CARDI

Belize

Country Highlights 2009

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

Improving lives through agricultural research

Caribbean Agricultural Research and Development Institute

Country Highlights 2009

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

CARDI Office in Belize
September 2010

PSC # BZ/004/10

TABLE OF CONTENTS

List of acronoyms and abbreviations

AED	Agriculture Enterprise Development for Rural Belize
ASTI	Agricultural Science and Technology Innovation System
BAHA	Belize Agricultural Health Authority
CARDI	Caribbean Agricultural Research and Development Institute
CFCS	Caribbean Food Crops Society
CIMMYT	International Maize and Wheat Improvement Center
CREI	Citrus Research and Education Institute
CTA	Technical Centre for Agricultural and Rural Cooperation
CUN	Critical Use Nominations
DBM	Diamondback moth
FAO	Food and Agriculture Organization of the United Nations
GAP	Good Agricultural Practices
GDP	Gross Domestic Product
GEF	Global Environment Facility
ha	Hectare
IGR	Insect Growth Regulator
IICA	Inter-American Institute for Cooperation on Agriculture
kg	Kilogram
m	Metre
MAF	Ministry of Agriculture and Fisheries
MBTOC	Methyl Bromide Technical Options Committee
MTP	Medium Term Plan
NATS	National Agriculture and Trade Show
NCCARD	National Coordinating Committee on Agricultural Research and Development
NGO	Non-Governmental Organisation
QSC	Quarantine, Structures and Commodities Sub-committee
Red SICTA	Proyecto Red De Innovacion Agricola
SLM	Sustainable Land Management
TGL	Trunk Girdling Larva
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme

1.0 Message from the Country Representative

According to FAO in the next 40 years the world food supplies need to be more than double due to increase of the population from the present 6 billion to 9 billion by the year 2050, mostly in developing countries, but land will be less available because of the pressure of urban expansion and other economic activities (tourism, for example). This poses enormous challenges on national development. The needed increased food production and expected more varied demand for food and other agricultural products have to take into account the considerable increased pressure on the environment and scarce natural resources. Food security exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life. The four pillars for food security are availability, access, utilisation and stability.

Yields per unit area of the main crops worldwide are in decline, as is investment in agricultural research and development in the developing countries. In order to increase sustainable production, developing countries will have to increase yields and productivity. The development of sustainable agriculture requires integrated plant and animal production systems in harmony with the environment and emerging issues like climate change, food safety, etc.

In Belize, agriculture is highly complex and dynamic, with farm households, traditional production systems, and sophisticated enterprises operating side by side. Nonetheless, all sectors are challenged by emerging issues like climate change, inequality, changing consumption patterns, natural resource management, food safety demands and increased urbanisation.

Over the year Belize has done well in the production of grain crops like corn, beans and black-eye peas and is self-sufficient in these staple grains. However, there are opportunities to export to Central American and the Caribbean countries. It means that there is need to improve productivity and reduce cost of production and also meet all food safety requirements. CARDI in Belize is introducing improved high-yielding germplasm and also small-machineries for increasing efficiency in the production systems

ANIL K. SINHA
CARDI Representative, Belize

2.0 REVIEW AND UPDATE OF AGRICULTURAL AND RURAL SECTORS

Belize has a small open economy with a GDP at current market prices of US$1.4 billion in 2009. The open economy and its dependence on exports and tourism earning were especially impacted on during 2009 as the effects of the global recession and financial crisis impacted on employment and growth levels. Its principal sectors are currently (i) agriculture, (ii) agro-processing and (iii) services, primarily tourism. The contribution to GDP (at current prices) of the hotel and restaurant sector was 3.7% in 2002, 3.7% in 2008 and 3.5% in 2009. During the same period, the agriculture and forestry sector contributed 18.8% in 2002, 11.9% in 2008 and 11.6% in 2009 to the GDP. Agriculture, agro-product manufacturing and tourism are the major foreign exchange earners. In 2009 sugar, citrus and bananas and marine products accounted for 65% of the earnings accruing from merchandise exports. Sugar and bananas are sold under preferential arrangements that ensure access to markets and generate higher than world market prices. This system of preferences is gradually being phased out and makes the need to increase productivity very important as Belize will have to compete based on prices and by lowering costs of production.

Agriculture, forestry and fishing continue to form the foundation of the productive sector and the rural economy of Belize. Approximately, 26% of total employment is directly dependent on agriculture, fisheries & forestry.

In 2009 production of agricultural commodities had sharp increases compared to 2008. In 2009 corn production increased from 38,000 metric tonnes in 2008 to 57,000 metric tonnes (50% increase) which was the result of an increase in area planted and harvested and higher productivity. Similarly, rice production increased by 75 per cent (21,000 metric tonnes) in 2009 as compared to 2008. Red kidney production increased by 6.2 per cent (2,700 metric tonnes) as compared to 2008 whiles the production of black bean increased by 18 per cent (1,300 metric tonnes) in 2009. Soybean production had highest increase in 2009 as compared to 2008, from 24,545 kg in 2008 to 586,364 kg in 2009. The increase in 2009 was as a result of high prices of soybean and soybean meal in the global market.

