	2.944
13	(CLRCW40/CLRCW42) CLSPLW04	3.209
14	(CLRCW44/CLRCW42) CML269	2.755
15	(CML448/CLRCW42) CLRCW36	2.811
16	(CML448/CML449) CLRCW36	3.015
17	Local Control #1 Jalacte	1.881
18	Local Control #2 DK-234	2.254
	Average LSD	1.256
	P	0.604

*Plot size = 7.7 m²

Table 4. Adjusted grain weights (kg) of Elite Tropical Late White Corn Normal and QPM Hybrid Trial

Entry No.	Entry/Pedigree	Adjusted Grain weight/plot* at 13% Moisture content (kg)
1	CML503/ CML273Q	3.162
2	CML492/ CML150	3.715
3	CLQ-RCWQ26/CML150	3.766
4	CLQ-RCWQ13/CLQ-6316	4.062
5	CLQRCWQ121/CML591	4.648
6	CLQRCWQ122/CML491	4.225
7	CML491/CML503 (RE)	3.898
8	CLRCW35//CL04343	4.271
9	CML269//CML476	5.063
10	CLRCW76//CLSPLW04	6.225
11	CML269//CL04343	4.613
12	CML448//CML449	3.809
13	CML269//CML448	3.811
14	CML247//CML254	4.229
15	CLRCW49//CLSPW04	3.217
16	CLRCW79//CL04343	4.022
17	CML269//CML264	5.445
18	CML264//CML311	3.379
19	CML448//CML476	4.119
20	CLRCW40//CLRCW36	3.529
21	CLRCW40//CML500	3.199
22	CML499//CML500	4.013
23	CL04369//CLSPLW04	5.198
24	CLRCW11//CML500	2.313
25	CLRCW43//CLRCW36	4.065
26	CLTHGA001//CML448	4.349
27	CML448//CLRCW76	3.922
28	CLRCW70//CL04343	3.317
29	CLPSTG01//CL04343	4.827
30	CLRCW45//CL04343	4.543
31	CML404//CML476	4.429
32	CLRCW95/CML494	4.283
33	CML494/495 (RE)	5.044
34	LA POSTA SEQ C7-F64-2-6-2B-B/CML495	3.945
35	LA POSTA SEQ C7-F86-3-1-1-1-B-B-B-B/CML495	3.529
36	Local Control - DK-234	4.357
	Average LSD	1.585
	P	0.021

*Plot size = 7.7 m²

Table 5. Adjusted grain weights (kg) of Hybrid Yellow/White Corn Varietal Trial

Entry No.	Entry/Pedigree	Adjusted Grain weight/plot * at 13% Moisture content (kg)
1	Pioneer 30F32	7.428
2	DK-2045	5.627
3	DK-353	7.690
4	DK-357	8.499
5	MF-8672	2.629
6	MG-9051	8.135
7	MG-9052	6.683
8	MG-9053	6.185
9	MG9054	4.773
10	DK-234	8.167
11	BD-9607	8.400
12	BE-9615	9.759
13	DK-2045	3.334
14	DKB-191	5.898
15	UNKNOWN	7.515
16	Pioneer 30K73	7.543
17	Pioneer 30K73-CRUISER	5.848
	SED at 16df	1.107
	LSD	3.336
	P	0.002

*Plot size = 15 m²

Fourteen varieties of mung bean, *Vigna radiata* (L.), were planted in December 2007 in a preliminary evaluation of mung bean. Agronomic data were collected. The number of days to harvest for the 14 varieties ranged between 68 and 84 days after planting. Three varieties, *VC-6173-B10*, *VC-6173A* and *KPS-2* had larger seed size (100 grain weight > 6.0 g) than the other varieties. The size is an important characteristic for the consumer. Harvested seeds were held in cold storage for further evaluation.

At the request of the Ministry of Agriculture and Fisheries, CARDI initiated the evaluation of beans and red kidney beans, *Phaseolus vulgaris* L., (RKB) for the first

time, due to their importance in the local and export markets. Seeds of RKB, black beans, small red beans and pinto beans were obtained from San Ignacio local market; two varieties of RKB were also obtained from Spanish Lookout. These varieties were planted on 4 January 2008 in an observational trial. The variety *small red bean* was harvested 73 days after planting, while the others were harvested 8 days later, together with the cowpea. The harvested seeds were stored in plastic containers and kept in cold storage for further evaluation.

