

**ECONOMIC / COST BENEFIT ANALYSIS and
POLICY INSTRUMENTS for**

**The Implementation of Good Agricultural Practices in Belize
For the**

**Belize SAICM Initiative
Mainstreaming into Development Plans the Sound
Management of Chemicals (SMC) Priorities for Key
Development Sectors in Belize and Associated SMC
Governance
Project**

**Development of the Concept Papers, Policies and
Cost Benefit Analysis**

Submitted to the

**Project Coordinator
Belize SAICM Initiative
Department of the Environment**

By

Humberto Paredes

October 16, 2010
Belmopan, Belize

TABLE OF CONTENTS	
Content	Page
1.0 Describe the Issue	4
1.1 Specific Sources of the Problem	4
1.2 Major Findings in Current Practices	4
1.3 Alternatives Addressed	5
2.0 Scope of the Analysis	5
2.1 Source of Data	5
2.2 Technological Approaches	5
2.3 Geographic Boundaries	6
2.4 Timeframe of the Analysis	6
2.5 Stakeholders	6
3.0 Description of the Baseline	7
3.1 Estimation of Chemical Use in Belize	8
3.2 Selected Farm Unit	10
3.3 Belize Recommended Best Practices	12
3.4 Quantification of Costs and Benefits of GAP	16
3.5 Extrapolation of the Results	17
4.0 Risk Identification and Assessment	18
5.0 Setting Targets, Policies and Instruments for Implementation	20
6.0 Cost Benefit Accounting Statement	22
7.0 Summary	22
8.0 References	24

LIST OF TABLES	
Table	Page
Table 1 Estimation of Chemical Use in Belize	8
Table 2 Traditional Agricultural Exports	9
Table 3 Ratio of Chemical Imports to Agricultural Exports	9
Table 4 Gross Income under Traditional Production	13
Table 5 Gross Income under Good Agricultural Practices	13
Table 6 Traditional Costs	13
Table 7 Costs under good Agricultural Practices	13
Table 8 Costs and Yields for Replanting - Comparison	14
Table 9 Costs and Yields for Ratooning - Comparison	15
Table 10 Net Gains from GAP for Replanting	16
Table 11 Net Gains from GAP for Ratooning	16
Table 12 Cost Benefit Accounting Statement	22

ACRONYMS and TERMS

Froghopper	Pest that affects Sugarcane plant
Meterhizium	Fungus used as a natural control of Froghopper
Pre-emergent	Before the weed emerges or starts growing
Post-emergent	After the weed has emerged or started growing
Replanting	The stage where new seed is planted into an existing cane field.
Replanting Crop	One crop from new seeds
Ratooning	The crop that emerges from the roots after 1 st harvest
Ratoon Crop	Five subsequent crops without the need to replant
ACP	Africa, Caribbean and Pacific Nation beneficiaries from the EU
ER	Efficiency Ratio
EU	European Unions
GAP	Good Agricultural Practices
ISO	International Sugar Organization
NPV	Net Present Value of a stream of future benefits
SIB	Statistical Institute of Belize
SICB	Sugar Industry Control Board
SIRDI	Sugar Industry Research and Development Institute
SMC	Sound Management of Chemicals

1.0 Description of the Issue

The purpose of this review is to carry out a quantitative analysis of the Costs and Benefits of implementing Good Agricultural Practices (GAP) in Belize.

1.1 Specific Sources of the Problem

The 2010 Situation Analysis Report for Belize shows that Belize is not a producer of chemicals in its own right. Chemicals are imported for use mainly in the agricultural sector, as shown in that report.

Given the situation that most chemicals are inputs into agricultural production, it is useful to carry out a study of this sector as it is the source of the biggest direct impact on the environment resulting from chemical use.

Of particular importance to Belize is the efficient utilization of chemicals included in the overall concept of the Sound Management of Chemicals. Efficiency can be demonstrated either by reducing the amounts of chemical inputs used while sustaining yields or by being able to increase production through Good Agricultural Practices following recommended guidelines for chemical inputs.

1.2 Major Findings in Current Practices

The following are major findings in current agricultural practices in the Northern Districts of Belize.

- Standards are recommended by the industry and farmers association, yet farmers follow their own experience in the application of chemical inputs with regards to quantities and timing;
- Fertilizers are applied directly to the arable area with fertigation (application through the use of irrigation) being non-existent except in experimental plots;
- Herbicides are applied using manual spraying as opposed to using mechanical sprayers;
- More modern shielded or hooded mechanical sprayers that reduce the quantities of chemical inputs applied are not used;
- Manual spraying, while being labour intensive, is not efficient in that spray drift occurs, which wastes inputs and causes greater exposure to the workers involved;
- The timing of the application of herbicides is critical as the proper timing application has a notable effect on the yields;
- International price variations for crops from year to year has a serious effect on farmers' willingness to follow Good Agricultural Practices as there is a high element of uncertainty;
- Producers do respond, even if slowly, to international best practices (GAP) as demonstrated by the elimination of the use of Paraquat (Gramaxone) and the introduction of biological control (meterhizium fungus) for pest control;

- Established cultural/behavioural practices in farm operations are not easy to overcome, even when using best practices has clear advantages;
- The small average sizes of the farms requires ongoing field demonstrations and extension services in applying GAP relevant to the local situation in order to convince farmers to adopt them;
- Any available external funding needs to be linked directly to overcoming traditional and cultural practices through improved and more extensive field extension services.

1.3 Alternatives Addressed for the Specific Issue

- a) Do nothing
- b) Implementation of Good Agricultural Practices (GAP)

2.0 Scope of the Analysis

2.1 Source of Data and Information for Considered Issue

The document used is Belize's National Chemical Management Situation Report, Ministry of Natural Resources and the Environment, 2010.

2.2 Technological Approach for Solving the Problem

A review of best practices as developed locally and internationally shows that the best indicated technical approach is the adoption of Good Agricultural Practices as a means to solving the problem identified.