3.0 IMPLEMENTATION OF THE MTP, 2008-2010

CARDI's current work programme has been guided by CARDI's Medium-Term Plan 2008-2010 (2008-2010 MTP). The 2008-2010 MTP and annual work programmes are organised around three Strategic Axes; Strategic Axis 1 – Development of Sustainable Industries, Strategic Axis 2 – Development of Strategic Linkages and Strategic Axis 3 – Institutional Strengthening. The *'Strategic Axes'* are the first tier of the hierarchical framework of the MTP and, accordingly, are the foundation upon which the portfolio is constructed. These are distinctly separate but interdependent Strategic Axes. They 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.

Highlights of Work Programme 2009

In Belize, CARDI's work programme for 2009 spanned two cropping seasons, the November/December 2008 planted crop which was harvested in March/April 2009, and the June/July 2009 planted crop harvested in September/October 2009. One notable feature of 2009 was that the precipitation recorded for most of months at Central Farm, Cayo District was well distributed (Figure 1). It helped in the timely land preparation and planting of the corn crop in June 2009 and also the timely harvesting of the corn crop in October 2009.

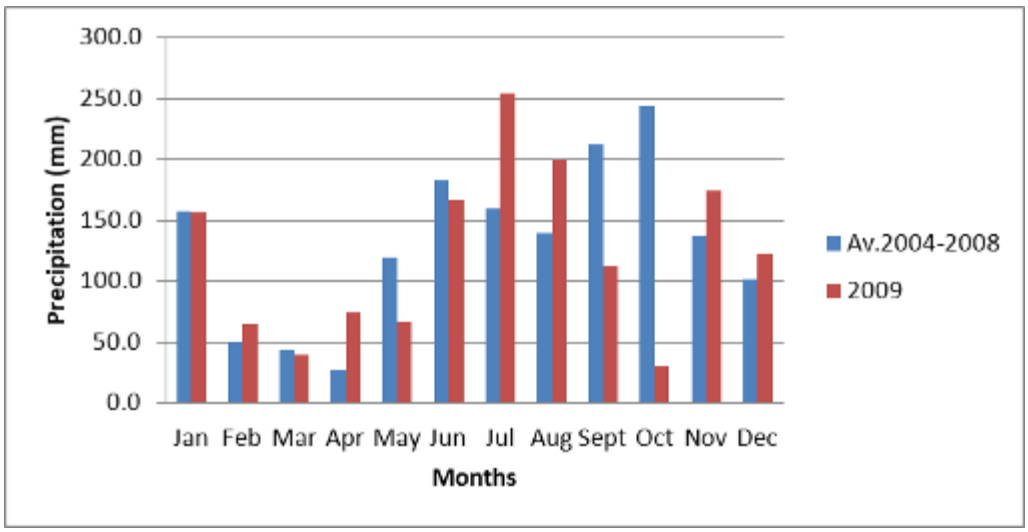

Figure 1: Monthly precipitation recorded at Central Farm, Cayo District, Belize

3.1 Development of sustainable industries

CARDI's research and development 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 will result in CARDI contributing to (1) increased regional food security, food supply / food sovereignty and agro-industrialisation 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.

Cereals and grain legumes

In 2009, the Cereal and grain legume programme focused on:

1. The annual evaluation of yellow and white corn hybrids to identify those that perform better than the hybrids that are currently being planted by large-scale mechanised producers.
2. The annual evaluation of yellow and white corn varieties to identify those that perform better than the local varieties that are currently being planted by small-scale producers.
3. The annual evaluation of bean varieties to identify those that perform better than the local varieties and also have acceptable grain quality for the export market.
4. The evaluation of new biopesticides for the management of fall army worm which recently has become a major insect pest of corn in Belize.
5. The production and marketing of quality seed of the open pollinated yellow corn variety CARDI YC-001 (introduced as Trinidad 7728) to meet the seed demand of small and medium-sized producers.
6. The production and marketing of quality seeds of cowpea, soybean, beans, peanut and other grain legumes.
7. The development of handling and storage systems to reduce post-harvest losses at the small farm level.

Evaluation of new improved germplasm of corn and beans

Open pollinated white corn (*Zea mays* L.) germplasm was evaluated at the CARDI Field Station, Central Farm, Belize. The trial consisted of 20 entries, including those from CIMMYT, Mexico (15) and Guatemala (1). There were four local germplasm in the trial. The entry CARDI YC 001 was the check. The trial was planted in June 2009. Data and

observations were recorded following the guidelines established for managing trials in the CIMMYT's International Maize Testing Programme. There were highly significant differences (P<0.001) among the entries for plant height, ear height, disease score, number of plants that were lodged at the stalk and number of ears harvested. There were significant differences (P=0.007) among the entries for yield of shelled grain per plot (7.5 m^2) at 13% moisture content. Extrapolated grain yield showed that all entries yielded more than 2,400 kg/ha with an average of 5,302 kg/ha across all entries. Extrapolated grain yields for the best 13 entries are shown in Figure 2. The entry Local White Corn (Jalacte), recorded the lowest extrapolated yield of 2,451 kg/ha while CARDI YC 001 recorded the highest extrapolated yield of 6,755 kg/ha, among all entries (Figure 2). The CIMMYT entry S03TLWQAB01 recorded an extrapolated yield of 6,359 kg/ha. The seven top yielding varieties will be further evaluated in 2010.

