Organic Farming in the Tropics and Subtropics

Exemplary Description of 20 Crops

Sugarcane

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Franz Augstburger, Jörn Berger, Udo Censkowsky,
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The cultivation guidelines are available in English, Spanish and German for the following crops:

banana, brazil nut, cashew nut, cocoa, coconut, coffee,
cotton, hibiscus, macadamia, mango, papaya, peanut,
pepper, pineapple, sugar cane, sesame, tea, vanilla.

The cultivation guidelines for Bananas, Mangoes, Pineapples and Pepper were revised in 2001 for the United Nations Conference on Trade and Development (UNCTAD) by Udo Censkowsky and Friederike Höngen.

In 2002 two more guidelines, for rice and date palms, were published in English.

Furthermore the authors kindly call upon for critical remarks, additions and other important information to be forwarded to the address below. The cultivation guidelines will be updated regularly by Naturland e.V.

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Organic cultivation of sugar cane

1. Introduction

1.1. Botany

Genetically, sugar cane *(Saccharum officinarum)* originates from New Guinea. The plant belongs to the Gramineae (grasses) family. Sugar cane is a C4 plant with a high rate of photosynthesis (its rate lies around 150-200% above the average for other plants). It is a perennial crop with a high self-tolerance. The plant tillers 4-12 stems, depending on the variety and site conditions, which can grow to between 3 and 5 metres in height. The sugar content (saccharose) fluctuates between 11% and 16%.

1.2. Varieties and countries of origin

Sugar cane only rarely produces seeds capable of germination. Most of the several hundred usable clones are cross-fertilisations between *S. officinarum* (high sugar content), *S.sinensis* (adaptable), *S. spontaneum* and *S. robustum* (disease resistant). The most common clones are octaploid, and are propagated vegetatively.
The production of cane sugar for home consumption on small farms is wide-spread in many regions of Asia and Latin America. Large scale cultivation of sugar cane, though, is only possible in combination with commercial or industrial processing. The most important producing countries of organic cane sugar are currently Brazil, Paraguay, Philippines, USA, Mauritius and the Dominican Republic.

1.3. Uses and contents

Sugar cane is chewed in all of the producing countries because of its sweet cell juice. Sugar cane juice is obtained by pressing the sugar canes, and is mostly used to sweeten foodstuffs, but can also be consumed as fresh or fermented juice. Processing into thickened sugar cane juice, into raw sugar cane or into whole cane sugar is described in chapter 3. White sugar from organic cultivations is only rarely available on the market.
Many producers also offer molasses (thickened sugar cane juice) and alcohol (a by-product of sugar processing) in organic quality. Organic alcohol is used in the manufacture of cosmetic and pharmaceutical products.
The following provides a brief description of the two most important processed forms of sugar cane:

Thickened and spontaneously crystallised sugar cane syrup
This is usually produced by small industrial plants. The crystals are irregular and amorphous. The product quality and trade names vary according to their country of origin (Rapadura, Mascobado, Panela, Chancaca). The product has a brown colour and tastes more or less strongly of caramel or sugar cane, making it only of limited value as a sweetener for foodstuffs and drinks (see also 3.1.).

Centrifuged and crystallised sugar
Is manufactured in industrial sugar mills. Crystallized sugar has well-defined crystals and a grey-brown or "dirty white" colour. This type of sugar contains no taste of its own, and is therefore especially suited to sweeten/preserve processed foods (see also 3.2.).

1.4. Social aspects of sugar cane cultivation

Due to its very size, the commercial sugar industry has a considerable demand for labour. The risk of unreasonable social treatment is especially high among seasonal and casual labourers. For this reason, in addition to satisfying organic standards, care should be taken to provide at least the minimum requirements for these workers, as set out in the IFOAM Basic Standards. The complex low-price politics of the international global market hinder these objectives considerably.

