agribusiness handbook

Fruit and Vegetable Processing

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This handbook is part of a series of agribusiness manuals prepared by the FAO Investment Centre Division, in collaboration with FAO's Rural Infrastructure and Agro-Industries Division. It was prepared for the EBRD Agribusiness team, under the FAO/EBRD programme of cooperation. The production of the manuals was financed by FAO and by the EBRD multidonor Early Transition Countries Fund and the Western Balkans Fund. The purpose of this handbook is to help agribusiness bankers and potential investors in the Early Transition countries (ETCs) and the Western Balkan countries (WBCs) to acquire basic knowledge about the technical features of fruit and vegetable processing and to become acquainted with recent economic trends in the sector around the world, with a special focus on the ETCs and the WBCs. This volume was prepared by Olivier van Lieshout, Agribusiness Expert, and reviewed by Emmanuel Hidier, FAO Senior Economist, as well as by members of the EBRD Agribusiness team. Electronic copies can be downloaded from www.eastagri.org, where a database of agribusiness companies, including fruit and vegetable processing companies that operate in the ETCs and the WBCs, is also available. Please send comments and suggestions for a future edition of the manual to TCI-Eastagri@fao.org.

Design and page layout Alberto Pedro Di Santo

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ACRONYMS AND DEFINITIONS

Abbreviation	Meaning	Comments
AJC	Apple Juice Concentrate	HS-Code 2009.70.0020
BRC	British Retail Consortium	In 1998, the BRC – responding to industry needs – introduced BRC Food Technical Standards to evaluate the manufacturers of retailers' own brand food products (see www.brc.org.uk).
Bx or Brix	Breaking Index	The breaking index reflects the percentage of soluble solids in a solution (e.g. the percentage of sugar in tomato juice). Brix is measured with a refractometer.
CA/ULO	Controlled Atmosphere Ultra Low Oxygen	After the harvest, many vegetables and fruits are preserved for long periods under 'Controlled Atmosphere' (CA) or 'Ultra Low Oxygen' (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 realized by creating an atmosphere with an increased CO_2 (carbon dioxide), a reduced O_2 (oxygen) concentration and a product focused temperature/humidity. By storing fruits and vegetables within this atmosphere, the ripening process can be controlled (see www.besseling-group.com/caulo.htm).
CB	Cigar Box	The Cigar Box is a spreadsheet-based cost-and-price calculation system with different modules.
CIP	Cleaning In Place	CIP is a processing technology used to clean parts of a factory without the need to dismantle it. This technique is used commonly in the food processing industry.
ETCs	Early Transition countries	In early 2004, the EBRD launched a new initiative to increase its activities in the eight Early Transition countries (ETCs). These are the poorest EBRD countries of operations: Armenia, Azerbaijan, Georgia, Kyrgyz Republic, Republic of Moldova, Mongolia, Tajikistan and Uzbekistan.
EurepGAP	Eurep Good Agricultural Practices	EurepGAP is a private sector body that sets voluntary standards for the certification of agricultural products around the globe (see www.eurepgap.org).
EXW, f.o.b., DAF, C&F, DDU, DDP	Incoterms (i.e. standard trade definitions)	See http://www.iccwbo.org/incoterms/id3040/index.html

Abbreviation	Meaning	Comments
FC	Fixed Cost	Fixed costs are costs that are not influenced by the quantity produced.
FTE	Full Time Equivalent	Two people working 50% of the time correspond to 1 FTE.
GOST	Gosudarstvennyy standard	GOST standards were originally developed by the government of the former Soviet Union and were later on adopted by the CIS. This creates confusion among users who often refer to GOST standards as the national standards of the Russian Federation. This, however, is a common misconception because GOST standards are the official standards of the Euro-Asian Council for Standardization, Metrology and Certification, which is a regional standards organization headquartered in Minsk.
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, as opposed to finished product inspection. HACCPS is used in the food industry to identify potential food safety hazards, so that key actions – known as Critical Control Points (CCPs) – can be taken to reduce or eliminate risks. The system is used at all stages of food production and preparation processes, including packaging and distribution.
Hot fill		Hot fill is a food industry term used when containers are filled at high process temperature to ensure continued sterility of the container and product during and after the filling process (see: http://www.barry-wehmiller-company.com/content/menus/bwb/Glossary.aspx).
HS	Harmonized (Commodity Description and Coding) System	The Harmonized Commodity Description and Coding System (HS) of tariff nomenclature is an internationally standardized system of names and numbers for classifying traded products developed and maintained by the World Customs Organization (WCO) (see: http://www.vassl.com/data/01-24.txt).
IQF	Individually Quick Frozen	Through this process, fruits, berries, or pieces of vegetables are transported over a belt at minus 50–60 °C. Within minutes, the temperature inside the product drops to minus 20 °C.
ISO 22000		ISO 22000 is an ISO standard dealing with food safety. It integrates ISO 9001 and HACCPS.