2. Develop and transfer production technology packages

Asian Soybean Rust (ASR), caused by *Phakopsora pachyrhizi* Syd., is one of the most devastating diseases of soybean (*Glycine max* L. Merr.) worldwide - including Belize - causing yield losses of up to 80 percent. The disease normally affects soybean which are planted during the November to March planting season. Four fungicides were evaluated for their efficacy against Asian Soybean Rust. In general, soybean planted in December 2007 had low rust severity score (less than 5 in the scale of 1 to 9) for Asian Soybean Rust as compared to 2006/2007 plantings. All fungicides, (Silvacur-Combi®, Duett®, Tilt® and Amistar®) treatments had significantly lower disease severity (less than 1.5) as compared to the untreated plot, which had a rust severity score of 5 (Table 6). There were no differences between the means of treatments involving one and two fungicide applications for rust. Based on the results of two years' (2007 and 2008) trials, any of these fungicides could be applied between 55 and 60 days after planting as the disease seems to affect soybean after its flowering, which is approximately 55 days after planting.

Table 6. Effect of fungicide treatments on the Asian Rust on various canopy of soybean var. *CARDI S-89* planted on 14 December 2007 at Central Farm, Cayo District

Fungicide Treatment and Rate/ha	One Application				Two Applications			
	Rust Severity Score ¹				Rust Severity Score ¹			
	Bottom	Middle	Top	Overall	Bottom	Middle	Top	Overall
Silvacur Combi 30 SC, 0.5 L	1.1	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Duett 25 SC, 0.8 L	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Tilt 25 EC, 0.4 L	1.2	1.1	1.0	1.1	1.0	1.0	1.0	1.0
Amistar 50 WG, 200 g	1.4	1.1	1.0	1.2	1.3	1.3	1.1	1.2
Untreated Control (Water)	5.0	5.0	2.7	4.2	6.5	6.3	3.7	5.5
SEM 27 df	0.363	0.340	0.449	0.272	0.363	0.340	0.449	0.272
LSD 5%	1.053	0.986	1.302	0.789	1.053	0.986	1.302	0.789
P	<0.001	<0.001	0.001	<0.001	<0.001	<0.001	0.001	<0.001

¹Rust severity was scored in the scale of 1 to 9, where 1 was 0% coverage with rust lesion while 9 was more than 20% coverage.

Table 7. Efficacy of Three Seed Treatments of Insecticides in Hybrid corn (Pioneer 30K73) for the control of *Spodoptera frugiperda*

Treatment No.	Treatment	No. of plants harvested	No. of cobs harvested	Weight of cobs harvested (kg)	Grain weight at 13% Moisture Content		Yield per cob (g)	Shelling %
					Kg/plot*	Kg/ha		
1	Cruiser by Pioneer.	57.0	47.7	6.65	5.35	3,567	111.7	85.7
2	Cruiser by CARDI	88.7	85.0	10.97	9.06	6,040	106.2	80.9
3	Semevin 35FS	91.0	87.0	11.22	10.04	6,693	115.4	84.7
4	No treatment	82.0	78.0	10.02	8.34	5,560	107.3	84.6
	SED 6df	6.33	5.14	0.728	0.792		7.69	
	LSD	15.49	12.57	1.781	1.937		18.83	
	P	0.006	<0.001	0.003	0.005		0.636	

*Plot size = 15 m²

Three seed treatments were evaluated for protection against seed and foliar insect pests. There were significant differences in the number of plants and ears harvested and weight of cobs and grain harvested among the treatments (Figure 2; Table 7).

