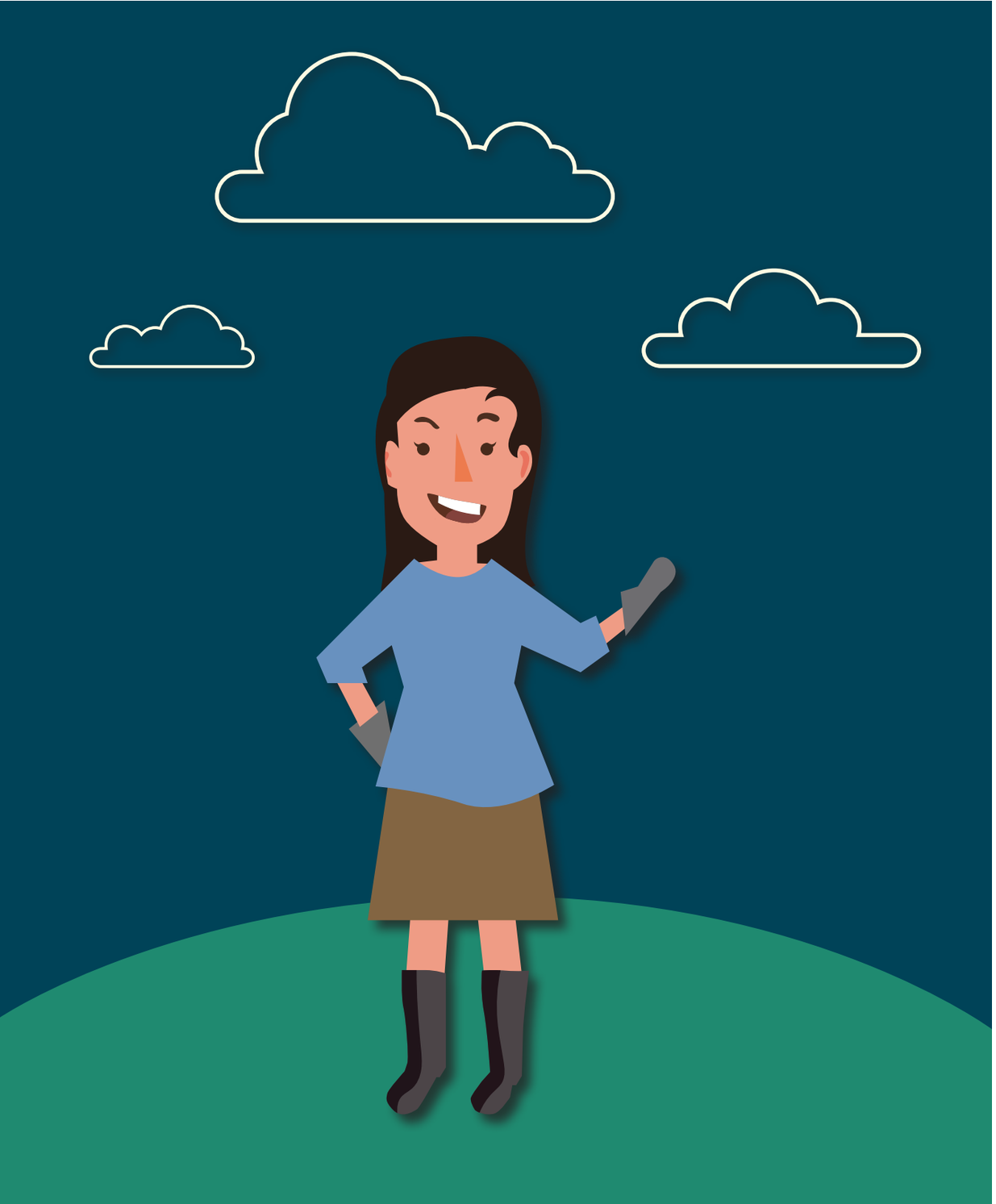
Best Management Practices Manual

For the Cultivation of Sugarcane in Belize

FARMER FIELD SCHOOL



Content

Best Agricultural Practices

Site Selection and Land Preparation	Page 14
Planting of Sugarcane	Page 24
Sugarcane Nutrition	Page 33
Integrated Pest Management in Sugarcane	Page 40
Calibration of Equipment	Page 55
Pre-harvest and Harvest	Page 60
Ratoon Maintenance	Page 66
Occupational Health and Safety	Page 71
Inclusion of Women and Youth	Page 82
Environmental Sustainability	Page 86
Financial Literacy	Page 94
Annex	Page 102

Acknowledgements

Project Concept:

Mac McLachlan (ASR)
Rafael Vayá (ASR)
Julia Clark (Tate & Lyle)
Olivia Avilez (BSI)
Marcos Osorio (SIRDI)

Authors:

Olivia Avilez
Modesto Ulloa
Leticia Westby
Ermin Gonzalez
Gabriel Flores
Elbert Cowo
Marvin Garcia
Ronaldo Gonzalez
Miguel Keme
Saul Vasquez
Saul Osorio

Graphic Designers:

Jeremy Gongora
Arturo Carrillo

Editors:

Leticia Westby
Gabriel Flores
Susana Castillo
Jeremy Gongora

Expert Consultants:

Fairtrade Standards
Proterra (Julia Clark y Rafael Vayá)
Jeffrey Joseph (SIRDI)
Adrian Zetina (BSI)
Carlos Itza (SCPC)
Michael Tewes (IDB Project Manager)
Leonardo Folgarait (CSCPA)
Abigael Pech (PSCPA)
Zune Canche (BSCFA)
Rubén Ortiz (Agrosoil)
Technical Team - Pesticides Control Board of Belize

Maps:

Vasni Pech (SIRDI)
PACT (Protected Areas Conservation Trust)

Photographs:

SIRDI's Techinical Extension Team

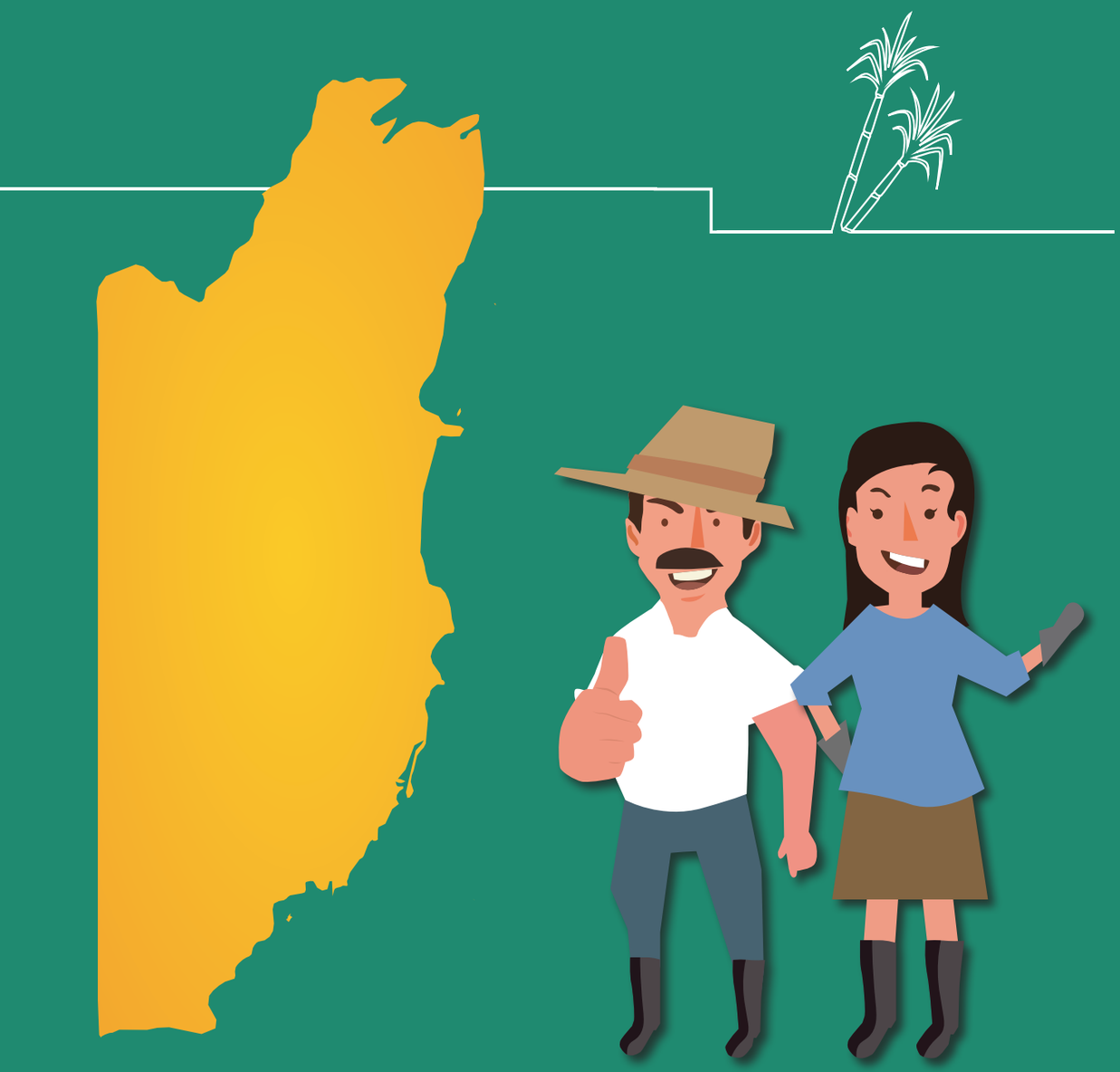
Graphics:

Daniel Villanueva
Marvin Garcia

Printer: The Angelus Press Limited

Executive Summary

Best Agricultural Practices in Sugarcane Cultivation

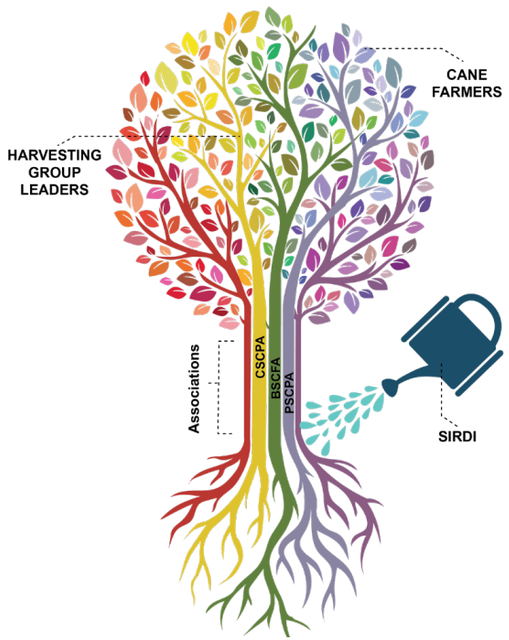


Sugarcane production in Northern Belize is an important part of the economy and social activity. There are approximately 75,000 acres of land under sugarcane with 5,450 farmers represented by three associations that deliver cane to Tower Hill Factory. The sugarcane supply chain is an important source of employment that generates more than 10,000 direct jobs and more than 7,000 indirect jobs. Major stakeholders in Belize's sugar industry include cane farmers, represented by three associations; Belize Sugar Industries Ltd. - which is part of the ASR Group; the regulatory bodies established by the Government, such as the Sugar Industry Control Board (SICB) and the Sugarcane Production Committee (SCPC) and the technical arm of the industry, the Sugar Industry Research and Development Institute (SIRDI).

Stakeholders of the Belizean sugar industry seek to improve agricultural practices and related environmental, labor, health and safety issues, so that the industry becomes more competitive and sustainable for the future. In efforts to achieve this, a manual has been developed and designed focusing on four key themes, namely: human rights, health and safety, and best environmental and agricultural practices. The manual is a set of generic principles and practices that will be used by SIRDI in field schools to train the participating cane farmers who, in turn, will seek to disseminate the information to other cane farmers. This manual will also support the consolidation of the themes of best production practices in the Fair Trade criteria and any other certification.

The manual is divided into 11 individual modules disseminated throughout the year and synchronized so as to have the academic exercise performed before the actual operation. The focus of the modules are as follows:

1. Site Selection; to prepare the foundation to establish the sugarcane crop.



The goal is: to comply with site selection laws and standards and establish a crop at the lowest cost taking into account land conservation through the development of proper land preparation practices.

2. To comply with site selection laws and standards and establish a crop at the lowest cost taking into account land conservation through the development of proper land preparation practices.

The goal is: to establish the adequate plant population to achieve high yields and sustainability.

3. Fertilization of the crop for the adequate growth of the sugarcane plantation.

The goal is: to apply the appropriate fertilizer blend with the recommended dose and the required method to achieve efficiency.

4. The identification of weeds and pests to be able to recommend an integrated management, whether manual, mechanical or chemical.

The goal is: to control weeds and pests with the least impact on the environment and the crop.

5. Calibration of the equipment and chemical dosage calculation.

The goal is: to apply chemicals safely with correct dosages to avoid environmental and safety problems caused by over-dosage or insufficient dosage.

6. Characteristics of sugarcane associated with pre-harvest and best practices during harvesting.

The goal is: to have a variety structure that adjusts to a harvest plan taking into account the required regulation and quotas. Harvesting Management protocol to reduce the losses from field to the mill and ensuring the delivery of clean and high quality cane.

7.Ratoon maintenance complies with a series of activities for the proper management of the newly harvested cane fields that includes the management of the cane resuide and the ratoons.

The goal is: to carry out timely practices at minimum cost following the best management practices to enhance good sugarcane development.

8. Emphasizes the main labor standards and safety measures required

in the different activities of sugarcane cultivation, from site selection to harvesting and delivery.

The goal is: to ensure occupational health and safety compliance during sugarcane cultivation activities.

9. The inclusion of women and youth in our society and their role is important for the sugarcane production chain.

The goal is: To have their active participation, support and empowerment in the sugarcane business.

10. Environmental sustainability - explains the importance of protecting and safeguarding our environment and how adopting best agricultural practices helps to protect the soil, air, water, flora and fauna of our environment.

The goal is: To ensure the conservation and protection of our natural resources.

11. Explains the importance of record- keeping of the main activities and operations.

The goal is: To let the cane farmers know the importance of having accurate records of their production and determining if they are making profits.

Calendar of Activities of Sugarcane Cultivation

Module	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1. Site Selection and Soil Preparation		■	■	■	■			■				
2. Sugarcane Planting									■	■	■	
3. Nutrition of Sugarcane	■	■	■	■	■	■			■	■	■	■
4. Pest Management in Sugarcane	■	■	■	■	■	■	■	■	■	■	■	■
5. Calibration of Spray Pumps	■	■	■	■	■	■	■	■	■	■	■	■
6. Pre-harvest and Harvest	■	■	■	■	■	■						■
7. Ratoon Maintenance	■	■	■	■	■	■						■
8. Occupational health and Safety	■	■	■	■	■	■	■	■	■	■	■	■
9. Inclusion of women and youth	■	■	■	■	■	■	■	■	■	■	■	■
10. Environmental sustainability	■	■	■	■	■	■	■	■	■	■	■	■
11. Financial Literacy	■	■	■	■	■	■	■	■	■	■	■	■

So then...