Abbreviation	Meaning	Comments
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.
NTU	Nephelometric Turbidity Unit	NTU is a unit of measuring transparency in apple juice.
P	Price	
Private label		Private label products (or services) are typically those manufactured or provided by one company for offer under another company's brand. Alternatively, it can refer to a contractual agreement to pack a customer's product its store or chain brand name.
Q	Quantity	The term "volume" also refers to the quantity of product.
RM	Raw Material	RM is an abbreviation used in the Cigar Box.
SIG		SIG is the brand name of the aseptic carton sold for CombiBloc (juice) packing machines.
SKU	Shelf Keeping Unit or Stock Keeping Unit	SKUs refer to all articles sold, e.g. peach jam in 200 ml and 500 ml containers are two different SKUs, although the jam is identical.
TAM/BAS	Turn Around Management/ Business Advisory Services	TAM/BAS are technical assistance programmes offered by the EBRD to support small and medium private enterprises in its region of operation (see www.ebrd.com/apply/tambas/index.html).
Tetrapak		Tetrapak is the brand name of the aseptic carton sold for Tetra/Alfalaval (juice) packing machines.
VAT	Value Added Tax	
VC	Variable Cost	Variable costs are costs that depend on the volume produced.
WBC	Western Balkan countries	
WUA	Water User Association	A WUA is a group of farmers in a specific water catchment or irrigation area who jointly manage the water system.

This handbook is about fruit and vegetables processing. It is written for bankers who, on a field visit to a Western Balkan country (WBC) or an Early Transition country (ETC), want to get a basic understanding of the issues at hand in the fruit and vegetables sector. It explores where (hidden) risks are and what needs to be investigated.

This volume starts with a description of trends in consumption patterns in the developed world, as well as market trends in the WBCs and the ETCs. These trends can be opportunities for producers in the regions but can also pose serious challenges that add to existing constraints. Seen from the perspective of an entrepreneur, there are many opportunities to improve existing businesses. However, only a holistic approach can lead to success. The entire chain must be tackled – from farming, raw material collection and intermediate storage, to primary and secondary processing, distribution, marketing and sales. Management information systems must be introduced to enable daily operational monitoring and ensure traceability. And, last but not least, owners, managers and factory workers need to be trained, coached and motivated to implement new production systems. These changes do not come overnight and cannot usually be paid from the cash flows of existing companies. New types of investments and partnerships are needed, which makes the role of the EBRD – and programmes such as TAM/BAS – so important.

This handbook provides factual information about the fruit and vegetable processing sector and introduces a tool called the Cigar Box, which allows for quick and concise analysis of the viability of existing and new ventures in agroprocessing.

1.1 Market trends in developed countries

Five clear trends can be discerned:

Convenience. Households become smaller and women are more integrated in the production process. This calls for foodstuff which is washed, sliced, pre-cooked and in small portions. i.e. ready-to-prepare or ready-to-eat.

Eco-awareness. More and more, consumers want organic, pesticide free, or ecologically responsible products. Some of them are wary of “fruit miles” and ask themselves if year-round availability of strawberries is really a must for a person’s happiness.

Certification. Large food chains dominate the food retail sector. They require standardization and safeguards against food safety risks. Through certification processes, supermarkets select suppliers. The most common certification systems are BRC, EurepGAP, HACCPS, ISO 9001, and ISO 22000.

Private labels. Consumers in the West start to believe that all products come from the same factory and are of good quality, regardless of the brand name. People are no longer willing to pay 30% more for an A-Brand. Supermarket chains use this opportunity to use their own name as a brand for middle market segments.

