Fruit and Vegetable Processing

Basics of F&V Processing for Cigar Box Specialists

Learning objectives

Knowledge of 6 categories of processed F&V. Able to explain basic production steps in processing F&V. Able to identify bottlenecks in production process. Able to identify key cost indicators and deviations from industry benchmarks.

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GENERAL ACRONYMS / DEFINITIONS

Abbreviation	Meaning	Comments
AJC	Apple Juice Concentrate	HS-Code 2009.70.0020
Autoclave	Autoclave	Equipment to pasteurize or sterilize products with steam under high pressure.
BRC	British Retail Consortium	In 1998 the BRC, responding to industry needs, developed and introduced the BRC Food Technical Standard to be used to evaluate manufacturers of retailers own brand food products. See www.brc.org.uk/
Bx; Brix	Breaking Index	Percentage of soluble solids in a solution (say sugar % in mango juice); Brix is measured with a Refractometer. In F&V processing 'Brix' usually refers to the sugar contents.
CA / ULO	Controlled Atmosphere Ultra-low oxygen	After the harvest, many vegetables and fruits are preserved for long periods under CA or ULO conditions. This enables the products to be supplied throughout the year whilst the quality is maintained. Through CA/ULO application, the physiological processes in the stored product are retarded/inhibited which extends the shelf life. The required preserving conditions are realised by creating an atmosphere with an increased CO2 (carbon dioxide), a reduced O2 (oxygen) concentration and a product focused temperature/humidity. By storing your products within this atmosphere, you can control the ripening process. See www.besseling-group.com/caulo.htm
CIP	Cleaning in place	CIP is a technique from process technology used to clean parts of a factory without the need to dismantle. This technique is used commonly in the food processing industry.
EUREPGAP		EurepGAP is a private sector body that sets voluntary standards for the certification of agricultural products around the globe. See www.eurepgap.org
HACCPS	Hazard Analysis Critical Control Point System	HACCPS is a systematic preventive approach to food safety and pharmaceutical safety that addresses physical, chemical, and biological hazards as a means of prevention rather than finished product inspection. HACCP is used in the food industry to identify potential food safety hazards, so that key actions, known as Critical Control Points (CCP's) can be taken to reduce or eliminate the risk of the hazards being realized. The system is used at all stages of food production and preparation processes including packaging, distribution.
Hot fill	Method of filling at high temperature.	Food industry term used when containers are filled at process temperature, hot, to ensure continued sterility of the container and product during and after the fill process. See: http://www.barry-wehmiller-company.com/content/menus/bwb/Glossary.aspx
HS code	Harmonized System Code	See Appendix C, Statistical Information about Fruits and Vegetables and http://www.vassl.com/data/01-24.txt
IQF	Individually quick frozen	Fruits, berries, pieces of vegetables are transported over a belt at minus 50-60^{o}C; within minutes the temperature inside the product drops to minus 20^{o}C.
ISO 22000		ISO 22000 is a standard developed by ISO dealing with food safety. It integrates ISO 9001 and HACCPS.
ISO 9001		ISO 9000 is a family of standards for quality management systems. ISO 9000 is maintained by the International Organization for Standardization and is administered by accreditation and certification bodies.
SIG		The brand name of the aseptic carton sold for CombiBloc (juice) packing machines.
Tetrapak		The brand name of the aseptic carton sold for Tetrapak/Alfa-Laval (juice) packing machines.

CIGAR BOX ACRONYMS / DEFINITIONS

Abbreviation	Meaning	Comments
CB	Cigar Box	A spreadsheet based cost price calculation system with 5 modules.
CB1	Cost price analysis	Cost price and profit for one SKU in one year.
CB2	Portfolio analysis	Cost price and profit for the entire portfolio in one year.
CB3	Operational monitoring	Cost price of all SKU's every day of production.
CB4	Investment analysis	Analysis of an investment over 6 year period.
CB5	Value chain analysis	Cost price and profit for an entire value chain in one year.
CB6	Customer satisfaction analysis	Measurement system based on Quality, Price, Service, and Reputation.
FC	Fixed cost	Cost which are not influenced by the volume produced
FC1	Fixed cost 1	Cost of depreciation
FC2	Fixed cost 2	Cost of interest
FC3	Fixed cost 3	Overhead costs
FC4	Fixed cost 4	Cost of sales and marketing
FTE	Full time equivalent	2 people working 50% of the time = 1 FTE
Global Facts	Owner of Cigar Box	For more information visit www.globalfact.nl
P	Price	1. Sales price or purchase price 2. CB6 parameter that measures customers' satisfaction with the purchase price of a product.
P(FOB), P(DAF), C&F, DDU, DDP	Price, Inco term	http://www.iccwbo.org/incoterms/id3040/index.html
P(EXW),	Price Ex Works	Sales price used in CB1 calculations
q	Quantity	
Q	Quality	CB6 parameter that measures customers' satisfaction with the perceived quality of a product.
PR	Processing ratio	Kilo of input required for 1 kg of output
VC	Variable cost	Cost that fluctuate with the volume produced
VC1	Variable cost 1	Cost of raw materials and ingredients
VC2	Variable cost 2	Cost of transforming raw material into a finished product
VC3	Variable cost 3	Cost of packaging
VC4	Variable cost 4	Cost of delivery
R	Reputation	CB6 parameter that measures customers' satisfaction with the perceived reputation of the brand and promises that the manufacturers of a product make.
RM	Raw Material	Not an official abbreviation, but just in the Cigar Box
S	Service	CB6 parameter that measures customers' satisfaction with the perceived service level with which the product is delivered.
SKU	Shelve keeping unit Stock keeping unit	All articles sold. E.g. peach jam in 200ml and 500ml are two different SKU's, although the jam is identical.
VAT	Value Added Tax	

1 Background on Production and Processing

1.1 Different types of fruits and vegetables

The term '*fruit and vegetables*' covers all edible horticultural products. Fruits and vegetables are highly adaptable to climate and soil conditions but the types of produce and yields will vary greatly because of these conditions. Because of its perishability, the geographical location of planted areas in relation to markets, processing units, and consumers is more important than with other crops.

Maintaining post-harvest quality of fruits and vegetables is the essence of processing.

Table 1 - Difference between Fruits and Vegetables

Botanic cycle	Carrier	Kernel	Biological name	Common name	Examples
perennial	tree	seed	Seed fruit	fruit	apple, pear, cashew
perennial	tree	stone	Stone fruit	fruit	mango, peach, cherry
perennial	bush	seed	Seed fruit	berry	strawberry, raspberry
annual	fruit	seed	Vegetable	fruit	tomato, squash
annual	flower		Vegetable	vegetable	broccoli
annual	leaf		Vegetable	vegetable	cabbage, spinach
annual	stem		Vegetable		onion
annual	root		Vegetable		carrot, potato
annual	leaf		Herbs	herbs	parsley, dill, basil
perennial	leaf		Herbs	herbs	rosemary

1.2 Ripeness or harvest readiness

Ripeness, or harvest readiness, depends on *physiological* and *commercial maturity*.

Immature → Mature → Ripe → Overripe

Step 1 *Step 2* *Step 3*

On the plant On/off the plant Off plant

- Physiological maturity is reached on the plant or the tree. Full maturity is reached when the product development is over and does not grow anymore (step 1 in the graph).
- It is followed by the ripening process (step 2). *Climacteric* fruits can ripen after being picked. This facilitates transport and storage. Examples are tomatoes, apple, apricot, peaches, pear, plum, mango and of course banana. *Non-climacteric* fruits such as peppers and citrus can only ripen on the plant. The degree of ripeness is called commercial maturity and it is determined by the market.
- Harvesting time thus is a function of the distance to the market. Changes in color are the most apparent external symptoms of ripening. They are the result of chlorophyll degradation (disappearance of green color) and the synthesis of specific pigments. With some crops (garlic, onions, potatoes, sweet potatoes and other roots) curing by removing tops and drying in the shade is undertaken in the field or under shelters.

- The last step is when the product starts deteriorating, it gets overripe and spoils (step 3). This must be avoided with post-harvest actions. For climacteric fresh fruits this is done e.g. by taking out ethylene ('scrubbing') and replacing oxygen by carbon dioxide or nitrogen. The latter is done in ultralow oxygen (ULO) chambers. For storage of non-climacteric fresh fruits and vegetables cold storage is applied.

1.3 Post-harvest actions

Because of its perishability fruits and vegetables are usually sold immediately after harvest at field level and dispatched directly through marketing channels, so that it can reach consumers as quickly as possible. The produce is cleaned and graded so that it can obtain a better price in the market or be subjected to an industrial process to suit consumer demands and extend shelf life. Industrially processed vegetables are usually preserved within 7-10 hours after harvesting. This is much faster than with fresh products so less deterioration will have taken place and more nutrients and taste will have been preserved, provided the right technology was used.

