

Saccharum Officinarum

AGRICULTURAL CLASS
MONOGRAPH

Laura Pabón

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Introduction

This monograph is going to be a deep research about *Saccharum Officinarum*, which in other words is Sugarcane. This plant that is part of the grass family around the world, is one of the most important so that lots of products can be made. Known as sugarcane which lots of tropical countries have this product as the main source of economy, shows how important this plant is for the world. This plant has been in the planet earth since 6000 BC, such that it has been a really important product for commerce always.

In the first chapter of this monograph talks about the ecology from the plant, which gathers lots of information. Some information that is going to be read is: the distribution, affinity and origin, the rank, present distribution. Also the first chapter has some information about: environmental factors, which has the elevation and climate that it has to be planted, next is the geology and soils where the plant can grow, lastly there is the vegetation components from this grass. The second chapter talks about the biology, it offers different investigation that is deeper about the plant. The information that is written is the chromosome complement, life cycles and phenology, deciduousness, flowering and fruiting, the reproductive biology, the sexuality of the plant, a thesis, and Eco physiology. Third chapter talks about the natural regeneration, the nursery propagation, propagation from seed, vegetation propagation, grafting, plating, management, and pest and disease control. Each part is really detailed and important for knowing about the planting of this grass. Chapter four talks about the emerging products and the potential markets, then it would talk about food items based on pulp skin and juice, next is the items based in the sugarcane and lastly is the medicinal use of this plant.

If you are interested in learning about this important plant for humans continue reading this monograph. It is complete about the most important information from this plant and its more deep research.

Chapter 1: Ecology

1.1 Distribution

Saccharum Officinarum is a member of the grass family; from this crop sugar is extracted so that humans can use this as a sweetener or in the cosmetics industry. This crop is also known as; sugar cane, noble cane, ikshu, khanda and other names. Sugar Cane habitat is a hot humid tropic and in moist soils, that's why in Valle del Cauca this is one of the top industries. This member from the grass family is widely cultivated around the world, and gives approximately 70% of the world's sugar (KEW).

1.1.1 Affinity and Origin

The center of this crops origin was in New Guinea since 6000 BC and cultivated from about 1000 BC. It was first given to the Pacific Islands; the Persian Emperor gave it the name of “the reed, which gives honey without bees”. Getting to western Europe by Alexander the Great they discovered this plant named it “honey-yielding reed”, but then the crusaders brought it to Europe and it expanded it world wide. It was spread throughout human migration and then brought to America in 1493 by Columbus in his second expedition. As said before being such an important cultivation for the world is being grown over 70 countries, the top producers are India and Brazil (KEW). Sugar cane is grown in southwestern Europe, Africa, temperate Asia, tropical Asia, Australia, the Pacific, southeastern USA, Mexico and South America (KEW).

Rank

Kingdom: Plants

Subkingdom: Tracheobionta-Vascular plants

Super division: Spermatophyta- Seed plants

Division: Magnoliophyta- Flowering plants

Class: Liliopsida- Monocotyledons

Subclass: Commelinidae

Order: Cyperales

Family: Poaceae/Gramineae- Grass family

Genus: Saccharum- Sugarcane

Species: Saccharum Officinarum

1.1.2 Present Distribution

Today sugarcane is cultivated mostly commercially around the world. As a commercial place, United States has a big sector, which contains states such as Florida, Louisiana, Texas and Hawaii. The state, which has a bigger rate of production, is Florida, producing more than 13.1 million tons of sugarcane for 2011.

But as for world production Brazil is the world's largest producer of sugarcane, reaching for one third of the world's production. The other part of the world which produces the same quantity as only Brazil is the Asian production but dealing with 3 countries.