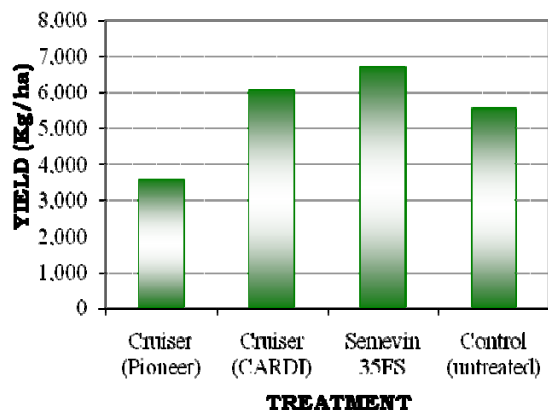


Figure 2. Effect of three seed treatments on yield of hybrid corn (Pioneer 30K73)

The trial to assess the efficacy of three insecticides - azadirachtin, permethrin and imidacloprid - against the pepper weevil, *Anthonomus eugenii* Cano, was conducted in CARDI's field station at Central Farm, Cayo District. Two applications of the insecticides were carried out. There was no significant difference in the number of live larvae found in fallen peppers or in the weights of harvestable pepper fruits, before, and seven days after, insecticide treatment. However, there was a significant difference ($P < 0.001$) in the number of fallen fruits (indicating weevil infestation) among the different treatments (Figure 3). The data suggest that Neem-X® and Helmethrin® can be used in the chemical management of the pepper weevil.

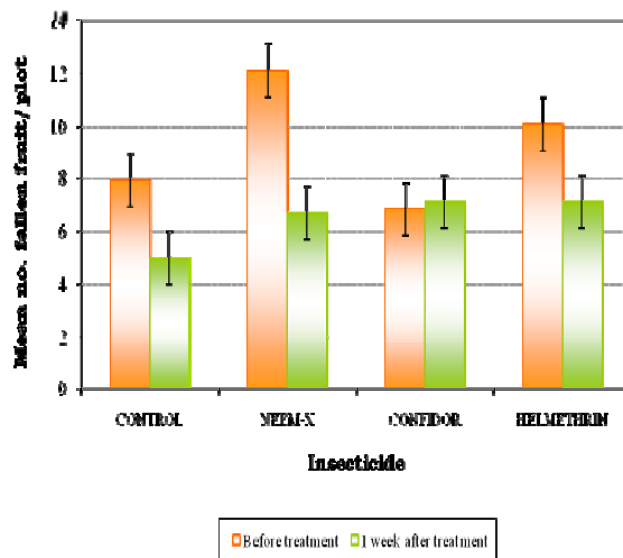


Figure 3. Mean number of fallen fruit per plot before and one week after treatment with selected insecticides

Hot pepper (*Capsicum* sp.) seed which had been soaked in EM (Effective Microorganisms™) 1 + EM-treated germination mix produced insignificantly ($P = 0.298$) taller seedlings than either those which had been soaked in EM1 but sown in untreated germination mix or the control treatment.

3. Produce breeder, nucleus, stock and commercial seeds of improved varieties and landraces

During 2008, CARDI produced nucleus, stock and commercial seeds of various crops, the quantities of which are given in Table 8.

Ninety-six (96) entries of soybean were planted on 18 December 2007 for the maintenance of germplasm (Table 8). Harvested seeds were stored in gallon plastic bottles and placed in the cold seed store room.

Table 8. Breeder, nucleus, stock and commercial seeds of improved varieties and landraces produced at CARDI Belize

Crop Type	Seed Type	No. Varietal Lines	Quantity Seed Produced (Kg)
Soybean	Nucleus seed	96	190.8
	Stock seed	10	2,031
	Commercial	2	8,119
Corn (open pollinated)	Stock seed	1	2,000
	Commercial	1	13,636
Peanut	Nucleus seed	41	-
	Stock seed	3	-
Cowpea	Stock seed	1	393.3
Mung bean	Stock seed	2	91.2
Urid pea	Stock seed	1	25.0
Hot pepper	Nucleus seed	1	2.0

Dash (-) denotes where the crop was destroyed by floods and could not be harvested

Ninety-six (96) entries of soybean were planted on 18 December 2007 for the maintenance of germplasm (Table 8). Harvested seeds were stored in gallon plastic bottles and placed in the cold seed store room.

Nucleus (41 entries) and stock (three entries) seed of peanut were planted in July 2008 but these crops were completely destroyed due to prolonged flood when the crop was almost mature to harvest.

Ten selected soybean varieties, var. *CARDI S-15*, *CARDI S-89*, *CB-1099*, *3296*, *Huasteca 200*, *D-082-2740*, *TGX 293-63E*, *TGX 1025-8E*, *TGX 297-10F*, *UFV-1* and *H-9000* were planted in December 2007 for stock seed multiplication. Harvesting was carried out in the first week of April 2008. A total of 2,031 kg of seeds were harvested, dried, cleaned and stored for further use.