Why this manual?

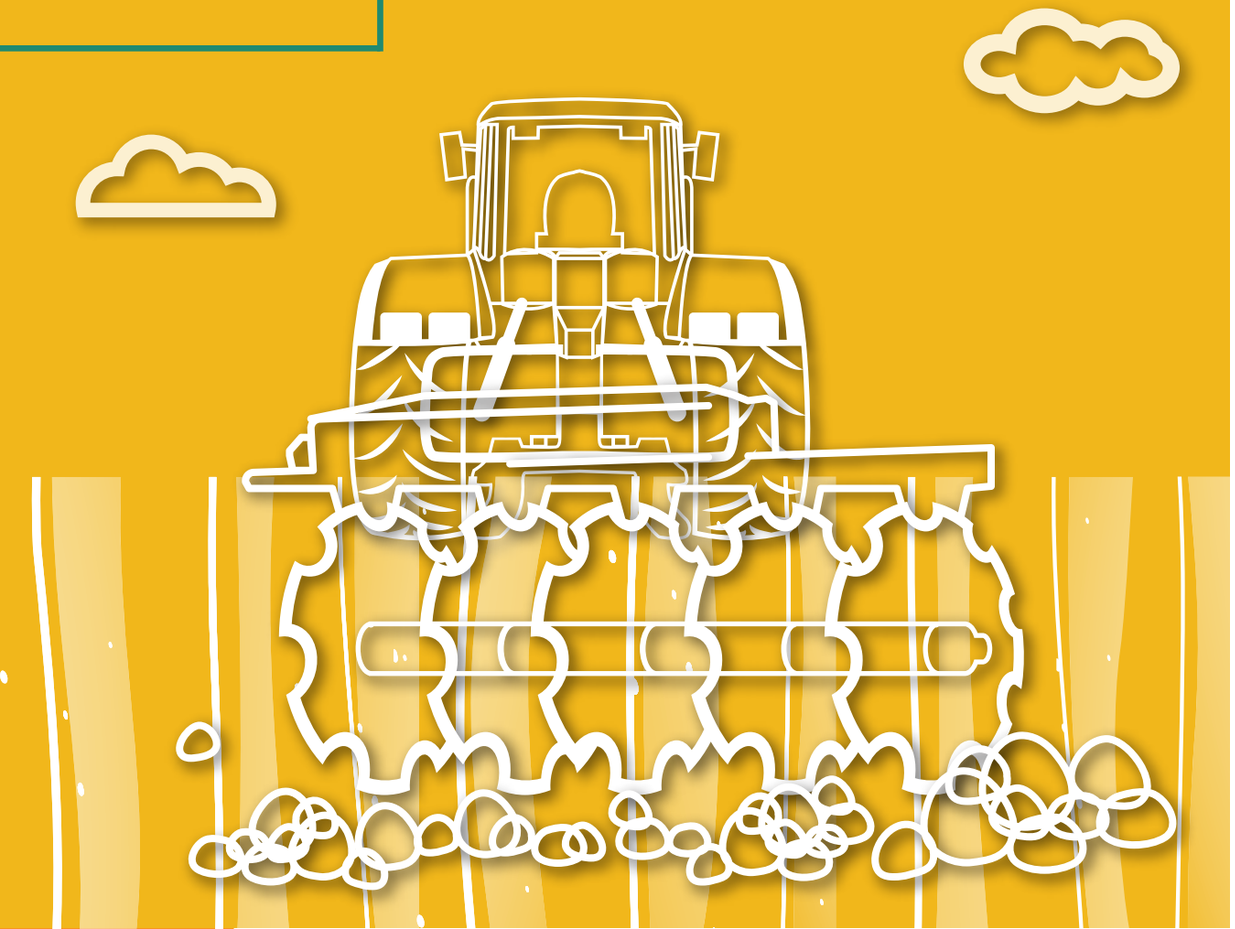
Having a technical guide is like having a good file. It helps you to improve your work in the field so that you are more effective in managing your sugarcane crop. With this guide you can tackle the problems from the root and improve the productivity of your sugarcane fields.

This technical guide is written especially for you by people specialized in different subjects including:

- **Agriculture**
- **Environment**
- **Occupational health and safety**

Best Agricultural Practices

Site Selection and Soil Preparation



How do you select your site?
Place a check mark to the site for proper Land preparation.

To make your investment worthwhile, it is important for YOU to renovate your low low-yielding cane fields.

The soil: Is where all agriculture activities are conducted. The soil usually contains 47% non-living material, 3% organic material, 25% water and 25% air. Before planting it is important to observe and know the conditions of the soil in which we are going to establish a canefield.

To select the planting site, keep the following in mind:

1. **Soil:** ensure that the soil is suitable for sugarcane production:
(a.) Find out what previous use was given to the land as this may help or affectyour cane cultivation.

(b). Seek the technical support from SIRDI's or your association's technicians to interpret the soil analysis results; determining the soil fertility and the amount of fertilizer that is required. *See Annex I for details on how to collect a soil sample for analysis in a laboratory.*

2. **Stones and stumps:** Remove stones and stumps. These are the major cause of equipment breakdown.

3. **Low lying areas:** Be careful when there are areas with water logging, it is necessary to drain them taking advantage of the natural inclination of the land. Consult the agricultural technician about which type of drainage is best for the field.

4. **Pests:** It is recommended that other crops fall within a distance of 30 feet in order to reduce other pests.

5. **Risk Zones:** Move your crop away from areas prone to flooding.

Avoid Problems with the Law

• Verify that you are not planting in Belize's Protected Areas, as it is prohibited by law. These protected areas are monitored by the Ministry of Natural Resources. *See Annex 2 for a map of these Protected Areas.*

• If you establish a sugarcane field in a NEW area or you are going to build a construction on the property, you need to apply for an environmental permit from the Department of the Environment of Belize. Call 802-2816 for more information.

• If you are going to cut one or more trees, especially our national tree, the Mahogany, to clear the land to be cultivated, you need to apply for a logging permit at the Forestry Department. Call 822-2325 for more information.

Do you know your Soil Type?

Before planting, know your soil. It will help in making a good decision for proper Land preparation and tillage of the land. You can find the types of soil of your area on the table published by the Study of Soils 2011 (Belize Sugarcane Farmer's Association) in collaboration with TECNOAZÚCAR, based on the international classification of soils:

A. Inceptisols

B. Vertisols

C. Mollisols

D. Alfisols

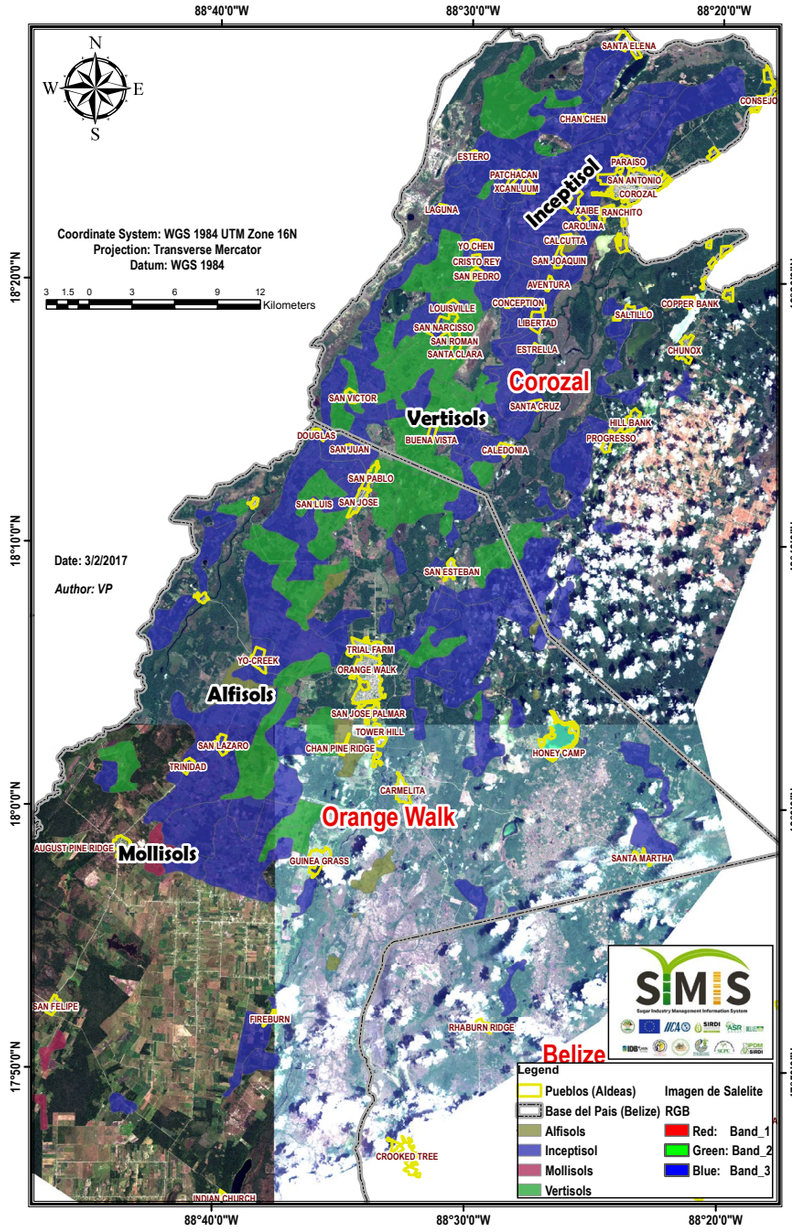
A. Inceptisols: This type of soil occupies 71.9% of the total area. It is located primarily in the northeast portion of the sugar mill area, coinciding with the Corozal, Xaibe, Louisville and San Narciso branches. Most of the soils of this nature have a medium to thick texture profile, generally moderate to good drainage, organic material content and a slightly acidic pH.

B. Vertisols: This type of soil occupies 24.50% of the total area; it is located mainly in the south central portion of the supply area of the BSCFA, coinciding with the branches of San Narciso, San Jose, Orange Walk and Yo Creek. Most of the soils of this nature are derived from transported material, possess moderate mineral reserves, the pH is slightly acidic to neutral and its organic material properties are from medium to high. They are medium to fine textured soils.

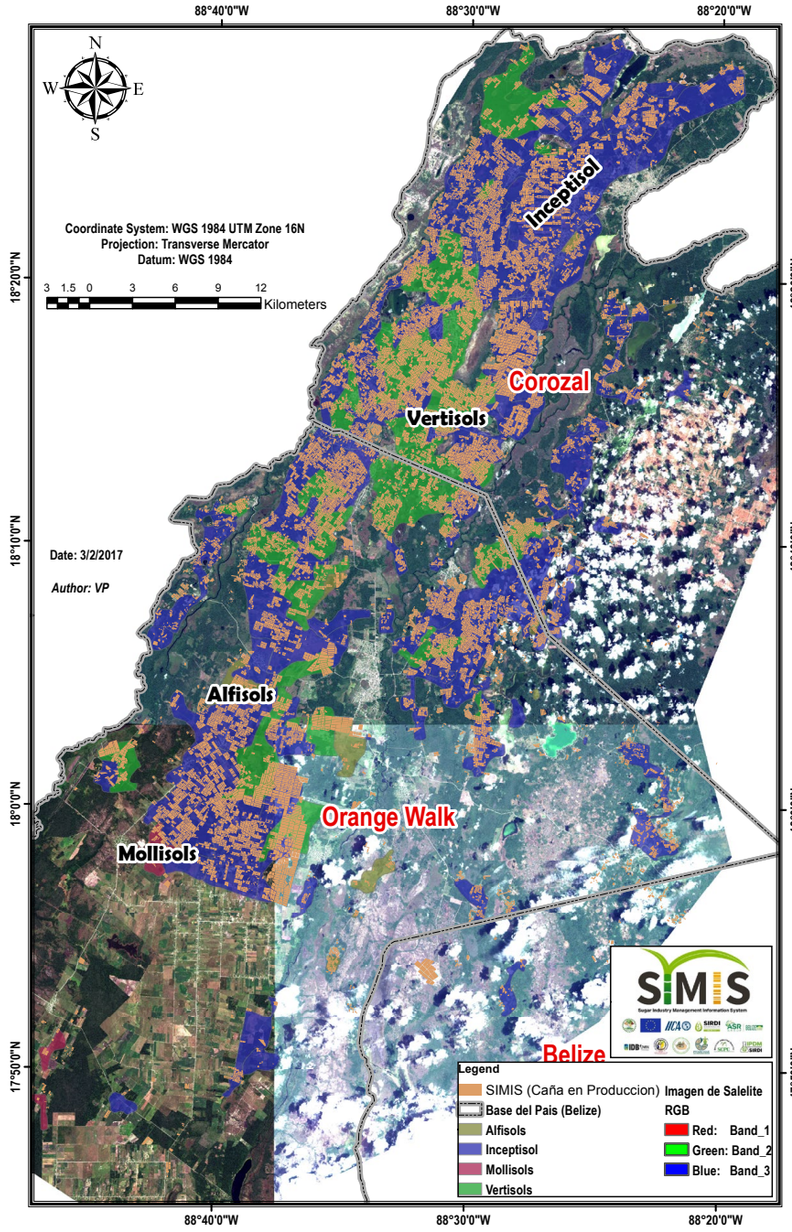
C. Mollisols: This type of soil occupies 0.99% of the total area; it is located mainly in the southwest portion of the Recognized area of the mill, coinciding with the branch of San Lazaro. They are deep soils with high content of organic matter, dark colored and with a percentage of saturation higher than 50%, with a slight to strong compaction, has a clayish to Clay Loam texture and comes with moderate to imperfect drainage.

D. Alfisols: This type of soil occupies 2.61% of the total area, they are located mainly in the southeast portion of the sugar supply area, coinciding with the Orange Walk, San Lazaro and Guinea Grass branches. They are medium deep soils, reddish colored in their interior with light to strong compaction, with a clayey loam to loamy texture and moderate drainage. They present an acidic soil reaction and organic matter content of medium to low.

Map of the Different Soil Types in Northern Belize



Map of the Different Soil Types in Northern Belize

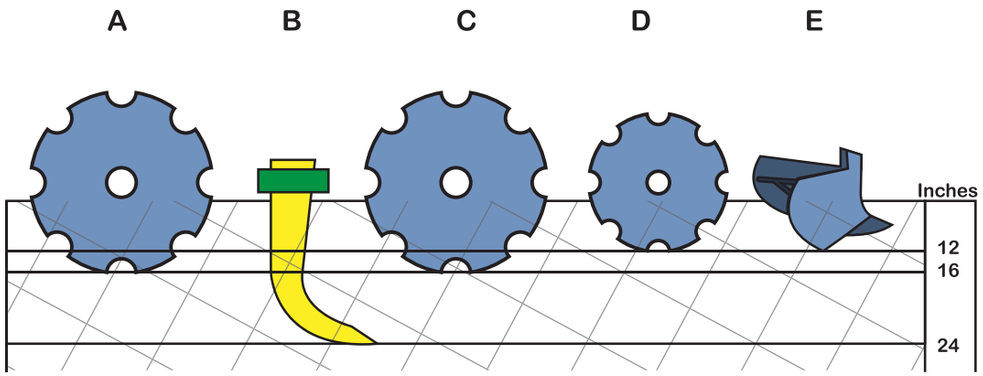


Start out right with a good soil preparation!