In the specific case of Belize, the government can provide support through policies and regulations directed at encouraging farmers to adopt GAP. Financial support for some of the more basic and cost effective measures can come from the Fairtrade premium presently being paid by the international sugar producer Tate & Lyle. Farmers should be encouraged to use this premium in the best interest of meeting their objectives, which is the survival of the sugar industry and their own economic well being. This should be straight forward but in the case of Belize it has cultural overtones coming from many years of competing interests that may be well intended but work against the effective regulation and cost-effective operations of the industry. It would be fair to state that this situation is not unique to Belize and does require sensitivity and tactful persuasion, starting with relevant knowledge of the exact extent of the potential costs and benefits of making positive changes to these deep-rooted practices.

If adopted, the timeframe for effective implementation of GAP in the specific industry selected would be five years. A shorter time frame is not reasonable given that, despite the urgent need to address the problem, there is a long history of slow implementation due to cultural legacies.

2.3 Geographic Boundaries for Assessment of the Future Benefits and Costs

Immediate geographic area: the two Northern Districts of Corozal and Orange Walk.

Broad geographic area: the nation of Belize.

Regional area: Central America with specific reference to the Belize Barrier Reef (also referred to by some international organizations as the Meso American Barrier Reef).

Belize is located in Northern Central America and is bordered to the North by Mexico and to the South and West by Guatemala and to the East by the Caribbean Sea. The land area covers 8,867 square miles including the cayes, and the offshore territorial limit is 12 miles. There are some 1000 small islands known as cayes with a land area of 266 square miles. Some unique features of Belize include the facts that the northern part of the nation as well as the entire coastal area and all the islands are comprised of flat and low-lying land. The Maya Mountains, 300 – 1100 metres in altitude, occupy the south centre of the country. Belize is well supplied with fresh water from many rivers and aquifers and has 595 square miles of lakes. The climate is sub-tropical with two distinct seasons, the rainy season, which normally begins in late, May and lasts until November, and the dry season which begins in December and ends in early May. Belize has the second longest barrier reef in the world and the longest in the Northern hemisphere; this barrier reef runs from the Mexican border to the Sapodilla Cayes close to Guatemala.

2.4 Timeframe of the Analysis

The Good Agricultural Practices should be implemented in most of the sugar producing farms in the country within five years. This is a reasonable time given that the farmers need to be educated about GAP and takes into account the need for policy development and implementation in order to change long-standing cultural practices.

2.5 Stakeholders

The stakeholders involved are the farmers, farm workers, present and potential providers of mechanized and other farm services and inputs, the people living in proximity to the farms, the farmers associations, agriculture research organizations, sugar processor, local and external consumers, donors, and line ministries as well as the broader government, among others.

The aims of Good Agricultural Practice (GAP) are to ensure safety on farms and processing plants, healthy food in the marketplace and sustainable farming. Broadly defined, GAP applies available knowledge or best practices to address environmental, economic and social sustainability for on-farm production and post-production processes resulting in safe and healthy food and non-food agricultural products. GAP allows for countries to improve food security, rural livelihood and incomes. While GAP is not a convention it is increasingly becoming an international standard, especially and

importantly in the markets (and countries) most important to Belize's economic well being, these being the European Union and the United States.

The adoption of GAP reduces the risk of non-compliance with national and international regulations, standards and guidelines. The four pillars of GAP are:

- Economic viability
- Environmental sustainability
- Social acceptability and
- Food safety and quality

From the farmers' point of view GAP assists in their economic viability while protecting the natural resource base and environment and respecting their social and cultural values. From the consumer point of view GAP helps to address the issue of food safety as well as the important social issues involved in the production processes, such as worker safety and protection of the environment. In this there is considerable overlap in that the benefits offered in implementing GAP occur to the farmers as well as to the consumers and to the workers/society and to the environment.

In summary, through the adoption of this viable international "standard" Belize can help to ensure that its agricultural exports remain viable through not encountering barriers in its main export markets. It will also greatly assist in ensuring the long-term protection of our natural resources and biodiversity, which are the basis for the single most important non – traditional revenue source, tourism.

3.0 Description of the Baseline Situation

Belize has a small agrarian-based economy where agriculture and aquaculture accounted for 65% of yearly exports revenue in 2009. In northern Belize sugar cane is the dominant agricultural crop while in the west and south citrus and banana predominate; substantial quantities of grains as well as poultry, pork, dairy and beef are also produced in the west. In central Belize the main agricultural commodities produced are cattle, rice, vegetables and fruits. Historically, fertilizers and pesticides have been heavily used to either boost plant production or eliminate competing plants, insects or pathogens.

The GDP at current market prices was US\$1.4 billion in 2009. The open economy and its dependence on exports and tourism earnings were especially impacted during 2009 as the effects of the global recession and financial crisis impacted 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 in percent) 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 11.65% 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.

Notably, 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 (sugar has now been phased out completely) and makes the need to increase productivity very important, as Belize has to compete based on global prices and by lowering its costs of production. This is a key link to development planning that goes beyond looking at the environment.

Belize’s major export market is the United States of America (USA), which accounted for US\$ 124.1 million in 2008 and US\$81.26 million (32.4% of total export value) in 2009. The European Union accounted for US\$79.1 million in 2008 and US\$92.02 million (36.7% of total export value) in 2009. The context here is that these two economic giants are also the major markets for other nations that are producers of identical agricultural products as Belize has to offer.

According to the SIB Main Labour Force Indicators of May 2008, the Primary Sector employed 30,035 persons (26.2% of total employment), the Secondary Sector employed 18,835 persons (16.5%) and the Tertiary Sector employed 65,595 persons (57.3%).

Belize has about 11,000 farmers using a total land area of 265,000 acres, or 5% of the total landmass, 146,000 acres being for crops and 119,000 acres for pasture. Of these, 5851 farmers depend on sugar cane production from 60,000 acres (SIB 2009) for their livelihood. This is a major poverty alleviation issue that the Government of Belize needs to address in its development plans.

3.1 Estimation of Chemical Use in Belize

In Belize dollars the net imports of chemicals into Belize is as shown in the following table. (\$2.0 BZ = \$1.0 US).