Cowpea, *Vigna unguiculata* (L.) Walp., *California # 46* was planted in January 2008 for stock seed multiplication. A total of 393.3 kg of seeds were harvested. After drying and cleaning it was stored as stock seed for further multiplication.

Seeds of Mung bean, var *Laxmi and CARDI Green* were planted on 13 January 2008. The crop was harvested on the 08 April 2008. The yield obtained was 24.2 kg and 67 kg of seed, respectively, for the two varieties. Seeds were cleaned and stored.

Seeds of Urid beans, *Vigna mungo* (L.) Hepper, were planted on 14 January 2008 for stock seed multiplication. The yield obtained was a total of 25 kg. Seeds were cleaned and stored.

A selected variety of sweet corn was planted in January 2008 for seed multiplication. The yield obtained after shelling was a total of 43 kg out of which 17.7 kg was stored for seed purpose.

Soybean varieties, *CARDI S-15* and *CARDI S-89* were planted in December 2007 for commercial seed multiplication. About 2,119 kg seed of *CARDI S-15* and 6,000 kg seed of *CARDI S-89* were harvested, dried, cleaned stored for sale as commercial seed.

Open pollinated yellow corn var. *CARDI YC-001* (Plate 1) was planted in June 2008 for stock and commercial seed production. The crop was harvested by hand in October/November 2008. Total yield obtained was 13,636 kg. A total of 5,000 kg of seed was sold to FAO and the Ministry of Agriculture distributed seeds to farmers who were affected by flood during October 2008. This amount of seed could plant about 200 ha. A total of 2,000 kg of stock seed has been stored for planting in 2009.



Plate 1. Corn cobs of open pollinated yellow corn, var. CARDI YC-001

Hot pepper, var. *West Indies Red*, was multiplied for seed extraction. About 264 kg of fruits were harvested for seed extraction and 2 kg of seeds were extracted, dried, cleaned and then stored for sale.

4. Technical assistance to the Belize Agricultural Health Authority (BAHA) and Citrus Research and Education Institute (CREI)

Assistance to BAHA

Fifty-three pest interception samples collected by BAHA Quarantine Officers were examined and identified as far as possible. The majority (71.7%) of samples were taken from fresh vegetables (mainly broccoli and cauliflower). The insects found on the vegetables were mainly field pests, such as diamondback moth (DBM), *Plutella xylostella* L., while those taken from rice shipments were all storage pests. None were exotic to Belize. Some non-pest insects (including insect-parasitic wasps, ladybird beetles, ground beetles and springtails) were also identified from samples collected. This information is available to other countries and is of special interest to the neighbouring countries, particularly if intercepted pests pose potential threats to their natural

resource and agricultural sectors. Thorough cleaning of the national insect collection housed at BAHA began in the previous year and is still ongoing.

As part of the work programme, technical assistance was also provided to BAHA in areas deemed necessary. One area was with respect to the prospective export of pitahaya (*Hylocereus* spp.) fruits to the USA. One of the pests of concern to US authorities is *Geraeus* sp., a weevil reported to attack pitahaya. Sampling of fruits from pitahaya farms in the Cayo District was conducted in 2008. However, no signs of weevil infestation were found in fruits from any of the farms visited.

A task force – with members from MAF (Ministry of Agriculture and Fisheries), BAHA and CARDI – was formed in late 2008, after the first report of the presence of the rice mite, *Steneotarsonemus spinki* Smiley, in Belize. The task force would be responsible for research, management and education on the rice mite. A varietal trial, consisting of 43 varieties, was planted in June 2008. Seventeen of these were currently being planted in Belize, while the rest were from Nicaragua and Honduras. Unfortunately, the mite population did not reach levels in which an assessment could be made to compare the tolerance of the different varieties.