A Good land preparation can make a big difference in your investment since it is the foundation of the production process. Soil preparation should help you to:

1. Destroy weeds and incorporate the previous crop's residues
2. Increase the capacity of water retention and filtration in the soil
3. Improves root penetration and development
4. Increases the availability of nutrients
5. Loosens the soil for root development

Soil must be prepared according to its type. Consult SIRDI technicians for the best recommendation that suits your soil type. But to give you an idea of the sequence of land preparation activities, we share an example:



Land preparation Sequence for cane field renewal.

A: Plowing- to level the ground with banking/beds and to destroy the old ratoons incorporating them into the ground.
B: Subsoiler- used to achieve soil decompaction caused by heavy machinery; it also facilitates the infiltration of water and air for the penetration of roots.
C: Plowing - Second pass over is done in the opposite direction of the first; this activity is to complete the breakage of the soil, destroy old stools and incorporate the crop residues. This activity is carried out two to three weeks after subsoiling.
D: Harrowing- Needed to crumble or break clods/lumps into smaller units. This activity is performed four weeks after plowing.
E: Furrowing- Activity to open uniform grooves to deposit sugarcane setts during planting. The distance between grooves should be according to your type of crop. Mechanical harvesting requires a minimum of 1.8 meters of distance between furrows.

When should you renew?

Cane farmers every year face the decision to either continue the crop for an additional production cycle, or completely rennovate it, with the consequent investment in adaptation, preparation and planting activities. The decision of replanting also involves selecting a cane variety that is appropriate to the particular conditions of the area.

Caution! The farmer's best tool is observation. If the field population is low, there are problems and you will not attain maximum productivity.

There are several reasons when it is advisable to renew your cane field:

1. Low yielding cane fields- cane fields that yield less than 18 tons do not generate enough profits to make the business feasible. Therefore it is necessary to renew it.

2. Variety change- When the cane variety does not match your harvest plan, it is necessary to renew the cane field. It is necessary to have a variety structure that fits the harvest in the early, middle and late seasons.

3. Diseases and pest infestations- When the variety planted is susceptible to disease or pest attacks it is necessary to renew to switch to a more tolerant cane variety.

4. Change in harvesting system- If you want to change harvest system, for example to mechanized harvest, in some cases you may have to renew to condition the field.

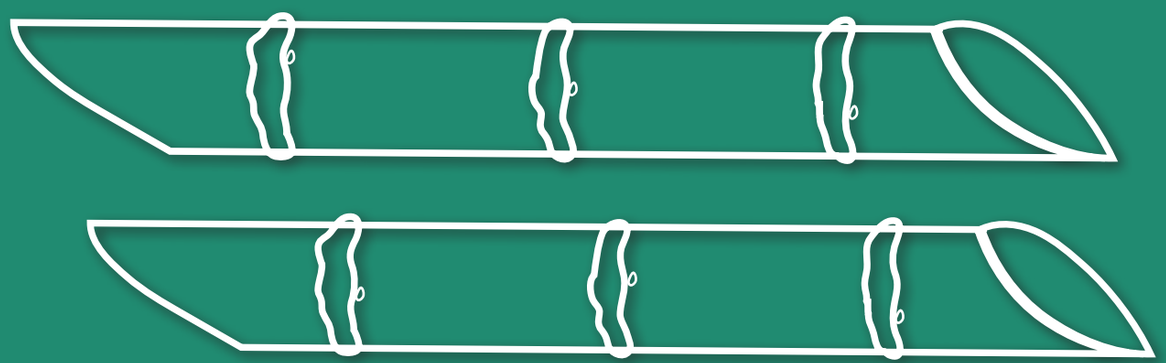
Fields can be damaged by harvesting in rainy weather. It does not matter the cycle of the field, but it may be necessary to renew.

In Summary, the decision of when to renew a plantation should be based on a cost/benefit analysis, i.e., if you are making money or losing.

Illustration of a plot ready for planting

Good Agricultural Practices

During Sugarcane Planting



Invest well and make more money by following good planting practices!

Planting to make profit

Sugarcane is a crop that is harvested more than once (perennial). A cane plantation must allow us to obtain at least seven (7) crops with good yields. A plant-cane field in Belize must allow production of a minimum of 35 tons per acre and in ratoon a minimum of 25 tons per acre. For this reason, good planting is of utmost importance.

The soil must be properly prepared for the new planting; i.e., when you are building your house, the foundation has to be strong in order to support the weight of the building. This is similar when you decide to plant your cane field.

Some criteria to take into account to achieve a quality crop:

1. Make a good soil preparation that is up to 24 inches deep, as long as the arable soil layer allows it.

2. The furrows should be deep, uniform and with the necessary looseness to facilitate the covering of the seed. The furrower should work straight as an arrow and each should be equal in width. Adapt the furrow to the ratoon maintenance and harvesting equipment. This facilitates the operations, and reduces the losses of the cane stools and mature cane.

3. The cane planting should be done at a depth of 6-8 inches to ensure good stool establishment, with it, we are improving the anchoring capacity and absorption of water and nutrients from the root system.

Choose a quality variety!

Dear cane farmer, once you have prepared the soil where you will grow your sugar cane, make sure to use quality seeds. Seed selection is important and can make the difference between making or losing money at harvest time. Select the appropriate variety that meets the following requirements:

• That can be scheduled within a harvest plan.
• Is specific to each soil type/terrain.
• Is appropriate for the planting season.
• With high agricultural yields and sugar content.
• Tolerant to pests and diseases.

Choose quality seeds!

Use **quality seeds** that meet these requirements:
- That comes from a plant cane between 8 to 10 months old.
- Is free of physical damage.
- With varietal purity (no variety mix).
- Is free of pests and diseases (treat with hot water and fungicide).
- Has good vigor and development.

During a high quality cultivation:

• Fertilize at the bottom of the furrow with the least soluble nutrients like . Phosphorus (P) and the micro elements. This nutrient is responsible for stimulating sprouting and initial vigor and is less mobile in the soil. Fertilization should be according to the recommended dosage e of a soil analysis. *See Annex for an example.*

• After the sprout (40 to 60 days after planting), apply the most soluble nutrients; Nitrogen (N) and Potassium (K).

• The distribution of seeds in the field is done by placing double stalks in the rows ensuring that there are at least 18 buds per linear yard. Sugarcane by nature has the peculiarity that the buds at the ends regulate the budbreak of the next buds; this is known as "apical dominance."

• For this reason the stalks should be cut in setts of 3 to 4 buds to achieve a uniform sprouting when the apical dominance that exists in an entire stalk is broken. It is estimated that 4 to 5 tons of seed, equivalent to 1.0 - 1.25 mecates (1 mecate equals 25 yards), are needed to plant an acre.

• Planting should be done when there is good soil moisture to ensure a higher sprouting percentage (at least 12 buds/linear yard). The optimal months for planting are from August to October, as these factors influence sprouting; other factors include seed depth, seed age, and variety.

• The distance between furrows should be 1.5 meters (5 feet). The furrow width depends on the fertility of the soil and the width of the machinery and harvest equipment (5-6 feet). If you will harvest with a combine (mechanized) leave space between the furrows so that it can pass.

During the seed covering phase, beds will be formed which is recommended for clay and heavy soils with poor drainage. Also, if you plan to use the mechanical harvester, it will be easier to cut the cane and reduce losses.

Be alert! Make sure to cover the seed with 3 to 5 inches of soil depending on soil moisture and the time of year.

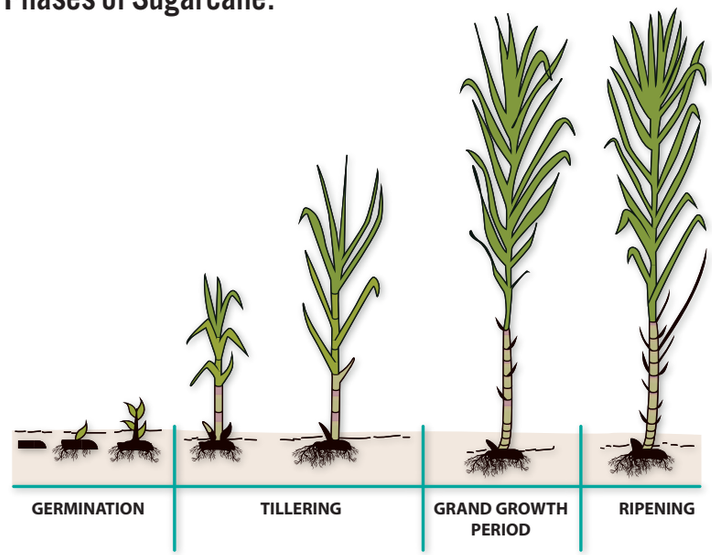
Fertilization: Plant density and application dosage

Planting density is expressed as the number of buds per linear meter placed in the furrow. This is one of the main determining factors for the number of primary shoots to emerge from the planting which influences stalk population and yield.

For example, if a new cane plantation has been established with spacing of 1.50 m between rows, and placing 18 buds per linear meter, 30 days after planting, a shoots count is performed in a linear meter, randomly choosing 3 different points of the field.

The purpose of doing a primary shoots count is to calculate the population density that directly influences the final yield of the field. At the same time it indicates the need for filling the empty spaces.

Phenological Phases of Sugarcane:



(a.) Germination and establishment - emergency and establishment stage of the initial population of shoots. (1-35days)
(b.) Tillering period and cane field closure.
(c.) Grand Growth Period:
- Determination of yield.
(d.) Ripening/Maturation: sugar production defined.

Germination

It refers to the period from planting until the buds emerge. In field conditions it starts between 7-10 days and ends at 30-35 days of planting.

Germination requires warm temperatures and soil moisture. At the field level a 45% emergence is satisfactory to establish a good plantation and an 85% population is considered good.

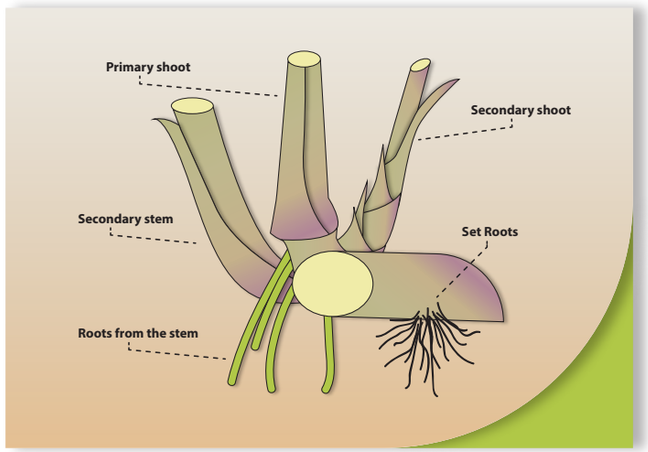
Factors that influence the germination process:

Humidity -the presence of humidity is essential to stimulate the sprouting of buds.

Temperature- Sprouting is activated at temperatures above 10 °C. Optimal temperature: 28-33 °C, and 32 °C for tillering.

Light - Sprouting occurs in the absence of light, although light favors tillering.

• The first roots (called "primordia") emerges after 24 hours of planting, according to the variety. This root system is established and serves as an anchor for the plant; it also absorbs water and sustains life in the first few weeks.



The main root system emerges from the base of the new bud (primary stem) between 5-7 days after planting. These roots are thicker and fleshy and are the ones that will form the permanent root system that will absorb water and nutrients for the plant.

Thirty five days after you have established or planted your cane, carry out an emergence evaluation to ascertain the percentage of buds that emerged.

Evaluation of emergence when 18 buds are deposited

Point of Evaluation	Number of buds	% Emergence
No. 1	12	66
No. 2	14	78
No. 3	15	83
Average	***13.7***	***76***

Make your calculations using the following formula:

$$\% \text{ Emergence} = \frac{(\text{Number of buds}) \times 100}{(\text{Number of buds planted})} = \frac{13.7}{18} \times 100$$

To ensure that you have a well-established population you need to calculate your percentage of empty spaces so as to make the decision if you have to fill empty spaces before the cane continues its growth stage.

How do you tell that there are empty spaces?

• Carried out at 35 - 45 days after planting randomly, selecting 3 points diagonally.
• Measure 100 linear feet (A). on the selected point of the cane row
• Count and measure spaces greater than 2 feet (B) and record. The space occupied by a cane stool is 2 feet (P), which is the space needed.
• The total distance of all empty spaces (C).

Make your calculations using the following formula:

$$\% \text{ Empty Spaces} = \frac{C - (B \times P) \times 100}{A}$$

• This is done at 3 randomly chosen points in the rows. For the final result, use the average of the 3 results.
• Values of 66-80% of emergence and empty spaces of 5-15% are acceptable. Remember the goal is to have 12 buds emerge per linear yard.

Benefits obtained from a good planting:

• A high percentage of bud sprouting and emergence (> 65%).
• The emergence results in a high population (12 primary shoots per yard)
• Greater homogeneity is obtained in the cane field (cane emerges evenly).
• An earlier sugar cane field foliage closure.
• Less Weeds
• Development of improved cane fields
• Higher yields at harvest

Good Agricultural Practices

Sugarcane Nutrition

Belizean cane farmer take note!

Among the external factors that influence the growth and development of plants, nutrients are the most easily controlled by humans.

Sugarcane is cultivated in different soil types, and each year large amounts of nutrients are extracted ; it is necessary to fertilize to increase or maintain productivity.

There are several factors that influence the productivity of sugarcane, with nutrition being one of the fundamental aspects in achieving high yields and quality.

A condition to obtain high yields in sugarcane is the use of fertilizers, since the soil is unable to provide all the nutrients at the rate and quantities required by the sugar cane plant.

In order for plants to grow healthy, plants need 16 nutrient elements in sufficient quantities. These are considered essential based on the following:
•Their absence greatly reduces growth
• Their absence produces visual symptoms and deficiencies
• These symptoms are eleminated by the application of nutrients.

The following are the three primary nutrients for fertilization:

Nitrogen

Nitrogen is primarily responsible for agricultural yield due to the influence it exerts on the growth of sugarcane, the increase of the stalk population and the most used nutrient.Nitrogen deficiency causes the following disorders in sugarcane:

Nitrogen defficiency

• Decreased growth of the entire plant.
• Thinner and stiffer leaves of yellow greenish color that can appear yellow in young leaves and purple reddish (brown) in older leaves.
• Stalks are thinner.
• It reduces tillering.
• The size of the roots are reduced

An excess in NITROGEN causes the following effects (Countrywide we will rarely find symptoms of excess, more likely there are deficiencies of this nutrient):

• The cane falls; late tillering.
• Increased presence of immature “suckers” at the time of harvest and greater losses.
• Decrease resistance to Pest and Disease.
• Reduces Cane Quality and Sugar Cane extraction.

Phosphorus:

Phosphorus is responsible for storage and transfer of energy inside the plant. It is required at high concentrations in growth regions. Phosphorus is a slightly mobile element in the soil.