J.A. Mathews / Energy Policy 35 (2007) 3550–3570

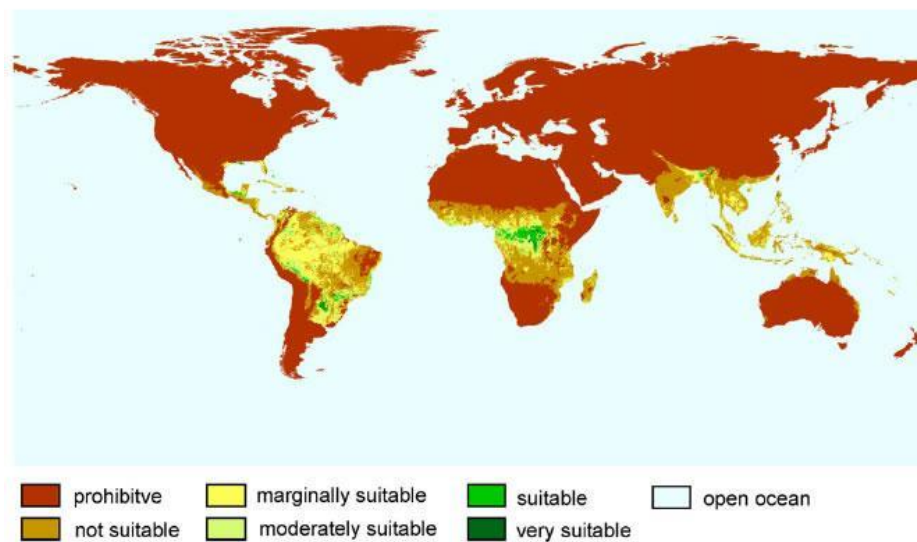


Chart 3. World map of sugar cane cultivation utilizing rainfall only. *Source:* FAO Terrastat.

Figure 1: World Map of Sugar Cane Cultivation with Rainfall

1.2 Environmental Factors Affecting Distribution

1.2.1 Elevation and Climate

Saccharum Officinarum is normally from a low elevation sea level 1000 m of altitude and latitude 36.7 N and 31.0 S. This crop is considered a tropical plant; it can grow throughout the most climates that can occur in this elevation (NETAFIM). The relationship with Sugar Cane and the climate is necessary; some important components about the climate may be yield, quality temperature, light and moisture. This crop mostly likes to produce lot better in a tropical hot area. To characterize the best climate for its production is; long warm season and moisture, where typhoons and hurricanes are not created, rainfall (1100-1500 mm), the temperature should be 32-38 degrees. The reason why this crop needs a high temperature is because the reversion of sucrose into fructose and glucose may occur via photorespiration. Also, the humidity needed for this product from the grass family is high almost 80-85%, but it can also vary from 45-65%. As said before sugarcane needs lots of sun and heat to grow strong and give all its nutrients so it needs daylight almost all the 14 hours the sun is out.