There were several requests to BAHA from farmers requiring assistance with pest problems on crops. Field visits were made to the Mennonite farming communities in Little Belize and Shipyard in connection with the decline of corn plants in their fields. It was concluded that *Oligonychus pratensis* (Banks), commonly known as Banks grass mite (BGM), was most probably responsible for the observed decline of the corn plants (Plate 2). The high levels and incidence of

BGM observed in the corn fields were most probably due to a combination of factors, including reported elevated temperatures, low rainfall, low humidity, insecticide use (particularly broad-spectrum ones applied against other corn pests such as *Spodoptera frugiperda* (J.E. Smith)) and lack of natural enemies.



Plate 2. Corn field in Little Belize; plants showing symptoms of mite damage

Several recommendations were made on the management of the BGM, including regular monitoring of fields once conditions become favourable for the increase of BGM populations, conservation of the natural enemy complex of the mites, application of a suitable miticide in hot spot areas only when chemical control was warranted and avoidance of treatment with broad-spectrum insecticides against other corn pests.

Assistance to CREI

In the Technical Assistance to CREI, activities continued on determining the identification of the trunk girdling larva (TGL). Three adults emerged from TGL larvae fed on carrots kept in pots of soil in emergence cages, one of which appeared to be a female with eggs. Adult (Plate 3) and

larval specimens were sent to the Global Plant Clinic in the UK for identification.



Plate 3. Adult moth (left) which emerged from trunk girdling larvae; moth at rest (right) in emergence cage

The taxonomic identification of the moth is Order: Lepidoptera, Family: Cossidae, Genus and species: *Langsdorfia francki* (Hübner).

L. francki larval infestations in all three farms monitored showed similar trends throughout the year, with peaks during February-March, June-July and September-October 2008 (Figure 3). Infestation levels among all three farms ranged from 0 to 20%, with the highest infestation level being recorded from Sagitun Farm in February and December 2008.

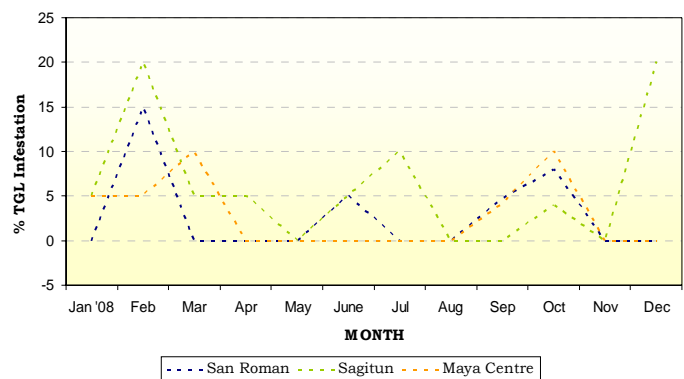


Figure 3. Infestation levels of the trunk girdling larva, *Langsdorfia francki*, during January-December 2008 at three citrus farms in the Stann Creek District

Sagitun Farm was also the most frequently infested farm, with active *L. francki* infestations occurring during eight months of the year.

The positive identification of this pest is an important breakthrough as (i) the pest name is now known and (ii) it provides a more focused starting point for work towards the development of an integrated pest management programme for *L. franckii*, based on what is known of pests belonging to the same Family and/or genus.

Observations on the distribution of the Asian citrus psyllid, *Diaphorina citri* Kuwayama and its population levels in different parts of the country were recorded during the CREI national survey for exotic diseases conducted in February 2008. The adult psyllid population was generally low throughout the country, though slightly higher than it was in the last survey in October 2007. Belize was the district with the highest mean population (2.6 psyllids/branch) in February, while Corozal (which had the highest mean population in October 2007) had the third highest mean population of 1.4 psyllids/branch (Figure 4). No psyllids were recorded from most (47.8%) of the 66 sites surveyed; however, the highest number (total of 46 adults) of psyllids found was observed on a “Jamaican” lime tree in Ladyville, Belize District.

The generally higher populations at the time of this survey, compared to population levels in October 2007, are probably due to the increase of the psyllid populations during the relatively drier months of December and January. Ideally, a more focused and intense monitoring should be carried out more regularly in the areas of high psyllid population in order to obtain a

better understanding of the population fluctuations of *D. citri* in Belize.