A deficiency of phosphorus causes a reduction in the length of the cane stalk. There are only primary stalks and few secondary stalks. Reduction of tillers. Short and elongated internodes (see image 1). Green-bluish color of leaves (see image 2).

Older leaves show the first symptoms of phosphorus deficiency.

Potassium

Its function is linked to the transport of sugars and therefore allows the thickening of the stalks. This is critical in the regulation of the water content within the leaves and helps to tolerate drought. A potassium deficiency produces the following symptoms:

- Reduced growth
- Edges and tips of the leaves turn yellow
- Old leaves with a burnt or completely brown appearance, thin stalks, reddish discoloration at the top of the central vein.
- Young leaves of dark green color.

When you are going to fertilize, pay attention to the following:

Identify your soil type, research the previous land use and remember the yield of the previous harvest. Contact SIRDI technicians for advice on how to obtain the best production.

When to apply fertilizers?

The amount of phosphorus fertilizers are applied in full at the time of planting at the bottom of the furrow. The nitrogen and potassium fertilization is performed at 40-60 days after planting in plant cane. In ratoon cane it is done 40-60 days after harvest.

Fertilizer should never be applied to dry soil because the plant cannot absorb nutrients without water. Fertilization should be done in lines applied to the planting furrow, preferably incorporated into the soil with agricultural machinery.

Take advantage of fertilizers as they are an expensive resource; do not throw money away. Take note of the following:

- Incorporate the granulated fertilizer next to the stubble, about 10 to 15 cm deep and closest to the roots, ensuring that it is properly covered.

Things to take into account when preparing your fertilization:

- The fertilizer equipment must be calibrated before each season and during the application period. Keep a log of the calibration. Avoid waste due to under or over dosing.
- Obtain fertilizers from suppliers who ensure protection from sun and rain.
- Keep a list of fertilizer suppliers and request the safety sheet of each product, so you know the storage conditions and safety measures of each fertilizer.
- Store adequately the amount of fertilizer you will apply during the crop cycle.

• The benefits of fertilization will be greater in clean, weed-free cane fields.

Conservation and storage of fertilizers

Keep fertilizer stored, protected from rain and high temperature, in a well ventilated and roofed structure.

When storage capacity is limited the fertilizer should be protected with a tarpaulin or other suitable material to avoid the effects of wind and rain, as well as environmental pollution.

Cane farmer, bear in mind that the best storage for fertilizer is the soil; remember to incorporate it near the cane stubble.

Reminder! Considerations to achieve greater effectiveness in fertilization:

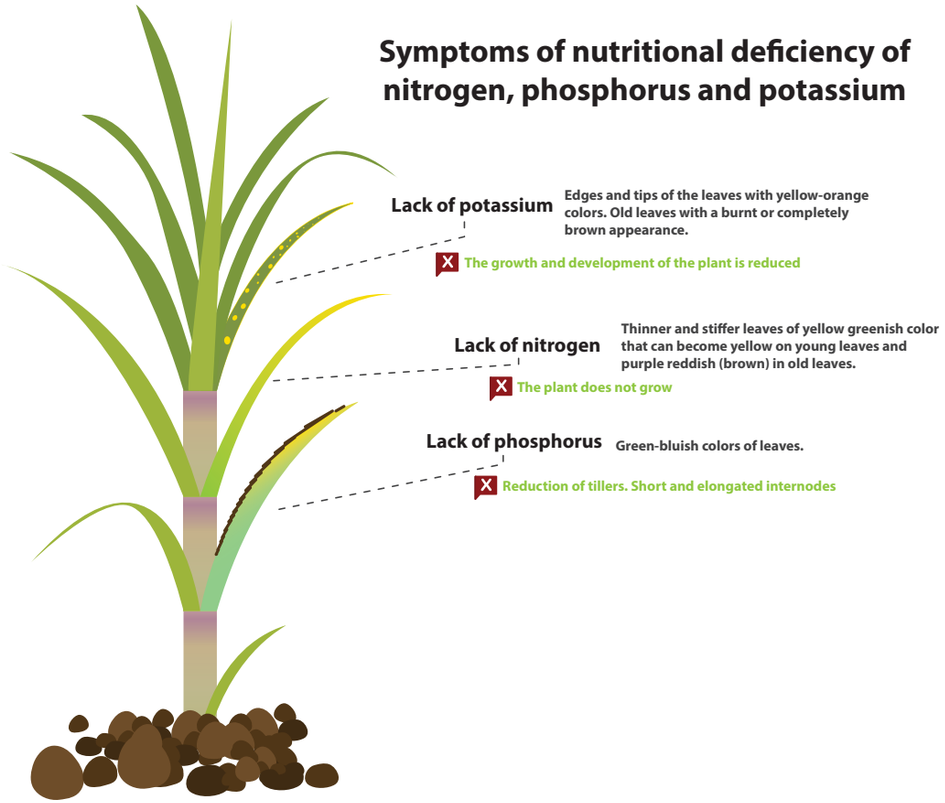
The aim of fertilization is to increase the economic returns of the crop.

Fertilization is a big investment, so keep in mind the following points:

1. Evaluate the situation of the cane parcel prior to fertilization by identifying weeds, population, expected yield and moisture present.
2. Review rigorously and apply recommended dosage per acre.
3. Select the most suitable technology of application according to its capacity and need of the cane field.
4. The efficiency of fertilization depends on the proper application and timeliness of application.

And finally, remember that with the efficient application of fertilizers you can gain the following:

• Increases in yields
• Quality in the harvest
• Protection of soil and environment
• Increased profitability



+ Fertilizer + Productivity = + Profitability ($)

"If fertilization is not increased, productivity will not be achieved!"

Good Agricultural Practices

In pest Management of Sugarcane

How do we manage pests?

No one wants invaders in their cane fields. There are different practices that you can implement to keep them out of your cane fields with the minimum use of chemicals. Invaders pose hazards to your workers, crop and environment. They are also very expensive to reduce or eliminate.

Here are some tips to follow:

Keep them out!

• There are different varieties of sugarcane. Choose the variety of cane that best suits your soil type, considering the time of harvest and the resistance to pests and diseases. Ask the SIRDI technicians which is the best variety for you.

During the establishment and growth of a sugarcane plantation, one of the main problems that arise is the presence of weeds that compete with the crop for space, water and nutrients.

What are weeds?

Weeds can be considered an unwanted plant that grows or invades the cane fields negatively affecting yields.

WHAT ARE THE EFFECTS OF WEEDS?

- They greatly reduce yields of sugarcane.
- They make harvesting more difficult.
- They increase the content of extraneous material in the harvested cane.
- They reduce the life span of plantations.
- They serve as hosts for other pests.

An integrated weed control program requires that the farmer knows:

- The weed species that are predominant in their cane field
- Their main form of reproduction.
- The type of weed (broad leaf) or narrow leaf (grass) present.

The most aggressive and common weeds found in our cane fields

Scientific name: Sorghum halepense Common name: Johnson

Scientific name: Brachiaria mutica Common name: Para Grass

Scientific name: Panicum maximum Common name: Guinea

Scientific name: Rottboellia cochinchinensis Common name: Itch Grass

Scientific name: Mucuna pruriens Common name: Velvet Bean

These observations will help you to easily and efficiently plan and implement the control methods and the acquisition of the necessary inputs to carry out these activities.

To achieve weed control, combine practices like:

- Preventative
- Cultural
- Manuals
- Mechanical
- Agrochemical

HOW CAN YOU CONTROL WEEDS?

1. Preventative control

Preventive management attempts to minimize the introduction, establishment and dissemination of weeds into new areas and to avoid

seed production in established plants. Preventive control measures include:

- Good soil preparation
- The use of quality cane seeds free of weeds.
- Rapid sprouting varieties with early closure.
- High population densities of sugarcane.
- Cleaning of harvesting equipment and implements.
- Cleaning of fire paths.

2. Cultural control

It is not a matter of eliminating work but rather, carrying out the activities in a way that they do not favor weed multiplication. Cultural control methods include:

Crop rotation - the frequent renewal of crops over time on the same land to control erosion and maintain the productivity of the land among other advantages. This technique includes sowing legumes.

Fertilization management - Any work that favors the development of the cultivated plant limits the development of weeds. Some practices such as incorporated fertilization and the absence of weeds help the farmer to improve his yield.

3. Manual control

Manual weeding is an important component of weed management practices.

Its effectiveness is limited by wet conditions and high labor costs. Therefore, it must be administered with other methods of Weed Control.

4. Mechanical control

Mechanical control focuses on the use of implements attached to a tractor such as the plow rake and the moulder. This allows for weed control between furrows and soil conditioning for better sugarcane development.

5. Chemical Control (Herbicides)

Today, there is a great variety of chemicals used for weed control. However, their use must be subject to strict precaution and good management to minimize negative effects on health and the environment.

Be Alert! Remember to use your personal protective equipment (PPE)when making herbicide applications; it's your responsibility to protect yourself and to ensure your well-being and health.

1. Pre-emergent: It is necessary to apply the product before the weed seed emerges.

2. Post-emergent: They are applied to eliminate weeds after they have germinated, when the weed is in the early growth stage.

What are the major sugarcane pests in Belize?

1. Froghopper/Spittlebug (Genus: Aeneolamia, specie: varia and albofasciata)

Spittlebug Aeneolamia albofasciata

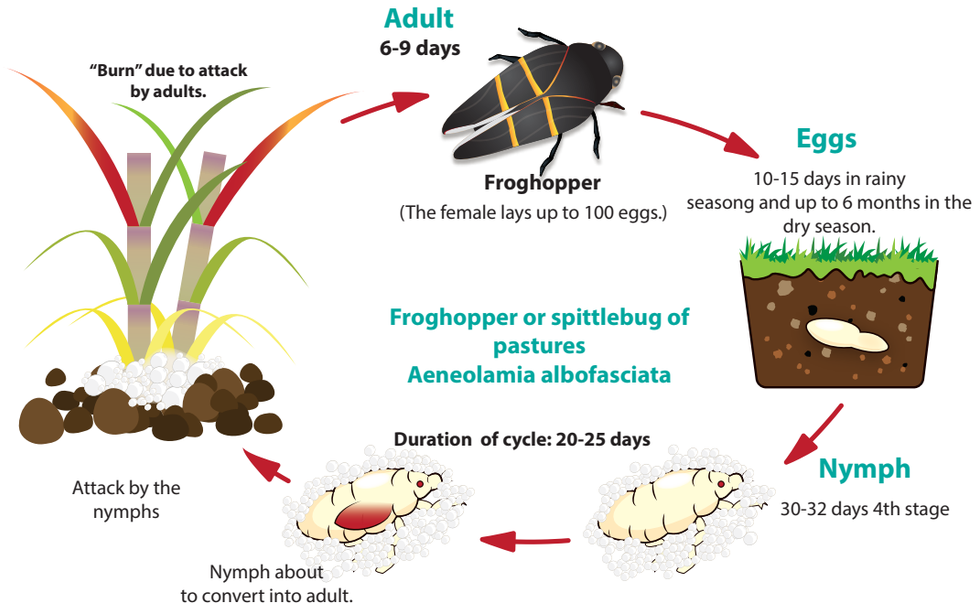
Sugarcane froghopper Aeneolamia varia

It is an insect with a sucking mouthpiece, which feeds off a wide variety of plants including sugarcane.
The froghopper reproduces via eggs; they hatch when the rains start and if they are not controlled in time, they multiply until they invade the field. Both adults and nymphs suck the juice from the cane to feed; when they fly they suck from the leaves causing damage known as “burning” or froghopper blight.

The increase in the population of the froghopper in the field is related to:

- the deterioration of natural enemies due to the irrational use of chemicals
- lack of drainage
- the distribution of rainfall in the year
- high temperatures
- the amount of weeds that serve as hosts.

Life cycle



The egg - The female lays 200-300 eggs. The egg has a period of 14-21 days to hatch forming a nymph. It deposits two kinds of eggs: Non diapausic and diapausic.
- Non diapausic eggs are scheduled to hatch in rainy seasons, or within two years.
- Diapausic eggs hatch (emerge) between 6 to 8 days as nymphs.

Nymphs - They feed on the roots of a plant (cane or itch grass, Johnson grass) and introduce their mouthpiece (Proboscis) feeding on the xylem, producing through their anal opening a dense foam that protects them from adverse conditions (temperature and sun) and natural enemies. The nymph goes through five stages (I-V) from 5 to 6 days, until it reaches the adult stage.

FIVE STAGES OF THE FROGHOPPER NYMPH

FIVE STAGES OF THE FROGHOPPER NYMPH

Stage I	Stage II	Stage III	Stage IV	Stage V
Transparent body; no differentiation between head, thorax and abdomen	There is already a differentiation between the head, thorax and abdomen	The formation of the wings are already observed, but these are glued to the body	The wing structures are longer and separated from the body	Fully formed; pale colored

Adult: The adult lives between 6-9 days and is responsible for the burn or blight in the leaves of the sugarcane, affecting in this way the production.

How to control the froghopper?

TO CONTROL THE FROGHOPPER, AN INTEGRATED MANAGEMENT THAT INCLUDES SEVERAL TACTICS IS REQUIRED:

1.) Monitoring
2.) Cultural, ethological, biological and chemical control as described below:

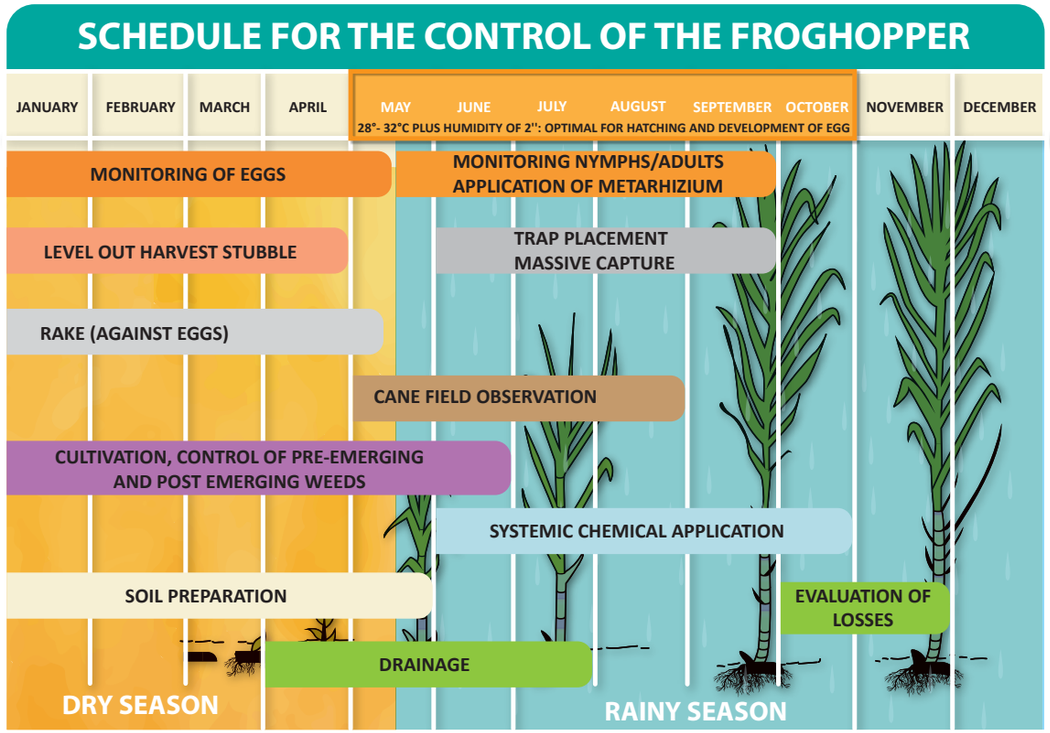
Types of Control	Strategy
Cultural Control	With the use of a disc harrow to expose the eggs to the sun and natural enemies (example ants); good control of weeds inside and outside the cane
Biological Control	With the use of the fungus *metarhizium* and protection of natural enemies
Ethological Control	Placement of massive light traps (either yellow or green) is an example of ethological control.
Chemical Control	Use of authorized insecticides

Monitoring: The use of traps to determine the population of the froghopper in the cane field is a monitoring strategy. As well visual monitoring to detect the presence of adults and nymphs. With the results we can know how best to control the pest (see Annex 4).