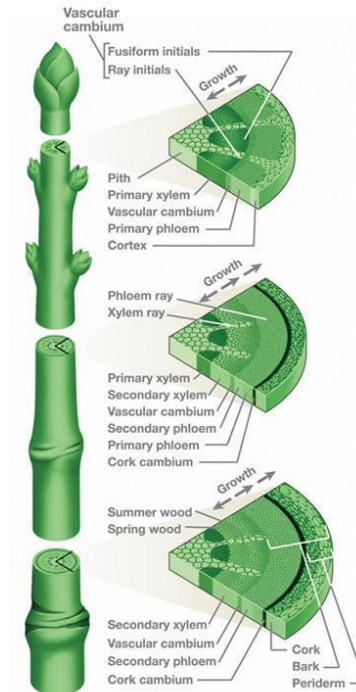


Figure 2: Form of Sugar cane

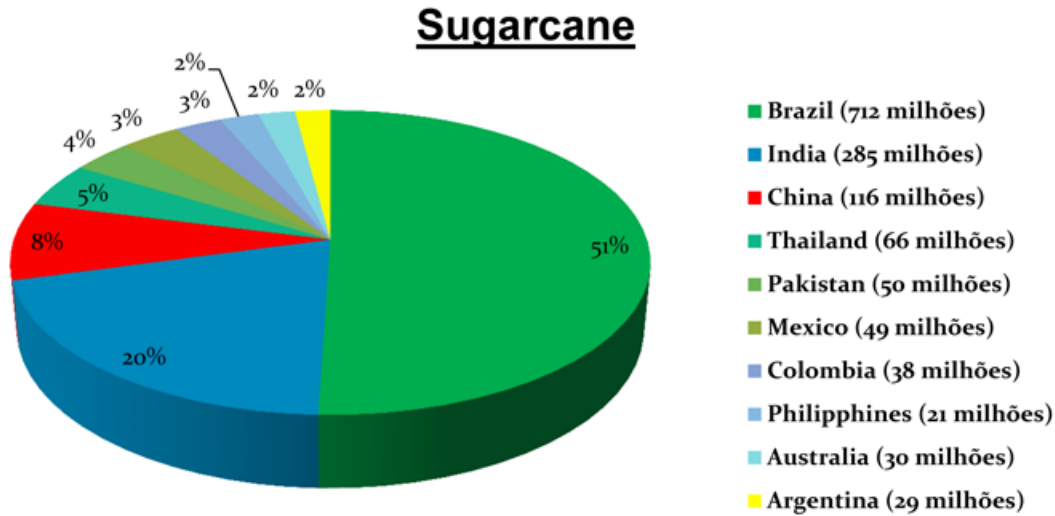


Figure 3: Graph of Production of Sugarcane Worldwide

1.2.2 Geology and Soils

For a crop to grow it needs soil, without this natural source it would be literally impossible. Thanks to the soil the plant can grow with strong nutrients. But Sugar Cane doesn't need a specific type of soil; it can grow from sandy soil to heavy ones. As Netafim says the optimum soil pH is about 6.5 but sugar cane can tolerate considerable degree of soil acidity. As every crop before being planted the soil needs to be in an optimum macro and micro nutrient application, which would help a lot the crop to grow.

There are two types of species, the wild ones and the hybrids. The most important are "saccharum robustum", "saccharum officinarum", "saccharum spontaneum", and "saccharum sinense". The first one listed normally is regarded as the original specie, the second one as a variety of cane with high resilience to diseases but unable to produce sugar, and the last ones are a Chinese variety. While the hybrids are the ones that depend with the soil and climate conditions, these weren't produced in a natural world but they were by interbreeding some variety.

1.3 Vegetation Components

1.3.1 Soil Environment and Effects of Soil

Sugarcane uses a different kind of soil so it can be produced in big quantities; its name is loamy fertile soil. Which is mixed with salt and lime that is good for the plant itself. The land this crop needs to be planted on is a plain land, where there can be a small slope.

Chapter 2: Biology

2.1 Chromosome Complement

“*Saccharum* species present high ploidy levels. *S. Officinarum* is octoploid ($2n=80$) having $x=10$ chromosomes, which is the basic chromosome number of members of the Andropogoneae tribe (D’Hont et al. 1995; Cesnik and Miocque 2004; Nobrega and Dornelas 2006). *S. Spontaneum* has $x=8$ chromosomes (D’Hont et al. 1996) but presents great variation in chromosome numbers with five main cytotypes: $2n=62, 80, 96, 112$ or 128 (Daniels and Roach 1987; Sreenivasan et al. 1987).” (Cheavegatti-Gianotto & et al, 2011).

2.2 Life Cycles and Phenology

2.2.1 Life Cycle

The process of the life cycle of this crop has different steps, which simply starts with planting, then watering and care, the harvesting and replanting and having seed production. The first part is when the crop is planted that is normally by August through January, but the seeds can’t be reused for reproduction because they normally don’t grow as a “clone” and then end up differently (Sharpe, n.d.). The next step requires lots of water; these crops are better with being moist. In other words, if the soil is nutrient poor, the seed won’t grow as it should be. When the plant is ready to harvest, it would be actually once per year. “The plants are maintained for three years and will achieve three harvest before the field is replanted” (Sharpe, n.d.).

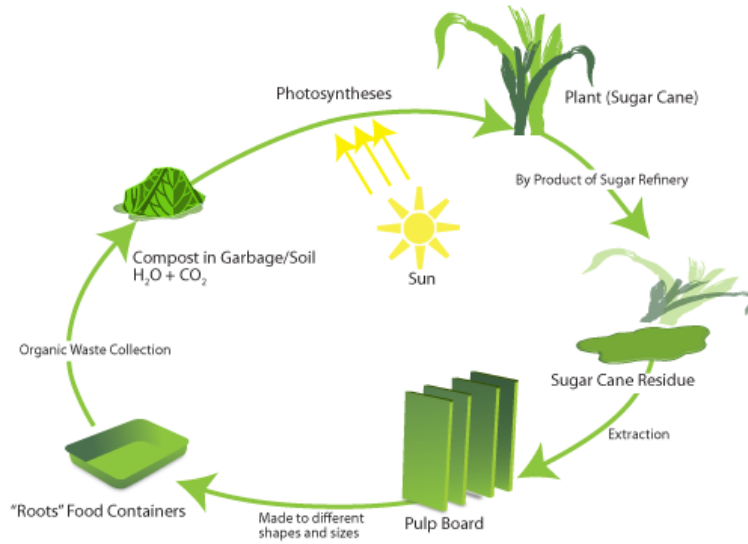


Figure 4: The Life Cycle of Sugarcane

2.2.2 Phenology

The growth stages of sugarcane, this plant “is considered as one of the most efficient convertors of solar energy, and has five steps or stages during its growth.