1.5. Important aspects of processing sugar cane

Large-scale sugar cane cultivation is closely tied to processing in an industrial sugar mill. In the Dominican Republic, for example, a few large sugar mills dominate processing. Separate processing of organically cultivated sugar is not possible there, or, is laden with substantial organisational problems that serve to seriously hamper the proliferation of organic sugar cane cultivation. In Paraguay, contrastingly, an organic sugar industry was able to rapidly develop, because older and smaller sugar mills in relatively good condition became available to process the organically cultivated sugar cane. In Brazil, large farming combines have constructed their own sugar mills to specifically process organic crops.

2. Aspects of cultivation

Organic sugar cane is mostly cultivated on small farms of 0.1-3 ha. The work is carried out manually, or with the help of animals. Only ripe sugar cane is cut down during the harvest. Cut off leaves and unripe plants are left on the plot. In this way, the field is never cleared, and soil is constantly covered by a thick layer of mulch. Such systems make sustainable cultivation of sugar cane possible, also on relatively sloping ground.

2.1. Site requirements

Sugar cane is a very adaptable crop that is grown between latitude 37° North and latitude 31° South. Good site conditions are necessary for successful organic cultivation. Under natural conditions, the plant seeks its place in an eco-system amongst the canopy, and therefore needs to reach above the additional crops. Relatively wet conditions on organic cultivation systems tend to cause more difficulties than do sites that are too dry. This due to a more involved mechanical tilling of weeds, and also to the difficulties the shoots have in developing.
Ideal site conditions are met with average temperatures of 20-28ºC and little fluctuation between night and day. The ideal amount of rainfall is around 1700 mm, whereby a drought occurring during harvesting is perfect. The soil should be deep, humus-rich, well-aerated and drained.

2.2. Seeds and seedlings

In principle, recommended varieties for organic sugar cane cultivation are those that have proven themselves under the prevalent climatic conditions on site. Sugar cane is an intensely bred crop. Varieties are available that are resistant against the most important pests and diseases.
Brazilian breeders have developed varieties for the alcohol industry (alcohol as a substitute for petrol) that require practically no N-fertiliser. A variety is generally available for every kind of processing. For instance, there are special late-ripening varieties, special early-ripening varieties, varieties that lose their leaves, varieties particularly suited to be processed into Rapadura or Panela, and many more besides.
As long as these varieties do not stem from gen-manipulated material, they can also be used for the special requirements of organic sugar cane cultivations.
Seedlings must come from organic nursery fields (own, or from specialised institutes). In contrast to perennial field cultivation of sugar cane, the nursery fields need to undertake a strict regimen of crop rotation, in order to prevent infestation by soil-borne diseases and pests, such as, e.g., nematodes, sugar cane smut *(Ustilago scitaminea)* and Red rot *(Glomerela tucumanensis)*.
Moreover, in problem cases, treatment of the seedlings with hot water can be effective. Sugar cane smut *(Ustilago scitaminea)*, the pineapple disease (*Ceratocystis paradoxa*) and nematodes can be successfully counteracted with a 20-30 minute hot water treatment at 52°C, although this temperature may not be exceeded.
Seedlings are taken from unripe sugar cane, whereby the cane is cut into 30 cm pieces. The use of seedlings stemming from conventional nurseries which have been treated with chemical dressing preparations (mercury, Benomyl etc) is not permitted.

2.3. Planting methods

2.3.1. Establishment of new crops

The seedlings are planted in rows in pre-prepared furrows (furrow depth ca. 40 cm). On conventional sugar cane cultivations, the average distance between the rows is 150 cm (120 cm - 180 cm). On organic sugar cane cultivations, the best results have been achieved with double rows (40-50 cm gap between two single rows and 110-180 cm distance to the next double row). It is necessary to plant legumes on newly developing organic plantations.

In general, the distances between the rows should take into account the special requirements of organic sugar cane cultivation, the irrigation infrastructure which may be present and the degree of mechanisation.

Every new plantation should be fertilized with organic material. The organic fertiliser must be well-rotted, so that no fires can be caused by it. It should be spread as near to the plants as possible, so that any nutrients released are immediately available to the plants' roots.

The broad middle gap between the rows of new plantations is for the sowing of legumes. On farms with enough labour available for the manual harvest, these can be beans (*Phaseolus vulgaris* in drier, and *Vigna spp.* in wetter regions), which, in addition to supplying nitrogen, are also an important source of food, and therefore useful to the economics of the plantation. Care must be taken during the bean harvest to leave the entire foliage of the bean plants in the middle row. Sugar cane will then be planted in precisely this row during the next season.