Processing includes the production of concentrates, fruit juices, purees, dried fruits, preserves (jams, jelly, marmalade, conserves, sauces, pickles and chutneys) and fruit leathers (dried fruit pulp). For example, of all the fruits and vegetables consumed in the United States each year, roughly 60% are processed into canned, frozen, or dried consumer products, 50% in Japan, 40% in Western Europe and 25% in Eastern Europe. The rest is eaten fresh.

1.4 Preserving food

Preservation is creating an environment that prevents harming micro-organisms (bacteria, viruses, moulds or yeasts) from multiplying, while keeping the original taste and texture as much as possible. There are three steps:

Killing micro-organisms	→	Packing	→	Storing
Step 1		*Step 2*		*Step 3*

Micro-organisms need: 1. ambient temperature, 2. water, 3. oxygen, and 4. chemically neutral environment. Micro-organisms die outside this environment. There are **10 principles** of killing micro-organisms (step 1) and to keep them from re-infecting and spoiling the product (step 2 and 3):

Table 2 - List of preservation principles

Preservation principles	1. Temperature	2. Moisture	3. Oxygen	4. Chemical	5. Radiation
1. Pasteurization	high				
2. Sterilization	high				
3. Refrigeration	low				
4. Freezing	low				
5. Drying		low			
6. Vacuum treatment			low		
7. Anti-microbial agents				high	
8. Submersion					
- Salinity				high	
- Sugar		low		high	
- Acidity				low pH	
- Base				high pH	
9. Ionizing radiation (UV)					high
10. Combination of these principles					

No method is perfectly dependable as a preservative. For example, spore forming thermal resistant micro-organisms, such as Clostridium botulinum (which causes botulism) is not killed at when boiling at 100ºC, however Clostridium dies when pH is below 4.4. Another example: if a fruit was properly dried (<12% moisture) it can keep for a long time, provided it is not in contact with water or humid air, therefore airtight packaging is recommended. Or, when pickling cucumbers, a combination of acidity and salinity preserves the product, but once opened micro-organisms may re-enter and keeping the jar in the fridge is recommended.

In the F&V industry **4 methods of preservation** and packing are common:

1. Canning is a method in which the food is processed, filled and sealed in an airtight container and then heat-treated (pasteurized or sterilized) and cooled down. The process was first developed as a French military discovery. Usual containers are jars, bottles, tins, pouches, etc. made of glass, PET or aluminum. For useful background on canning, see http://ucanr.org/freepubs/docs/8072.pdf. The same applies to bottling of liquids.
2. Aseptic packing is a method in which food is processed, heat treated, cooled and then filled and sealed under vacuum conditions in an airtight container (*cold fill*). Usual containers are multi-liner plastic bags or cartons (Tetrapak, Elopak, SIG). E.g. UHT milk, or juices.
3. IQF (individually quick frozen) fruits and vegetables are preserved by deep freezing. In IQF the product remains free-flowing while rapidly deep freezing in an environment of -50ºC. The core of the product will reach -18º within 2-3 minutes. With IQF, most natural characteristics of fresh fruit and vegetables are retained. Fruit and vegetables can be frozen whole, or in slices of different sizes. IQF products are easily processed as they defrost rapidly and are perfect for portion control.

4. Drying is a method in which food is processed after which 85-90% of the water is removed. Water is usually removed by evaporation (air drying, sun drying, smoking or vacuum drying) or freeze-drying, where food is first frozen and then water removed by sublimation.

Table 3 - Overview of Processing Systems and Investments Needed

LEVEL OF PROCESSING	SCALE	RM INTAKE	TYPE	FILLING	PASTEURIZATION	INVESTMENT RANGE (USD)
Artisan	small	100-500 kg/hr	batch	by hand	autoclave	10,000
Semi-industrial	medium	2-5 t/hr	batch	capper	autoclave	50,000
Industrial medium-scale	large	5-10 t/hr	continuous	filler / capper	aseptic	500,000
Industrial large-scale	very large	10-20 t/hr	continuous	filler / capper	aseptic	2,000,000

Table 4 - Overview of Product Categories in Fruit and Vegetable Sector

Nbr	F&V	Product category	Brix	Raw material grade	Prod. Use	Processing Level	Process	Preservation method	Storage	Weight	Packing material	Use
1	F	fresh fruit	5-25	1	whole		none	none/cooling	ULO, 6°C	10-25 KG	crates	FP
2	F	frozen fruit	5-25	1	whole	semi-indus	IQF	deep freezing	-25°C	10-25 KG	lined box	IP
3	F	dried fruit	22-36	1/2	whole	artisanal	drying	drying	ambient	10-25 KG	crates	FP
4	F	fresh fruit mix, pre-packed	15-20	1/2	whole/sliced	semi-indus	cutting, mixing	cooling	7-8°C	200-1000 G	pet	FP
5	F	compotes	14-16	2	whole	artisanal	heat	pasteurized	ambient	1-3 LITER	jar	FP
6	F	preserves	68	2	whole	artisanal	heat	pasteurized	ambient	300-500 G	jar	FP
7	F	jams	62	3	pulped	artisanal	heat	pasteurized	ambient	300-500 G	jar	FP
8	F	syrup	54	3	pulped	artisanal	heat	pasteurized	ambient	1-3 LITER	jar	FP
9	F	juices	12-13	3	pulped	semi-indus	heat	pasteurized	ambient	250-1500 ML	carton, pet, jar	FP
10	F	puree, single-strength	12	3	pulped	semi-indus	heat	pasteurized	ambient	1-3 LITER	jar	FP
11	F	puree, double, triple-strength, aseptic	24	3	pulped	industrial	heat	aseptic	ambient	25-250 KG	aseptic bag in drum	IP
12	F	concentrate, aseptic	70	3	pulped	industrial	heat	aseptic	ambient	250 KG	aseptic bag in drum	IP
13	F	fruit filling	54	2/3	whole/sliced	semi-indus	heat	pasteurized	ambient	25-250 KG	aseptic bag in drum	IP
14	V	fresh vegetables		1	whole		none	none/cooling	ULO, 6°C	10-25 KG	crates	FP
15	V	frozen vegetables		1	whole	semi-indus	IQF	deep freezing	-25°C	10-25 KG	lined box	IP
16	V	canned vegetables		1	whole/sliced	semi-indus	heat	pasteurized	ambient	200-1000 G	jar	FP
17	V	marinades, pickles		1	whole/sliced	artisanal	heat	pasteurized	ambient	200-1000 G	jar	FP
18	V	fresh vegetables mix, pre-packed		1/2	whole/sliced	semi-indus	cutting, mixing	cooling	7-8°C	200-1000 G	crates	FP
19	V	dried vegetables		1/3	whole	artisanal	drying	drying	ambient	10-25 KG	crates	FP
20	V	vegetable preserves		2	whole/pulped	artisanal	heat	pasteurized	ambient	200-1000 G	jar	FP
21	V	fresh tomato	4-6	1	whole		none	none/cooling	ULO, 6°C	10-25 KG	crates	FP
22	V	sauces, tomato ketchup	18-25	2/3	pulped	semi-indus	heat	pasteurized	ambient	200-1000 G	jar	FP
23	V	tomato puree, paste	18-25	2/3	pulped	semi-indus	heat	pasteurized	ambient	200-1000 G	jar	FP
24	V	tomato paste, aseptic	25-36	2/3	pulped	industrial	heat	aseptic	ambient	250 KG	aseptic bag in drum	IP

Notes
F = FRUIT (SEED, STONE), BERRIES
V = FRUIT, LEAVES, STEMS, ROOTS
1 = NO DEFECTS, FRESH MARKET QUALITY
2 = SMALL DEFECTS, FRESH MARKET QUALITY
3 = LARGE DEFECTS, NOT FRESH MARKET QUALITY
Intermediate products need additional processing = IP
Finished product, ready to consume = FP