Table 1 Chemical Imports for Belize in BZ \$

	2004	2005	2006	2007	2008
Imports	76.3	88.7	93.6	102.0	118.1
Exports	3.5	8.7	5.7	3.1	4.0
Re-Exports	1.0	2.3	0.4	1.0	0.3
Net Imports	71.8	77.7	87.5	97.9	113.8

Source: Abstract of Statistics 2009, Statistical Institute of Belize (SIB).

Belize does not have a chemicals industry and apart from a fertilizer plant that uses imported raw materials it does not produce the basic ingredients for fertilizers. The data provided by the Statistical Institute of Belize (SIB) is not sufficiently detailed to be able to know the exact quantities and values of fertilizers, herbicides and pesticides imported into Belize. The above may also include household items such as cleaners and disinfectants. The basic assumption that can be made is that the greater portion of the chemical imports relates directly to agricultural chemicals of all types. This is direct inference from the structure of the Belizean economy and production of goods.

It is clear that the tendency is towards the increase in the value of the chemical inputs.

Table 2 Traditional Agricultural Exports by Value in BZ \$
(Main traditional crops only, as fisheries and forestry are not consumers of chemical inputs such as fertilizers, herbicides and pesticides)

	2004	2005	2006	2007	2008
Sugar	81.5	69.9	100.1	88.1	71.4
Bananas	52.4	48.9	50.6	41.5	65.7
Citrus	80.6	107.2	109	117.4	112.6
Molasses	1.8	2.8	4.2	5.5	2.8
Total	216.3	228.8	263.9	252.5	252.5

Source: SIB 2009.

Table 3 Ratio of the Value of Chemical Imports to the Value of Agricultural Exports

	2004	2005	2006	2007	2008
Efficiency Ratio (ER)	0.3319	0.3396	0.3316	0.3877	0.4507

ER = Chemical Imports divided by the value of traditional agricultural exports

There is a gradual decline in the efficiency ratio when comparing the cost of overall chemical inputs to the value of our main and traditional agricultural exports upon which the majority of our farmers and our export earnings depend. This can also be looked at as an economic issue by itself as it reflects a gradual decline in the terms of trade for the nation of Belize. This by itself is sufficient justification for looking at improving the production methods, yields and the Sound Management of Chemicals (SMC) used in the country.

In essence, with the trend shown above, taking into account the removal of preferential prices for our main export cash crops and realizing that there are many other costs involved in producing a crop such as labour and the preparation of the fields, harvesting and transportation plus the need of the farmers to earn a sustainable level of income, Belize is slowly faced with a situation where either an entire industry or many small farms may become uneconomic. Clearly this is a situation that needs to be reversed, as it poses a serious risk to the poverty alleviation strategies and ability to meet the millennium development goals of Belize, and the implementation of GAP is a way to do this.

The main issue with regards to the use of the chemical inputs of all types including fertilizers and herbicides has to do with the exact timing of the application of these vital inputs. As illustrated in the case study for the production of sugar cane it is likely that most farmers use fewer inputs than recommended due to financial constraints. At the same time the late application of the inputs will act to minimize the benefits derived. This offers an opportunity to address the issue through farmer outreach programs which can be implemented through farmer associations or NGOs.

The types of fertilizers and other chemical inputs used in the sugar industry include NPK (Nitrogen, Phosphorus and Potassium) mixes as well as direct applications of urea. Herbicides used include the standard inputs used internationally in the sugar industry such as Diuron and Ametryn. One notable change in chemical use is that Paraquat or Gramaxone is not a permitted chemical in the sugar industry and is also not allowable under the Fairtrade program that Belize is currently benefitting from. Under the Fairtrade program through the financial assistance of Tate & Lyle, the amount of USD\$60.00 per ton of sugar is being made available to the cane farmers through the Belize Cane Farmers Association to assist them in improving their practices and become more competitive.

There is also a move to start using biological control measures for pests instead of using pesticides, such as through the use of *Meterhizium* fungus. Other than this move towards a natural means of pest control instead of a chemical, the use of organic fertilizers is not common in Belize. The use of irrigation and related fertigation in growing sugar cane is also very rare on small, medium or large sugar cane farms.

3.2 Selected Farm Unit – Justification for the use of Belizean Recommended Best Practices

The problem studied was addressed through looking at a major agriculture industry in Belize. That is sugar cane production in Belize. Through this medium the costs and benefits can be quantified. Costs and yields have been extrapolated from a best practices unit, which is used as an industry standard for all acreage covered by sugar cane production.

The data used in the analysis is taken from the recommended best practices and observed actual practices of the Sugar Industry Control Board (SICB) and Sugar Industry Research and Development Institute (SIRDI). Other data used for the same case study comes from industry participants and standards in Belize.

In the case of sugar cane there is also a need to look at the replanting as well as the ratooning (there is no need to re-plant as there is re-growth from the initial planting for five subsequent years).

The international best practice for sugar cane fertilizer recommended use is a total of 491.2 pounds of fertilizer per acre while in Belize the recommended use is of 440 pounds. Similar formulations of NPK and also direct applications of urea are used. This difference is not materially significant with the major exception that the international recommended application is through fertigation or drip irrigation. That in and of itself is a major difference as the application is direct to the plant root as opposed to application to the general surface area of the plant bed when irrigation is not used. As a result, the yield or production is affected by the benefits derived by the plant from the fertilizer directly and also by the use of irrigation to remove fluctuations in the availability of water. The mode of application of inputs is one variable that can be manipulated.

The amount of herbicides used in international best practices is 280 ounces per acre while in Belize the recommended rate is of 232 ounces per acre. Two herbicides were comparable in that they are used in Belize and are part of international best practice recommendations as to their use. These are Diuron and Ametryn. The recommended international level of Diuron is of 70 ounces per acre (pre-emergent along with other chemicals) while that of Ametryn is of 140 (pre and post emergent) ounces per acre. On the surface this may appear to be roughly similar to the recommended levels of Diuron (64 ounces) and Ametryn (64 ounces) when combined with other chemicals to arrive at the total recommended amounts in Belize. For these two chemical inputs the recommended levels are not materially significant.