Late payment. Even before the credit crisis, supermarkets exerted their bargaining power by paying late. Payment after 120 days or even 180 days is common.

1.2 Opportunities to export

The need for supermarkets to keep their shelves filled with homogeneous products the whole year round leads to worldwide sourcing of foodstuff. This trend opens up production possibilities for everybody. However, if exporting fresh watermelons from Tajikistan into the European Union (EU) is relatively straightforward, selling three types of melon, sliced and packed in trays of 350 g and sent to Tesco within 24 hours can be a challenge for the ETC or the WBC producers.

Challenges. This illustrates the challenges faced by agribusiness exporters in emerging markets. They have to keep up with quality standards, supermarket delivery schedules (especially for fresh food products), and aircraft logistics

and then wait 180 days for their money. The most successful producers ought to be certified, with solid working capital, sophisticated processing technology, good logistics and trained labour.

There is a small but growing market for organic products. Consumer prices of organic products are typically 20–25% higher than conventional products. Because of the high costs of inspection, certification and labelling, only 50% of the higher price is paid to producers. It takes three years before agricultural land and orchards can be declared ”fit for organic”. During this transition period, products are sold as conventional, non-organic products.

1.3 Market trends in emerging markets

Two clear trends can be discerned:

Quality consciousness. Households are fed up with bad looking, foul smelling, poorly packaged and tasteless food products. The import of food products from developed countries has set an irreversible trend. Because more households have better incomes, they are willing (and able) to pay more for better quality.

Brand awareness. Households have become used to advertisements from the world’s global food players. A strong brand is believed to reduce the risk of poor quality. Especially among youngsters, a fresh looking, modern brand encourages buyers to identify themselves with progress, giving a feeling of living in an advanced society and being part of a modern world.

1.4 Opportunities for import substitution

Local processors can copy imported foodstuff. Unfortunately, for the regional businessman, this requires more than just new equipment. Food technology is needed to bring quality up to the desired level. Food marketing is needed to develop brands that are able to convince young consumers. The most successful producers are those that invest in teams of good specialists inspired by what their western competitors are doing in terms of both production and marketing.

2.1 Increasing raw material supply

The scarcity of raw materials is the single largest problem for most agroprocessing companies throughout the regions. Five problems are common and must be overcome in as short a period as possible:

Irrigation. Water is no longer free – except in Uzbekistan – but is still largely wasted due to improper irrigation systems. Water User Associations (WUAs) are set up in countries like Armenia and in the south of Kyrgyzstan. These organizations serve to collect water fees from farmers to pay for the maintenance and operations of pump houses and canals and to equally distribute water to the fields. Many WUAs do not function because of farmers' mistrust and, as a result, pumps are not maintained, electricity bills are not paid and water arrives late, or not at all. Yields are low and there is even less preparedness to pay in the next season. It is crucial to break this vicious circle. Another problem is the reduction of water wastage. Drip irrigation is a good alternative and it has been calculated that investment in field pipes has a payback period of less than two years. Without solving the water problem, agriculture in the regions will have difficulty to prosper.

Land fragmentation. After the collapse of the Soviet Union, many kolkhozes and sovkhozes were divided among workers. Most farmers own 0.3–0.8 ha of irrigated land, which is too small for mechanized agriculture. Where state cadastres are not fully operational, land reform cannot take place.

Collection/cold storage. Most small farmers drive 100 km to the nearest market with a car packed with onions or watermelons. Traders, who normally buy raw material, cold store it and resell it to exporters, local markets or processors at a later time for a higher price, are virtually absent. The first CA/ULO storage cell in Central Asia was built in Margilan, Uzbekistan, as recently as 2007.

Farmer mentality. To be a farmer means to be an entrepreneur. When former kolkhoze/sovkhoze workers took possession of the land in the early 1990s, they were not used to being farmers in the business sense of the word, that is, able to take calculated risks. They were farm workers who usually lacked initiative and were used to following instructions. Eighteen years later, not much has changed in the mentality of the majority of farmers. The brightest

ones have left for greener pastures: from Central Asia and the Caucasus to the Russian Federation; from Eastern Europe to Germany, the United Kingdom and southern Europe. In addition, many donors have been giving free inputs and this has gradually being perceived as “normal”.