Table 5 - Processing Ratios for Selected Fruits by Product Category

Nr	Fruit	Product category	Use	Processing ratio	Nr	Fruit	Product category	Use	processing ratio
1	Apple	Frozen small	IP	1.89	*30*	Pear	Frozen small	IP	n.a.
2	Apple	Puree	IP	1.28	*31*	Pear	Puree	FP	n.a.
3	Apple	Juice	FP	1.00	*32*	Peppers	Frozen split	IP	1.25
4	Apricot	Frozen half	IP	1.22	*33*	Potato	Frozen split	IP	1.43
5	Apricot	Frozen small	IP	1.35	*34*	Pumpkin	Preserves	FP	1.11
6	Apricot	Ice cream fruit preparation	IP	0.67	*35*	Quince	Preserves	FP	0.83
7	Apricot	Juice	FP	0.67	*36*	Raspberry	Frozen	IP	1.18
8	Apricot	Preserves	FP	0.50	*37*	Raspberry	Ice cream fruit preparation	IP	0.59
9	Apricot	Yoghurt fruit preparation	IP	0.67	*38*	Raspberry	Juice	FP	0.71
10	Bamia	Frozen split	IP	1.20	*39*	Raspberry	Preserves	FP	0.50
11	Beans	Frozen	IP	1.20	*40*	Raspberry	Yoghurt fruit preparation	IP	n.a.
12	Beans	Preserves	FP	n.a.	*41*	Rose leaves	Preserves	FP	0.12
13	Black salsify	Frozen	IP	1.28	*42*	Sour cherry	Frozen	IP	1.19
14	Blackberry	Frozen	IP	1.18	*43*	Sour cherry	Frozen destoned	IP	1.59
15	Blackberry	Preserves	FP	0.45	*44*	Sour cherry	Ice cream fruit preparation	IP	0.67
16	Cauliflower	Frozen split	IP	1.43	*45*	Sour cherry	Juice	FP	0.80
17	Cherry sweet	Preserves	FP	0.80	*46*	Sour cherry	Preserves	FP	0.80
18	Cornelian cherry	Preserves	FP	0.50	*47*	Sour cherry	Yoghurt fruit preparation	IP	0.67
19	Currant	Frozen	IP	n.a.	*48*	Spinach	Frozen	IP	1.85
20	Egg plant	Frozen split	IP	1.20	*49*	Strawberry	Frozen	IP	1.37
21	Fig	Preserves	FP	0.59	*50*	Strawberry	Ice cream fruit preparation	IP	0.56
22	Mandak	Frozen	IP	1.22	*51*	Strawberry	Juice	FP	0.59
23	Mulberry	Preserves	FP	0.50	*52*	Strawberry	Preserves	FP	0.56
24	Peach	Frozen small	IP	1.85	*53*	Strawberry	Yoghurt fruit preparation	IP	0.56
25	Peach	Frozen split	IP	1.35	*54*	Tomato	Frozen split	IP	1.14
26	Peach	Ice cream fruit preparation	IP	0.71	*55*	Tomato	Paste 25Bx	IP	6.50
27	Peach	Juice	FP	0.80	*56*	Tomato	Sundried	FP	18-20
28	Peach	Preserves	FF	0.80	*57*	Walnut	Preserves	FP	0.67
29	Peach	Yoghurt fruit preparation	IP	0.71					

2 Cigar Box and Risk Analysis

The Cigar Box is a simple Excel tool allowing quick, yet concise calculation of the profitability of a single SKU or of an entire product portfolio that a factory wants to produce. CB1 uses four variables: sales price, variable cost, fixed cost and quantity.

A thorough understanding of these critical parameters is indispensable, along with industry benchmarks, adapted to the levels of processing technology dominant in the region: artisan, semi-industrial, industrial.

An example from processing apples into apple juice concentrate (AJC): in an artisan workshop, apples are pressed using wheel-presses and require 11 kg of raw fruit for 1 kg of concentrate. A better method is the use of a belt-press which has more power with higher yield and a lower processing ratio: only 8 kg of apples are needed. The most advance method is adding enzymes prior to pressing. The enzymes help to break the cell walls and even the last drop of juice is squeezed out of the apple: only 6 kg of apples are needed for a kg of AJC.

The most advance technology (belt-press + enzymes) results in more AJC per ton of apples and a lower cost price. The combined effect gives almost 3 times more contribution from the same quantity of apples procured from the orchards.

Item	artisan	semi-industrial	industrial
Processing ratio for apples → AJC	11 kg/kg	8 kg/kg	6 kg/kg
AJC output from 1000 ton of apples	91 ton	125 ton	167 ton
VC1, if apple price is $50 per ton	$550	$400	$300
Other VCs	$120	$150	$250
VC per ton	$770	$550	$550
P(EXW) per ton	$1,200	$1,200	$1,200
Margin per ton	$430	$650	$650
Contribution	$39,130	$81,250	$108,550
Index	100	207	278

The Cigar Box calculates **four risk parameters**: 1. Margin as percentage of sales; 2. Breakeven quantity of sales, and derived from that, 3. Breakeven quantity of raw material needed, and 4. Capacity utilization.

- **Margin.** The margin must generally be over 30%. This is needed as a buffer against price fluctuations of either raw materials or finished goods.

Margin %	Level	Comment
<15%	Very risky	Only acceptable when the production process parameters and all prices are fully under control.
15-25%	Risky	Only acceptable if production and price fluctuations are within 5-10% range.
25-35%	Normal	
35-45%	Robust	
>45%	Very robust	

- **Breakeven sales quantity.** The breakeven sales volume is the minimum sales quantity that the owners must justify or guarantee with sales contracts.

- **Breakeven raw material quantity.** The derived breakeven raw material quantity is the minimum availability of raw material that the owners justify from spot markets or supply through contract farming.

- **Capacity utilization**. Low capacity utilization results in higher VC and higher FC per ton produced. The general rule is 10% higher capacity utilization gives 35% higher contribution.

To enable ITC staff to train itself in the use of the Cigar Box, each chapter provides an example of a processing industry in an emerging market. The Cigar Box tool has been employed in many companies and here is a summary of lessons learned in the past 15 years.

2.1 P. Sales price

The Sales Price is expressed as a value with a specific currency per unit and a delivery condition. Sales price must be net of VAT.

- Price of AJC = USD 900 per ton C&F New York.
- Price of flour = Naira 8000 per bag of 50 kg EXW flour mill Lagos.
- Price of mango = CFA 53 per kg ex farm Kindia.

2.2 VC4. Variable cost of delivery

The delivery conditions are standardized INCO-terms. All costs that the seller incurs to deliver the goods are summarized in VC4 Cost of Delivery. The Cigar Box uses the EXW price is net of VAT, transport and sales commissions.
Hence: P(EXW) = P(C&F) – VC4.

A warning is justified. When import and export duties are applicable, many exporters and importers informally agree to under-invoice and pay the difference in another way: cash or to an offshore account.

- Lesson 1: always check the underlying sales agreements and check how differences in sales terms are being paid.

2.3 Variable cost of production

Variable costs (VC) fluctuate with the volume produced. The Cigar Box distinguishes three variable costs: VC1 = cost of raw material and ingredients; VC2 = cost of processing raw materials into a saleable product and VC3 = cost of packaging. The percentages of VC1, VC2 and VC3 in the total cost price of the product are useful benchmarks of efficiency.

2.3.1 VC1

VC1 depends on the seasonal price of the principal raw material, the grade used and the processing ratio. The processing ratio again depends on a) the pit and peel losses

which are fruit specific, b) the quality of the product (poorer quality, more losses, higher PR), and c) the final product (concentrates require more raw material).

- Lesson 2: Because raw material prices typically fluctuate heavily during the season and between years, careful procurement planning is essential.

- Lesson 3: fruit buyers must take the processing ratio (PR) into consideration when making a procurement offer and adjust the prices to it.

Assume: the price of apple is $50 per ton and the quality is such that a processing ratio of 8 kg/kg can be achieved. The resulting VC1 is then 8*$50=$400 per ton. If a better grade can be purchased that results in a lower PR, then the processor can afford to pay a higher price. See example in the table below.

Item	artisan	semi-industrial	industrial
Processing ratio for apples → AJC	8 kg/kg	7 kg/kg	6 kg/kg
VC1, if apple price is $50 per ton	$400	$350	$300
Parity price to obtain same VC1	$50	$57	$66

2.3.2 VC2

VC2 comprises the cost of steam, water, electricity and variable labor; traditionally cheaper in emerging markets. The recent increases environmental awareness and the higher energy prices triggered change in behavior: insulation of autoclaves, recycling of hot water, use of solar and wind energy. Companies with efficient energy saving operations will be more competitive.

- Lesson 4: Changing old equipment for new, more efficient equipment does **not automatically** lead to a reduction in costs. Worker behavior must change too. This requires training and demonstration, plus steady follow-up and pushing. Only that will lead to real changes in behavior and to savings.

2.3.3 VC3

VC3 is the cost of primary ('jar, cap and label'), secondary ('carton box, label, tape'), and tertiary ('crate, pallet, shrink wrap') packing materials.

2.4 Fixed cost

Fixed costs (FC) are not influenced by the quantity produced. They must be paid even if production is zero. The Cigar Box distinguishes: FC1 = depreciation; FC2 = cost of capital; FC3 = Overhead and FC4 = Cost of sales & marketing.

- Lesson 5: FC1 and FC3 are systematically underestimated and must be adjusted to include future investments and a realistic salary for owners and management.