However, there are two major differences in the timing and method of application. One is that the international best practice is to apply chemical weed control both on a pre-emergent and post emergent basis. In Belize the recommended best practice is to avoid application for pre-emergent and do two separate (early post-emergence and post-emergence) applications on a post emergent basis. Secondly, in the international best practice most farms use mechanical sprayers. This should account for a major reduction in the use of these chemical inputs in the international best practices. Yet the recommended levels of chemicals use are not necessarily lower than in Belize. More recently, advances have been made, on an experimental basis, in countries such as Australia where modified or shielded sprayers have been able to further reduce the quantities of herbicides applied as they remove losses due to wind and are applied directly rather than to the general area of the cane plants compared to when manual sprayers are used. As a result of the manual sprayer method of application in Belize the rates for an early post emergent stage and a post emergent stage should be theoretically more wasteful and require greater levels of inputs. The mechanical application of inputs internationally may to some degree account for an expected higher rate of production per acre internationally when compared to Belize. The timing of application of inputs presents another variable that can be manipulated.

The use of herbicides is recommended within the first 90 to 120 days as the weeds compete with the cane plant for nutrients and sunlight and water. The timely application is critical as late applications do not benefit the plant in the same way as earlier applications. This has a direct impact on yields as fields that are not properly managed show lower production.

Recommended international best practices put yields at 56 to 64 tons per acre (t/acre) for re-planting when using irrigation and fertigation. In Belize the recommended best practice yield is 36 tons per acre for re-planting. This is accounted for by the scale of farming operations, with most farms in Belize being small compared to the large farms in the large producing countries. The actual international rate achieved for rain fed only appears to be 26 to 28 tons per acre under rain fed conditions in countries such as Jamaica and Kenya. The world average for overall sugar cane production (all planting i.e. new, replanting and ratooning) is 27 tons per acre with some countries such as Colombia achieving as high as 50 tons per acre and others like Brazil achieving 26 tons per acre, Guatemala 37.86(t/acre), India (31 t/acre), Kenya (28 t/acre), USA (32 t/acre) and Belize

at 16 tons per acre average (International Sugar Organization ISO, Survey of Sugar Crop Yields, 2005). A final note here is that the average yields have not changed much since 1991/1992 to 2001/2002 with average yields only increasing by 13 % world wide during that period covered by the ISO survey (Survey of Sugar Crop Yields, 2005).

With the two exceptions noted above, the rest of the production is similar despite the slight differences in the amounts of inputs, the mechanization of chemical input applications and use of irrigation which do significantly affect yields.

While the international best practices are relevant to show a comparison and do have implications for both chemical management and yields, they are not directly comparable to the local Belizean situation where many small and medium farmers grow sugar cane on a rain fed basis as opposed to large industrial type farming operations that use irrigation.

During the time frame recommended for the introduction of GAP (5 years) it is not possible to change the existing structure of the sugar industry. As such, the locally developed best case scenarios for re-planting and ratooning are most relevant to the Belizean situation. For the purpose of doing a cost benefit analysis it also provides sufficient information to show the methodology. An attempt to make a direct comparison to the international best practice would be inappropriate and bias the CBA analysis toward what is not realistic or achievable given local constraints. The use as a general illustration as was shown above does serve a useful purpose in showing what Belize as a nation is up against. Some policies can be developed for timely consideration as a result of this knowledge. At a future stage the question of the structure of the industry may be looked at. The chance of it remaining unchanged due to local cultural and social concerns is a future risk.

3.3 Belize Sugar Cane Production Recommended Best Practices

The data from the Belize Good Agricultural Practices case is used to compare with the actual or traditional production results achieved by Belizean farmers. The inputs under the GAP and traditional production methods are presented subsequently. The price for sugar does fluctuate on the world market; in order to account for this the most recent price for the 2010/11 cane season which reflects the full effect of the reduction in the European Union ACP preferential prices for sugar is used. This is BZ\$46.15 per ton of sugar cane. The average for the previous five years is BZ\$56.00 per ton of cane but this would include part of the remaining preferential prices phased out during that period, which is not indicative of the non-preferential rates. In this specific case the most recent price is the real situation facing our farmers.

The following all use Belize Dollars (BZ\$) and tons per acre (t/a) with a one year time period or crop year.

Note that ratooning occurs for 5 years after replanting.

The following tables 4 and 5 show the gross income under Traditional production and under Good Agricultural Practices (GAP).

Table 4 Gross Income under Traditional Production (per acre)

Crop	Quantity	Price Per Ton	Total
Replanting 1 st Year	25 t/a	\$46.15	\$1,154.00
Ratooning Year	15 t/a	\$46.15	\$692.25

Table 5 Gross Income under Good Agricultural Practices (per acre)

Crop	Quantity	Price	Total
Replanting 1 st Year	36 t/a	\$46.15	\$1,662.00
Ratooning Year	23 t/a	\$46.15	\$1,061.45

The following tables 6 and 7 show the costs of production using the traditional methods and using Good Agricultural Practices.

Table 6 Traditional Costs (per ton of cane)

Crop	Quantity	Price per ton	Total per Acre
Replanting	25 t/a	\$33.16	\$829.00
Ratooning	15 t/a	\$ 24.79	\$372.00

Table 7 Good Agricultural Practices Costs (per ton of cane)

Crop	Quantity	Price per ton	Total per Acre
Replanting	36 t/a	\$31.67	\$1,140.00
Ratooning	23 t/a	\$21.35	\$491.00

Table 8 Showing Growing Costs and Yields for Replanting under GAP and Traditional