Cultivation example of 10 years in stages

The following is an example of how an organic sugar cane plantation could be cultivated.

If the straw is not be cut up, then the following figures should be applied to every second row, whilst the straw is left in the other row as mulch where a cultivator cannot be used. The mulched row is swapped over each year.

New plantation	1. stage	2. stage	3. stage	4. stage	5. stage	6. stage	7. stage	8. stage	9. stage
Digging in of old crop; green manure; organic fertiliser for new crop; beans sown between rows	harvest beans; cultivator	cultivator organ. fertiliser manual tilling of weeds in rows	cultivator sowing of legumes cultivator	cultivator organ. fertiliser manual tilling of weeds in rows	cultivator sowing of legumes cultivator	cultivator organ. fertiliser manual tilling of weeds in rows	cultivator sowing of legumes cultivator	cultivator manual tilling of weeds in rows	Direct sowing of a rapid-growing legume to suppress growth of sugar cane and weeds

2.4. Diversification strategies

Agricultural system

The transport distance from the field to the sugar factory is decisive to the profitability of a sugar cane cultivation. For this reason, the lands surrounding a sugar factory are usually dominated by sugar cane fields. Crop rotation is rarely practised.

Because it is self-tolerant, it is also possible on organic sugar cane cultivations to keep the plant as the main crop, on the same field, over longer periods of time, as in the above example (see also 2.3.1.). Depending on the intensity of use, a plantation is renewed after 6-12 stages (years).

Some organic sugar cane producers only possess relatively small fields, which are also interspersed with other crops, secondary forests and meadows. Yet these are the exception. It is therefore important, during the transformation into an organic sugar cane cultivation, to establish ecologically diversified areas (groups of trees, bushes etc.) and wind protection hedges on the predominantly monotone sugar cane monocultures. Less productive fields and corners which are difficult to cultivate etc. should be used as for improving the agro-ecosystem, and planted with connecting, diverse hedges. They should be set out so that the sugar cane fields themselves can nonetheless be cultivated mechanically, yet still be inter-connected. It is important that these ecological compensatory tracts are also useful, in that they provide fuel (eventually an important source of energy for the sugar factory), constructing materials or fruits. Owing to the compensatory tracts, an organic sugar cane cultivation region will also differ optically from a region of conventional monocultures.

2.5. Supplying nutrients and organic fertilisation management

2.5.1. Nutrient requirements

On organic sugar cane cultivations, it makes no sense to strive for maximum yields of 200 t or more of foliage per ha. Depending on the site, an organic sugar cane plot can deliver optimum yields of between 45 t and 120 t of foliage. When calculating the nutrient balance, it is important to bear in mind that large amounts of harvest residues remain in the fields. If the cane is to processed into Rapadura or Panela, around 25% of the foliage is left in the field, because a relatively long portion of the sugar cane shoots cannot be utilised. When cristallized sugar is being produced, around 20% of the total amount of foliage remains in the field.
This results in the following average extraction and mulch amounts for the most important plant nutrients (depending on the site):

Nutrient extraction and residue per 100 t sugar cane / ha and stage in kg:

kg / ha	N	P_2O_5	K_2O	CaO	MgO	S
Extraction	75	40	180	36	20	80
Remain as mulch	35	31	110	21	18	35