2.5 Quantity sold

The sales volume is the most difficult parameter to predict and is systematically **overestimated** during planning. My experience in the past 15 years has proven this. One reason is that sales assumptions are rarely worked out in detail. E.g. sales in a local market can be quantified by the number of outlets where the products will be available, multiplied by the shelf space in those outlets, multiplied by the shelf turnover time, which is to be verified with the number of shop visitors and their purchasing behavior during the day. Export sales can be quantified by the number of clients, the average order size and order frequency during the year.

- Lesson 6: always double check all sales assumptions.

2.6 Quantity produced

In processing industry, another important reason for the difficulty to predict the sales quantity, is the difficulty to predict the quantity of raw material that will be processed. The reasons being: poor raw material procurement planning; lack of (timely) working capital; poor harvests due to lack of irrigation water, inputs, tractors, farm management… Again, procurement assumptions must be worked out in detail: in how many regions can I buy, from how many farmers, and which volumes? When will they deliver? Is there a route planning and sufficient means of transport available?

- Lesson 7: always double check all raw material procurement assumptions.

Sometimes processing companies try to overcome the raw material uncertainty by contract farming on open land or in greenhouses. But this does not work well when contracts are not honored, and difficult to enforce legally. The price is the stumbling block. After a big harvest the price drops and processors tend to buy cheaper elsewhere; when the harvest is tight, farmers try to opt out and sell more expensive elsewhere. A good contract offers a fixed floor price against which the farmers must sell the volume required to pay back advance payments received. A variable market price is agreed for additional volumes if partners so wish.

- Lesson 8: importance of professional contract farming should not be underestimated. The underlying production assumptions should be carefully checked.

And sometimes processing companies try to farm fruits and vegetables themselves. Very often this also leads to problems. First of all, the additional investments, and efforts in management may become too burdensome, especially for smaller enterprises. But there is another problem, especially in fruit farming. Most processors use only the low grades of the fruit for which a low price can be paid. However an orchard will not only produce low grades (in fact preferably not, as the farms must be a profit center in its own right), but also the higher grades which fetch higher prices, the factory cannot afford.

- Lesson 9: importance of own (fruit) farming should not be overestimated. The underlying production assumptions should be carefully checked.

3 Product Category Information

Evaluating opportunities in agro-processing requires specific knowledge of many different products. It is not uncommon for an F&V company to be processing 40 different types of fruits, vegetables, berries and herbs into, say, 100-200 different SKU's. Nevertheless, it is possible to summarize the key issues by addressing six general product categories:

1. Fruit juice concentrates and purees;
2. Juices, nectars and drinks;
3. Jams, syrups and compotes;
4. Canned vegetables and
5. Frozen fruit and vegetables
6. Dried fruit and vegetables.

3.1 Fruit Juice Concentrates and Purees

Product. Fruit juice is obtained by extracting cellular juice from a single fruit. All seeds, stones, skin and intercellular walls are removed.

- The term '*single strength'* refers to a juice that has the same sugar level as the original fruit. It has a short shelf life and must be packed aseptically or frozen.
- To reduce transportation costs, single strength juice is concentrated by evaporating water out of the juice. During evaporation the sugar level increases from say 14% to 28% (double) or 42% (triple). This is done for all fruits and berries.
- The term '*concentrate'* is used for fruits which give *clear juices*, without particles: Apple Juice, Cherry Concentrate. Concentrates have high Brix 60-70[1].
- The term *'puree'* is used for fruit types which give *not clear juices*, containing fruit pulp: e.g. Mango Puree, Peach Puree. When a single strength puree is concentrated, the terms double strength or triple strength are used.

Raw material. Concentrates and purees are made from fruit which cannot be sold on the fresh market due to damages or leftovers. Fruits have natural sugar levels, which differ between varieties, but which increase towards maturity.

Mango (12-18 Brix);
Peach (9-18 Brix);
Cherry (17-22 Brix);
Apple (11-13 Brix),
Tomato (4-6 Brix).

The higher the Brix, the more valuable the fruit for the processor. The value of apples is also influenced by its acidity. Chinese AJC is cheap because of its low acidity (0.8-2%); for the European market it must be blended with more expensive AJC of high acidity (4-5%), e.g. from Poland.

Yield benchmarks

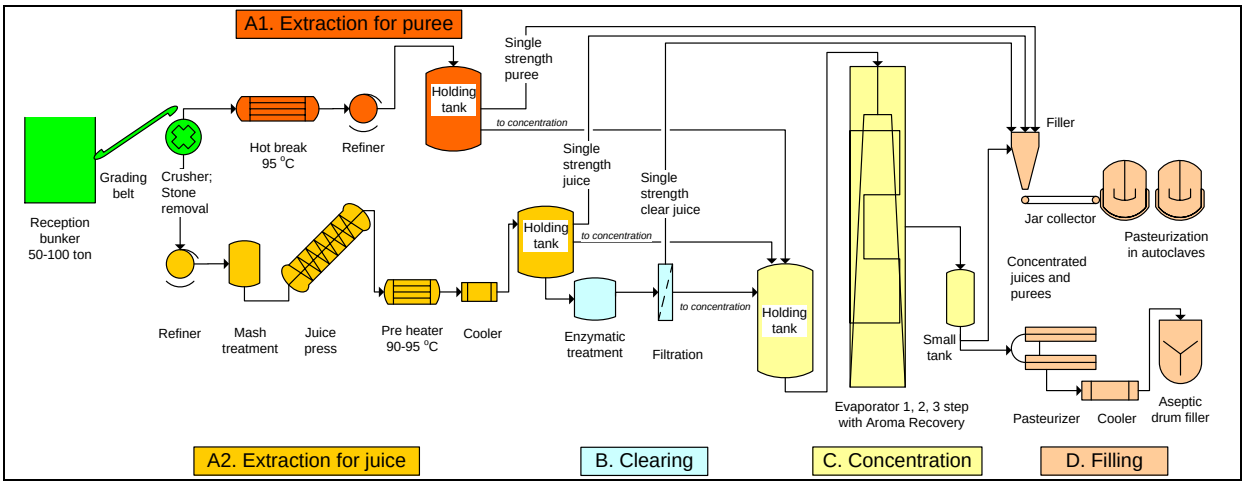
	Fruit	actual yield (not irrigated, low maintenance, low tree density)	medium yield (irrigated, proper maintenance, low tree density	high yield (irrigated, good management, high tree density)
1	Apple/pear	4-9 ton/ha	15-25 ton/ha	30-80 ton/ha
2	Mango/peach	2-4 ton/ha	5-8 ton/ha	9-16 ton/ha
3	Cherry	3-8 ton/ha	10-15 ton/ha	20-30 ton/ha

[1] An exception is Cloudy Apple Juice Concentrate which contains evenly-distributed small pulp suspensions and has 45 Brix.

Processing ratio. Depends on the desired concentration. The higher the sugar contents (measured in Brix) of the fruit, the lower the processing ratio, hence the lower the cost price. Example: to produce 1 kg of AJC 70 Brix, using apples of 12 Brix, one needs 70/12=5.8 kg of apple juice, or 7-8 kg of raw apples. Or, to produce 1 kg of mango puree double strength 28 Brix from raw mangos of 14 Brix requires 28/14=2 kg of mango puree, or 2.8 kg of raw mango, whereby 0.8 kg is waste of skin and stone.

Production process. To produce purees the fruit must be pulped only (after peeling and destining), but heavy pressing equipment is needed to produce juice. After pulping or pressing, the intermediate puree/juice is evaporated under vacuum up to the desired concentration in Brix. To produce clear juices two additional treatments have to be done on the cloudy product, namely treatment with enzymes and filtration of the final product. Modern installations recover aromas which may be returned back into the product.

Flow diagram 1 – Fruit juice concentrates and purees



Packaging. Concentrates and purees are intermediate products for industrial use and thus packed in aseptic bags of 15-200 liter. Big containers are also in use carrying up to 1000 liter.

Quality description. Clear apple juice **concentrate** must be clear golden brown with no impurities (color = 60-70 NTU) with a standard Brix around 70 percent. Three acidity levels: low = 0.8-2%; medium = 2-4%; high = 5-7%. Peach and mango **puree** must have the original fruit color and original aroma; no deviations, no impurities; and the standard Brix. E.g. double strength mango puree has 28 Brix.

Quality problems. 1. Not clear >70 NTU = poor filtration; 2. Bad/yoghurt smell = presence of lactic acid bacteria due to long standing of fruit before being processed; 3. Too liquid = not enough concentration leading to an inferior product; 4. Too weak aroma = bad recovery of aroma; 5. Too dark = overheating during evaporation and/or pasteurization; 6. Browning of the final product and unwanted change of taste = loss of sterility.