2.2 Modernizing agroprocessing industries

Equipment. The low output of factories is not due to lack of capacity or outdated equipment. During the Soviet period, colossal factories were built because steel and concrete were cheap. Despite their modest appearance, most of these factories still operate and it is a fallacy that better quality can only be achieved by first replacing all equipment. Stainless steel pipes and vessel forms are essential components of any fruit and vegetable (and dairy) factory, with stainless steel lasting almost forever. Boilers and autoclaves may be energy inefficient, but they still function. An advantage of most factories is that they are multipurpose. With the installed equipment, they can produce preserves, jams, syrups and juices. Many factories also have an (inefficient) evaporator so they can make paste, purée and concentrates.

Energy efficiency. Energy efficiency helps to reduce the cost of processing and must be pursued. However, it is not the most important problem to be addressed.

The most common problems are:

CIP. CIP – cleaning in place – is rarely applied, and hygiene levels are low. CIP is a system which uses return pipes to continually circulate hot water mixed with caustic soda, keeping the pipes and barrels properly cleaned.

Outdated technology. A technologist can be compared with a cook who determines the recipe and the cooking methods. Technologists perform quality control and new product development in the laboratory and supervise processing in the factory. During Soviet days, all recipes and processes were standardized by GOST. For the authors of GOST, food safety was of prime concern because it protected working class comrades against illness. As a result, pasteurization was severely exaggerated, leading to colour and taste losses and to unnecessary steam consumption. This practice is extremely difficult to change, but must be tackled if quality is to be improved.

Packaging material. Packaging material is important for consumer markets. Soviet style glass jars (“steklo banka”) are still widely used for preserves. Modern looking jars with twist-off lids can be imported but the quality of the jar and the cap fluctuates. Aseptic packing material for juices (Tetrapak, SIG) and concentrates (aseptic plastic bags) must invariably be imported.

Operational monitoring. Operational monitoring is absent, despite the many registers (“kniga”) which are kept by production staff and bookkeepers. As a result, production problems and losses are not systematically recorded and corrected. Improvement cycles such as ”learning by doing” or “learning from mistakes” are not taking place and management is not improving.

Cash mentality. Most owners run their factories only if they have an order with secure payment, preferably an advance payment. Only then will they buy raw material, recruit staff and start processing. This makes it difficult to follow any market strategy with a customized product portfolio or to build a strong brand name.

Small production batches. To get orders from the Russian Federation, Kazakhstan and Europe, significant volumes must be offered. In many cases, one single manufacturer does not have the working capital to produce large quantities and sourcing from different producers is difficult because the finished products are not uniform (despite GOST). A Swiss initiative in Kyrgyzstan has resulted in the establishment of a producers’ association that sells under the common brand name “Vkus Solntsa” (Taste of the Sun).

3. CIGAR BOX AND RISK ANALYSIS

The Cigar Box is a simple Excel tool allowing quick yet concise calculations of the profitability of a single SKU or of an entire product portfolio that a factory wants to produce. The Cigar Box uses four variables: sales price, variable cost, fixed cost and volume. In every risk analysis, a thorough understanding of these critical parameters is indispensable, along with industry benchmarks adapted to the levels of processing technology dominant in the regions (artisan, semi-industrial, industrial).

The Cigar Box calculates three risk parameters: (1) gross margin as a percentage of sales; (2) break-even volume of sales and, derived from that, (3) break-even volume of raw material needed.

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

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

- Break-even sales volume. The break-even sales volume is the minimum volume of sales that the entrepreneur must guarantee with sales contracts.
- Break-even raw material volume. The derived break-even raw material volume is the minimum availability of raw material that the entrepreneur needs to ensure from spot markets or through contract farming.

The Cigar Box tool has been employed by many companies and here is a summary of lessons learned.

3.1 Sales price

The EXW price is the sales price, net of VAT, transport and sales commissions. Most export deals are invoiced DAF, C&F or DDU, suggesting that the seller is paying the cost of delivery. In reality, the underlying agreement is a f.o.b. or even EXW price, meaning that the buyer must pay for the transport cost. The price difference is often paid in cash or to an offshore account.