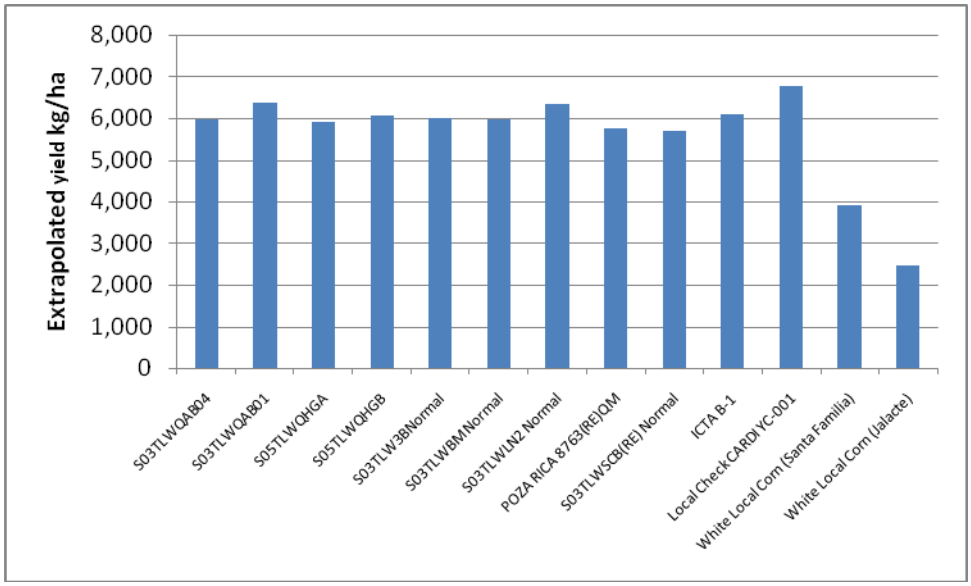

Figure 2: Extrapolated yields (kg/ha) of selected entries of white corn open pollinated varieties planted in June 2009 at the CARDI Field Station, Central Farm, Belize

A Yellow Hybrid Corn evaluation trial comprising 12 entries provided by a local seed supplier of Pioneer Seed Company was established on 24 June 2009 at CARDI Field Station, Central Farm. Data and observations were recorded following the guidelines established for managing trials in the CIMMYT's International Maize Testing Programme. There were highly significant differences (P<0.001) among the entries for plant height, ear height, number of plants that were lodged at the root and the stalk, number of ears harvested, weight of harvested ears and yield of shelled grain per plot (15 m^2) at 13% moisture content. Two entries, Pioneer 30K75 and Pioneer 30F83 had significantly lower number of plants at 10 days after planting and also at harvesting. These two entries recorded

the lowest grain yield (Figure 3). Pioneer P4082W recorded the highest extrapolated yield of 7,607 kg/ha, among all entries. The root and stalk of this entry was much stronger as evidenced from the low number of plants lodged at the root and stalk. Promising hybrids will be further evaluated in 2010 and then recommendations will be given for commercial evaluations.

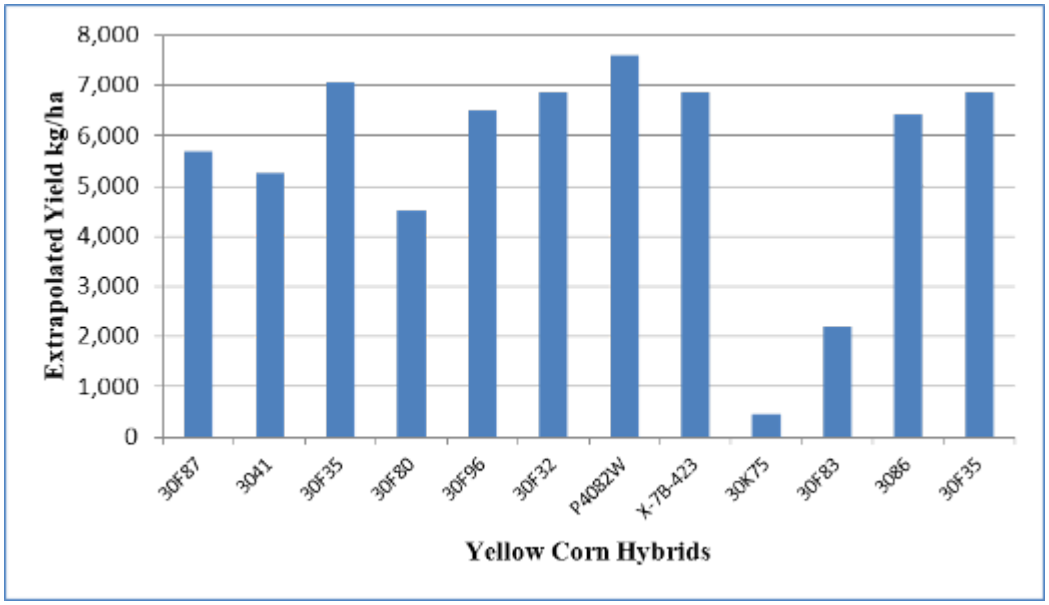

Figure 3: Extrapolated yield (kg/ha) of shelled grain of yellow hybrid corn varieties planted in June 2009 at the CARDI Field Station, Central Farm, Belize