Some valuable tips!

- Use plastic traps, green or yellow, that are sticky to control the froghopper.
- After harvesting your cane, use the disc harrow as soon as possible; the idea is to expose the eggs to dry out in the sun and be eaten by ants.
- Apply *Metarhizium spp.* fungus as biological control.
- Carefully apply insecticide only when the pest is out of control.

Calendar of activities for the control of the froghopper



2.2. Sugarcane borer (Diatraea spp.)

The sugarcane borer arrives when the adult moth lays its eggs on the leaves of the cane. Then when the larvae hatches they feed on the leaves, then pierce the stems forming galleries. These galleries are gateways for fungi such as *Colletotrichum falcatum* or bacteria that cause red rot of the stems. This secondary damage then affects the quality of the sucrose at the factory.

How to control the sugarcane borer

To know how to control the pest, you first have to sample. For this purpose focus on 10 acre plots. The four corners and center of the plot are sampled choosing 10 stems at random. This is done by variety and before harvesting. The number of cane stalks that are perforated should be recorded.

With these data you calculate the PERCENTAGE OF INFESTATION by *Diatraea spp.:*

$$\% \text{ Infestation} = \frac{\text{Number of perforated cane} \times 100\%}{\text{Total number of stems}}$$

Results!!

It is considered that for every 1% of infestation, an average sugar loss of 650 grams per ton of cane occurs.
Control Tips!
• Emphasize the control of weeds, especially the grass that are hotels for this pest.
• Harvest in blocks, and eliminate buds to avoid them being colonized by the pest during the next cycle.
• When you are going to cut cane, cut it IMMEDIATELY ABOVE the ground so that pests such as borers DO NOT stay in the trunk.

Be Alert!

Always Ask:
Is the pest growing?
In what part of the plot is it?
How developed is it?
How do I stop it naturally?

Pesticides – The last resort!

The use of pesticides is the last resort in an integrated management approach. If you have already done all the above practices and still have pests that can seriously damage your harvest, then use them in a very responsible way:

• Choose only pesticides that are SELECTIVE for sugarcane use.
• When buying pesticides always ask for the safety sheet for each product and keep it in the warehouse. This way you will know how to store and handle it in the best way.
• The application of good management practices is aimed at protecting farmers' health and the environment. That is why it is necessary to learn the 5 golden rules of pesticide use.

Important advice!

• Ensure that your equipment is properly calibrated to avoid economic losses.
• Always use to recommend dosage. If you put too little it may not work, and if you put too much it can damage the crop and the environment.
• If you use the same pesticides often, pests become resistant to them. If this is the case, use 2 or 3 pesticides from different chemical families and whenever possible, use natural products, always ensuring that the application is effective.

Five Golden Rules:

1. Practice good hygiene.
2. Keep application equipment in good condition.
3. Wear appropriate protective equipment.
4. Handle pesticides with care at all times
5. Read the label and ensure you understand all safety precautions.

See annex to select the type of personal protection according to the pesticide.

Attention: The Pesticide label is the Law!

The labels are included with the pesticide and contain all the information about the product.

To best attack the pest, apply the pesticide very early or in the evening. Take into account two important factors: temperature and wind in order to make a decision. And if it rained after the application, do not reapply. After using it, remember to record the date, time, name of the pesticide, the pest you want to eliminate, the dose you used, the equipment you used, and the name of the person who applied the pesticide.

Always Review

Write everything in the GAP (Good Agricultural Practices) Logbook; this can be very useful in the future so always record:

- Pests in the plot.
- Control Methods.
- The list of pesticides that are approved for use in Belize by the Pesticide Control Board.
- For the use of agrochemicals, always consult a specialist and respect what's established in the list of prohibited or dangerous materials (red, orange and yellow labels).
- The pesticide applications you have made.
- Always keep a list of all pesticides you have in the warehouse.

In the ".... Chapter Numbers and Data ....." we share basic tables to record these data.

Good Agricultural Practices

Calibration Spraying Equipment

If it is necessary to use agrochemicals to control weeds, make sure you use the correct amount. Over or under dosing can lead to problems in the control of the pests.

How do you do it?

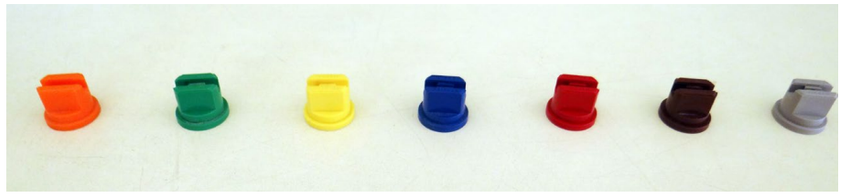
- Select the correct pesticide
- Use the proper equipment to spray
- Select the best nozzle
- Apply pesticides at the correct time
- It is important to use the recommended dose to avoid having problems

Calibration of knapsack:

You need to:

1. Calculate the dose
2. Calibration is a practical exercise to determine the amount of water needed to spray an area. For this, you must follow the following 6 steps:

Step 1:



- Choose the appropriate nozzle (see image above)
- Choose the appropriate pressure for spraying
- Check if the nozzle is working using a pump with water
- Empty the pump

Step 2:

Measure an area of 10 meters by 10 meters inside the field. This will be called the “test area”.

Measure one test area = 100 square meters

Step 3:

a. Measure and pour 10 liters of water into the pump
b. Spray the test area
c. Measure the remaining water

Be Alert! You started with 10 liters of water. After spraying the test area, you were left with 8 liters. Therefore, the amount of water used to fumigate the test area = 2 liters

Step 4:

Determine the amount of water needed to spray 1 hectare
(1 ha = 2.47 acres)
*There are 100 test areas on 1 hectare

Step 5:

Calculate the number of pumps you will need to spray one hectare

Caution! The number needed to spray one hectare is 200 liters. If your pump has one capacity of 20 liters, 200 liters/20 liters = 10 pumps

Step 6:

1. Determine the dose of presticide per pump.

2. Read the label and check the recommended dose (500 ml/Ha)

3. To calculate the dose per pump use the formula:

$$\text{Dose per pump} = \frac{\text{dose/Ha}}{\text{\# pumps/Ha}}$$

$$= \frac{500\ \text{ml}}{10\ \text{pumps}}$$

= 50 mililiters/pump

Good Agricultural Practices

Pre-harvest and Harvesting

What is Pre-Harvest?

The pre-harvest summarizes all the activities that are done before you harvest your cane. The pre-harvest is necessary to know the state of maturity of the cane and if the cane is ready to be cut. This ensures that when your cane is delivered it has the highest amount of sugar accumulated.

When do I know that my cane field is ready to harvest?

Here are some ways you can tell if your cane is ready to be harvest:

1. **Visual symptoms**
    a. The leaves turn yellow and dry.
    b. The number of green or active leaves reduce to five or less.
2. **The age of my cane** – this is according to the variety planted.
3. **Using indicator parameters to determine the maturity status of your cane, using the Maturity Index:**

a. One of these parameters is the testing juice brix to know if your cane is mature, immature or over mature . For more information on how to calculate the maturity index, contact your SIRDI technician.

4. **In a laboratory:** using equipment that measures the sugar content in the cane. These are: Percentage of sucrose or **POL (polarimeter) and apparent purity.**

How can I estimate my yield (tons of cane per acre)?

To know the yield of a cane field we apply a procedure known as Production Estimate. This procedure does not take into account crop losses. For more information please see annex 5.

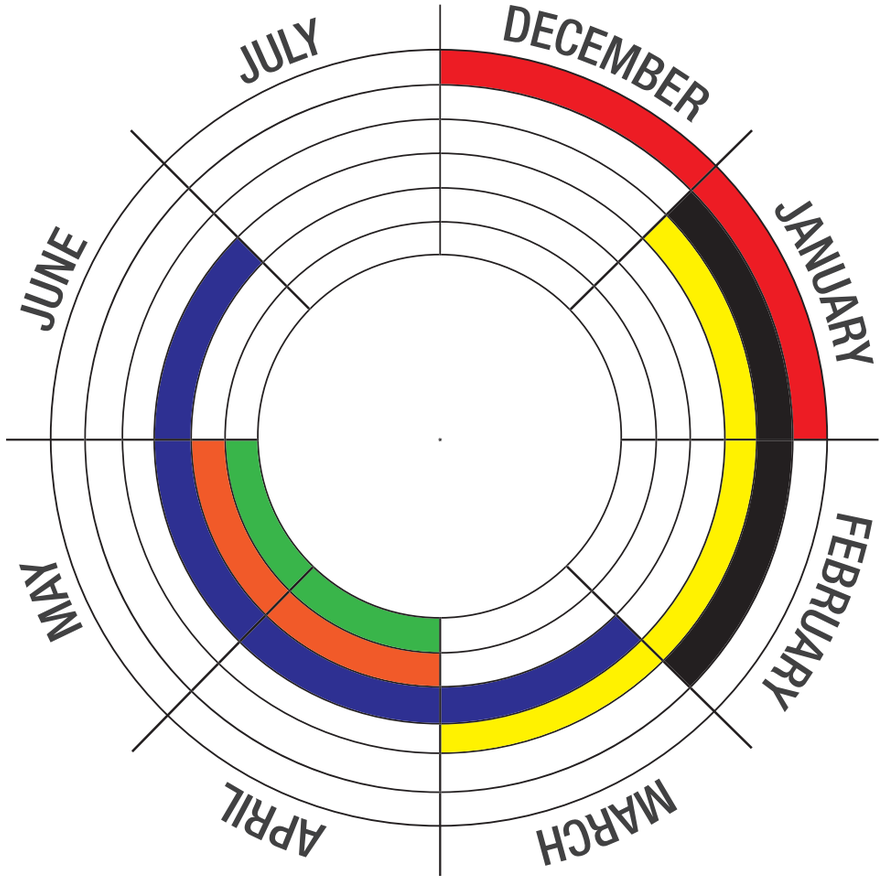
How can I make my cane worth more?

To uceed in life you have to prepare well and carry out everything according to a schedule; likewise, to achieve a good production with high yields it is important to apply good practices in the cultivation and harvesting of sugarcane.

What should I do to improve my quality?

- Plant new varieties
- Have a harvest plan or in other words know when to harvest the variety of each plot. This is called a Harvest Plan.
    - o Crop Cycle :
        - Leftover ratoons
        - Standover plant canes
        - Ratoons
    - o Age: according to the time when you harvested your cane during the last crop (Ratoons).
    - o Variety (early, middle, late): according to the maturity index (Brix).
- Remember to measure maturity before harvesting your cane.

Harvest Calendar



Early varieties

- CP 72I3I2
- CP70II33
- CP722086
- BJ7262
- BBZ8257
- BBZ80240
- RD75II
- ITV92-I424

Middle/late varieties

- B79474
- PR70II
- Mex69290
- PRI048
- B52298 (White)*
- B64I25 (Barrel)
- B8565I (Hairy cane)
- B7678
- UCW5565
- POJ2878

*It is recommended that the B52298 variety be replaced with other varieties

Let us Harvest!

Harvesting is one of the most important activities that you should carry out. Ensure that harvesting is carried out optimally in order to achieve the best quality. Always consider the variety and climatic conditions.

The optimal conditions for harvesting sugarcane are:

- Relatively low temperatures
- Dry seasons

Here are some recommendations for a good harvest:

Do not burn!

The best thing for everyone is not to burn, but if you do burn follow the instructions mentioned below. Remember that fire kills EVERYTHING, including the nutrients of your land; your cane fields, the environment and affects nearby villages.

- Remember to inform your neighbors before burning cane.
- Varieties of cane that shed their leaves are very easy to burn.
- Burn only what you are going to deliver to the mill.
- It is best to burn in the morning before 6 A.M. and in the evening after 6 P.M.
- Make firebreaks or firepaths on your plots and those of your neighbors, to avoid unwanted fire.
- Protect your employees by complying with occupational safety and health standards.

How should I harvest the cane?

Harvesting in Belize is done mainly manually with machete.
The basic steps of a manual harvest are:

• The cane should be harvested at its maximum state of maturity, (avoid cutting over ripe or immature cane).
• The cane should be cut close to the ground (considering that the lower internodes are high in sugar content, which will increase yield and sugar quality).
• Removing or cutting of tops (Leaves) should be done at a suitable height to remove the immature upper internodes.
• The cane should be clean, removing all extraneous matter (leaves, trash, roots, stones, etc.).
• Form large bundles to avoid pushing with the loader.

Be Alert!

Remember that workers have the right to fair treatment.

Give it a try! Harvest cane without burning!

Not burning the cane has more benefits than burning it; benefits for you, your family and future generations. If you care for the land, it will yield good crops over time.
With green harvesting the environment wins and you do too, because that way you keep cane residue (which we sometimes call trash) like buds, leaves and tips.

Harvest Loss

What are harvest losses?

• Happens mainly between burning and delivery period. The harvested cane must be transported to the mill quickly (before 24 hours) to avoid deterioration.
• The sugarcane harvesting season is an arduous activity; SIRDI technicians have an extensive experience in this activity and provide support with technical assistance and planning for the same.

You can also do mechanized harvest!

• Mechanical harvesters are designed specifically for the harvesting of sugar cane.
• The harvester works better if there are long rows, therefore modification of parcels are required.
• Keep wide fire pass to avoid destroying the stools by machinery.
• Varieties must be erect.
• The cane field must be adjusted (leveled).
• At least 1.8 meters are needed between rows.
• A harvester (pictured below) can cut between 400-600 tons per day.

Good Agricultural Practices

Ratoon Maintenace

What is a Ratoon?

A ratoon refers to the resulting shoots after cutting your canefield. After harvesting, your cane is damaged by the passage of tractors, loaders and trucks; some of the furrows are deteriorated, and there are cane ends and tops left on the field.

In order to continue with good production it is necessary to provide good maintenance for your cane field.

Be Alert! Part of the maintenance is to replace what is extracted from the soil.

What should i do to improve my cane fields?