2.2.2.1 Deciduousness

The germination phase when is cultivated commercially, sugarcane is propagated only in the vegetative by stem parts or by whole stems. During the tillering phase the sugarcane plant starts after the sprouts appear. The grand growth phase is the stage which lasts for 5 to 8 months, is the vegetate stage, which is mostly with heat and moisture. The stage of maturation and ripening is phase that only last over three months, which is determined by sucrose level in the steams.

As to continue the germination phase of cultivation and growth of sugarcane has to be described more deeply. In the initial stages from this process the roots from this crop would new roots, but these roots “would not be connected to the primary shoot but are important in the maintaining of the moisture in the sett” (Bull 2000). Each root from this crop is germinated “to produce the shoot roots that

support the plant growth. The shoot is then independent of the original sett” (Bull 2000).

2.2.2.2 Flowering and fruiting

The main conditions that are important so that the flowering of sugarcane occurs are three. Starting with “latitudes between 5° and 15, that means a region in which there is a gradual reduction of photoperiod that is an essential factor for flowering induction” (Sharpe, n.d.). The next important condition is high temperatures, “sugarcane requires at least 10 inductive nights for flowering” (Sharpe, n.d.). The last important condition is the high relative humidity, which is critical for the panicle and the pollen fertility. “The flower opening only occur hours before sunrise when the plant is totally hydrated and RAH is high.” (Moore and Muss, [1987](#)).



Figure 5: Sugarcane Flowering

2.3 Reproductive Biology

3.3.1 Pollen

“Sugarcane pollen is small, is honeycombed exine and is dispersed primarily by wind. Sugarcane pollen grains dry rapidly after dehiscence with an estimated half-life of 12 minutes. So, pollen that is dispersed over large distances is not expected to be viable.

2.3.2 Sexuality

The sugarcane sexuality is based on breeding which is the mating and production of offspring. “Sugarcane breeding is based on the selection and cloning of superior genotypes from segregating populations that was obtained by crossing contrasting individuals” (Sharpe, n.d.). The first step is making a “large number of crosses among selected parental genotypes” (Sharpe, n.d.). Next the seeds grow “to a large number of progeny, that are needed to increase the chance of obtaining improved cultivars from superior genetic combinations” (Sharpe, n.d.). Cutting the day length, night temperatures and day temperatures started the floral development.

2.3.3 Anthesis

“Sugarcane forms an open panicle type of inflorescence, whose shape, degree of branching and size are highly variety specific. The sugarcane flower consists of three stamens and a single carpel with feathery stigma typical of wind pollinated flowers” (Australian).

“Flower initiation cause the apical meristem to switch from a vegetate to floral development, causing stalk elongation to cease, consequently flowering of the crop can affect yields. The older and more vigorous stems in a stool are the most likely to initiate flowering” (Australian) (Moore & Nuss 1987).

2.4 Eco physiology

Sugar cane has two main industrial processing, sugar and ethanol. The process of this two production requires obtaining the sugarcane juice, that go by different process to

make ethanol as well as sugar. For producing ethanol which is “obtained by the distillation of fermented sugars” (Sharpe, n.d.), this good is a flammable liquid used for an add up to gasoline. For making sugar, is “obtained directly from sugarcane processing that consists of 99.8% sucrose and 0.2% impurities”



Figure 6: Sugarcane produces Ethanol and Sugar

Chapter 3: Propagation and Management

3.1 Natural Regeneration

The “natural regeneration is a process by which forests are restocked by trees that develop from seeds that fall and germinate in situ” (*Forest Research*).