REPLANTING FIELDS						
	BEST CASE SCENARIO FARMERS			ACTUAL CASE SCENARIO FARMERS		
Operations	Yield 36 Tons per acre \$	\$ Cost Per Ton	Comments	Yield 25 Tons Per acre \$	\$ Cost Per Ton	Comments
Land Preparation						
Plow (2X)	140.0	3.89	120 hp RWT w 3 disc plow - hire	100.0	4.00	120 hp RWT with 3 disc plow - hire
Harrow (2X)	80.0	2.22	100 hp RWT with 28" discs – hire	60.0	2.40	100 hp with 28" discs – hire
Bed Formation	40.0	1.11	100 hp RWT w bed former - hire	40.0	1.60	100 hp RWT with bed former – hire
Reforming Beds Interrow Cultivation	0	0				
Planting						
Cane Seed Material	187.5	5.21	2.5 tons @ 75/ton “clean” seed	112.5	4.50	1.5 tons @ \$75/ton of “clean” seed
Cutting & Loading Cane Seed	37.5	1.04	2.5 tons @ 15/ton – labor cost	22.5	0.90	1.5 tons @ 415/ton – labor cost
Transport & Spread Cane Seed	50.0	1.39	Truck/tractor & Trailer Cost	50.0	2.00	Truck/tractor & Trailer Cost
Spread & Chip Seed; Spread Fertilizer	50.0	1.39	Labor Costs	50.0	2.00	Labor Costs
Cover Cane Seed	40.0	1.11	80 hp RWT with covering implement - hire	40.0	1.60	80 hp RWT with covering implement – hire
Supplying	20.0	0.56	May not be necessary if good emergence	20.0	0.80	
Fertilization						
Fertilizer at Planting	200.0	5.56	2.5 bags 22-10.5-22 @ \$80/bag	80.0	3.20	1.0 bag 18-18-18+TEM @ \$80/bag
Fertilizer to Sidedress	97.50	2.71	1.5 bags/ac Urea @ \$65.0/bag	65.0	2.60	1.0 bag/ac urea @ \$65.0/bag
Sidedress application	7.50	0.21	Labor cost to manually spread fertilizer	5.50	0.22	Labor cost to manually spread fertilizer
Weed Control						
Manual – Machete	0	0		56.00	2.24	Manual Weed Control
Early Post Emergent Herbicide	45.0	1.25	Diuron (32 fl oz) + Ametryn (32 fl oz) + 2,4-D Mix (32 fl oz)	5.65	0.23	Diuron (4 fl oz) + Ametryn (4fl oz) + 2.4 D Mix (4fl oz)
Post Emergent Herbicide	45.0	1.25	Diuron (32 fl oz) + Ametryn (32 fl oz) + 2,4-D Mix (32 fl oz)	45.0	1.80	Diuron + Ametryn + 2,4-D Mix, same quantity
Applications (2X)	40.0	1.11	Labor @ \$20/ac (\$2.50 per pump)	40.0	1.60	Labor @ \$20/ac (\$2.50 per pump)
Spot Spray Post Emergent Herbicide	8.05	0.22	Helosate (40 fluid ounces)	4.83	0.19	Helosate (24 fl oz)
Pest Monitoring & Control	25.0	0.69		15.0	0.60	Biological Monitoring and Control
Hard Water & pH Corrector	10.0	0.28		0	0	
Maintenance of Intervals & Headlands	7.00	0.19	Bush Cutting	7.0	0.28	Bush Cutting
Post Harvest Operations	10.0	0.28	Trash Burning	10.0	0.40	Trash Burning
TOTALS	1,140	31.67		829.0	33.16	

Table 9 Showing Growing Costs and Yields for Ratooning under GAP and Replanting

RATOON MAINTENANCE						
	BEST CASE SCENARIO FARMERS			ACTUAL CASE SCENARIO FARMERS		
Operations	Yield 23 Tons per acre \$	\$ Cost Per Ton	Comments	Yield 15 Tons Per acre \$	\$ Cost Per Ton	Comments
Land Preparation						
Plow (2X)						
Harrow (2X)						
Bed Formation						
Reforming Beds Interrow Cultivation	30.0	1.30	100 hp RWT with bed former - hire	30.0	2.00	100 hp RWT with bed former - hire
Planting						
Cane Seed Material						
Cutting & Loading Cane Seed						
Transport & Spread Cane Seed						
Spread & Chip Seed; Spread Fertilizer						
Cover Cane Seed						
Supplying	20.0	0.87	May not be necessary if good stool emergence	20.0	1.33	May not be necessary if good stool emergence
Fertilization						
Fertilizer Material	200.0	8.70	2.5 bags 22-10.5-22 @ \$80/bag 2 wks after harvesting	100.0	6.67	1.25 bag 22-10.5-22 @ \$80/bag 2 weeks after harvesting
Fertilizer to Sidedress						
Sidedress application	7.50	0.33	Labor cost to manually spread fertilizer	7.50	0.50	Labor cost to manually spread fertilizer
Weed Control						
Manual – Machete	0	0				
Early Post Emergent Herbicide	41.0	1.78	Diuron (4 fl oz) + Ametryn (4 fl oz) + 2,4-D Mix (4 fl oz)	22.00	1.47	Amigan – Diuron + Gesapax + Merlin – Kilo/acre
Post Emergent Herbicide	32.0	1.39	Using Helosate 40 fl oz)	32.0	2.13	Manual Weed Control or Directed Chemical Control
Applications (2X)	20.0	0.87	Labor @ \$20/ac (\$2.50 per pump)	20.0	1.33	Labor @ \$20/ac (\$2.50 per pump)
Spot Spray Post Emergent Herbicide						
Pest Monitoring & Control	51.00	2.22	Biological control – use of Meterhizium (fungus)	15.0	1.0	Biological Monitoring and Control of Froghopper
Chemical Control 1	32.0	1.39	Actara (80grams/acre)	51.0	3.40	Actara (80 grams/acre)
Chemical Control 2	42.5	1.85	Neem (1 1/2 Bayer) X + Tri Clan (1 Bayer) per 5 gals water	36.0	2.40	Neem (1 ½ Bayer) X + Tri Clan (1 Bayer) per 5 gals water
Optional				23.4	1.56	Using Procon
Maintenance of Intervals & Headlands	5.0	0.22	Bush Cutting	5.0	0.33	Bush Cutting
Post Harvest Operations	10.0	0.43	Trash Burning	10.0	0.67	Trash Burning
TOTALS	491.0	21.35		371.9	24.79	