When the correct variety is chosen, and with a legume variety that is easy to combine, a good 80% of the N-requirements can be produced within the cultivation system. Sugar cane possesses efficient endo-mycorrhizae which can supply an additional source of phosphorous. Free-living N_2-bacteria in the rhizosphere can provide an additional supply of nitrogen. The use of organic fertiliser should not be for more than 20% of requirements. The supply of potassium and other nutrients must be established by mobilising soil reserves and the application of organic fertiliser.
It is best when the sugar cane fibres (bagasse) and other sugar processing by-products (especially the ash) are composted near to the sugar factory. Sugar cane bagasse has a C/N ratio of around 150, and therefore needs a source of nitrogen to be composted. As a rule, chicken or cattle dung is used. Hereby, it is essential that the dung does not come from conventional large-scale livestock farming. The ash resulting from the burning of bagasse should also be composted. Additions of rock phosphates, sulphur and ripe compost have proven their worth as starters. Under certain circumstances, it may make sense to infect the compost subsoil with non-symbiotic N-fixers.
If the demand for potassium, magnesium and sulphur cannot be met using the measures mentioned above, application of magnesium bearing potassium sulphate (e.g. langbeinite) or magnesium sulphate (e.g. kieserite) may be beneficial. Any additional fertilisers may only be used after being approved by certification body.

2.5.2. Crop rotation

The ideal method is to cultivate sugar cane in a crop rotation system, yet for economical reasons, this is often difficult. Therefore, the good self-tolerance of sugar cane, the planting of legumes, the creation of sufficient compensatory tracts and niches, as well as a comprehensive fertilisation management system all have to help replace a lack of crop rotation on organic cultivations.

Green manure plants in existing sugar cane crops:
On older plantations, a covering layer of legumes can quickly be achieved by sowing directly after the harvest. The seeds and re-growing sugar cane will form a compact, green mass that can be lightly worked into the soil after 3 months, before the seed bed is prepared for the new sugar cane. At sites with a strong growth of weeds, it may be worthwhile planting a second type of rapid-developing green manure plant. If no machines are available to sow directly, then it may help to break over the sugar cane and subsequently apply one or two sowings of green manure plants.
The green manure plants should be competitive, and able to suppress any weeds that may appear. They should be non-climbing varieties, as these would be detrimental to the sugar cane cultivation.

Sowing legumes in the middle rows:
The gaps between rows and mechanisation should be adapted to each-other so that directly following the harvest, rapid-growing legumes can be sown in the in-between rows. These will die off after the sugar canes has appeared.

Species	Suitable for	Notes
Mucuna deeringiana (Florida velvet bean)	Sown in old sugar cane before breaking over; green manure; sow between rows	Early ripener, blossoms after 80 days. Does not entwines itself in sugar cane
Mucuna pruriens (velvet bean)	Sown in old sugar cane before breaking over; green manure	Creates very large amount of biomass, rapid growth, slow at ripening. Only recommended when seed formation can be effectively avoided, as plant creeps around the sugar cane
Crotollaria breviflora	green manure and sow between rows	Fastest growing among the crotolarias; still needs around 100 days to blossoming; produces little standing crop
Calopogonium muconoides (Calopo)	Sown in old sugar cane before breaking over; green manure at wet and hot sites	Very slow early development, produces compact soil-coverage with large amount of biomass
Flemingia congesta	green manure	slow early development; good production of biomass, high proportion

		of lignin and therefore suited to long-term creation of humus
Canavalia ensiformis (Jackbean)	green manure Few sown between rows	slow early development; good biomass production ; good suppression of grasses; suitable as pig fodder;
Centrocema pubescens (Centro)	Sowing between rows on very hot and wet sites	Little experience in sugar cane cultivation.

2.5.3. Burning off and mulching

A 'green harvest' of sugar canes, whereby the cane is harvested without burning-off is practised in some sugar cane cultivation regions. Due to internal saccharose decomposing processes, sugar cane must be processed relatively quickly after harvesting. Due to a shortage of labour following the second world war, a method began, first in Australia and Hawaii, and then in many other sugar cane cultivation regions, to practice a controlled burning-off of the sugar cane fields. Before the actual harvest, the foliage of the sugar canes is set alight. Quite often, the sugar cane is again burned down after the harvest, in order to make the field easier to work.

Advocates of burning-off argue that:

- An increase in efficiency of sugar cane cutting of around 30% (the work is usually carried out by casual labourers at piece rates).
- Non-burnt sugar cane contains more foreign substances, making sugar processing less efficient.
- Working the soil is not hampered by the mulch layer.
- The mulch layer hinders the shoots, especially in wet climates.
- Pests and diseases are destroyed by the fire.
- Nutrients in the ash are made easily available.