Marketing issues. Concentrates and puree are commodities. Prices are usually quoted C&F Rotterdam. These commodities are traded by companies specialized in on time delivery to juice makers who in turn produce the final juice for the consumer

market. Commodity sales can be financed with warehouse receipts under warrant. Processors can ship the goods to, say, Rotterdam, store it there and receive 50-80% of the value prior to concluding the final sale.

Cigar Box Benchmarks:

1. APPLE JUICE CONCENTRATE, 70Bx, aseptic bags 200 liters in steel drums

- **Price range:** $600 - $1400 C&F Rotterdam
- **Variable costs:** VC = $611 (84% of TC); VC1=75%; VC2=10%; VC3=15%.
- **Fixed cost:** FC = $446,000; FC1=31%; FC2=15%; FC3=54%; FC4= negligible.
- **Breakeven:** Min. sales volume = 2,770 ton; min. raw material = 30,400 ton.
- **Profitability:** AJC gives low to moderate profitability to the processor. Capacity utilization (seasonal) must be over 75%. Profitability (2011) for 3800 ton AJC from 38,000 ton apples = 5-9%.
- **Sensitivity:** Margin = 21%. Risky: because the processing ratio is very high, the price of apples is crucial. In the Cigar Box example below, a 12% increase in the price of apples, will reduce the profit to zero. Hence, the importance of irrigated, well-maintained orchards in the vicinity of the factory, preferably with medium/high acidity apple varieties.

CB1. Apple Juice Concentrate, 70 Brix, in aseptic bags of 220 kg in steel drums

	USD per ton			USD per year	
Price (DDP Moscow)	1,200		Total Revenue	2,933,600	
Import duties, 16%	192		Total Cost	2,768,144	
VC4 Transport, sales commission 3%	236		**Profit Before Tax**	**165,456**	
Price (EXW)	**772**		Profit %	6%	
Price (RM, delivered factory)	45		Asset value	1,400,000	
Processing ratio	8.00		Depreciation %	10.0%	
Raw Material cost	360	*59%*	**FC1**	**140,000**	*31%*
Other ingredients	100	*16%*			
VC1	**460**	*75%*	Debt (40% of Asset value)	560,000	
			Interest rate	12%	
Production cost per hour (steam, electricity)	145		**FC2**	**67,200**	*15%*
Production quantity per hour	2.5				
VC2	**58**	*9%*	Number of FTE employed	50	
			Salaries permanent staff incl. social taxes	175,000	*39%*
			Other overhead, repairs, maintenance	64,000	*14%*
Cost of packing (aseptic bag + drum)	20.2		**FC3**	**239,000**	*54%*
Number of packs per ton	4.5				
VC3	**92**	*15%*	**FC**	**446,200**	*100%*
			FC % attributed to product	100.0%	
Finished Goods losses %	0.2%				
VC	**611**	*100%*	**FC (attributed to product)**	**446,200**	
Margin	**161**		Quantity sold q (ton)	3,800	
Margin %	21%		**Contribution**	**611,656**	
			Break even quantity (sales)	**2,772**	
FC / q	**117**	*16%*	Break even quantity (raw material)	22,177	
TC / q	**728**	*100%*	Output capacity per hour in ton	2.5	
			Operating hours per day	22	
Profit / q	**44**		Working days per year	90	
			Max. output capacity per year	**4,950**	
			Capacity utilization %	77%	

*Note: figures in **blue** are assumptions; figures in **pink** are calculated in another sheet; figures in **black** are formulas*

2. MANGO PUREE, 28 Brix in 200kg aseptic bags in steel drums:

- **Price range.** $800 - $1400 C&F Rotterdam
- **Variable costs.** VC = $392 (79% of TC); VC1=72%; VC2=6%; VC3=22%.
- **Fixed cost.** FC = $425,000 (50% attribution); FC1=28%; FC2=23%; FC3=49%
- **Breakeven.** min. sales volume = 1,000 ton; min. raw material = 1,700 ton.
- **Profitability.** Mango puree gives moderate profitability to the processor. Profitability (2011) for 5700 ton of mango into 2000 ton puree = 8%.
- **Sensitivity.** Margin = 28%. Normal: in the Cigar Box example below, a 15% increase in the price of raw mango from $100 to $115 per ton, will reduce the profit to zero.

CB1 - Mango puree 28 Brix (double strength), in 200kg aseptic bags in steel drums

	USD per ton			USD per year	
Price (C&F Rotterdam)	1,000		Total Revenue	1,088,000	
Import duties, 17.6%	176		Total Cost	1,001,519	
VC4 Transport, sales commission 3%	280		**Profit Before Tax**	**86,481**	
Price (EXW)	**544**		Profit %	8%	
Price (RM, delivered factory)	100		Asset value	2,000,000	
Processing ratio	2.86		Depreciation %	6.0%	
Raw Material cost	286	*72%*	**FC1**	**120,000**	*28%*
Other ingredients	-	*0%*			
VC1	**286**	*72%*	Debt (40% of Asset value)	800,000	
			Interest rate	12%	
Production cost per hour (steam, electricity)	46		**FC2**	**96,000**	*23%*
Production quantity per hour	2.00				
VC2	**23**	*6%*	Number of FTE employed	15	
			Salaries permanent staff incl. social taxes	65,000	*15%*
			Other overhead, repairs, maintenance	142,886	*34%*
Cost of packing (jar, cap)	17.00		**FC3**	**207,886**	*49%*
Number of jars per ton	5				
VC3	**85**	*22%*	**FC**	**423,886**	*100%*
			FC % attributed to product	50.0%	
Finished Goods losses %	0.2%				
VC	**395**	*100%*	**FC (attributed to product)**	**211,943**	
Margin	**149**		Quantity sold q (ton)	2,000	
Margin %	27%		**Contribution**	**298,424**	
			Break even quantity (sales)	**1,420**	
FC / q	**106**	*21%*	Break even quantity (raw material)	4,062	
TC / q	**501**	*100%*	Output capacity per hour in ton	2.0	
			Operating hours per day	20	
Profit / q	**43**		Working days per year	90	
			Max. output capacity per year	**3,600**	
			Capacity utilization %	56%	

*Note: figures in **blue** are assumptions; figures in **pink** are calculated in another sheet; figures in **black** are formulas*

Main investment risks. The market for concentrates and puree is huge; when the standard commodity can be produced, it can always be sold. The main risk is to secure sufficient volumes of low priced fruit. Improved orchard management leads to a lower percentage of waste and lower volumes of industrial apples. The dilemma for the processor is that investments in (new) orchards are only affordable for fresh market apples, not for industrial fruit which fetches much lower prices.

3.2 Juices, nectars, drinks

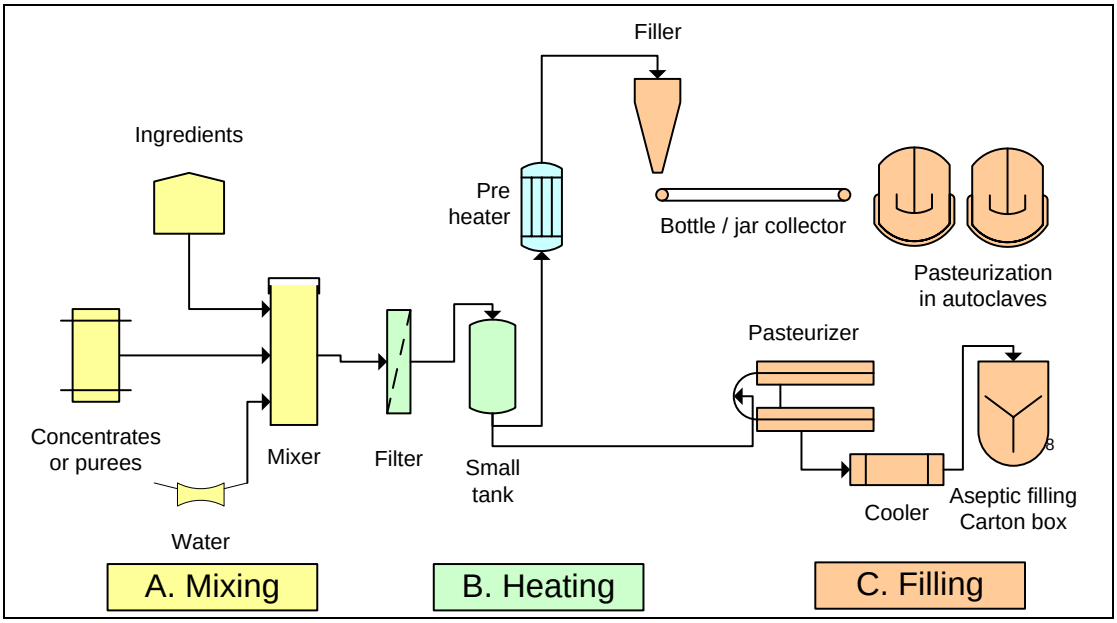
Product. Juices and nectars are single strength products (=100% fruit juice) obtained from the extraction of cellular juice from a single fruit or from a mixture. Nectars contain

fruit pulp and juices are clear, without pulp. Both can be produced with or without additions of sugar and other ingredients. Drinks are mixtures of juice or nectar with water. The fruit contents = less than 100%. Usual drinks contain 15-35% fruit. The taste can be boosted with natural or synthetic aromas, sugar and other ingredients.