Here are some activities that are very important for the good maintenance of ratoons:

1. Harvest residue or Cane Stubble

Cane residue, or trash, is generally considered useless and burnt. This residue however, can be very useful if left unburnt on the field since it provides organic material, maintains moisture, aids in pest control and replace lost nutrients.

Best practices now being taught replaces the traditional practice of reburning (second burning). The benefits achieved by avoiding second burning are:

- It serves as compost for the cane and helps to maintain a good amount of nutrients.
- It protects the soil from the sun, wind and soil erosion.

• It works as a weed control medium and therefore less chemicals are used.
• Retains soil humidity
• The cane residue provides the necessary environmental conditions for the development of entomopathogenic fungi (eg., *Metarhizium spp*.) that control the froghopper.

It is recommended to align the cane residue by removing it from the area near the stool and depositing it in between the inter rows. It can be chopped and incorporated into the soil mechanically in case the resource exist (such as the rototiller) and apply products that accelerate the process of decomposition of this plant matter.

Be Alert! It is important to keep the soil fertile and free of chemicals to conserve the land for the future!

1. Levelling (stumping) of trunks

Levelling is an activity that is done when improper cutting was done (high cuts). Ideally cane should be cut just above ground. It is important to cut or harvest at ground level to achieve the following benefits:

• To promote the initial development of off-shoots with vigor and anchorage.
• In addition, this work facilitates subsequent activities such as fertilization and cultivation.
• Levelling avoids pest hosts for the froghopper and the sugarcane stem borer.

2. Use of phytosanitary harrow

The use of a phytosanitary harrow helps to control froghopper eggs. The preventive action of the harrow occurs when it is passed on the cane stubble after the harvest is completed and before the shoots emerge. It is recommended to use the harrow immediately after harvesting or before 15 days elapses.

• Always remember to use protective gear, such as gloves and proper foot wear, at all times when applying fertilizer.

Be Alert! Remember it is important to know what you are applying to the soil, helping it to improve and avoid contamination.

Weed control

The presence of weeds should be evaluated in the field 30 days after harvest. Manual or chemical control of weed can be selected (see section on Integrated Weed Management). Crop residues and cultivation helps reduce the use of chemicals.

• Remember to use Personal Protective Gear when applying herbicides. *See Annex to select the type of personal protection according to the herbicide.*

3. Integrated Weed Management (IPM)

The IPM program uses a preventative approach and inludes all activities designed to prevent your cane from being affected by weeds or pests. The most important pest in the cultivation of sugarcane is: the froghopper or spittlebug. (See the Integrated Pest Management section).

4. Integrated fertilization

Fertilizers should be applied based on results of soil and/or leaf analysis. Formulations should be adjusted according to the needs of plants. Most formulas contain Nitrogen, Phosphorous, and Potassium (N-P-K). The use of fertilizer is recommended within 40-60 days after harvest.

Good Agricultural Practices

Occupational Health and Safety

Personal safety tips

When going to the field your machete can be used to protect yourself. Take into account the following tips to protect yourself throughout the harvest:

1. Become familiar with hygiene, first aid, and fire prevention tips; to be prepared in the event of accidents.
2. Ensure all employees know the safety rules.
3. Establish basic procedure for accident prevention
4. Always follow the occupational health and safety laws of the country.

Caution: During Cultivation:

To prevent unnecessary accidents, all workers need to know and adhere to the following guidelines:

• Make sure your workers (cane cutters, agro-chemical applicators) are well aware of safety and health laws.
• Teach employees how to avoid the most common accidents (cuts or bruises).
• Teach employees what to do in case of a fire.
• Teach employees what to do if someone gets hurt.
• You need to be well organized in the event of an emergency.
• Use protective equipment when handling agrochemicals.
• Always place signs in dangerous areas, such as agrochemical warehouse, in areas where you prepare pesticides mixtures, and fields that have been sprayed.

Caution: with fire

• A fire outbreak can start from a small spark, so be very careful with fire.

• To prevent fires, have water pumps available.

Caution: with chemicals

To protect the health of cane growers and the environment in Belize we should implement **Good Handling Practices (GHP)** of pesticides. Remember it is important to keep your family, workers and communities safe by avoiding contact with chemicals used to fertilize and control pests. A license is required from the Pesticides Control Board (PCB) for the purchase and use of pesticides when purchasing, handling or using herbicides. This license certifies you as a responsible user.

Chemicals are very dangerous even in small quantities. If you want to always be safe, you must follow these steps:

When you use them:

Be Alert! Keep all PPE separate from pesticides in storage.

• All chemicals are labelled with information on how to mix, apply and use. Personal Protective Equipment (PPE) required is also shown. Always keep this information in a safe place and give a copy to whoever will use the product.

• The environmental impact of pesticides refers to the effects of pesticides on species for which they were not intended. More than 95% of herbicides reach a destination different from their target. The most sensitive areas are: rivers, lagoons, animals, crops, and others.

• It is the LAW that anyone using, applying, mixing or loading these products must use the proper Protective Equipment detailed on each product.

To apply a product:

• Minors should not handle or apply pesticides.
• Must be able to read and follow the instructions given on the product.
• Must be trained in the safe use of chemicals.
• Must be in good health.

After applying chemicals to the field:

• Signs or tape should be placed around the field to demarcate the affected area. The time period required for safe re-entry depends on the recommendation given on the labels.

Type of Pesticide	Time of Re-entry
Blue and Green Label	4 to 12 hours
Yellow Label	24 to 48 hours

• Shower thoroughly after applying chemicals.
• Wash any used clothing separately, DO Not mix with any other laundry.
• NEVER wash contaminated clothing or equipment near rivers, wells or ponds.
• Check with your medical doctor in case of contamination for proper testing and treatment.

What should I do with the containers?

• The empty containers of the chemicals are also very harmful,and should be disposed of in the following manner:

• Triple wash it, filling the container halfway with water and shaking it thoroughly for a minute. The wash water should be put in the pump that will be used to apply the chemicals to the canefield.
• **Do not burn, bury, or use empty pesticide containers to store water or food.**
• Instead, puncture them (drill holes into them) to make them useless and put them in a collection center for chemical containers.
• Never wash them in rivers, lakes, springs or ANY source of water.

How do I store my products?

Store ALL of your chemicals in a warehouse. In order to comply with safety regulations, the warehouse must have certain characteristics as follows:

Place: Must be away from schools, homes, rivers, ponds and wells.

Size: Must be able to store the products that you are going to use during the season (purchase only what you will need).

Material: Must have smooth walls and floors; these should be impermeable to chemicals.

Ventilation: The warehouse must be well ventilated; the air must run freely.

Characteristics of my warehouse:

• An organized and well controlled warehouse is safe; be sure to keep it neat and tidy with these standards:
• Keep it locked and marked with safety signs.
• Always keep handy and absorbent material (such as sand or dry sawdust) to use in the event of a spill.
• Organize chemicals according to their type of packaging and degree of toxicity (label color). Powdered and granulated chemicals should always be stored above liquid chemicals.
• Herbicides should be stored on the lower shelves to prevent cross contamination
• Store products in their original containers with their safety data sheets. Never re-pack products.
• Never store any kind of food, medicine, gasoline or any flammable substances in the warehouse.

What should be done in the event of an Emergency?

We all know that ***prevention is better than cure***, which is why you always have to be alert and know what to do in case of an accident.

The priority of any field worker is their health and the well-being of their colleagues. Health risks can arise with the use of any tool, machinery or use of pesticides during the control of weeds. Field workers are always exposed to occupational accidents that can cause body injuries or chronic illness when exposed to pesticides.

Always keep a first aid kit with you when you are working.

¡Be Alert! The most important thing is the well-being of yourself, that of the workers and your family.

Protect yourself from direct sunrays

Sunlight is one of the most important factors to consider while woriing in the field. The following are recommendations you can follow to minimize the effects of the sun's rays:

• Use caps, hats, long-sleeved shirts and long pants while working.
• Establish a shaded resting place, such as an area with trees.
• Drink plenty of water, at least 7 liters of water per person each day.
• It is advisable to work during the coolest hours with less sunlight.

Protect from dust:

• Wear sunglasses and a mask in case of heavy dust, for example, when harvesting.
• Avoid toxic substances.
• It is important that you know how to use agrochemicals before using them.
• All persons handling chemicals must be adequately equipped and trained.

Beware of Injuries

• Field tools can be dangerous which is why it is important to know how to properly handle or use field equipment.
• When harvesting, wear boots, long pants and caps to avoid injuries and scratches.

Beware of fire

• It is most important to ensure everyone's safety when a fire occurs. Avoid exposure to flames in order to avoid serious accidents.

Beware of snakes

• It's important to recognize and avoid venemous snakes. In case you are bitten by a snake, seek medical assistance immediately.

Be careful when harvesting

• It's important for workers to know the safety measures involved during lifting and transporting sugarcane.
• Wear basic protective equipment such as boots, long sleeves, long pants and caps
• Firmly secure your truck to avoid cane falling on the way to the sugar mill.
• It's important to check your trucks and loaders often.

Working Conditions and Fair Treatment

How should I treat my employees?

The better you treat an employee, the better they will perform; in addition, you will be complying with the laws established in Belize. The following recommendations help you achieve proper working conditions and fair treatment for employees:

Hiring an employee

• When hiring a worker you must follow the recruitment requirements established by law. Never hire minors under 18 years for dangerous work.

A fair remuneration

• You must follow the salary payment established by Belize law. The minimum hourly wage should be $3.30.

Social Security

• Be sure to make your social security contribution to get your benefits. The contribution to social security using the official scale based on income is essential to maintaining a sustainable system that provides medical services.

Fair Treatment

• It is important to encourage workers to send their children to school.
• Drinking water must be available to workers at all times.
• The use of threats, insults, beatings or sexual harassment is prohibited.

No to Child Labour!

Children are the future of our country and they deserve to live a happy childhood filled with fun and education to be able to progress in life.

It is illegal to hire minors in the sugarcane industry; they should be advised to attend school. In Belize, persons under 18 years of age are considered minors. However, labor laws allow individuals from the age of 14 to join the workforce by engaging in work practices considered "Light Work".

International Labour standards and fairtrade certification require that minors not be exposed to heavy work that can endanger their health.

• At no time should the minor be exposed to machete or other dangerous objects. They should likewise be kept away from agrochemicals, machinery and heavy equipment.

In order for minors to be involved with, and to learn the sugar cane farming business, they can be allowed to do light work under the supervision of the parents, while still attending school.

• To ensure that minors are not hired, farmers or contractors should request potential employees for an official document to verify their date of birth and social security number.

If you hire a minor, you deprive this child of his/her childhood; which is harmful to his/her physical and mental health.

Best Agricultural Practices

Inclusion of Women and Youth

Women and Youths are key and important players in the sugar industry.

Their participation will contribute to the sustainability of a vibrant sugar cane industry. The contribution to the work force by women is well known. Women participate in the cane farming business by attending to financial matters as well as assisting their husbands in the hiring and supervision of workers. It is necessary for the youths to become involved so that knowledge can be gained to advance and improve the business of sugar cane farming.

In many sugar-producing countries, discrimination against women persists in terms of free access to land, access to credit, technology, extension services, training, and even, to participate in a decision-making board of a company or institution. In our country there is great potential, but the lack of security, lack of opportunities and in many cases, the lack of pedagogical (educational) preparation, limits them from involving in any activity relevant to the sugarcane business.

The importance of women in the economy is very well documented in other countries. The multiple roles they play in the economic sector and the opportunities they are offered contribute to improving the financial status of different families, since in many cases, it is them motivating their children to continue their education. Opportunities for women are limited by the lack of

information, lack of programs, and gender inequality to obtain a decent work, something very necessary for their economic empowerment and social progress.

A series of sessions were held involving women from the sugar industry community to get a first-hand idea of how they can become more involved in the sugarcane business. The highlight was:

• To receive training on the financial aspect, such as budgeting, management and accounting; in many cases women are the ones responsible for banking transactions and payroll preparation.
• To receive information about employment opportunities, access to credit for canefarmers, and credit for the education of their children.
• Unequal opportunities in accessing job training.

The role of the youth in Belize's sugarcane industry

It is said that young people are the future of our society, and the ones to continue the business of their parents. The reality is different; in many cases our young people are interested in pursuing an educational career apart from agriculture. For this reason, it is necessary to include young people to make them see that cultivating sugarcane is hard work, but can be rewarding.

Due to a lack of financial resources, our young people have a tendancy to drop out of school and enter the work force. As well, due to the lack of job opportunities, other youths engage in drug and alcohol use and do not take up the cane farming business.

The following factors deprive the participation of young people in agricultural activities:

• **Transition from school to work:** school programs generally tend to discourage young people from agricultural careers. Given that the negative effects of the transition between school and work have been more intense in the agricultural sector than in any other sector, agriculture is considered as the occupation of last resort.

• **Access to land:** Access to land is an impediment to both young people and some women in agriculture. This prevents young people from having access to the land on which they can invest. In many cases, parents are the land owners and only assign a portion to their child "by name". In the case of women, while they may have access to the land of their husband, they often have no control over its use but the husband who makes the decisions.

• **Low Income for Time Invested:** traditional products (sugar, citrus, bananas) from establishment to harvest take time. For this reason, young people are discouraged because they do not have a fast revenue generation source.

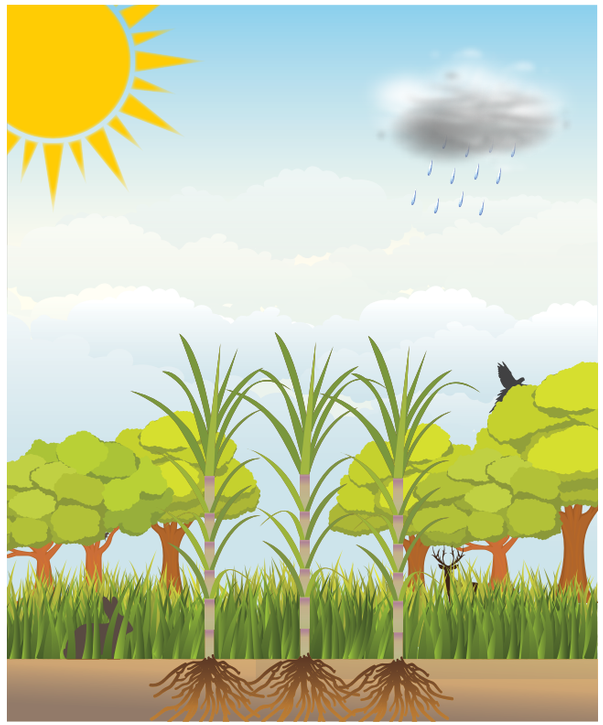
• **Seasonality of Income:** Due to the lack of industries in our country, when the crop season is over, young people have no other stable source of income. This situation is tied to rainfall and harvest cycles during the year.

• **Urbanization of Youth:** After leaving high school or sixth form, many young people prefer to look for work in the cities and not in the countryside or in rural areas.

Best Agricultural Practices

Sustainability of the Sugarcane Environment and Mitigation Strategies

Environmental Impacts



The environmental impact of activities related to the production of sugarcane are those that affect the soil, air, and water resources. This impact is created by all the activities in the cultivation of sugarcane (from planting, to harvesting and post harvesting). These activities, , in general have indirect impacts that affect the communities and the environment that surrounds them (flora and fauna).