The tables above do not show a reduction in the use of chemical inputs using GAP. The benefit is in yields as the application in the recommended best practice quantities work to improve farm outputs. Under the traditional method, farmers apply inputs according to their own experience and try to avoid costs without undertaking a Cost Benefit Analysis with all costs being taken in to account as well as the difference in yields. The risk here is that even though a CBA does show a net benefit, the farmers may be reluctant to change their practices due to their own attempts to cut costs being paramount in their own farming methods. The gains from GAP and from the CBA require good efforts to demonstrate the benefits through improved field extension services. It should be noted that when farmers apply the same amount of chemicals required under ratooning their individual cost still is marginally higher due to the amount of labour required for manual applications such as involved in spraying. This may have a possible cost savings for future exploration versus the costs of new machinery and the costs of renting these by the farmers on a pooled sharing of resources basis. The use of modern mechanized sprayers would also involve some reductions in chemical use due to less wastage through direct applications and less spray drift from wind. At this point that is still in the future as mechanization will require newer methods of levelling the fields and planting to maximize the possible benefits from using machinery. It is a good first step to convince farmers to adopt Good Agricultural Practices as shown here in the recommended compared to the traditional methods.

3.4 Quantification of the Costs and Benefits of GAP

The following tables 10 and 11 show the net gains or benefits from using GAP on a per acre basis.

Table 10 Net Gains from GAP for Replanting

	GAP	Traditional	Net Gain Per Acre
Income	\$1,662.00	\$1,154.00	\$508.00
Costs	\$1,140.00	\$829.00	-\$311.00
Net Gain	\$522.00	\$325.00	\$197.00

Table 11 Net Gains from GAP for Ratooning

	GAP	Traditional	Net Gain Per Acre
Income	\$1,161.45	\$692.25	\$469.2
Costs	\$491.00	\$372.00	-\$119.00
Net Gain	\$670.45	\$320.25	\$350.20

The crop cycle is 6 years; therefore the net benefit per acre of sugar cane produced under Good Agricultural Practices is as follows:

Year 1 Replanting \$197.00
 Year 2 Ratooning \$350.00

Year 3 Ratooning	\$350.00
Year 4 Ratooning	\$350.00
Year 5 Ratooning	\$350.00
Year 6 Ratooning	\$350.00
Average	= \$324.5

Average is \$324.50 per year which can be assumed to be a useable figure as at any one time different sets of farmers are replanting (1/6 of the farmers in every year) and others are going through the years of ratooning (5/6 of the farmers in every year). An assumption is being made that this is a true average that does not need to be subjected to NPV analysis due to the rotation of planting and ratooning (averaging effect) over the entire sugar cane crop in Belize which occurs on a yearly basis.

Likewise the benefits and costs can be summarized and averaged on a per year basis for each acre of land.

	Net Benefits	Net Costs
Replanting Year 1	508.0	311.0
Ratooning Year 2	469.2	119.0
Ratooning Year 3	469.2	119.0
Ratooning Year 4	469.2	119.0
Ratooning Year 5	469.2	119.0
Ratooning Year 6	469.2	119.0
Averaging	BZ\$475.67	BZ\$151.00

The Benefit to Cost Ratio is $\$475.67 / \$151.00 = 3.15$

Likewise the Cost to Benefit Ratio is $\$151 / \$475.67 = 0.32$ which is the Efficiency Ratio for the application of GAP.

3.5 Extrapolating the Results to 146,000 Acres of Crop land in Belize

An assumption is being made that GAP can be introduced in Belize over a five year period. A second assumption being made for the purpose of showing the impact of the Cost Benefit Analysis is that benefits can be transferred between different crops that use chemical inputs. This is important as the other crops mentioned in this CBA paper also depend for their income on the same GAP sensitive export markets. During the first year, 1/5 of the acreage under crops in Belize will be brought under GAP. At any subsequent year an additional 1/5 will be brought under GAP until the entire acreage is covered.

There are an estimated 265,000 acres of land under agricultural production, of which 119,000 are estimated to be pasture land. Pasture land is used mainly for the production of meat and milk for local consumption with any limited exports of live cattle being aimed entirely at neighbouring countries. Beef in particular is grass fed, and in total pasture based agriculture in Belize is not a major user of chemicals. For this reason the acreage under pasture is not being considered as a part of this CBA.

In summary the assumption is that 1/5 of 146,000 acres of cropland or 29,200 acres per year will be brought under GAP.

4.0 Risk Identification and Assessment

There are three major risks, which can result from not implementing GAP. The first is environmental, the second is social/health and the third is economic. The importance of agriculture to the Belizean economy has been stated earlier and it is an industry that is not replaceable in terms of contributions to export earnings, employment and social stability.

Belize has a growing population who are consumers in their own right for the same crops which are our main agricultural exports plus others that are either consumed in their entirety locally or exported in smaller amounts. These include among others, rice, corn, beans, papayas, vegetables etc.

It has been noted that in an effort to meet the demands of producing export crops with price constrained markets the tendency is to not apply chemical inputs in the recommended amounts at the indicated times. Inappropriate use of chemicals in this manner leads to a diminished benefit for the crops and lends itself to a higher risk of contamination of the environment due to the traditional approach taken as it lends itself to some level of wasted inputs. This is also an indicator that the protection of the broader environment including biodiversity is not the highest priority and indeed may not be built into the present farm practices as other priorities, namely cost savings, rank higher in the behavioural patterns shown to date.

An example of any Good Agriculture Practice is following recommended environmental guidelines such as having buffer strips between agricultural land and streams, lakes, rivers and water catchment areas. Together with the correct timing and using modern methods of spraying or applying inputs it serves the necessary requirement of benefitting the crops while mitigating effects on the surrounding flora and fauna. When this is not followed it is very likely that there will be runoff into the source of our water supply for urban use as well as impacts further downstream in the fish stock and barrier reef. Environmental risk can also be mitigated through the effective application of GAP and the present CBA to show that farm-based income can be improved through the proper management of agricultural practices without resorting to increasing acreage under cultivation. This is important, as any increase in acreage while following traditional methods and without the benefits of GAP will merely perpetuate the existing inefficient situation.