3.2 Nursery Propagation

The propagation of the sugarcane comes in cuttings or sections, which are called setts or seed pieces, that propagate sugarcane. “Each set contains one or more buds, and the buds are located in the root band of the node, are embryonic shoots consisting of a miniature stalk with leaves” (NETAFIM). This propagation of the sugarcane come in different sizes shapes and has other characteristics, but each one has a root primordial. “The primordial exhibits a dark center, which is a root can, and a light colored “halo” (NETAFIM).



Figure 7: Greenhouse of Sugarcane

3.2.1 Propagation from seed

The propagation of the seed, also known as the planting material is most likely for a commercial cultivation. That has different kinds of planting materials, cane setts and other kind of important cuttings.

3.2.1.1 Pre-preparation and implication for germination

The preparation and implication for germination in sugarcane starts with the “cane setts”. This also called as seed pieces, contain one or more buds. For making a germination first start with some genetically pure setts as the seed material. “Experimental evidence shows that germination of 3-bud setts is higher, the middle bud of a 3-bud set has the highest germination capacity. The middle bud has an advantage of germination because, as a non-terminal bud having nodes on either side, its moisture

resources are better protected than those of the terminal buds” (NETAMIN). There is another kind of sets that are with roots and they’re known as settings. These parts can be kept in nursery beds or polythene bags, but the single nodes are used for planting material in transplanting crops.

3.2.1.2 Sowing and the germination process

For a great selection of the best cuttings and the best germination process there are some kind of conditions they`ve need to be. When selecting the stem cuttings, the upper half portion of the plant, are the best ones to raise new crop. The plants, which have 3-4 vegetative buds, are normally the healthier and free from bad things that won’t let the plant grow. (Agropedia) With the set treatment the cane-seed-sets are wet and are the sugariest, so when this are planted they would have more damages, so before planting this kind of plant pass it through a process of chemicals. The best time for planting the sugarcane is when the atmospherics temperature is about 25 Celsius. (Agropedia)

The methods for sowing a sugarcane crops are flat planting, furrow planting and trench method. The flat planting is used when their needs to be intensively grown, so the plant has some conditions lay the depth of the crop and the long it needs to be. The furrow planting is when there are low soil moisture conditions. The trench method is mostly used where there are lots of winds and the raining seasons cause the lodging of the cane damage, so they are grown in costal. (Agropedia)

3.2.2 Vegetation propagation

The vegetation propagation is a form of asexual reproduction of a plant. Only one plant is involved and the offspring is the result of the parent. The new plant is genetically identical to the parent.

3.2.2.1 Grafting

Grafting is a method in which the cut stems of two different plants are joined together in such way that the two stems join and grow as a single plant. This way is mostly used in sugarcane plants the plant needs to grow up really fast. As said before in the preparation of germination the nodes and sets are commonly used for grafting.