Raw material. Fruit puree → nectar; fruit juice concentrate → juice.

Production process. Production starts with blending purees and/or concentrates and adding water, while heating. Then, other ingredients and aromas are added. Depending on the required shelf life, the juice is pasteurized and packed under aseptic (sterile) or non-aseptic conditions. The sterile product has a long shelf life (>6-12 months) while the non-sterile product is for immediate consumption (<3 months). Two filling methods exist: hot fill and cold fill.

Flow diagram 2 – Juices, nectars, drinks



Packaging. Non-sterile products are packed in glass or PET bottles and the aseptic (sterile) products in special carton (Tetrapak, Purepak, SIG). Carton and bottles are supplied in the range of 150-2000 ml.

Quality description. Juices and nectars: the product must reflect the original taste, smell and color of the fruits. Drinks: the product must reflect consumer demand; no original fruit flavors are required.

Quality problems. Inflation/exploding containers = gas formation during storage = improper packaging. If a system of returning bottles is used it is important that the recycled bottles are properly sterilized before their use and sterilized again with the product inside. Weak aroma / deviating color = bad recipe, cheap raw material. Wrong aroma = adulteration of raw material supplier.

Marketing issues. Clients want a broad assortment, usually >10 aromas in 2-3 different sizes or 20-30 SKU's. In addition to larger volumes of regular products (apple, orange, apricot, peach, cherry) more exclusive fruit flavors in small volumes must be offered (pomegranate, currant, pineapple, national red fruit). The juice containers

require proper labeling with a list of ingredients and net content and the whereabouts of the manufacturer. The products can be branded under own label to reward the manufacturer for superior quality. It is more common however, to sell under private label of the importer / wholesaler or supermarket.

Cigar Box Benchmarks:

FRUIT JUICE from CONCENTRATE

- **Variable cost** (1 liter): VC=$500 (77% of TC); VC1=61%, VC2=14%, VC3=24%
  (150 ml): VC=$580 (77% of TC(; VC1=53%, VC2=12%, VC3=35%
- **Fixed costs:** FC=$1,000,000; FC1=20%; FC2=18%; FC3=63%
- **Breakeven:** min. sales volume = 4,200 ton; min. raw material = 3850 ton
- **Profitability:** Fruit juices give high profitability to the processor. Capacity utilization (year round) must be over 70%. Profitability (2011) for 10,000 ton from 3800 ton of concentrates = 17-20%.
- **Sensitivity:** margin = 33%; normal / desirable: 20% price fluctuations will not lead to losses.

Main investment risks. Juice business = creative marketing. Manufacturing is not at all difficult, especially when using (imported) concentrates and purees. Recipe recommendations from concentrate suppliers are common but it makes the processor dependent. An adapted assortment of recipes must be used to meet local market requirements, since all markets have their own specific tastes and preferences. To ensure independence, the owners must invest in capacity building in marketing and product development, not just in stainless steel!

CB1 - Fruit Juice (100%) from Concentrates in 1 liter carton brick, 6 in shrinkwrap (6 kg)					
	USD per ton			USD per year	
Price (C&F)	985		Total Revenue	7,462,083	
VAT 20%	164		Total Cost	6,037,398	
VC4 Transport, sales commission 3%	75		**Profit Before Tax**	**1,424,686**	
Price (EXW)	**746**		Profit %	19%	
Price (RM, delivered factory)	600		Asset value	2,550,000	
Processing ratio	0.38		Depreciation %	8.0%	
Raw Material cost	231	*46%*	**FC1**	**204,000**	*20%*
Other ingredients	74	*15%*			
VC1	**305**	*61%*	Debt (40% of Asset value)	1,020,000	
			Interest rate	18%	
Production cost per hour (steam, electricity)	216		**FC2**	**183,600**	*18%*
Production quantity per hour	3.0				
VC2	**72**	*14%*	Number of FTE employed	100	
			Salaries permanent staff incl. social taxes	300,000	*29%*
			Other overhead, repairs, maintenance	350,000	*34%*
Cost of packing (brick, cap, shrink wrap)	0.73		**FC3**	**650,000**	*63%*
Number of carton boxes per ton	167				
VC3	**122**	*24%*	**FC**	**1,037,600**	*100%*
			FC % attributed to product	100.0%	
Finished Goods losses %	0.2%				
VC	**500**	*100%*	**FC (attributed to product)**	**1,037,600**	
Margin	**246**		Quantity sold q (ton)	10,000	
Margin %	33%		**Contribution**	**2,462,286**	
			Break even quantity (sales)	**4,214**	
FC / q	**104**	*17%*	Break even quantity (raw material)	3,846	
TC / q	**604**	*100%*	Output capacity per hour in ton	3.0	
			Operating hours per day	16	
Profit / q	**142**		Working days per year	300	
			Max. output capacity per year	**14,400**	
			Capacity utilization %	69%	
*Note: figures in **blue** are assumptions; figures in **pink** are calculated in another sheet; figures in **black** are formulas*					

3.3 Preserves, jams, syrups and compotes

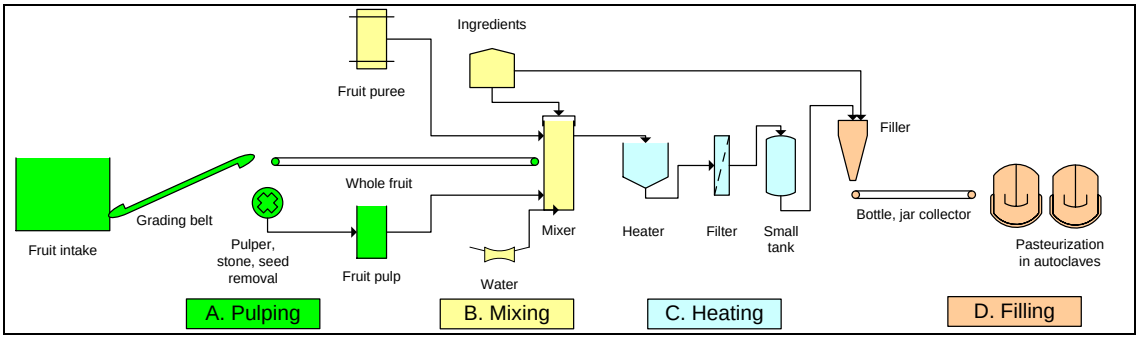
Product. Preserves refer to fruits or vegetables that have been prepared for long term storage, using pectin, sugar or honey as a gelling agent and adding sweet (in fruit preserves) or savory (in vegetable preserves) ingredients according to taste. **Jam** is made from 50% pulped fruit and 50% sugar (60-70 Brix). Syrup is condensed, sweetened fruit juice (60-70 Brix). Compote is a drink made by extracting aromas from whole fruits in water, adding sugar to taste (30-50 Brix).

Raw material. Most types of fresh fruits, berries and vegetables. Different grades are used; see Table 3 - Overview of Product Categories in Fruit and Vegetable Sector.

Production process. Fresh or pre-cooked fruits are boiled with a solution of sugar until sufficient water is evaporated to give a mixture. For syrups the evaporation is less than for jams. For jams, water is evaporated until only one third of water is remaining. Fruits with high pectin and sugar start to gel automatically in the process, other fruits need additional sugar and pectin. The addition of sugar is also a matter of taste. For syrups, preserves and compotes less water is evaporated as for jams. Preserves and compotes contain the whole fruits and added sugar. For syrups, the original mixture is filtered to remove the pieces of fruit and arrive at a smooth liquid with a higher viscosity than juice as part of the water is evaporated and sometimes sugar added. In the hot

boiling of the products, micro-organisms are destroyed and the products are filled hot to achieve a natural vacuum under the caps.

Flow diagram 3 - Preserves, jams and syrups



Packaging. Traditionally preserves, jams, syrups and compotes are packed in 200ml to 3000ml glass jars, mostly twist off, although the soviet style 1, 2 and 3 liter jars are still used. Hotels, restaurants demand larger volumes packed in 1-5 liter jars and tins. The containers require proper labeling with a list of ingredients, net weight and contents and the whereabouts of the manufacturer.

Quality description. The product must reflect the original color and flavor of the fruits and be free from impurities.