Organic sugar cane cultivation consciously rejects the burning-off method in favour of a "green harvest" for the following reasons:

- The sugar cane biomass remaining after harvesting is the basis for long-term sugar cane cultivation.
- Mulch encourages N-fixing, from independent and symbiotic N-fixers.
- Mulch suppresses unwanted growth.
- In combination with the measures outlined above, this method serves to improve the humus content and die structure of the soil.
- High nutrient and energy loss is caused by carbon and nitrogen compound gases escaping.

- There is no danger that the fire can get out of control and destroy whole crops and/or forests (in the meantime, burning-off has been forbidden for environmental reasons in some producing countries).

Various methods are necessary to ensure that the requisite maintenance tasks can be performed, in spite of the large amounts of sugar cane straw lying on the ground:

- When few weeds are present, spreading the straw across the ground will make mechanical tilling unnecessary.
- The straw should be laid in an in-between row, whilst the next row is worked.
- The straw should be piled up, and cut up with a field hacker. Despite the energy requirements, this has several advantages:

⇒ No hindrance of soil working and weed tilling,
⇒ The cut up straw can be evenly spread as mulch, thereby helping to suppress weed growth,
⇒ Sowing within the middle rows possible
⇒ The cut up mulch material can be rapidly decomposed, the nutrients made available for the sugar cane.

In order to decompose the straw, the micro-organisms require nitrogen which they extract from the soil. Therefore, during the limited time decomposition of the mulch layer takes place, a certain competition develops between the sugar cane plants and the layer of mulch for the available nitrogen. When a level of decomposition has been reached, the rivalry ceases, and the mineralised nutrients from the mulch are made available to the sugar cane. The following measures are useful in keeping the competition short and at a low level:

⇒ Cut up the straw,
⇒ Mix the straw with a small amount of chicken or cattle dung,
⇒ If this is not possible, work the straw into the soil.

2.6. Biological methods of plant protection

Diseases and pests

Under unfavourable conditions, sugar cane can become infested by a variety of diseases and pests. The following offers a list of causes:

- Unsuitable site (too warm, too wet, water-logging, too dry)
- Soil compression, caused by incorrect use of heavy machinery
- Insufficient or no levelling and drainage of soil
- Degenerated and poor soil; lack of organic material
- Plants too close together

Effective cures often involve improvements to the whole system, providing the site is at all suitable for the crop.

Varieties are available that are resistant against the most important diseases and pests. Nevertheless, plants may be difficult to obtain, and also to test within a short enough space of time whether the variety is suitable.
The usefulness of employing prophylactic measures when creating seedlings was mentioned in chapter 2.2.. Past experiences on organic sugar cane cultivations have shown that diseases and pests only play a subordinate role. Stem borer sometimes appear in the Dominican Republic, yet these can be easily controlled with the egg parasites trichogramma. In the Philippines, solitary cases of sugar cane smuts also occur.

The following is a list of the most important diseases and pests on sugar cane cultivations:

Disease / germ	**Appearance / symptoms**	**Possible measures**
sugar cane smut (*Ustilago scitaminea*)	Whip-like, branch-less shoots on the plant tip, adorned with black spores	Treat seedlings with hot water; strict crop rotation in nurseries/ nursery beds; choose suitable varieties!
Root rot (*Pythium arrhenomanes* also pythium-types)	On heavy, insufficiently drained soil; during cool, wet weather / growth and tillering delayed; sometimes die off	Practice crop rotation; strict crop rotation in nurseries/ nursery beds; Treat seedlings with hot water; choose suitable varieties
sugarcane red rot (*Glomerella tucumanensis*)	in all production regions; wilting and rapid drying out	Practice crop rotation; strict crop rotation in nurseries/ nursery beds;
Viruses		
Fiji-disease (sugar cane Fiji disease virus, SFDV)	Growth hindering, discolours leaves, forming of plant gall on underside of leaves; transmission by seedlings and vector: *Perkinsiella saccharicida* (cicadas)	Treat seedlings with hot water (52°C, 20 Min.); encourage natural antagonists of cicada hosts;