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

3.2 Variable costs

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.

VC1 depends on the seasonal price of the principal raw material, the grade used and the processing ratio.

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 prices to it.

VC2 includes the cost of steam, water, electricity and variable labour, traditionally all very cheap. The recent increases in energy prices triggered a change in behaviour: the insulation of autoclaves and the recycling of hot water. Companies with efficient energy saving operations will be more competitive.

Lesson 4: Changing processing behaviour requires training and demonstration, plus steady follow-up and prompting. Only this will lead to real changes in behaviour and savings.

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

3.3 Fixed costs

Fixed costs (FC) are not influenced by the volume produced. The Cigar Box distinguishes three fixed costs: FC1 = depreciation; FC2 = cost of financing; and FC3 = all other overheads, including salaries for staff not included in VC2.

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

3.4 Volume produced and sold

It is generally felt that sales volume is the most difficult parameter to predict during any due diligence or fact-finding mission. The main reason for this is the difficulty in predicting the volume of raw material that will be processed. This difficulty exists because of poor raw material procurement, lack of (timely) working capital, poor harvests due to insufficient water, inputs, tractors, farm management, etc.

Lesson 6: It is more difficult to produce large volumes than to sell them.

Several processing companies try to overcome the raw material uncertainty with contract farming on open land or in greenhouses. However, this seldom works well because contracts are typically not honoured and difficult to enforce legally. 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 at a higher price elsewhere. A good contract offers a fixed floor price against which 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 7: The importance of professional contract farming cannot be overestimated.

Evaluating opportunities in fruit and vegetable processing requires specific knowledge of many different products. It is not uncommon for a fruit and vegetable processing company to process 40 different types of fruits, vegetables, berries and herbs into 100–200 different SKUs. Nevertheless, it is possible to summarize key issues by describing seven product categories: (1) tomato paste; (2) ketchup; (3) fruit juice concentrates and purées; (4) juices, nectars and drinks; (5) preserves, jams, syrups and compotes; (6) canned vegetables; and (7) frozen fruit and vegetables.

4.1 Tomato paste

Product. Tomato paste is a thick paste made from ripened tomatoes with skin and seeds removed. Depending on its manufacturing conditions, it can be used to make either ketchup or reconstituted tomato juice. Tomato paste is concentrated tomato purée. Purée has a Brix of 15–20 and paste has a Brix of 25–36.

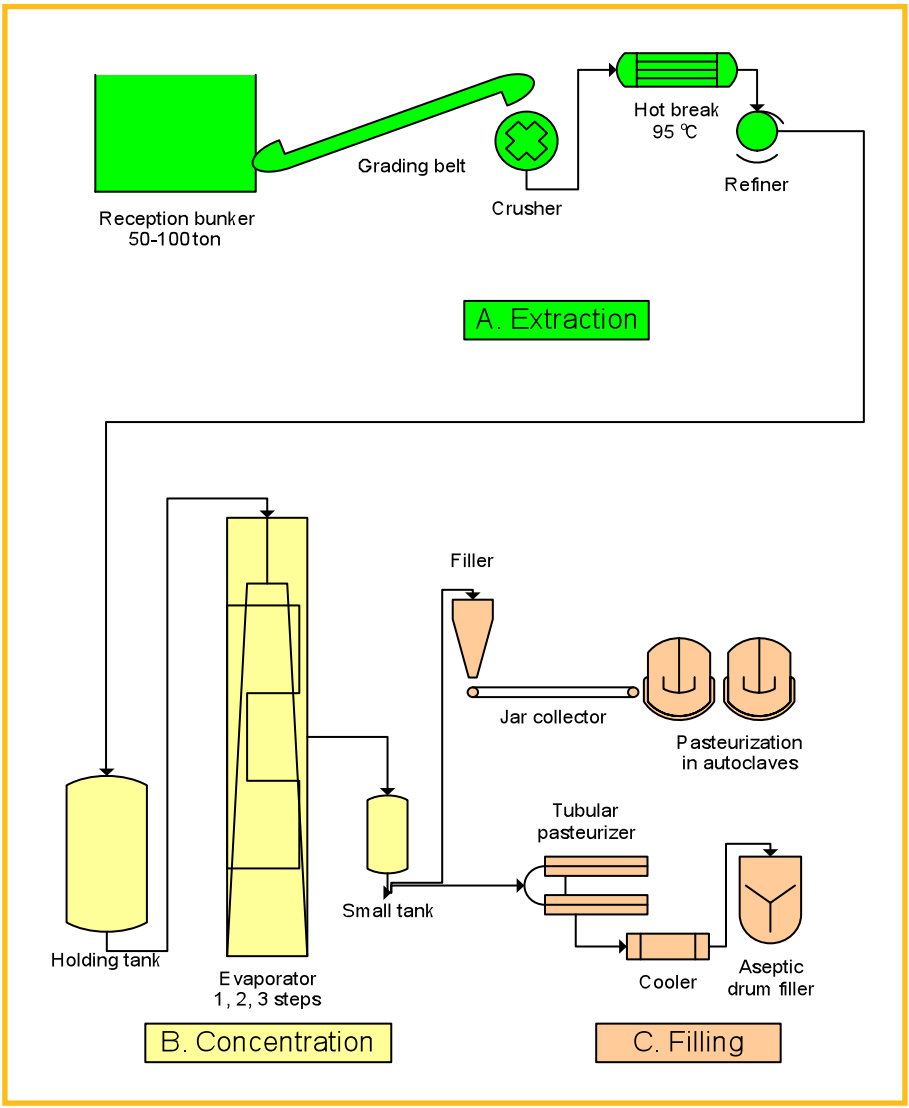
Raw material. The preferred raw material is processing tomato of 5–6.5 Brix, but consumption tomato of 4–5 Brix is more often used.