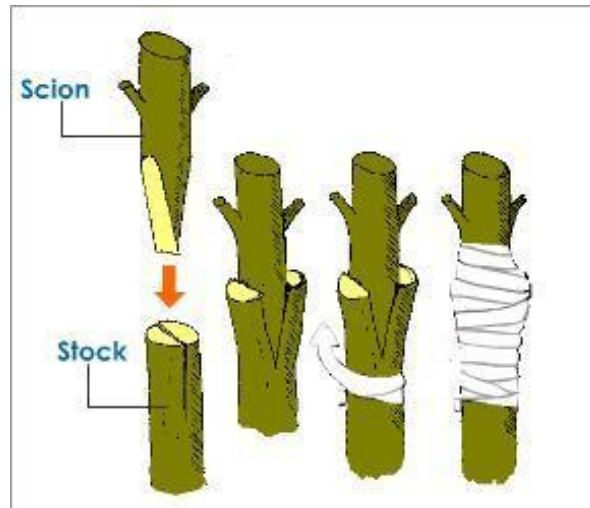


Figure 8: Grafting of Sugarcane

8.2.2.2 Cuttings

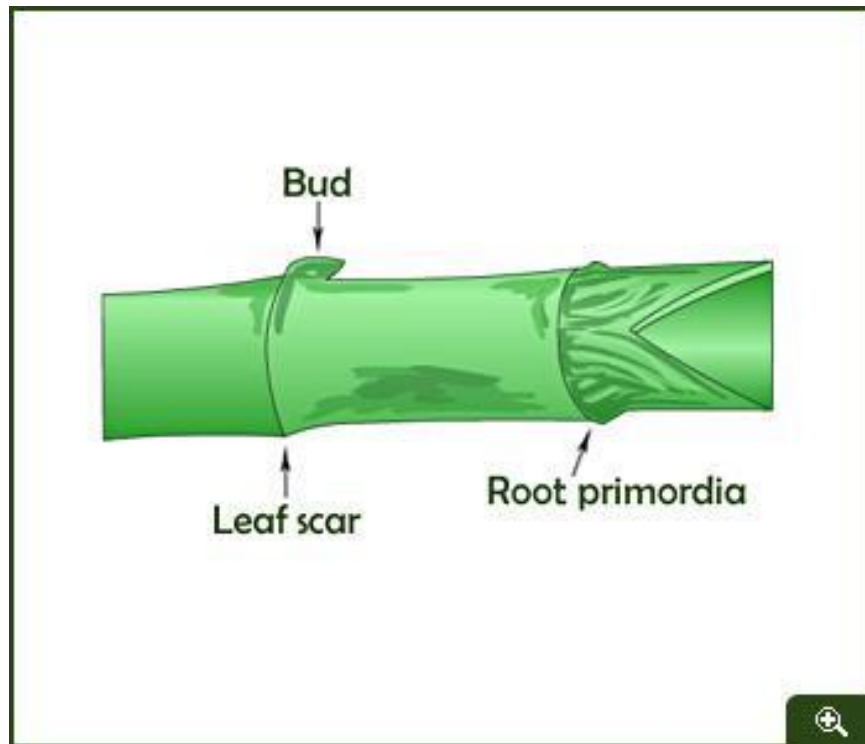


Figure 9: Sugarcane Cuttings

3.3 Planting

Sugarcane is grown in different agro-climatic conditions around the world, in other words different times. If we are talking about a more systematic planting, the machinery planting exists. They way this works is by a depth of soil covering over the cane, which is an almost 40 centimeters long part of the sugarcane that is healthy. The machine will cover the cane with lots of soil, but without dragging it down, that way the plant would grow easier. (Agropedia)

3.4 Management

3.4.2 Fruiting

The definition of fruiting is to produce fruit but in this case, is to produce this vegetable and its secondary products. To begin with what comes out the sugarcane is most famously known as jujube. So, the Jujube pollination is known for producing sugar and its derivatives, but what

about this? Well this vegetable is a small tree that causes a small vegetable; its name is a drupe. Small, this vegetable is used for medical causes just for many cultures; its popular use is for tea that cures sore throat. This vegetable is apart from the sugarcane plant but normally grow with this type of sugarcane and are known as “Sugarcane Jujube”. (CRFG)

3.4.3 Pest and disease control

As all crops grown around the world, they have a wide spectrum of pests and diseases that have its control and its management.

The Early Shoot Borer is a disease that attacks the crops in the early part that the cane grows, before the plant has any full formation. This disease is a heavy yield loss, it affects the plant area, and it makes the plant really harmed and difficult to re grow strong.

The Internode Borer is another plant disease in which it's affected after the internode is formed; the five immature internodes are affected with this disease. With this disease, the larvae feed and multiply in the water shots, and this animals damage 103 internodes. The length and girth of the infected internodes get reduced.

The Yellow Leaf Spot is a disease that normally is prolonged with raining and intermittent sunshine. Warm humid weather favors rapid and abundant production of conidia by the pathogen and prospered of the disease. The characteristics symptoms are a presence of small, yellow colored, irregular shaped sports over the leaf surface.

Chapter 4: Emerging Products and Potential Markets

4.1 Emerging Products, Potential Markets

Sugarcane has many products from where people use in a daily life, this plant has been cultivated for a long term. These days products use have been upgraded to more efficient things. The most important products that this plant produces are sugar, ethanol, bioelectricity, bio plastics and bio hydrocarbons (Apex Brasil, 2017).

The top ten producers of sugarcane are from the tropics. The largest producer is Brazil, that produces around 739,300 thousand metric tons of sugarcane per year, then India with an annual production of 341,200 thousand tons, in the third place we can find China which is the second strong producer in Asia with 125,500. In Brazil 90 percent of national production comes from the southern part of the country. While in India, the plant is used for alcoholic beverages or crystal sugar (Sheth, 2017).