Mitigation measures seek to reduce the impact of natural resource degradation. The main environmental impacts of cane production in Belize are discussed in this module. Likewise, main alternatives to mitigate these effects are mentioned and recommended, to contribute positively to the protection and conservation of resources.

Mitigation Measures for Environmental Impact Effects

Mitigation is the reduction of potential damage to the environment, in this case, by activities related to the production of sugarcane. All the activities in the sugarcane production cycle contain environmental risks to be addressed. This is the reason for the need to reduce the effects by implementing necessary strategies for each one.

The Soil

The most vital resource for the production of sugarcane is the soil. Over-exploitation, irrational use, pollution and abuse by agricultural operations are negative impacts on the resource and the main cause of significant negative impacts on the sugar belt of Belize. The following activities summarize the areas where the soil as a resource is mainly affected:

During Land Preparation:

Tillage is one of the main activities that affects the soil. Over-tillage and conventional use of soils (monoculture) deteriorates the main components of the soil, thereby affecting its production potential, fertility and retention capacity of elements. Removal of vegetative layers; compaction; alteration of the ecosystem and loss of organic matter contribute directly to the deterioration of the soils.

• In order to reduce impacts on the soil, minimum tillage practices should be carried out, altering the natural state of the soil as minimum as possible.
• It is also recommended to use machinery that generates less surface pressure on the ground, where possible of low horsepower and equipment with high flotation tires.
• Crop rotation and fallow helps restore most soil properties.

During Crop Maintenance: Weed Control and Fertilization

The excessive use of agrochemicals diminishes the biological activity of the beneficial organisms in the soil, this being the main measure of soil fertility. Microorganisms are primarily responsible for many biological processes in the soil.

• To reduce negative effects on the soil, it is important to select the appropriate agrochemical, application time and correct dosages.

During Harvesting:

Sugar cane burning has a great impact on the soil, since the burning causes the soil to lose its fertility. Over time, excessive burning destroys organic matter, accelerates sterilization and allows erosion of the soil. A second burning, or burning of crop residues, has more detrimental effects as this removes the surface organic matter leaving the soil exposed to the effect of direct sun and rainfall.

• As a preventative measure, the avoidance of the second burning is recommended.
• In the same way, green harvesting is a mitigation measure of the impact generated by burning close to the soil surface.

During Cutting, Loading and transportation:

Cutting, loading and transporting during harvesting directly affects soil characteristics due to the compaction caused by machinery.
• The use of appropriate machinery for soil harvesting is recommended.
• Harvesting in six rows and long rows reduces compaction and contamination.

Water

Water is one of the most vital resources in agriculture. From the development of the plant, to the application of agrochemicals, water is an indispensable element not only for humans, but also for living things in general.

During the land preparation

The excessive use of machinery puts the soil at risk of erosion, exposes water sources (such as rivers and seas) to pollutants from the production process of sugarcane

• In order to prevent this, protective zones must be maintained. An example is planting of trees at the borders of the plots.
• There are also laws that restrict the use of land in protected areas. This contributes to the preservation of water sources for the future generations.
• There are laws that restrict the use of land in protected areas. This contributes to the conservation of water sources for the future.

During crop maintenance: weed control and fertilization:

During ratoon maintenance,several forms of water pollution are created. One of these is the contamination of ground and surface water with the indiscriminate use of pesticides. Pesticides contaminate rivers and seas, where there is a diveristy of living organisms.

• As a preventive measure, do not wash equipment in areas near water sources, such as rivers.
• As a control measure, empty containers must be triple-rinsed. Apply the correct dosages in the required amount and in a timely manner.
• Do not apply agrochemicals in protected and conservation areas.
• The measures established by law should be followed; do not apply agrochemicals during periods of rainfall.

Air

Air quality, mainly affected by the burning activity of sugarcane, emits particles into the environment, which has a negative effect on the atmosphere.

During Harvesting

The main cause of air pollution from the production of sugarcane is from burning during harvesting. The first and second burning, (burning of crop residues), emit pollutants such as CO2 that affects the atmosphere.

• As a preventative measure, the established laws for burning must be applied and a contingency plan must be taken into account in case of fire.
• Consider wind direction and behavior.
• Respect burning schedules and control the size of the area to be burnt.
Therefore, follow the rules established by the competent authorities (SICB). Prevent the second burning of crop residues.

Flora and Fauna

The factors that damage flora and fauna in the environment are basically the irrational use of chemicals, habitat destruction (deforestation) and waste pollution.

During Land Preparation:

The clearing of forest areas for agricultural practices causes the destruction of wildlife habitats, thereby endangering many organisms.

• To conserve Flora and Fauna, you must maintain protection zones of forest and water sources.
• Reforestation and conservation programs should be considered.

Ratoon maintenance: weed control and fertilization

The indiscriminated use of agrochemicals, such as insecticides, eliminate natural enemies of pests. The applications of pesticides alters the habitat of species creating an imbalance in the agro ecosystem. Biodiversity loss over the past century as a result of high inputs of pesticides and

fertilizers has had a harmful impact on the diversity of genetic resources of crop varieties and animal breeds.
• Means of prevention is to apply the required dosages in a timely manner.
• The reduction of pesticide use in general.

During harvesting

Burning is the main contributor to biodiversity losses. Likewise, deforestion for establishing canefields eliminates natural habitats of species. With continuous burning, thousands of tons of carbon dioxide are produced, increasing the high levels of atmospheric pollution due to the emissions of particles.

• As a preventive measure, all technical and legal provisions must be applied for scheduled burning or green harvesting.

Social impact

The result of sugarcane production activities are directly detrimental to humans and surrounding communities.

During land preparation

• The machinery used in the different soil preparation activities create noise, dust and vibrations, which may affect rural and urban areas.

• As a control measure, soil preparation practices must be carried out at appropriate times.

During crop maintenance

• The use of agrochemicals can affect neighboring crops.

• A means of prevention is to respect the protection borders. Inform the community in advance about the applications and considerations to take into account to avoid damages. As a control measure, recommendations should be followed for handling and final disposal of agrochemical containers.

Harvest (cane burning)

• Impacts on the environment.
To minimize damage, proper firepass lines must be maintained and supervision done during burning. Have adequate staff (of legal age) and notify the neighbors when burning. Respect burning schedules.

Best Agricultural Practices

with numbers and data

1

2

3

Pay Attention! Keep track of numbers and figures!

Number and figures are difficult to track, but if we do not keep records, we cannot know if we are making a profit or losing money. Keeping proper records of the various costs of production in sugar cane has the following advantages:

• Agriculture is a business, and keeping good records can help with proper business management and decision-making. It is important to know if your business is generating a profit or a loss.

.• Keeping a complete and accurate record will help you make decisions in managing your business; it will help in knowing where to take action to maintain or improve production.

• Keeping proper and authentic records will assist you when obtaining a loan.

• Helps identify faults, weaknesses, and costly unsustainable activities which can be corrected.

• Canefarmers can avoid misjudgments and losses caused by relying only on their memory for guidance.

• Records and accounts are useful in gathering to correct data for analysis.

• Accurate information which helps in land acquisition policies and pricing.

• Producers need to have accurate knowledge of their gross income and cost of production in order to obtain more income.

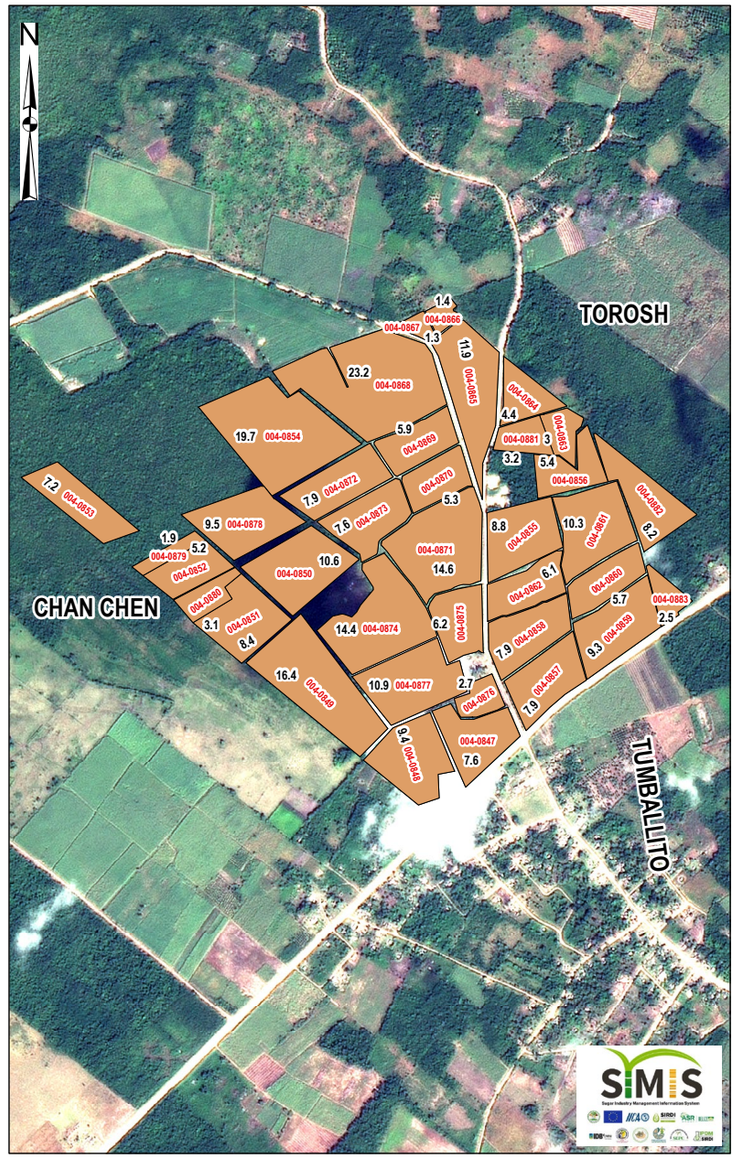
• Records assist in the development of a business plan.

• Records lead to better decision making. They allow the farmer to compare production costs by parcel and yield. This will assist in determining when to renovate their cane fields.

Rely on the SIMIS (Sugar Industry Management Information System) to get your parcel maps to keep your production records.

Data and activities by Parcel:

Here we give you an example of how to keep your records:

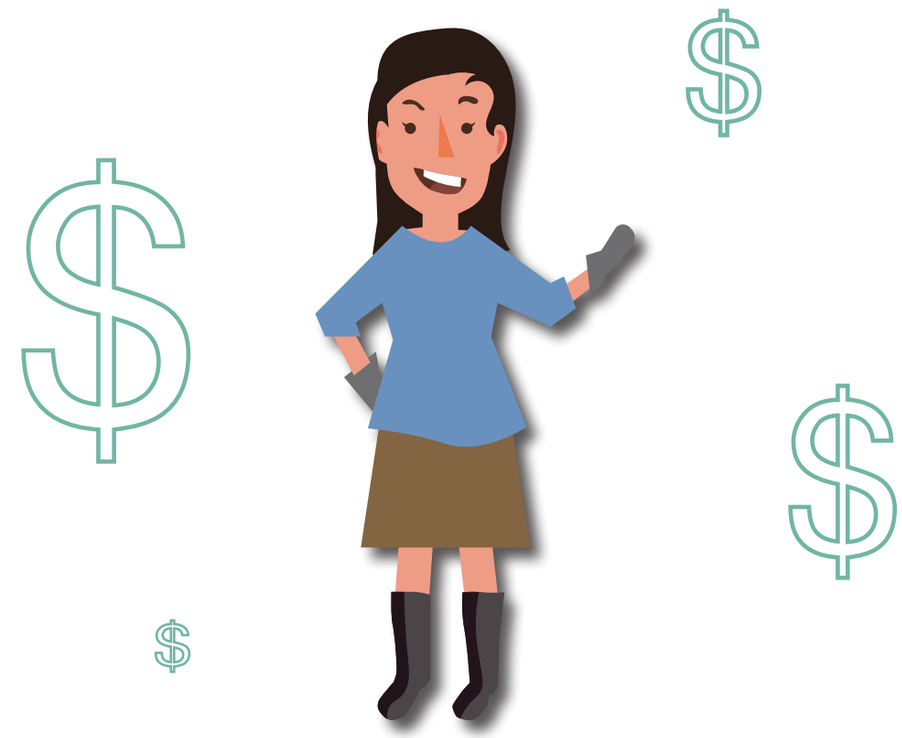


Production Owner	Field ID	BSI Code	Acres	Date of planting	Variety	Cycle	Last date of Harvest	Status
DOE, JOHN	015-0116	4321	13.88	7/1/2012	B79474	Ratoon	1/1/2014	Good

Harvest

Name:				No. 1			
BSI Code:			Open		In Progress		Close
Date Burnt:	mm	dd	yy	Acreage: 0.83			
Time:	hr	min	sec	Field Id: 021-0594			
Cutters				Grabs			
				Total Grabs			

Name:				No. 1			
BSI Code:			Open		In Progress		Close
Date Burnt:	mm	dd	yy	Class:			
Time:	hr	min	sec	License:			
Location: QUEMAZON				Parcel Acreage: 0.83			
Total Grabs:				Field Id: 021-0594			



Cost Analysis (Maintenance)	
Total cost	
Total tons harvested	
Total acres	
Tons per acre	
Cost per ton	
Cost Analysis (Harvest)	
Total cost	
Tons per acre	
Cost of harvest per ton	
Cost-Benefit	
Price per ton	
Maintenance cost per ton	
Harvest cost per ton	
Production cost per ton	

Name	Social Security Number	Date of Birth	Activity	Protective Equipment	Hours Worked	Salary per activity	Salary per Week	Signature

Annex

Annex

Annex I: How to collect soil samples for laboratory analysis

A fundamental prerequisite to obtaining higher yields of sugarcane is the presence of optimum conditions in the soil, considering that sugarcane cultivation will be maintained in the field for 5 to 7 years, due to the practice of harvesting multiple times.

Soil analysis is of great help in monitoring the state of fertility. Some supply houses in Belize offer the service to have the soil sent for analysis in a laboratory. Here we share the basic technique on how to prepare your sample to take advantage of those services.

Materials:

- Farm map (sketch)
- Machete
- Soil auger, shovel or spade
- Bucket
- Clean plastic bags
- Markers
- Sheets to identify the sample

Procedures:

1. Get the map or sketch of your cane fields from the SIMIS with SIRDI.

2. a) Take the sample at a point different to the application area of the fertilizer, avoid sampling in areas with residues left during in the old ratoon crop.

b) Plant Cane - perform soil sampling including from the furrow and between furrows to have complete information on the area to be renewed.

Note: It is better when the soil is ploughed because it is more homogenized.

3. You must draw 5 sub-samples per acre. Mix until you get a single composite sample

4. At each sampling site, remove the plants and fresh fallen leaves (1 inch) and then introduce the Soil Auger or shovel to the desired depth. Tools should be cleaned after taking each sub-sample.