CARDI was requested by the Ministry of Agriculture and Fisheries, Belize to conduct an evaluation of red and black beans (*Phaseolus vulgaris* L.) germplasm with a view to marketing the commodity to the neighbouring Central American countries. Thirty-six different varieties of black and small red beans obtained from different sources were planted in 4.5 m^2 plots on 5 January 2009 in Alpha Lattice Design. Data were collected and observations made on number of days to 50% flower and to maturity, plant height, height of the lowest pod, colour of flower, stem and pods, growth habit, characteristics of seed, and plot yield. There were highly significant differences ($P<0.001$) among the entries for plant height, flowering, maturity, grain yield and 100 seed mass weight. Among the red beans, the variety Cardenal yielded the highest (1.3 kg/plot), while among the black beans a local entry had the highest yield (1.3 kg/plot). The trial will be repeated in 2010.

Evaluation of biopesticides for managing armyworm on corn

Corn forms a large part of the Belizean diet and this has traditionally been met, to a large extent, by local supply. However, the repeated and frequent use

of synthetic pesticides has led to the development of serious pest (including the fall armyworm, *Spodoptera frugiperda* (J.E. Smith) problems in corn cultivation. Farmers are reporting that some of the insecticides traditionally used are no longer effective.

Insect growth regulators (IGRs) and biopesticides are newer classes of insecticides not widely used in Belize and it is postulated that they can be used in the control of *S. frugiperda*. An IGR disrupts the larval moulting process and eventually kills the affected larva, requires ingestion by target pests to be efficacious and is slow and more sustained-acting.

A study was conducted to assess the efficacy of two IGRs (chlorfluazuron and novaluron), one pyrethroid (deltamethrin), and one organophosphate (monoctophos) against the fall armyworm in corn. The latter two insecticides (deltamethrin and monoctophos) are presently used by farmers for the control of armyworm in Belize. A randomised complete block design was used to conduct the assessment. This investigation was conducted in corn fields at Georgeville, Esperanza and Santa Elena in the Cayo district of Belize.

There were significant ($P < 0.01$) differences in the mean number of live and dead larvae observed among the treatments at Georgeville and Santa Elena. At both locations, there were fewer live larvae in plots treated with chlorfluazuron and novaluron than in the control (untreated) plots and in the other two treatments. Conversely, chlorfluazuron and novaluron treated plots had higher numbers of dead larvae than the other plots. The impact of chlorfluazuron and novaluron on *S. frugiperda* population were most evident three days after application. Also, the effectiveness of chlorfluazuron persisted 7 to 14 days after application (Figure 4).

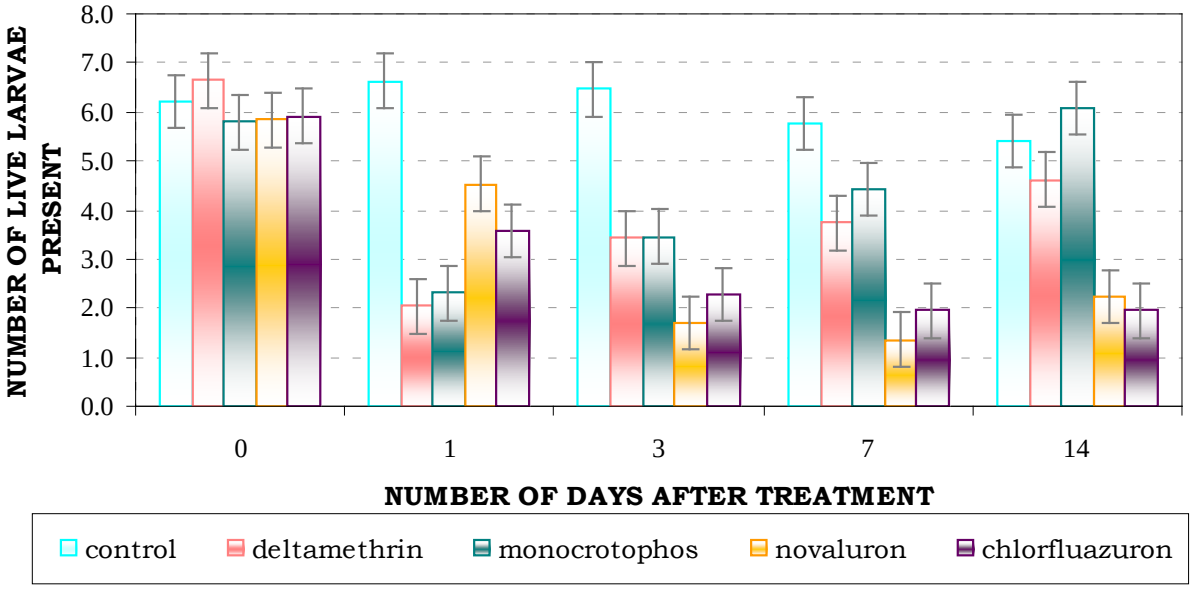

Figure 4: Mean number (± S.E.M) of live *Spodoptera frugiperda* larvae observed on corn plants in a corn field at Santa Elena, Cayo, Belize, before and after treatment with selected insecticides