Yield benchmarks. The actual yield (on partially irrigated, poorly managed open land) is 15–25 tons/ha. The potential yield (on irrigated open land) is 60–120 tons/ha. Greenhouse yield (year-round and with good management) is 300–600 tons/ha.

Processing ratio. Five to 7 kg of tomatoes are needed for 1 kg of paste. The higher the sugar content (measured in Brix) of the raw tomato, the better/lower the processing ratio.

Production process. After reception in 10–50 ton bunkers filled with water, the tomatoes are crushed by a pulper. The pulp is then pumped through a heat exchanger at a temperature of 95 °C to destroy the pectinase released during pulping (this is known as “hot break”). The pulp is sieved to remove seeds and skin, which constitute 3–4% of the weight. Next, water is evaporated from the pulp by adding steam. One kg of steam removes 1 kg of water. This is called the “effect”. To double or triple steam use efficiency, two or three effect evaporators are in use and the steam is recycled two or three times. To maintain quality, the temperature in the evaporator must be as low as possible; therefore, a vacuum is created above the pulp so that water will boil at 70 ºC. Once the paste has the required concentration, measured in Brix, it leaves the evaporator to be pasteurized and packaged.

Flow diagram 1 – Tomato paste, with jar filling and aseptic drum filling



Packaging. Industrial paste (to be repacked or reused later) is packed in aseptic bags of 25–250 litres and kept in steel or plastic drums. Consumer paste is either filled in tins of 30–900 g or in glass jars of 200–3,000 ml.

Quality description. The paste must be bright red and have the right

consistency: solid, not liquid. It must have a true tomato aroma and be free from off-tastes or smells.

Quality problems.

- If the tomato paste is too dark, it indicates that it has been overcooked.
- If it is too liquid, the temperature of the hot break is too low.
- A yoghurt taste indicates the presence of lactic acid bacteria, which results from the raw tomato standing for too long before being processed.

All these problems can be overcome with proper technology.

Market issues. The containers require proper labelling with a list of ingredients and net content, as well as the whereabouts of the manufacturer.

Cigar Box benchmarks (for tomato paste, aseptic bags of 220 kg in steel drums).