Animal pests		
Various stem borer e.g. Moth borer (*Diatrea saccharalis*) *Chilo sacchariphagus* *Scirpophaga nivella*	 Entire American region South-east Asia Asia	encourage natural antagonists; artificial introduction of parasites/ antagonists, such as the Cuba fly (Lixophaga diatraeae) against the moth borer or use biolog. Egg parasites of the genus trichogramma against the group of stem borers (also for caterpillar parasites such as *Descampsina sesamiae*; fungus parasites such as *Metarhizium anisopliae* and *Beauveria bassiana)*

2.7. Crop monitoring and maintenance

2.7.1. Weed management

On organic sugar cane cultivations, weeds are mainly controlled by the following factors:

- By the competitiveness of the sugar cane itself;
- By the large amount of foliage left out in the field after harvesting;
- By sowing in the in-between rows;
- Through mechanical equipment pulled either by machine or animal;
- Through manual intervention;
- Although burning is possible, it makes little sense, and is only practicable on new cultivations, because during growth, the mulch material can easily catch fire and there is also a great loss of organic substances.

During the conversion period, problem grasses such as *Penisetum spp , Cyperus rotundus* or climbers which attach themselves to the sugar cane may appear. The grasses can be suppressed by sowing legumes. In the case of climbers, a partial clearing may be necessary by hand after the in-between rows have been cultivated.
Not many mechanical devices exist on the market to help till weeds on sugar cane plantations. More usually, old, heavy and imprecise equipment is used. Yet equipment intended for use on maize cultivations can relatively easily be converted to the conditions prevalent for sugar cane. Animal traction is especially useful for wet soils. There is a good chance that new, ultra-light, machines especially designed for tilling and sowing will soon appear on the market.

2.8. Harvest and post harvest treatment

Harvesting begins when the leaves turn yellow (or when the optimum sugar content of 15% has been reached, that can be tested in the field with a refractometer). Very different kinds of techniques are used for organic sugar cane depending on the country and local conditions, (from automated combine harvesters, to cutting by hand and transport via ox and cart). Sugar cane is still widely cut by hand (machete), whereby the stem is cut down close to the soil. The cane tip and leaves are then also cut away.

When using heavy machinery (loading, driving through sugar cane fields with trucks or ox and carts), care must be taken that the soil is not wet. Otherwise, in spite of between-row sowing and a mulching layer, measures which should make it easier to drive on the ground, long-term damage can be done to the soil structure (compressing etc.).

Transport distances and costs should be rationalised as far as possible. The transport vehicles should be arranged so that they can transport sugar cane to the plant, and organic fertiliser on the return journey.

3. Product specifications

3.1. Rapadura, Panela

Thickened and spontaneously crystallised sugar cane juice

Organic products of this kind are processed in small commercial or industrial plants. Sugar cane fibres (bagasse) and additional wood are burned to supply the requisite energy. Lime is used to regulate the pH-value of the sugar cane juice, and bark extracts from *Guazuma ulmifolia*[1] to take out foreign particles.

3.2. Crystallized sugar

Centrifuged and crystallised sugar

Industrial plants are required to manufacture this product. In order to be suitable for processing, organic sugar must fulfil the following minimal requirements:

- The cultivation must have an adequate eco-balance. In addition, an ISO 14000 certificate should be striven for.
- Part of an overall concept for organic sugar production, including keeping transport distances for sugar cane and organic manure as short as possible, never more than 30 km.
- It is worth working towards having a plant which exclusively processes organic sugar cane. If this is not possible, then the plant must be able to process only

[1] Application of this processing aid has to be approved by the certification body.

organic sugar cane for a limited period (a few weeks). All main and by-products must be able to be separately stored and processed.