It was concluded that the two IGRs (chlorfluazuron and novaluron) were more effective than the insecticides currently being used (deltamethrin and monoctrophos) against the fall armyworm. Hence, chlorfluazuron and novaluron can play an important role in reducing losses to yield by *S. frugiperda* in corn.

Development and transfer of production technology packages

A project entitled **"Innovations to improve the competitiveness and the income of small producers of white maize and black bean of Jalacte and San Vicente Villages, Toledo District, Belize"** was approved by farmers of both Jalacte and San Vicente villages in May 2009 and the project officially started in July. Firstly, farmers were organised so as to maximize the use of technical and financial assistance provided by RedSICTA, MAF, FAO, Help for Progress, CARDI and IICA under the project. The one manzana (0.8 ha) each demonstration plots of corn were each divided into two to evaluate two farming systems. The project provided inputs for 0.4 ha (½ manzana) which was planted and maintained using improved agronomic practices while the farmers used their traditional planting practices on the other 0.4 ha. Improved agronomic practices included increased plant densities, herbicide application before planting, fertilisation at planting and a side dress, and contour planting. The ten demonstration plots were monitored and data collected to present findings so as to improve the farming practices in both communities. Planting of local varieties of white corn for both villages was done between 16 and 30 June, while the improved white corn (ICTA B-1) imported from Guatemala arrived late and was planted three weeks later.

The improved white corn variety matured 3 weeks earlier and had shorter plant height as compared to local white corn variety planted in the area (Plate 1).

Plate 1: Corn demonstration plot- left is the traditional local white corn while on the right is the improved early maturing and shorter-stalk white corn (ICTA B-1)

Traditionally, farmers in these communities shell their corn by beating the cobs with stick when the cobs are placed in a hammock (Plate 2). It takes about 8 hours to shell 40 kg corn using this method. In early October small mechanical corn shelling machines were introduced to reduce shelling time to 20 minutes (Plate 3). Each community received a small mobile grain dryer to ensure proper grain drying to reduce the incidences of pests and diseases (Plate 4). A storeroom was completed to house the machinery and training on their use and maintenance was provided. The rental of the machinery to farmers throughout the communities will form an integral part of the farmer group's revolving fund to enable sustainability of the project.

Plate 2: Traditional method of corn shelling

Plate 3: Use of mechanical corn sheller

Plate 4: Introduction of portable grain dryer

One training session for farmers highlighting pesticide use and safety, grain drying and storage and farmer organisation was held in September as part of a series of trainings to build farmer participation and capacity.

In December 2009 the project established ten 0.8 ha (one manzana) demonstration plots for black beans that will follow a similar pattern of activities as the white corn. The cost of production figures will determine the new price structure and market strategy to increase farmer income, food security and rural prosperity.

Production of nucleus and stock seed of selected cereal and grain legume germplasm for commercial seed production

During 2009, CARDI produced nucleus, stock and commercial seeds of various crops, the quantities of which are shown in Table 1.

Table 1: Quantity of seed produced by CARDI, Belize in 2009

Crop type	Seed type	No. varietal lines	Quantity of seed produced (kg)
Soybean	Nucleus	96	325
	Stock	7	5,702
	Commercial	3	11,556
Corn	Stock	2	2,318
	Commercial	1	10,909
Peanut	Nucleus	41	126
	Stock	4	133
Red kidney bean	Stock	1	186
Small red beans	Stock	1	159
Cowpea	Stock	2	221
Chickpea	Stock	1	83
Hot pepper	Commercial	1	32

Fruits and vegetables

Survey of farms in Cayo District to identify major pests of four selected vegetable crops

Baseline information on major vegetable insect pests and their natural enemies in Belize are not readily available. While many farmers may know certain pests, they often do not pay attention to the economically important stages of these (insect) pests and do not associate developmental or immature stages of the pest with the adult. Additionally, while some farmers are more observant of beneficial organisms, most others are not aware of the important role that natural enemies play in reducing pest populations. Hence, the main vegetable growing communities of San Antonio, Seven Miles, Barton Creek, Valley of Peace, La Gracia and Springfield in the Cayo District were visited to study the dynamics of pests and natural enemies on selected vegetables.