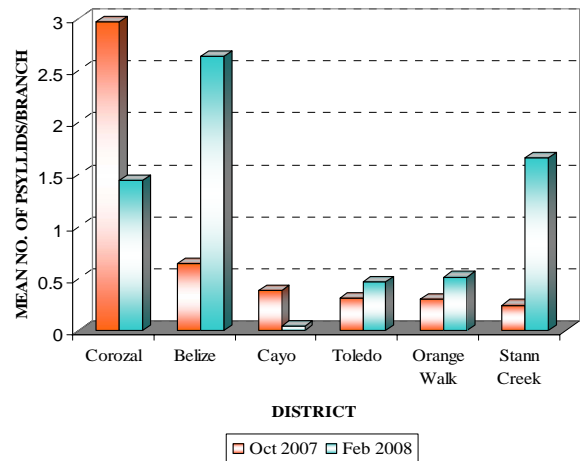


Figure 4. Mean number (per branch) of psyllids observed in the six Districts of Belize in October 2007 and February 2008

Since the first record of *D. citri* in Belize in 2005, observations are that its population levels are not very high. It is very likely that the psyllid population is being effectively suppressed by natural enemies. Hence, selected locations were visited to search for, and collect if present, citrus psyllid nymphs to see if they were parasitized. Eight sites were visited throughout the year and samples of psyllid nymph-infested branches collected. Citrus branches with psyllid nymphs collected from Seine Bight and Placencia in May 2008 were placed in emergence cages and, after about three weeks, were examined. Twenty-one parasitic wasps (Hymenoptera: Eulophidae) and four psyllid nymph casts with exit holes - indicative of parasitism - were observed (Plate 4).

These results are very encouraging as they indicate that natural enemies – parasitoids and predators – are already present in the country, which means that biological control can play a significant role in the management of this pest.

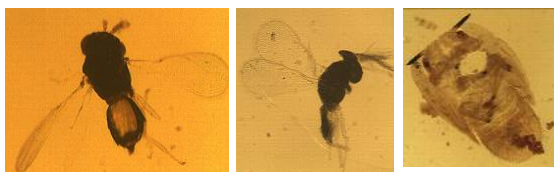


Plate 4. Parasitic wasp emerged from citrus psyllid nymph, dorsal view (*left*) and dorsolateral view (*middle*). Nymphal cast showing exit hole made by parasitoid (*right*)

Strategic Axis 2: Development of Strategic Linkages

Strategic Axis 2, Development of Strategic Linkages, addresses (i) relationships of the Institute with its stakeholders, as well as current and potential collaborators, partners and donors, and (ii) the implementation of a promotional/information process designed to demonstrate the Institute's achievements, capabilities and the environment within which it functions.

Support to development of National and Regional Research and Development

CARDI provided support to the National Coordinating Committee for Agricultural Research and Development (NCCARD) by serving actively in the CORE Committee of NCCARD. CARDI has also actively participated in the Grain Task Force and other commodity committees and other boards in support of agricultural research and development.

Accountability Seminar

CARDI, jointly with IICA, organized an Accountability Seminar in July 2008. The purpose of the seminar was to inform the major stakeholders of CARDI Belize Unit's accomplishments for 2007 and to present the

MTP 2008-2010 and Belize Country Work Programme for 2008-2010.

Meeting with Stakeholders and others

The Executive Director of CARDI visited Belize during 13-20 September 2008 and during that period along with the Country Representative had a series of meetings with key stakeholders, the Ministry of Agriculture, Commodity Association and other potential partners. The meetings included discussions on vegetable production (especially protected cover production), increased production of grains (rice, corn, beans), increased production of hot pepper for export, cassava germplasm introduction and evaluation, forage germplasm, development of standards for rice, corn, beans, capacity building of extension officers and farmers, training of agricultural scientists needs in impact assessment methodology due to climate change, production of alternative commodities which could be produced on marginal lands, the need for joint collaborations utilizing available resources and avoiding duplication of efforts emerging issues and CARDI's support in these areas. The Executive Director also gave a presentation on Global Food Crisis and relationship with the Caribbean to Ministry of Agriculture staff.

Participation in Exhibitions

CARDI participated in the National Agriculture and Trade Show and World Food Day by exhibiting its activities and accomplishments over the years.

The Unit has prepared new posters on the CARDI activities in the Region and in Belize. The Unit is maintaining a permanent

display area at the Operational Facility at Central Farm (Plate 5).