- Well-equipped plants use up around 35% of the bagasse in generating sufficient energy for the process. The rest of the bagasse must be composted along with the ash and other by-products and brought back to be spread over the fields.
- Clean water must be used if the sugar cane is to be washed, and adequate provision made to dispose of the waste water.
- The sugar canes needs to be cut up mechanically, enzymatic processes can only be utilised when there is a guarantee that no genetically modified organisms have been used.
- The extraction of sugar cane juice must also be performed mechanically, only water or the sugar cane juice itself may be used.
- The sugar cane juice should be cleaned by decanting, filtration and centrifuging. Calcium carbonate can be used to regulate the pH value, and carbon dioxide and calcium sulphate used as coagulating agents in precipitation. The use of sulphuric acid in sugar processing is allowed for export to Europe, yet not for the USA.
- The juices are concentrated by heating them in a vacuum, and crystallised in a centrifuge. Only organic sugar shall be used to induce crystallisation.
- To prevent infections occurring in the plants, they are cleaned with water and steam, yet acidic and alkaline cleansers can be used alternately, as well.

3.3. Whole cane sugar

3.3.1. Processing

The stems of the sugar cane plant, up to 5 cm thick, are filled with a thick sugary juice with a sugar content of 8-16%. Most of the sugar cane is processed into refined sugar. Because whole cane sugar is of greater importance to the organic food sector than refined sugar, the following supplies a description of the phases involved in traditional manufacturing methods for whole cane sugar:

- **Extracting the juices from the fibre cells**

The sugar cane stems, free of leaves, are cleaned, cut up and crushed and squeezed out several times between shredders. Generally, the sugar canes should be processed within 24-48 hours of being harvested to prevent loss of quality. The fibrous remains (bagasse) are usually used as fuel. The resulting sugar juice is filtered to rid it of fibres and foreign particles, and then collected in a container to be stored for a short while. A teaspoon of lime is added to 300-500 l of juice in order to bind any sediments and fruit acid in the sugar cane juice. This clarifies the juice, and particles bound by the lime can be skimmed off.

- **Skimming off unwanted particles in the juice**

The particles need to be removed to achieve good crystallisation of the sugar juice, whereby a row of pans is set up over a supply of hot air. The squeezed and dried sugar cane (bagasse) can be used as for burning here, and makes up around 80% of the fuel required. The foam created during the process, and particles floating on the surface, should be continually skimmed off.

- **Thickening the juice**

After a 4-hour thickening process, the sugar juice will have reached a syrupy consistency.

- **Crystallisation of the sugar syrup**

The syrup is poured into flat wooden tubs, partially lined with metal sheeting, where crystals begin to form in the sugar after only a few minutes. As it cools down, the sugar is vigorously stirred with scrapers and stirrers for a good 30 minutes. The longer and more vigorously the sugar is stirred, the finer will be the crystals produced.

- **Grinding the sugar crystals and packing**

The crystallised, cooled and dried whole cane sugar is finely ground and then packaged into units of 500 g to 10 kg.

3.3.2. Quality requirements

The following is a list of quality characteristics with minimum and maximum values for whole cane sugar, that are usually required officially or by importers. Different minimum and maximum values can be agreed between importers and exporters, providing these do not clash with official regulations.

Quality characteristics	Minimum and maximum values
Taste and smell	Variety-specific, light caramel taste, not fermented, not mouldy
Purity	Free of foreign particles such as sand, soil, plant fibres, insects etc
Water content	max. 2.5%
a_w-value	0.65%
Residues	
Pesticide	Not measurable
Bromide	Not measurable
Ethylene oxide	Not measurable
Mycotoxins	
Aflatoxin B1	max. 2 µg/kg
Total aflatoxins B1, B2, G1, G2	max. 4 µg/kg

The **‘National Soft Drink Association’** has published the following list of micro-biological criteria/guidelines for crystalline sugar (‘Bottler's-Test’), which could be used as orientation for whole cane sugar:

Micro organisms	Guidelines
Number of aerobe mesophile germs	max. 200 KBE° in 10 g sugar
Yeast and mould fungi	max. 10 KBE° in 10 g sugar

° KBE = Koloniebildende Einheiten (Colony-forming units)

In addition, the **‘National Canner's Association’** has published the following list of micro-biological criteria/guidelines for crystalline sugar (‘Canner's -Test’):

Micro organisms	Guidelines
Total no. of thermophile spore formers	A maximum of 150 spore formers are allowed in 5 samples, and on average, not more than 125 spore formers in 10 g sugar.
Spores of thermophile bacilli with acid formation	Of 5 samples, the maximum value must be under 75 KBE ° in 10 g sugar, and on average a maximum of 50 KBE° in 10 g sugar.
Thermophile sulphite reducing clostridia spores	Of 5 samples, a maximum of 2 may be positive. The content must be under 5 KBE° in 10 g sugar.