Quality problems. Caramel taste = too high processing temperature. Weak aroma = too low or too high processing temperature, poor quality fruit. Moulds = improper sealing of cap, leading to loss of vacuum.

Marketing issues. Clients want a broad assortment, usually >50 SKUs. In addition to larger volumes of regular products (apricot, peach, cherry) more exclusive fruits in small volumes must be offered (sea buckthorn, green walnut, mountain apples). The products can be branded under own labels to reward the manufacturer for superior quality. It is more common however, to sell under private label of the importer / wholesaler or supermarket.

Cigar Box Benchmarks

ORGANIC GREEN WALNUT PRESERVE:

- **Variable costs:** VC=$1370 (84% of TC); VC1=58%, VC2=12%, VC3=30%
- **Fixed costs:** FC=$742,000 (80% attribution); FC1=19%; FC2=17%; FC3=63%
- **Breakeven:** min. sales volume = 338 ton; min. raw material = 200 ton.
- **Profitability:** very high, provided sales volumes for all SKU's are good.
- **Sensitivity:** margin = 62%; very robust.

CB1 - Organic green walnut preserve 400gr, in 314 ml glass jar, 18 jars in carton box (7.2 kg)

	USD per ton			USD per year	
Price (C&F)	4,980		Total Revenue	8,563,200	
VAT 20%	830		Total Cost	4,027,981	
VC4 Transport, sales commission 3%	582		**Profit Before Tax**	**4,535,219**	
Price (EXW)	**3,568**		Profit %	53%	
Price (RM, delivered factory)	883		Asset value	2,250,000	
Processing ratio	0.59		Depreciation %	8.0%	
Raw Material cost	519	*38%*	**FC1**	**180,000**	*19%*
Other ingredients	280	*20%*			
VC1	**799**	*58%*	Debt (40% of Asset value)	900,000	
			Interest rate	18%	
Production cost per hour (steam, electricity)	155		**FC2**	**162,000**	*17%*
Production quantity per hour	0.96				
VC2	**162**	*12%*	Number of FTE employed	100	
			Salaries permanent staff incl. social taxes	300,000	*32%*
			Other overhead, repairs, maintenance	286,000	*31%*
Cost of packing (jar, label, cap, carton box)	2.92		**FC3**	**586,000**	*63%*
Number of carton boxes per ton	139				
VC3	**405**	*30%*	**FC**	**928,000**	*100%*
			FC % attributed to product	80.0%	
Finished Goods losses %	0.2%				
VC	**1,369**	*100%*	**FC (attributed to product)**	**742,400**	
Margin	**2,199**		Quantity sold q (ton)	2,400	
Margin %	62%		**Contribution**	**5,277,619**	
			Break even quantity (sales)	**338**	
FC / q	**309**	*18%*	Break even quantity (raw material)	199	
TC / q	**1,678**	*100%*	Output capacity per hour in ton	0.96	
			Operating hours per day	22	
Profit / q	**1,890**		Working days per year	170	
			Max. output capacity per year	**3,590**	
			Capacity utilization %	67%	

*Note: figures in **blue** are assumptions; figures in **pink** are calculated in another sheet; figures in **black** are formulas*

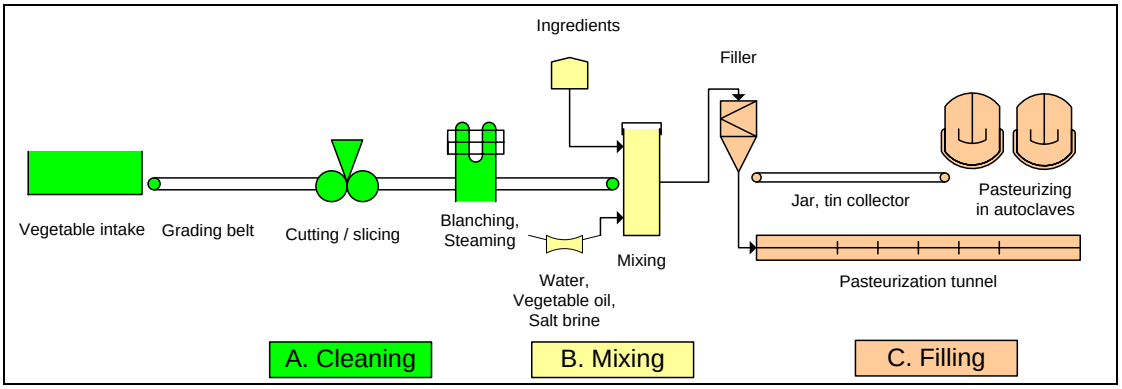
3.4 Canned vegetables

Product. Industry vegetables are low value, large volume vegetables which are grown on open fields. When processed, they are canned or frozen. Canned vegetables can be boiled in water, salted brine, vegetable oil and/or mixed with other whole or sliced vegetables and ingredients. Canned vegetables are a substitute for fresh ones when these are out of season. Because of the heat treatment they are closer to consumption and more convenient to prepare and consume.

Raw material. Preferably only first class vegetables are processed (see Table 3 - Overview of Product Categories in Fruit and Vegetable Sector). Common canned products are beans, asparagus, green beans, peas, (sweet) maize, carrots and cabbages.

Production process. The raw material is cleaned, washed and cut and subsequently blanched or steamed. Then led to the filling line where they are filled in containers, hermetically sealed and pasteurized. After cooling the container is labeled.

Flow diagram 4 - Canned vegetables



Packaging. Industrial canned vegetables (to be repacked or reused later) are packed in 1 to 5 liter containers. Consumer vegetables are packed in glass jars and tins of 50-1000 ml.

Quality description. The product must reflect the original color and taste of the vegetables. The product should not have lost its vacuum or be over-cooked.

Quality problems. Inflation/exploding, moulds, browning = improper sealing of cap, leading to loss of vacuum. Weak aroma = too low or too high processing temperature, poor quality vegetables

Marketing issues. Over the years, there has been controversy as to whether canned (and frozen) vegetables are better or worse than fresh ones. Generally, reports show that canned and frozen vegetables are nutritionally almost identical to fresh ones.

Cigar Box Benchmarks

CANNED PEAS:

- **Variable costs:** VC=$245 (91% of TC); VC1=71%, VC2=12%, VC3=16%
- **Fixed costs:** FC=$490,000 (100% attribution); FC1=41%; FC2=37%; FC3=22%
- **Breakeven:** min. sales volume = 12,600 ton; min. raw material = 10,250 ton
- **Profitability:** very low, 3-7%. Capacity utilization is key.
- **Sensitivity:** margin = 14%, very risky.

CB1 - Canned Peas in 340ml twist off glass jar, 400g, 12 in shrink wrap (4.8 kg)

	USD per ton			USD per year	
Price (C&F)	400		Total Revenue	5,666,667	
VAT 20%	67		Total Cost	5,391,450	
VC4 Transport, sales commission 3%	50		**Profit Before Tax**	**275,217**	
Price (EXW)	**283**		Profit %	5%	
Price (RM, delivered factory)	190		Asset value	2,500,000	
Processing ratio	0.80		Depreciation %	8.0%	
Raw Material cost	152	*62%*	**FC1**	**200,000**	*41%*
Other ingredients	23	*9%*			
VC1	**175**	*71%*	Debt (40% of Asset value)	1,000,000	
			Interest rate	18%	
Production cost per hour (steam, electricity)	120		**FC2**	**180,000**	*37%*
Production quantity per hour	4.00				
VC2	**30**	*12%*	Number of FTE employed	20	
			Salaries permanent staff incl. social taxes	60,000	*12%*
			Other overhead, repairs, maintenance	50,000	*10%*
Cost of packing (jar, label, cap, shrink wrap)	0.19		**FC3**	**110,000**	*22%*
Number of carton boxes per ton	208				
VC3	**40**	*16%*	**FC**	**490,000**	*100%*
			FC % attributed to product	100.0%	
Finished Goods losses %	0.2%				
VC	**245**	*100%*	**FC (attributed to product)**	**490,000**	
Margin	**38**		Quantity sold q (ton)	20,000	
Margin %	14%		**Contribution**	**765,217**	
			Break even quantity (sales)	**12,807**	
FC / q	**25**	*9%*	Break even quantity (raw material)	10,245	
TC / q	**270**	*100%*	Output capacity per hour in ton	4.00	
			Operating hours per day	22	
Profit / q	**14**		Working days per year	300	
			Max. output capacity per year	**26,400**	
			Capacity utilization %	76%	

*Note: figures in **blue** are assumptions; figures in **pink** are calculated in another sheet; figures in **black** are formulas*

Main investment risks. Capacity utilization and cost control are the keys to profit. Cooperation between growers and processor is essential to control cost and to ensure availability of large quantities and good qualities of vegetables. Large scale processors must run a product mix which keeps their capacity occupied. Breakeven sales and corresponding raw material volumes must be guaranteed. Development of a factory brand can be very rewarding: a 5% increase in the sales price may lead to a 100% increase in profit.