The crops, pests and natural enemies observed and recorded were: beans - *Thrips palmi* Karny, red spider mite, leafhopper; crucifers (broccoli, cabbage) – diamondback moth, whiteflies; carrots – *T. palmi*; celery – no pests observed; cilantro – *T. palmi*; corn – fall armyworm; cowpea (black eyed pea) – aphids being preyed upon by ladybird beetle (coccinellid) and syrphid larvae (Plate 5) ; cucumber – *T. palmi*, cucumber beetles, aphids, syrphid larvae; chive – *Spodoptera* spp.; hot pepper – pepper weevil; jícama or yam bean – flower thrips; potato – *T. palmi*, aphids, *Spodoptera*, whiteflies, syrphid flies, coccinellids; pumpkin – whiteflies; red

kidney bean – no insect pests observed; sweet pepper – whiteflies; tomato - *T. palmi* ; watermelon – *T. palmi*.

In one area in Valley of Peace, cabbage plants were observed until harvesting and there was no DBM (diamondback moth) present on any of the plants. The plants were watered with water pumped from a river through a hose. It is possible that this method may be responsible for the absence of DBM because the heavy spray would have washed off eggs and/or larvae. At another farm in Springfield, it was observed that there were very few DBM or signs of DBM damage on purple cabbage as compared with the white/green cabbage. This was probably because the white cabbage leaves were not as thick or tough as the purple cabbage leaves, and so may have been preferred by the DBM.

Plate 5: Larvae of syrphid (circled, *top left and right*) and pupa of coccinellid (circled, *bottom left*) preying on aphids infesting black-eyed pea leaves

3.2 Development of strategic linkages

Support to development of national and regional research and development strategies

CARDI provided support to the National Coordinating Committee for Agricultural Research and Development (NCCARD) and participated actively in its meetings. CARDI also served on other commodity committees and other boards, such as the Pesticide Control Board, Citrus Research and Education Institute (CREI) Committee and its Huanglongbing Task Force, Rice Technical Committee and Belize Organic Producers Association, in support of local and regional agricultural research and development.

Participation in exhibitions

In February 2009 the CARDI Belize Unit participated in the Central Farm Open Day organised by the Ministry of Agriculture. Farmers, Extension Officers, Technical Staff and students from several high schools visited the CARDI Belize Unit operating centre. The Minister of Foreign Affairs and Attorney-General made a special visit to acquaint himself with CARDI's activities in Belize (Plate 6). CARDI Belize also participated in the National Agriculture and Trade Show (NATS) in May 2009. The theme for this year's NATS was "Agriculture: Feeding… Growing…Securing Belize". The Unit also participated in the World Food Day exhibition at Central Farm in October 2009.

Plate 6: Minister of Foreign Affairs visits CARDI Fields at Central Farm, Cayo District, Belize

RedSICTA Project

In June 2009 an Alliance agreement was signed between RedSICTA, IICA, CARDI, Ministry of Agriculture and Help For Progress to implement a project **"Innovations to improve the competitiveness and the income of small producers of white maize producers and black bean of Jalacte and San Vicente Villages, Toledo District, Belize".** It was approved by farmers of both Jalacte and San Vicente in May and the project officially started in July. The official launch of the project was held on 26 November 2009 in Jalacte and had representation from the Government, Ambassadors/Country Representatives of Costa Rica, Mexico, El Salvador, United Kingdom, Country Representatives of international and regional institutions, NGO's, private sector and farmer organisations (Plates 7 and 8).

Plate 7: Signing of partnership for the execution of the RedSICTA Project

Plate 8: District Agriculture Coordinator addressing audience at the Launching Ceremony of RedSICTA Project 26 November 2009

UNDP/MAF Agriculture Enterprise Development Project for Rural Belize

In October 2008 CARDI submitted a proposal to the United Nations Development Programme for the implementation of part of the Project *Agriculture Enterprise Development for Rural Belize /00061306 (AED)*. The project is co-financed by the Project *PIMS 3409 Mainstreaming and Capacity Building for Sustainable Land Management in Belize /00043949 (SLM).* CARDI's responsibility was to establish integrated farming systems in southern Belize for two groups, Cerro Youth Group and Green Creek Cooperative. The demonstration sites were used to conduct capacity building exercises in farm management, GAP and the use of effective agro-techniques. Also, model post-harvest facilities were designed and constructed and used to train the farmers in appropriate produce-specific post-harvest practices.

The agreement between CARDI, UNDP and the Ministry of Agriculture was officially signed in February 2009.

Plate 9: Signing ceremony of agreement on the implementation of AED Project (Present Minister of Agriculture, UNDP Representative and CARDI Executive Director)

UNDP/Ministry of Natural Resources: Sustainable Land Management Project

An agreement was signed between CARDI, UNDP and the Ministry of Natural Resources in September 2009 to provide services in soil conservation and slope cultivation under the Mainstreaming and Capacity Building for Sustainable Land Management funded by the Global Environment Facility (GEF).