Even though it has been demonstrated that farmers do not apply the required amounts of chemical inputs due to the use of traditional practices and as a cost avoidance strategy, the fact remains that not applying chemicals at the right time is both wasteful, as there may be little benefit to the crop, and also can be used as an indicator that best practices in chemicals use and handling are not a high priority in their everyday lives.

That has implications for health as not following Good Agriculture Practices will impact the lives of farmers, workers and their families, as well as the population of the surrounding areas. While data does not exist to be able to differentiate or identify the health impacts from chemicals used in agriculture, it can be inferred from the use of manual spraying of herbicides and pesticides that there is spray drift that has an impact on human health and also on the surrounding plant life including other crops not being directly sprayed. The less efficient use of chemicals due to timing and manual spraying requires improved farmer education and awareness so that they become well versed with the impacts on their own health, that of their families and communities, as well as the impacts on the environment of continuing these traditional methods. The area of health impacts is one that requires better and distinct recording of the causes of illness under our present health records in order to be able to know and compute the cost of illness caused by traditional agricultural practices in Belize. Health care costs are presently absorbed by the Government of Belize through the provision of free health care at the public hospitals in the country. Farmers need to better understand the linkages between what they may consider as “normal” illnesses and the use of chemicals. A health education and awareness program as part of any field extension services could be useful in this regard in order to mitigate the health and environmental risk.

A direct social risk is that any reluctance to implement GAP will result in varying levels of social disruption due to a slow but certain inability to survive due to reducing farm incomes given the large number of farmers relative to the small overall output in total and on a per acre basis. This represents a significant risk to Belize’s poverty alleviation strategies. While there are competing interests at work the fact remains that on a per farm unit basis there is a need to be efficient and increase yields. A failure to have a positive interaction with farmers in overcoming their reluctance to change will have serious social implications for the two Northern Districts and also for the nation as a whole.

The economic risk is related very much to the social risk in that the present loss of income through not implementing GAP is already being felt in the low yields and reduced export earnings. There is a possibility that persistent economic losses can affect the ability of many small farmers to remain viable. A situation where this continues unchecked could also impact the viability of the export industries on a whole.

Related to the present economic risk and environmental risk is a future risk that there could be a consolidation of the farming sector with a consequent move towards more intensive agriculture which would have an economic benefit but could affect the environment if the entire relationship between the environment, sound management of chemicals and farm production is not accepted as positive and manageable in an internationally accepted and measurable way as offered by the early introduction of GAP.

A measurable “standard” such as GAP that is up to this point voluntary is important to Belize. First the international community is now requiring steps which, while they remain “voluntary” up to this date, are becoming mandatory in practice. These can be seen from different viewpoints such as safety of worker/population of economically disadvantaged persons and food safety.

From one point of view, which may be most readily seen in the American media with numerous incidents of infected vegetables, fruits, eggs and meat as well as milk among others, the main concern from GAP would appear to be food safety. While this can be seen as a requirement for their own market, the adoption of good chemicals management and food handling practices such as the timing of application of inputs and simpler steps such as proper washing of fruits and vegetables are also directly beneficial to the local consuming population whose health needs should be the primary concern.

From the European perspective the issue of the health and safety of economically disadvantaged persons such as workers, their children and families, and small farmers struggling to achieve economic sustainability is important. GAP also addresses this issue and is a good way to meet this increasingly important international concern. Farming must be productive, efficient and also work in harmony with the environment and meet socially acceptable standards for people who are at the heart of the production processes and who should share in any economic benefits derived from it.

The adoption of GAP can be seen as a good way to advance Belize's economic development objectives while doing so in a way that is socially, environmentally and economically sustainable for all Belizeans. This respects our right to grow economically while ensuring the long term sustainability of our natural resources which offer us beauty, national patrimony and economic benefits. It will also meet our long term international obligations under treaties related to the Sound Management of Chemicals and others that while not yet enforceable are surely becoming standard best practices. Overall the economic, social and environmental objectives of Belize can be compatible and achieved by a positive approach to our long term sustainability with all these objectives taken into account.

5.0 Setting Targets, Policies and Instruments for Implementation

Given that 5,851 cane farmers delivered 917,728 tons of sugar in the 2009/2010 crop season is an indicator that the large majority of them are smallholders with some medium and few large farms. The economic data provided indicates the importance of cane farming and farming in general for agriculture exports. The importance of the earnings and employment from farm based activities cannot be overstated.

At the same time there is no single national program that addresses the need for improving farm efficiencies while simultaneously addressing our present international obligations under the Sound Management of Chemicals as well as emerging opportunities and threats to and for our export earnings.

The introduction of Good Agricultural Practices is a good way to meet these challenges in an effective manner as it is broad in scope, voluntary in implementation up to this point in time and would serve as an incentive to improve efficiencies and maximize farm based income.

As part of this process the Cost Benefit Analysis shows clearly that the farm based income can be increased without increasing acreages under production and without exceeding the recommended levels of chemical inputs as per Belizean and International Best Practices. The need to introduce GAP is also for sound environmental, health/social as well as economic reasons.

In order to ensure an effective implementation of GAP there is a need for support from the Government and the other stakeholder, mainly the farmers associations, farmers and processors as well as donors to develop and carry out policies and actions for its success.