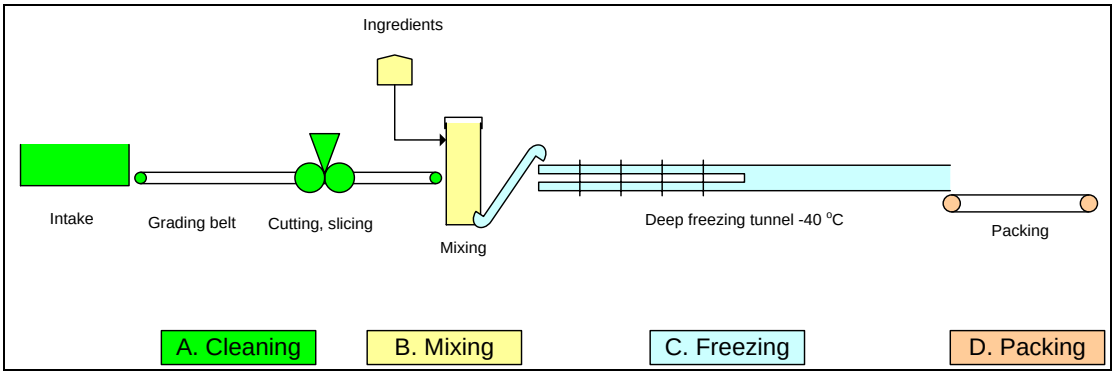
3.5 Frozen vegetables and fruit

Product. Frozen vegetables and fruits are slightly processed (not boiled) and rapidly deep frozen in order to retain as much of the original properties as possible. They defrost rapidly and are perfect for portion control.

Raw material. For vegetables first grade products are preferred (see Appendix B, Table 3 - Overview of Product Categories in Fruit and Vegetable Sector). Common vegetables are green beans, peas, (sweet) maize, broccoli, cauliflower and spinach and mixtures of these and other vegetables. Potatoes that are frozen without pre-boiling are also included in this category. Frozen potato for French fries, etc. are excluded. These fall under HS category 200410. Common **frozen fruits** are all red berries (usually whole), apples (slices or cubes), apricot/peach (halves or slices).

Production process. The raw material is cleaned, washed and cut and subsequently blanched or steamed. Then led to the filling line where they are filled in containers, hermetically sealed and pasteurized. After cooling the container is labeled.

Flow diagram 5 - Frozen fruit and vegetables



Packaging. Frozen **industrial** vegetables and fruits (to be repacked or reused later) are packed in 10-25 kg plastic lined carton boxes or in drums of 200 liter. **Consumer** products are packed in rectangle carton boxes or printed plastic bags ranging from 200-1000g. Frozen fruits are sometimes packed in plastic cups of 250-500ml, a small spoon is usually included.

Quality description. Fruits and vegetables must retain its original identity in shape, color and aroma. When sliced or cubed the original fruit must be recognized. It should not be smashed, pulped or broken, this will lower the grade.

Quality problems. Broken product = slow freezing, rough handling, small sizes = cheap raw material, uneven sizes = poor grading.

Marketing issues. Over the years, there has been controversy as to whether frozen vegetables are better or worse than fresh ones. Generally, reports show that frozen vegetables are not much nutritionally different than fresh ones.

Perceived advantages are:

- Increased identity, color and flavor
- Easy to process and often they are a step closer to eating
- Excellent shelf life (at least 24 months at -18º) and
- Availability when their fresh counterpart is out-of-season.
- In many cases, they are cheaper than the fresh product.
- More sanitary than fresh, since they are already cooked.

Perceived disadvantages are:

- Having been processed from their original form, they do not have the same taste as natural fruits and vegetables.
- Concerns over lost nutrients through the processing
- Their uses in recipes are also more limited.

Cigar Box Benchmarks

1. ORGANIC FROZEN BLACKBERRY, IQF:

- **Variable costs**: VC=$1387 (78% of TC); VC1=75%, VC2=17%, VC3=7%
- **Fixed costs:** FC=$466,000 (100% attribution); FC1=30%; FC2=27%; FC3=43%
- **Breakeven:** min. sales volume = 830 ton; min. raw material = 1060 ton
- **Profitability:** good, provided sales volumes for all SKU's are good.
- **Sensitivity:** margin = 29%; normal / desirable.

CB1 - Organic Frozen Blackberry IQF, 12kg in plastic lined carton box

	USD per ton			USD per year	
Price (C&F)	2,446		Total Revenue	2,343,439	
Transport, sales commission 3%	323		Total Cost	2,133,765	
VC4 Transport, sales commission 3%	170		**Profit Before Tax**	**209,674**	
Price (EXW)	**1953**		Profit %	9%	
Price (RM, delivered factory)	820		Asset value	1,750,000	
Processing ratio	1.28		Depreciation %	8.0%	
Raw Material cost	1,049	*75%*	**FC1**	**140,000**	*30%*
Other ingredients	-	*0%*			
VC1	**1,049**	*75%*	Debt (40% of Asset value)	700,000	
			Interest rate	18%	
Production cost per hour (labor, electricity)	144		**FC2**	**126,000**	*27%*
Production quantity per hour	0.60				
VC2	**240**	*17%*	Number of FTE employed	50	
			Salaries permanent staff incl. social taxes	150,000	*32%*
			Other overhead, repairs, maintenance	50,000	*11%*
Cost of packing (plastic, carton box, tape)	1.17		**FC3**	**200,000**	*43%*
Number of carton boxes per ton	83				
VC3	**98**	*7%*	**FC**	**466,000**	*100%*
			FC % attributed to product	100.0%	
Finished Goods losses %	0.2%				
VC	**1,390**	*100%*	**FC (attributed to product)**	**466,000**	
Margin	**563**		Quantity sold q (ton)	1,200	
Margin %	29%		**Contribution**	**675,674**	
			Break even quantity (sales)	**828**	
FC / q	**388**	*22%*	Break even quantity (raw material)	1,059	
TC / q	**1,778**	*100%*	Output capacity per hour in ton	0.60	
			Operating hours per day	22	
Profit / q	**175**		Working days per year	120	
			Max. output capacity per year	**1,584**	
			Capacity utilization %	76%	

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2. FROZEN SWEET MAIZE & PEAS MIXTURE:

- **Variable costs:** VC=$582 (79% of TC); VC1=66%, VC2=17%, VC3=17%
- **Fixed costs:** FC=$466,000 (100% attribution); FC1=30%; FC2=27%; FC3=43%
- **Breakeven:** min. sales volume = 2300 ton; min. raw material = 3000 ton
- **Profitability:** low, provided sales volumes for all SKU's are good.
- **Sensitivity:** margin = 26%; normal / desirable.

CB1. Frozen Sweet Corn and Peas Mixture, packed in PE bag of 500g, 10 bags per carton (5kg)

	USD per ton			USD per year	
Price (C&F)	1,000		Total Revenue	2,350,000	
VAT 20%	167		Total Cost	2,212,754	
VC4 Transport, sales commission 3%	50		**Profit Before Tax**	**137,246**	
Price (EXW)	**783**		Profit %	6%	
Price (RM, delivered factory)	280		Asset value	1,750,000	
Processing ratio	1.30		Depreciation %	8.0%	
Raw Material cost	364	*63%*	**FC1**	**140,000**	*30%*
Other ingredients	21	*4%*			
VC1	**385**	*66%*	Debt (40% of Asset value)	700,000	
			Interest rate	18%	
Production cost per hour (labor, electricity)	144		**FC2**	**126,000**	*27%*
Production quantity per hour	1.50				
VC2	**96**	*17%*	Number of FTE employed	50	
			Salaries permanent staff incl. social taxes	150,000	*32%*
			Other overhead, repairs, maintenance	50,000	*11%*
Cost of packing (PE bag and carton)	0.50		**FC3**	**200,000**	*43%*
Number of carton boxes per ton	200				
VC3	**100**	*17%*	**FC**	**466,000**	*100%*
			FC % attributed to product	100.0%	
Finished Goods losses %	0.2%				
VC	**582**	*100%*	**FC (attributed to product)**	**466,000**	
Margin	**201**		Quantity sold q (ton)	3,000	
Margin %	26%		**Contribution**	**603,246**	
			Break even quantity (sales)	**2,317**	
FC / q	**155**	*21%*	Break even quantity (raw material)	3,013	
TC / q	**738**	*100%*	Output capacity per hour in ton	1.50	
			Operating hours per day	22	
Profit / q	**46**		Working days per year	120	
			Max. output capacity per year	**3,960**	
			Capacity utilization %	76%	

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