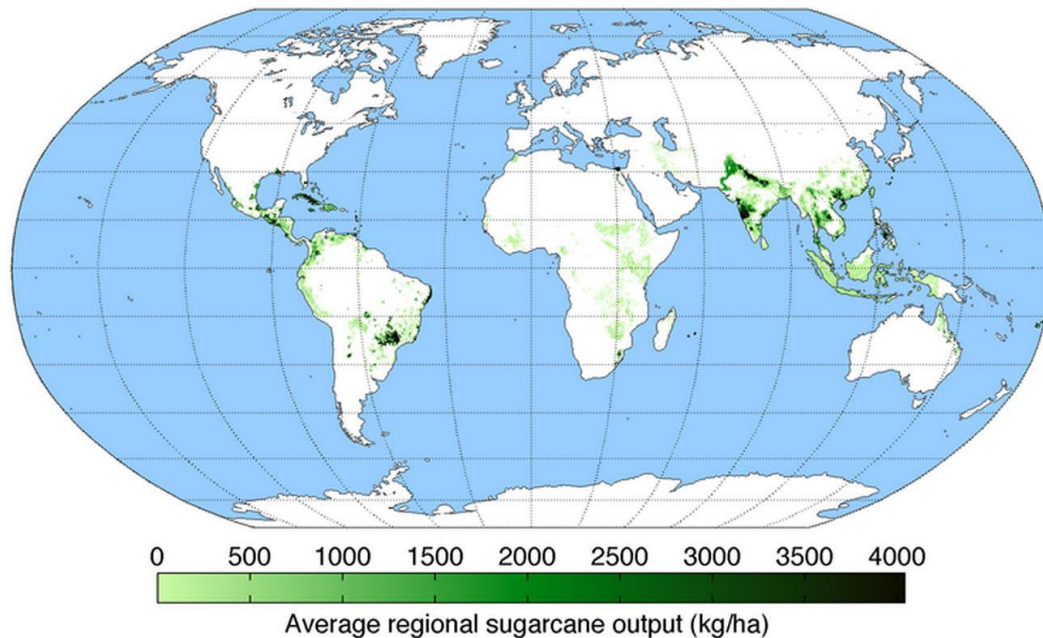


Figure 10: Sugarcane Production Worldwide Figure 25.3 Food Items based on pulp, skin and juice

4.3.1 Fresh Sugarcane Products

The fresh fruit product from the sugarcane is the sugarcane juice (Figure 2). This juice is produced by the cane where lots of juice that can be extracted. This sugarcane juice is mostly famous around Brazil, Thailand, and China.



Figure 11: Sugar Cane Juice

4.3.3 Alcoholic Beverages

Cachaca is alcoholic beverage made from sugarcane juice (Apex Brazil, 2017), it's fermented for it can be created. Fermenting and distilling molasses from Certified Organic Grown Sugarcane produce the way this beverage is made by. Molasses is a viscous product that is used to sweeten foods. This alcohol has a characteristic sugarcane smell, taste, clear color and has some impurities (Sasma ,n.d.).



Figure 12: Cachaca Alcoholic Beverage

4.4 Items based on Sugar Cane

The main products that can be produced from it on commercial scale are ethyl alcohol, citric acid, lactic acid, cattle feed, oxalic acid, baker's yeast, monosodium glutamate, torula yeast, lysine, acetone-butanol-alcohol (DAWN, n.d.). The Ethyl Alcohol is used as a fuel, where the alcohol is “blended” in to the gasoline, also is used in the medicine area as an antiseptic or disinfectant (Extractohol, n.d). The citric acid uses are for a house cleaners, for cosmetics, and for natural things. For the cows in some places they use the sugarcane so that they can eat in a safe way.

4.4 Medicinal and Traditional Uses

4.4.1 Medicinal Uses

Sugarcane has benefits for the people in a healthy way; there are many ways that would help the person get better in their life. The sugarcane can help the people by reducing the chance of getting diabetes, because the extract from the cane is better than prosed sugarcane. This plant would help fight off the common cold or flu, the juice from the cane would help cure the ache from the throat. This plant would help get stronger the organ health, has some supply in energy numerous of significant internal organs. This sugarcane is beneficial for cancer patients because is highly with phosphorus, calcium, iron, magnesium and potassium, which are some important things to beat cancer cells. This also is helps the by being an instant source of energy, also it helps with the decrease in urinary problems (Health Benefits, 2006)

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