- CARDI Soil Scientist, Dr Leslie Simpson, visited Belize in September 2009 to assess the challenges in soil conservation and slope cultivation.
- The specialist conducted a training session on Soil Conservation and Slope Cultivation for the technical and administrative personnel of the Ministries of Agriculture and Natural Resources, NGOs and farmers (Plate 10).
- Subsequently the specialist conducted an in-depth training for technical personnel
- The specialist conducted two training sessions for farmers in Toledo and Cayo districts (Plate 11).
- A manual on "soil conservation and slope cultivation" was prepared by Dr. Simpson and submitted to the Ministry of Natural Resources and the UNDP.

Plate 10: Dr Leslie Simpson, CARDI Soil Scientist giving presentations on Soil Conservation and Slope Cultivation in Belize

Plate 11: Participants (farmers) getting hands-on experience in marking contours using the "A" Frame

Entomological services support – BAHA

In 2009, 34 samples intercepted at ports of entry by BAHA Quarantine Officers between December 2008 and November 2009, were identified. The majority (79%) of the samples were taken from fresh vegetables (mainly cauliflower). Insects found on the vegetables included field pests, such as diamondback moth (DBM), *Plutella xylostella* (L.), aphids and cicadellids. Other insects were from stored products and included coleopteran such as dermestid larvae and curculionids. None of these pests was considered to be exotic to Belize.

The on-going process of reviewing electronic copies of the existing lists of endemic pests and pests of quarantine importance continued in 2009.

A complete cleaning of the insect collection began during the first quarter of 2008 and was completed in 2009. It was recommended that this process be repeated every year (if possible) or every other year.

In July 2009 corn fields in Banana Bank, Cayo, were visited. The problem observed on the corn plants (necrotic spots and drying of leaves) was due to the presence of two mites – Banks grass mite and two-spotted mites. Information was provided to the farmers present on aspects of the mites' life cycle and of the different factors, such as elevated temperatures, low rainfall, low humidity, insecticide use (particularly broad-spectrum ones applied against other corn pests such as *S. frugiperda*) and lack of natural enemies that could contribute to the mite population increasing.

Entomological services support – CREI

CARDI continued to provide technical assistance, mainly under trunk girdling, *Langsdorfia franckii* Hübner, and Asian citrus psyllid activities, to CREI up to April 2009. A comprehensive 40-page report, which covered all the work done during the period January 2006 to April 2009, was written and submitted to CREI.

Investigations on the trunk girdling larva (TGL), which was first recorded attacking citrus trees in Belize in 1999, focused on its distribution and population. A rapid survey to confirm the presence/absence of the TGL had been conducted in Cayo and Stann Creek in 2007-2008, but not in Toledo. In January 2009, the survey was conducted in Toledo. Eight farms were visited. Signs of TGL feeding and/or damage were not observed on tree trunks at any of the farms except for one tree at one farm, which showed damage that looked similar to that ascribed to feeding by TGL. Based on this survey, it would appear that the TGL is not widely distributed throughout Belize but is present in discrete areas in the citrus-growing regions of the country.

Monthly monitoring for TGL infestation in Maya Centre, Sagitun and San Roman continued during the period January 2008 to March 2009. The TGL was not present during this period except in February 2009, when 10% TGL infestation (number of trees with signs of active TGL infestation, expressed as a percentage of the total number of trees sampled) was recorded at Sagitun. The pattern of TGL infestation in the three farms during the same period in the previous year followed a similar trend, with a peak in infestation in February at San Roman and Sagitun.

The major activity for *Diaphorina citri* Kuwayama (Asian citrus psyllid) was the national survey conducted in the latter half of January 2009. The adult *D. citri* population, as in previous years, was generally low throughout the country (Figure 8). Indeed, no adult psyllids were recorded from more than half (54.7%) of the 106 sites surveyed. The overall mean population (± standard error) was 0.7 ± 0.21 psyllids/branch. The highest number of psyllids (total of 30 adults on one branch) was observed on a lime tree in Ladyville, Belize District. During this survey, both adult psyllids and nymphs were observed. Since adults are usually more abundant during the drier months, it was expected that very few or no nymphs

would be found. However, the rainfall pattern in 2008 was a little unusual as the country experienced higher than normal rainfall in most months, especially in September and October 2008, so there was recent flush still present on trees, and hence, *D. citri* nymphs, at the time the survey was conducted in January 2009.