Plate 5. Part of the permanent poster display at the CARDI Operational Facility, Central Farm

Strategic Axis 3: Institutional Strengthening

Strategic Axis 3 addresses the effective management of a critical minimum of financial, technical, physical and human resources. In this context, Axis 3 aims to ensure this critical mass and thus targets ‘*Income Generation*’ and ‘*Capacity Building*’ as its two Focal Areas

Project Development

Preliminary discussions were held with Red SICTA/IICA on the identification and preparation of project proposal for funding from Red SICTA. The project proposal is being finalized.

A project proposal for the implementation of three activities of a larger project on Agricultural Enterprise Development for Rural Belize was drafted and submitted to UNDP for funding. The project was accepted in principle.

Consultancy Services and Technical Assistance:

Memoranda of Understanding to provide technical assistance, mainly in entomology, to the Belize Agricultural Health Authority (BAHA) and Citrus Research and Education Institute (CREI) were signed in 2006. These MOUs sought to establish a framework for the provision of technical assistance through entomological support services to these organizations. Highlights of the technical aspects of this assistance are presented under Strategic Axis 1.

Technical assistance was also provided to the Ministry of Agriculture and Fisheries, Pesticides Control Board (PCB), Belize Organic Producers Association (BOPA) and individual farmers on a regular basis.

CARDI assisted FAO in the preparation of Belize profile on plant nutrient use in Belize under a Letter of Agreement.

The CARDI Entomologist actively participated as a member of the United Nations Environment Programme Methyl Bromide Technical Options Committee Quarantine, Structures and Commodities (UNEP MBTOC QSC) Sub-committee. The MBTOC QSC is mostly focused on reviewing Critical Use Nominations (CUNs) for durable commodities and for structural uses (flour mills, food processing facilities, bakeries, etc). MBTOC QSC reviewed the eleven CUNs before the meeting of the sub-committee in Tel Aviv, Israel in April 2008 to arrive at consensus (as far as possible) on the CUNs. By the end of the meeting, the QSC CUN report had been drafted. The spring progress report was also drafted at the meeting. It included progress with adoption of methyl bromide alternatives and any developments with new or modified alternatives, as well as progress in

registration of alternatives. The TEAP Spring Report was posted on the UNEP website in May 2008. The report on the “Current Status of Technical Efficacy, Costs and Adoption of Methyl Bromide Alternatives in Flour Mills”, which was drafted by M Marcotte, MBTOC QSC Co-Chair, in November 2007, with inputs from members of the QSC, was finalized during the meeting. On the afternoon of the last day of the meeting, there was a joint plenary session of MBTOC Soils and QSC.

CARDI Commercial Production

Cowpea var. *California* # 46 was planted on 16 January 2008 for commercial grain production. The area of this field was 16.2 ha. The crop was harvested on 09 April 2008. Total yield obtained from this field was 13,636 kg (30,062.2 lb) and was sold to an exporter.

Yellow corn hybrid *Pioneer 30F73* was planted in June 2008 for commercial grain production. The area of this field was 16.2 ha. The growth of corn crop was very good. Unfortunately, this area was completely submerged in water due to flooding caused by heavy and prolonged rains in October 2008. Therefore, only about 10 per cent of the area was suitable for harvest; the rest of the crop either germinated in cobs or cobs were covered with mud and were, therefore, unsuitable for feed or food (Plate 6). The total harvest from this field was 25,727 kg (56,718.3 lb), which was sold for feed.

The open pollinated yellow corn variety, *CARDI YC-001*, and hybrid white corn, *DK353*, were planted for grain production. These crops were also affected by the flood in October 2008, so the harvestable grain was lower than the anticipated average yield of 3,923 kg/ ha (3,500 lb/acre). The total grain harvested was 10,274 kg (22,650.3 lb).



Plate 6. Corn crop after flood in the commercial field of CARDI at Central Farm

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- Central Bank of Belize. 2008. Annual Report 2008
- Green, E.D. 2007. Climate change and national food security. Belmopan; Caribbean Climate Change Center.

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Our Mission

To contribute to the sustainable economic well being of Caribbean people by the generation and transfer of appropriate technology through agricultural research and development

CARDI

*Country Highlights
2008*

Our Vision

To be the centre of excellence in the Caribbean for the provision and application of research and development in agriculture and rural enhancement