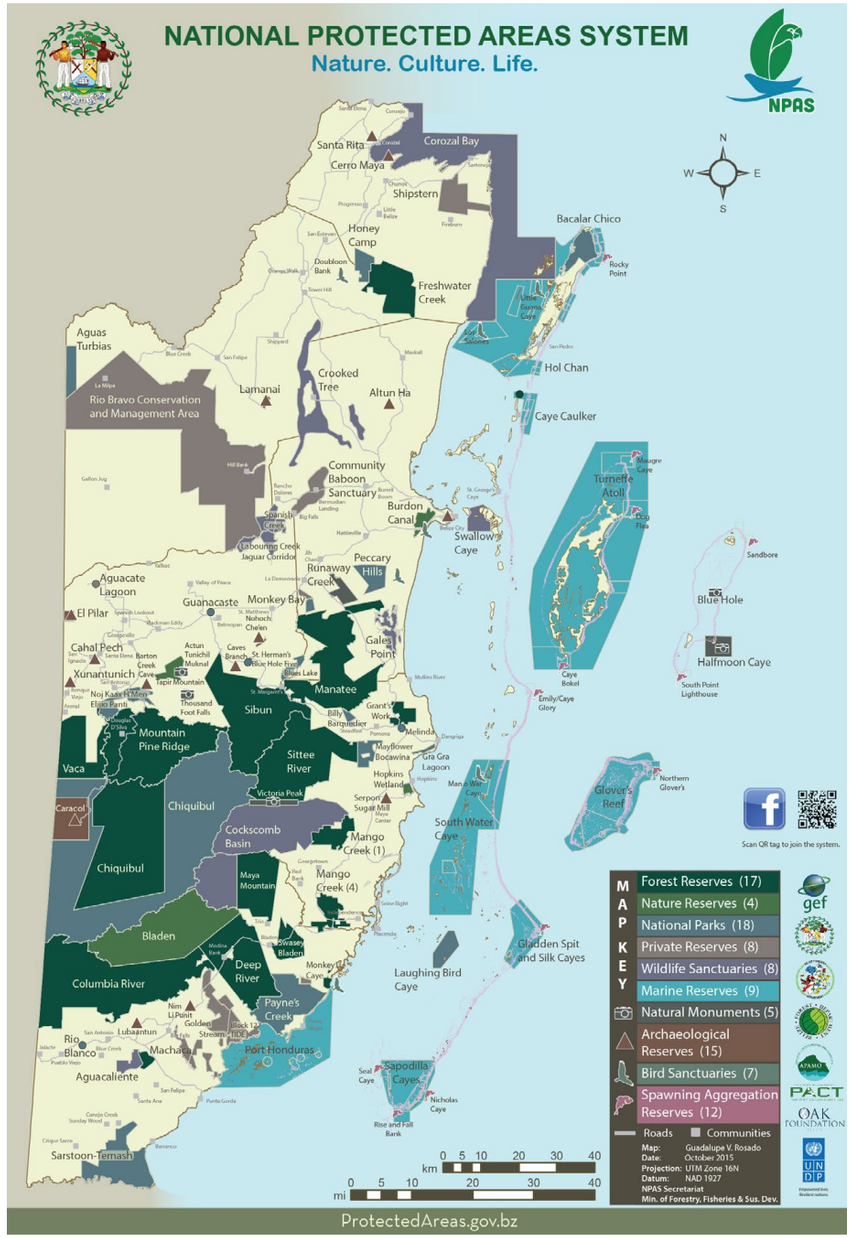
5. The sub-sample should be collected in a bucket or plastic bags or other recipient.

6. The soil is then thoroughly mixed. Weigh one to two pounds and store in a properly identified and labeled plastic bag.

7. Ready! Send to the laboratory.

Remember: the analysis result allows you to know the soil fertility status. This helps you to determine the formulation and amount of fertilizer needed.

Annex 2: Protected Areas of Belize



Annex 3: Example of a soil analysis result

In many industries the results of the soil sample are used before planting as a base. We need the results of a soil analysis. In this manual we will do a calculation of nutrient balance for nitrogen, phosphorus and potassium in sugarcane.

Example of a result of soil analysis:

Sample	pH	M.O %	N(%)	P (ppm)	K (ppm)	Textural Class	Effective Cationic Interchange	Exchangeable Cations			
								Ca^2	Mg^2	K+	Na+
Sotero Blanco							meq/100 g of soil				
	7.1	2.99	0.13	5.01	59	loamy-sand	12.20	12.20	9.82	0.15	0.00

Calculating the amount of nutrients that a canefield needs: 1000 kg of cane (1 MT) extracts the following:

Nitrógeno (N)	Fósforo (P_2O_5)	Potasio (K)
0.7-1.2 kg	0.4-0.8 kg	1.8-2.5 kg

If our objective is to produce 100MT of cane per hectare. We require:

Nitrogen (N)	Phosphorus (P_2O_5)	Potassium (K)
120 kg/ha	80 kg/ha	250 kg/ha

How much nutrients do we have in our soil? According to the soil analysis it has:

Nitrogen (N)	Phosphorus (P_2O_5)	Potassium (K)
50 kg/ha	29 kg/ha	183 kg/ha

Based on your soil analysis, how much fertilizer should you apply?

Nitrogen (N)	Phosphorus (P_2O_5)	Potassium (K)
70 kg/ha	51 kg/ha	67 kg/ha

Economic Thresholds of Action for the froghopper (*Aeneolamia spp).*

Control	Eggs	Nymphs/ stem	Adults/stem	Adults/ Trap/day
Use of phytosanitary harrow	Soil sampling (200,000/ hectare)	0	0	0
Use of phytosanitary harrow	Infestation history	0	0	0
Fungus (*Metarhizium anisoplae)*	0	0.15	0.15	14
Ethological (traps)	0	0	0.26	25 (indicator)
Insecticide	0	0.4	0.4	≥ 40
Sugar Industry Research and Development Institute				

Annex 5: Production estimate

The production estimate helps you know how much you can get out of your cane without taking into account any losses. (This estimate does not take into account losses during the harvest).

Procedure: Parcels are sampled as shown in the figure.

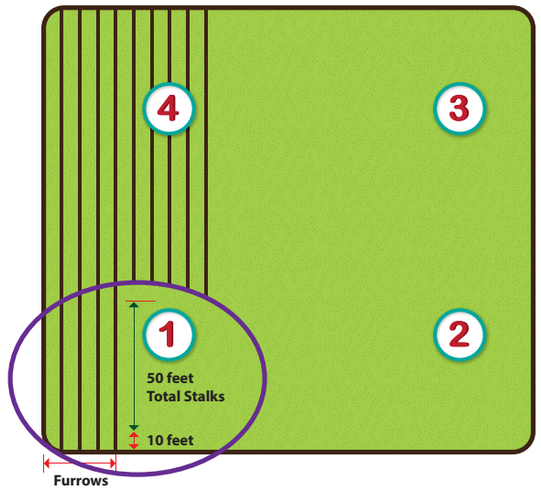
1. Enter the furrow (10 steps).

2. Measure 50 feet.

3. Count total number of millable stalks within the 50 feet.

4. Weigh 20 millable stalks

5. Apply the formula to tabulate Cane tons per Acre.



Annex 6: First aid for snake bites

Over the years, snake bite victims have been subject to all kinds of temporary measures before receiving medical attention: incision/cutting, freezing and squeezing. Some of these approaches, such as making an incision and trying to suck out the poison, have fallen largely in disegard.

"In the past five or 10 years, there has been a backing off in first aid from really invasive things like making incisions," says Arizona physician David Hardy, MD, who studies snake bite epidemiology. "This is because we now know that these things can do harm and we do not know if they really change the outcome." Many health professionals cover only a few basic first aid techniques. According to the American Red Cross, these steps should be taken:

• Wash the bite with soap and water.

• Immobilize the area of the bite and keep it below the heart.

• Seek competent medical attention as soon as possible. The most important thing is to get to a hospital without delay. Some medical professionals, along with the American Red Cross, cautiously recommend two other measures:

• If the victim is unable to get medical care within 30 minutes, a bandage wrapped between two and four inches above the bite may help slow the venom. The dressing should not cut off blood flow from a vein or artery. A good rule of thumb is to make the band loose enough so that a finger can slide under it.

• A suction device can be placed on the bite to remove venom from the wound without an incision. Suction instruments are often included in commercial snake bite kits.

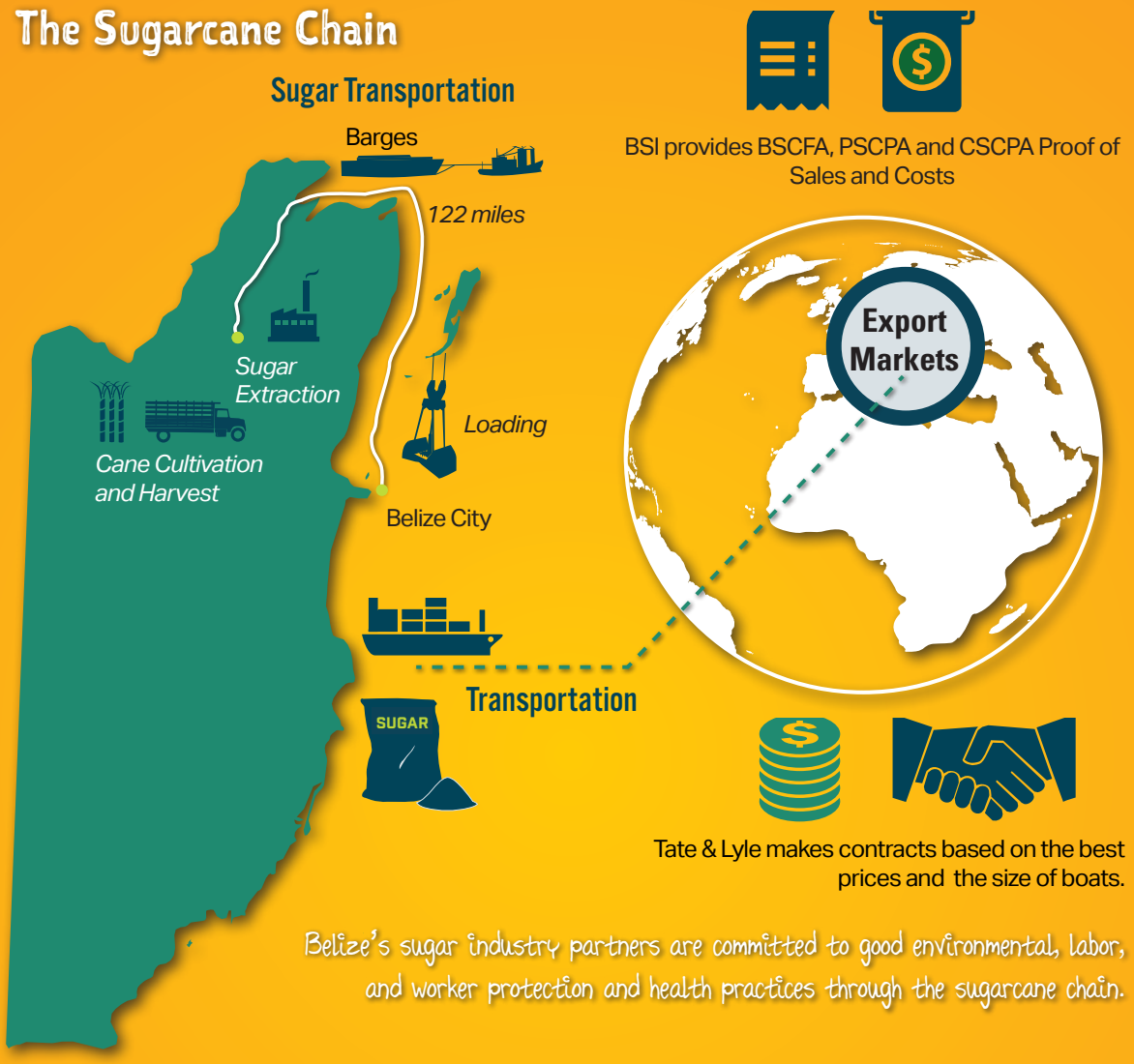
Annex 7: Personal Protective Equipment that should be used when applying Pesticides - Herbicides

Use	Active ingredient	Commercial name	Re-entry	Personal Protective Equipment								
												
Herbicide	Glisofato	Wipeout, Glifosato Aleman, Touchdown, Round up, Root out, Jaripeo	As soon as the solution has dried	✓		✓	✓	✓		✓		✓
	Diuron	Diuron	Until dry- 24 hrs minimum	✓		✓	✓	✓		✓		✓
	Ametrina + Terbutrina	Amigan	48 hrs	✓		✓	✓	✓		✓	✓	✓
	2,4-D Amina	Elimina 60 SL/ Elimina 72 SL	24 hrs	✓		✓	✓	✓			✓	✓
	Indaziflam	Alion	24 hrs	✓		✓	✓	✓		✓	✓	✓
	Glufosinato de Amonio	Finale	-	✓		✓	✓	✓		✓	✓	✓
	Imazapic	Plateau	4 hrs	✓		✓	✓	✓			✓	✓
	Saflufenacil	Heat	Once the surface has dried	✓		✓	✓	✓			✓	✓
	Pendimetaline	Prowl H20		✓		✓	✓	✓				✓
	Acetoclor	Harnnes		✓		✓	✓	✓				✓
	Atrazina	Atrazina 80		✓		✓	✓	✓				✓

Annex 7: Personal Protective Equipment that should be used when applying Pesticides - Insecticides and Fertilizers

Use	Active Ingredient	Commercial Names	Time of Re-entry	Personal Protective Equipment								
												
Growth Regulator (PGR)	Trinexapac	Moddus		✓		✓	✓	✓				
Insecticide	Isosaflutol	Merlin	-	✓		✓	✓	✓				
	Thiomethoxam	Actara 25 WG	24 hrs			✓	✓	✓		✓	✓	✓
	Thiomethoxam/ Lambda cyhalothrin	Engeo 24.7 SC Kendo 2 EC	24 hrs			✓	✓	✓		✓	✓	✓
	Imidacloprid	Jade 0.8 GR	24 hrs			✓	✓	✓		✓	✓	✓
Fertilizers			-	✓	✓	✓	✓		✓			
Additives	Surfact 820 Adjuvante	Sticker Bivert Inex A	-			✓			✓			
	Indicate 5	Corrector PH Sulfacil	-			✓			✓			

The Sugarcane Chain



BSI provides BSCFA, PSCPA and CSCPA Proof of Sales and Costs

Tate & Lyle makes contracts based on the best prices and the size of boats.

Belize's sugar industry partners are committed to good environmental, labor, and worker protection and health practices through the sugarcane chain.

SIRDI SUGAR INDUSTRY RESEARCH & DEVELOPMENT INSTITUTE BELIZE, C.A. | ASR GROUP | BELIZESUGAR | IDB Inter-American Development Bank | MIF Multilateral Investment Fund Member of the IDB Group

and Sugarcane Farmer Associations of the Belize Sugar Industry:

BELIZE SUGAR CANE FARMERS ASSOCIATION ESTABLISHED 1965 | PROGRESSIVE SUGAR CANE PRODUCERS ASSOCIATION