These should include:

- Improved field extension services to demonstrate and follow up on the implementation of the recommended best practices both in required amounts of chemical inputs as well as maximizing efficiencies through the correct timing of applications as well as in addressing education and awareness issues in safety in the sound management of chemicals through improved methods of spraying and handling guideline development;
- Farmers have shown a willingness to abide by local regulations for the sound management of chemicals (e.g. Gramaxone is no longer used). This requires ongoing efforts to provide good oversight of the SMC in Belize through effective regulations, monitoring and guidelines for the importation and use of hazardous chemicals as well as good labeling and handling guidelines that apply to all areas of use including but not limited to storage, mixing, and disposal of empty containers;
- Ongoing research to show the effectiveness of using new technologies to support the application of mechanization of the methods of chemical applications
- Effective studies to show the possibilities of pooling of resources to purchase and rent the equipment required for effective mechanization, such as shielded mechanical sprayers that reduce spray drift while maximizing the uptakes by the plant itself
- Ongoing research to follow up on the introduction of meterhizium fungus used in the control of frog hopper pest. This is a good first step and more can be done with research into the full range of organic or non chemical agricultural inputs;
- Donors should be requested to use their contributions in a manner that serves as an incentive and reward to improving efficiencies, such as under a GAP implementation program, rather than in a blanket manner that sends mixed signals of charity and entitlement rather than a means of improving the social, environmental and economic conditions of the stakeholders;
- Building and integrating into any sectoral, regional plans or crop specific plans the protection of our national biodiversity and broader environment, taking into account the at present barely tapped tourism potential of the two Northern Districts, and Belize's overall pristine rivers, lakes, territorial seas, forests and other flora and fauna;
- Inclusion of GAP in the National Development Plan so that it serves as a vehicle that helps to tie in the development objectives of the Government and People of

Belize with regards to meeting local and international objectives for the environment, and social and economic needs especially as expressed in the Millennium Development Goals.

6.0 Cost Benefit Accounting Statement

Note the table and calculations below are part of Table of Content Item 6 the Cost benefit Accounting Statement and then the NPV is calculated.

Table 12 Cost Benefit Accounting Statement

Year	Net Benefit Per Acre	Total Net Benefit
Year 1 = 29,200	\$324.5	\$9,475,400.00
Year 2 = 58,400	\$324.5	\$18,950,800.00
Year 3 = 87,600	\$324.5	\$28,426,200.00
Year 4 = 116,800	\$324.5	\$37,901,600.00
Year 5 = 146,000	\$324.5	\$47,377,000.00

Using a discount rate of 5%, the NPV is BZ\$119,071,604.37 or USD \$59,535,802.15.

The Benefit/Cost or Efficiency Ratio is 3.15 which clearly illustrates that every dollar of cost yields 3.15 dollars of benefit. This is a very good ratio when compared to other nations that have undertaken a similar CBA analysis with a view to GAP implementation.

7.0 Summary

The traditional method of farming used in Belize was examined with the findings that most farmers in the case studied for sugar cane farming do not:

- Use chemical inputs according to the recommended best practices;
- Adopt a Cost Benefit Analysis in determining the required levels of use;
- Take into account the environmental, social and economic impacts of not following best practices with regards to timing and modern methods of applications.

The case study reveals that farm-based income in Belize can be improved and the above negatives mitigated through the application of Good Agricultural Practices (GAP). A related finding is that increased acreages should not be seen as a solution in and of itself without first implementing GAP to ensure that the environmental, social and economic aspects of economic development are taken into account with the Sound Management of Chemicals.

Implementing GAP over a five year period would allow for the net benefit of BZ\$324.5 per acre per year and BZ\$119,071,604.37 NPV over a five year period. The benefit/cost

ratio of 3.15 shows that GAP is economically beneficial as well as being able to foster environmental and social development objectives.

While GAP is not an international obligation under any treaty, it is a good measure to use as a standard to implement in order to adapt to increasing international requirements for food safety as well as related social and other obligations as seen by our major trading partners. It should be seen as an incentive and opportunity in itself while having the potential to ward off some potential threats.

REFERENCES

- (1) Avella, Fernandez, Paredes. *Belize National Implementation Plan POPS*. March 2008
- (2) UNDP-UNEP. *Mainstreaming Poverty – Environment Linkages Into Development Planning. A Handbook for practitioners*. March 2009.
- (3) Conway, Thomas J. *Supplemental Cost-Benefit Economic Analysis Guide (Revised) RFI Draft*. July 2009.
- (4) Statistical Institute of Belize 2009 Abstract of Statistics released 2010.
- (5) Government of Belize, Medium Term Economic Strategy, 2010-2013. Building Resilience Against Social, Economic and Physical Vulnerabilities, Belmopan, Belize, 2003.
- (6) Paredes, Humberto and Vanzie, Errol. *Situation Analysis Report and Concept Papers*, SAICM Belize SAR, August 2010
- (7) UNDP Technical Guide for Integrating the Sound Management of Chemicals in MDG-Based Policies and Plans. UNDP. (2009).
- (8) Vargas, Alberto, *Sugarcane Growth Phases and Chemical Inputs*, Sugar Cane Field Technician, Belize 2007.
- (9) Sugar Industry Control Board and Sugar Industry Research and Development Institute, Recommended Costs of Production Sugar Cane, Belize 2010.
- (10) Quick Survey, Sugar Industry, Belize, 2010.
- (11) Sugarcane Production Best Management Practices (BMPs), Louisiana State University Ag. Center, Research and Extension 2000.
- (12) Australia Sugarcane Code of Practice for Sustainable Cane Growing, Cane Growers Council Australia Undated.
- (13) Australia Sugarcane Public Environment Report 2008, Cane Growers.
- (14) International Survey of Sugar Yields and Prices Paid, International Sugar Organization, United Kingdom, 2005
- (15) Planting and Timing Effects on Sugarcane Yield, Plant Management Network 2005.
- (16) African, Caribbean and Pacific Sugar Executive Brief, Technical Center for Agriculture ACP, January 2009.
- (17) Best Management Practices Plan, Sugarcane Production, US Sugar Corporation prepared for South Florida Water Management District, January 2009.
- (18) Ng Kee Kwong, K.F., *Impact of Sugarcane Production on the Environment in Mauritius*, October 2003.
- (19) Improving the Safety and Quality of Fresh Fruit and Vegetables, A Training Manual, University of Maryland, 2002.
- (20) Good Agricultural Practices (GAP) Report, FAO Conference, Rome 10 -12 November 2003.
- (21) Hobbs, Jill E., *Incentives for the Adoption of Good Agricultural Practices (GAP)*, Paper for FAO Consultation on GAP Rome, November 2003.
- (22) International Survey of Sugar Yields and Prices Paid, International Sugar Organization, United Kingdom, 2005