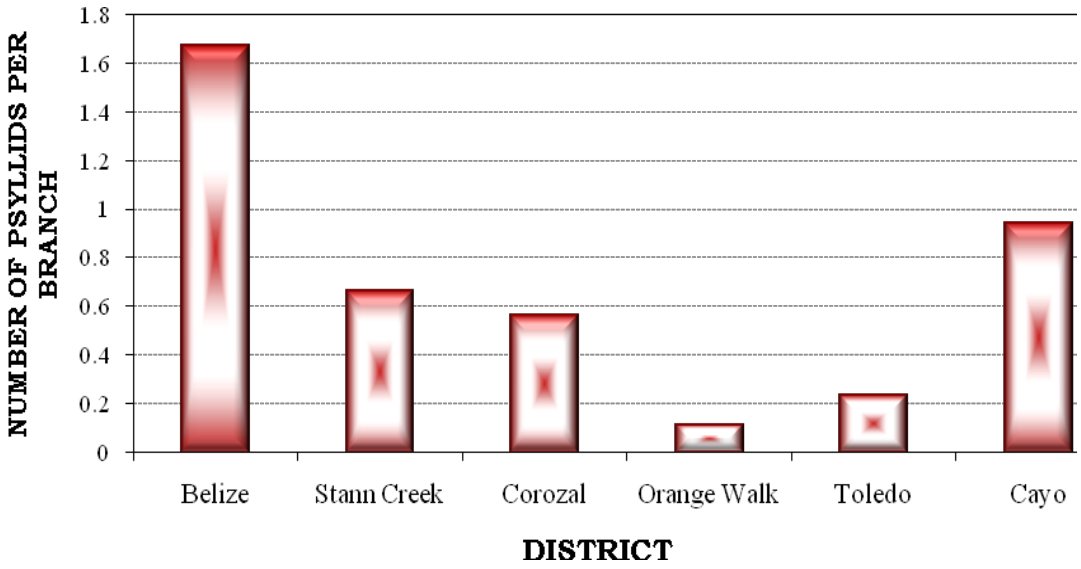

Figure 8: Average number of psyllids observed in the six districts of Belize in January 2009

UNEP Methyl Bromide Technical Options Committee

During the year, CARDI served on the United Nations Environment Programme Methyl Bromide Technical Options Committee, Quarantine, Structures and Commodities (MBTOC QSC) a sub-committee of the MBTOC that reports to the United Nations Environment Programme (UNEP) Technology and Economic Assessment Panel of the Montreal Protocol. 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.). During participation in the MBTOC QSC meetings in The Netherlands, field visits were made to sites in Amsterdam and Werkendam and approved fumigation locations in Antwerp, Belgium

ASTI Training Working

The Unit organized a Training Workshop for Trainers in Agricultural Science and Technology Innovation System (ASTI). It was held during the period 28 September to 2 October 2009 at Biltmore Plaza Hotel, Belize City (Plate 12). It was sponsored by the Technical Centre for Agricultural and Rural Cooperation (CTA). There were 12 local participants and 8 regional participants from CARDI.

Plate 12: Opening Ceremony of ASTI Training Workshop

3.3 Institutional Strengthening

CARDI commercial production

Cowpea

The variety of **Cowpea California # 46** was planted on 5 January 2009 in 15.3 ha. During the development of the crop, aphid infestations were observed but also it was noticed that the larvae of a predator, *Syrphid,* were already present in the field and were controlling the population, so there was no need for spraying any chemical. This field was managed following the agronomic practices for cowpea production. The yield obtained was a total of 9,019 kg. It was cleaned and sold for export.

Soybean

In December 2008 a total 12 ha of soybean was planted for commercial seed production. It was harvested in March/April 2009. The fields were managed following the agronomic practices for soybean production. Total yield obtained was 21,600 kg of seed. It was dried, cleaned and then stored in the cold seed storage room. During June to December 2009 seeds were sold to various producers for planting in about 400 ha.

Corn

In June 2009 26 ha of corn were planted for commercial production. Approximately 7 ha were for commercial seed production of open pollinated variety of corn and 19 ha were for grain production. A total of 143 tonnes of corn was harvested of which 11 tonnes were for seed. The seeds were used by farmers to plant about 405 ha.

Hot Pepper

Hot pepper variety *West Indies Red* was transplanted in July 2009 in 0.2 ha plot at the CARDI Field Station at Central Farm. The crop was transplanted for the production of berries for seed extraction and to collect the cost of production data as shown in Table 2.

Table 2: Summary of the cost of production (EC$) of commercial hot pepper seed

Capital cost	$ 4,117
Total direct expenses on the production of 0.2 ha hot pepper	$ 3,761
Total direct expenses on seed extraction	$ 268
Total amount of seed extracted: 25 kg	
Selling price of hot pepper seed per kg	$ 972
Total Expected revenue exclusive of electricity, water and technical personnel costs	$ 24,300

Human Resource Development

Dr Kathy Dalip, Entomologist, attended the CFCS (Caribbean Food Crops Society) 45th Annual Meeting in St Kitts in July 2009 where she made an oral presentation on "The trunk girdling larva, a pest of citrus in Belize".

Mr Anil Sinha, CARDI Representative, submitted a paper on Asian soybean rust control in August 2009 for publication in CARDI Review.

4.0 STAFF MEMBERS

Professional staff

Anil K. Sinha
CARDI Representative/
Agronomist (Cropping Systems)

Kathy M. Dalip
Entomologist

Technical support staff

Hector Reyes
Graduate Assistant

Martin Lindo
Field Technician

Cornelio Tzib
Field Assistant

Administrative support staff

Tenesha Reynolds
Administrative Assistant

Farm workers

Angel Garcia
General Farm Worker

Ambrocio Vanegas
General Farm Worker

Leroy Robateau
General Farm Worker

5.0 Contact information

CARDI
P.O. Box 2
Belmopan
Belize

Phone: (501) 824-2934
Fax: (501) 824-2936

Email: cardi@btl.net
Website: www.cardi.org