° KBE = Koloniebildende Einheiten (Colony-forming units)

In order that the quality requirements are upheld, and no contamination of the whole cane sugar occurs, preparation should take place under clean, hygienic and ideal conditions. The following aspects should be adhered to:

- Equipment (tubs, knives etc.), as well as working and drying surfaces (racks, mats etc.) and preparing and storage rooms, should be cleaned regularly.
- Personnel should be healthy, and have the possibility to wash themselves, or at least their hands (washrooms, toilets) and wear clean, washable overgarnments.
- Water used for cleansing purposes must be free from faeces and other contaminants.
- Animals or animal faeces must not come into contact with the product.

3.3.3. Packaging and storage

Bulk packaging

Whole cane sugar is usually bulk-packaged in order to be exported to Europe, in shrink packages made of steam-impermeable, sealable foil (e.g. polyethylene, polypropylene) in units of 10, 20 or 25 kg. Before the foils are sealed, a vacuum is generally created (vacuum packing).

Details given on packaging

If the whole cane sugar are packed directly for consumers, then the following details must be included on the outside of the packets:

- **Product name ('Brand name')**

The name of the product with the addition of 'from organic cultivation'[2]

- **Manufacturer**

Name and address of the manufacturer, importer, exporter or trader within the country of origin, and which country.

- **List of contents**

A list of ingredients and additions, beginning with the heaviest proportion of total weight at the time of packaging.

- **Weight**

Details of the total packed weight in grams

The numbers describing the weight of the contents must be of the following sizes

Weight of contents	Letter size
Less than 50 g	2 mm
More than 50 g to 200 g	3 mm
More than 200 g to 1000 g	4 mm
More than 1000 g	6 mm

- **Best before date**

The 'Best before ...' details must include day, month and year; e.g.. best before 30.11.2001

- **Batch number**

Consumer packages

If the whole cane sugar is not to be bulk-packed in the producing country, but instead packed into consumer packaging, then the product packaging should fulfil the following functions:

[2] When products from organic farms are being declared as such, it is necessary to adhere to the requisite government regulations of the importing country. Information concerning this is available from the appropriate certification body. The regulation (EEC) 2092/91 is applicable to organic products being imported into Europe.

- Protect it from loss of aroma and against undesirable smells and tastes from its surroundings (aroma protection).
- Offer sufficient conservation properties, especially against loss or gain of moisture.
- Provide a surface area for advertising and product information.
- Provide easy, re-sealable access, so that the whole cane sugar remaining in the packaging stays fresh and dry.

The following materials can be used for **product packaging**:

- Paper bags with/without transparent windows made of polyethylene or polypropylene
- Cardboard box lined with polyethylene or polypropylene
- Single layer plastic bag (polyethylene or polypropylene)

Aspects regarding transport packaging

- Transport packaging made, for example, out of cardboard, should be strong enough to protect the contents against being damaged by outside pressure.
- The packaging should be dimensioned to allow the contents to be held firmly, but not too tightly in place.
- The dimensions should be compatible with standard pallet and container dimensions.

Information printed on transport packaging

The transport packaging should display details of the following:

- Name and address of the manufacturer/packer and country of origin
- Description of the product and its quality class
- Year harvested
- Net weight, number
- Batch number
- Destination, with the trader's/importer's address
- Visible indication of the organic origin of the product[3]

Storage

Because whole cane sugar is very hygroscopic (draws water), it should be stored air-tight in a dry place. When the product is incorrectly stored, yeasts may begin a fermentation process. Under ideal storage conditions (dry, dark and no smells), whole cane sugar can be stored for 12-18 months.

[3] Organic products must be protected from contamination by non-compliant substances at each stage in the process, i.e. processing, packaging, shipping. Therefore, products originating from a certified organic farm must be recognisably declared as such.