- **Price range:** USD 500–1,000 C&F Rotterdam.
- **Variable costs:** VC = USD 500 (85% of TC); VC1 = 68%; VC2 = 12%; VC3 = 20%.
- **Fixed cost:** FC = USD 300,000; FC1 = 48%; FC2 = 29%; FC3 = 23%.
- **Break-even:** Minimum sales = 2,400 tons; minimum quantity of raw material = 16,000 tons.
- **Profitability:** Tomato paste is a commodity type product with high volume and low to moderate profitability level for the processor. Capacity utilization must be over 70%. Profitability (2007) for 21,600 tons of tomato into 3,600 tons of 25 Brix paste = 5–9%.
- **Sensitivity:** Gross margin = 13%. Very risky: because the processing ratio is high, the price of the raw tomato is crucial. In the Cigar Box example below, a 12% increase in the price of raw tomato will reduce the profit to zero. Hence, it is important to have a stable and cheap source of tomatoes in the neighbourhood of the factory.

Table 1: Investment benchmarks derived from the Cigar Box for tomato paste production (25 Brix, in aseptic bags of 220 kg in steel drums)

CIGAR BOX – Tomato paste					
	USD /ton			USD /year	
Price (c&f)	700		Total revenue	2,265,943	
Transport. sales commission	71		Total cost	2,115,272	
Import duties	–		Profit before tax	150,671	
Price (exw)	629		Profit %	7%	
Price (rm. delivered factory)	57		Asset value	1,800,000	
Processing ratio	6.0		Depreciation %	8.0%	
Raw material cost	343	68%	FC1	144,000	48%
Other ingredients	–	0%			
VC1	343	68%	Debt (40% of asset value)	720,000	
			Interest rate	12%	
Production cost per hour (steam. electricity)	124		FC2	86,400	29%
Production volume per hour (ton/hour)	2				
VC2	62	12%	Number of fte employed	15	
			Salaries permanent staff incl. Social taxes	50,000	17%
			Other overhead. repairs. maintenance	20,000	7%
Cost of packing (aseptic bag. drum)	21.80		FC3	70,000	23%
Number of drums per ton	4.50				
VC3	99	20%	FC	300,400	100%
			FC % attributed to product	100.0%	
VC	504	100%	FC (attributed to product)	300,400	
Gross margin	125		Break even volume	2,397	
Gross margin %	20%		Volume sold q (ton)	3,600	
			Raw material needed (ton)	21,600	
FC / q	83	14%			
			Input capacity per hour in ton	12.0	
TC / q	588	100%	Working hours per day	22	
			Length of harvesting season in days	110	
Profit / q	42		Max. Input capacity per year	29,040	
			Capacity utilization %	74.4%	

Note: Cells in blue are assumptions, orange is a link to another sheet, cells in light blue are calculations.

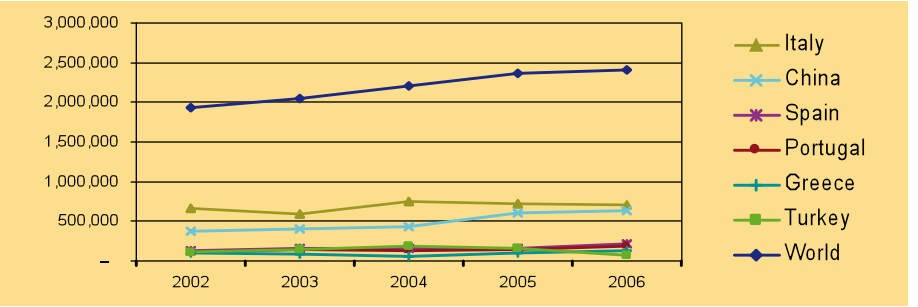
Main investment risks. The market for tomato paste is vast. When a standard commodity can be produced, it can always be sold. The main risk is to secure sufficient volumes of low-priced industrial tomatoes. If farmers prefer to grow consumption tomatoes for which higher fresh market prices are paid, the supply of sufficient raw material is always problematic.

Key players in the ETCs and the WBCs. See http://www.eastagri.org/agribusinesses

World market (2007): 2,500,000 tons of tomato paste (HS 200990)

Main exporting countries (tons)		Main importing countries (tons)	
China	841,000	Italy	210,000
Italy	657,000	Germany	182,000
Spain	241,000	Russian Federation	161,000
Portugal	177,000	United Kingdom	122,000
Uzbekistan	20,000	France	121,000
Armenia	4,800	Japan	117,000
		Kazakhstan	14,000

Figure 1: Exports of tomato paste over time (tons)



Source: http://www.trademap.org/

4.2 Ketchup

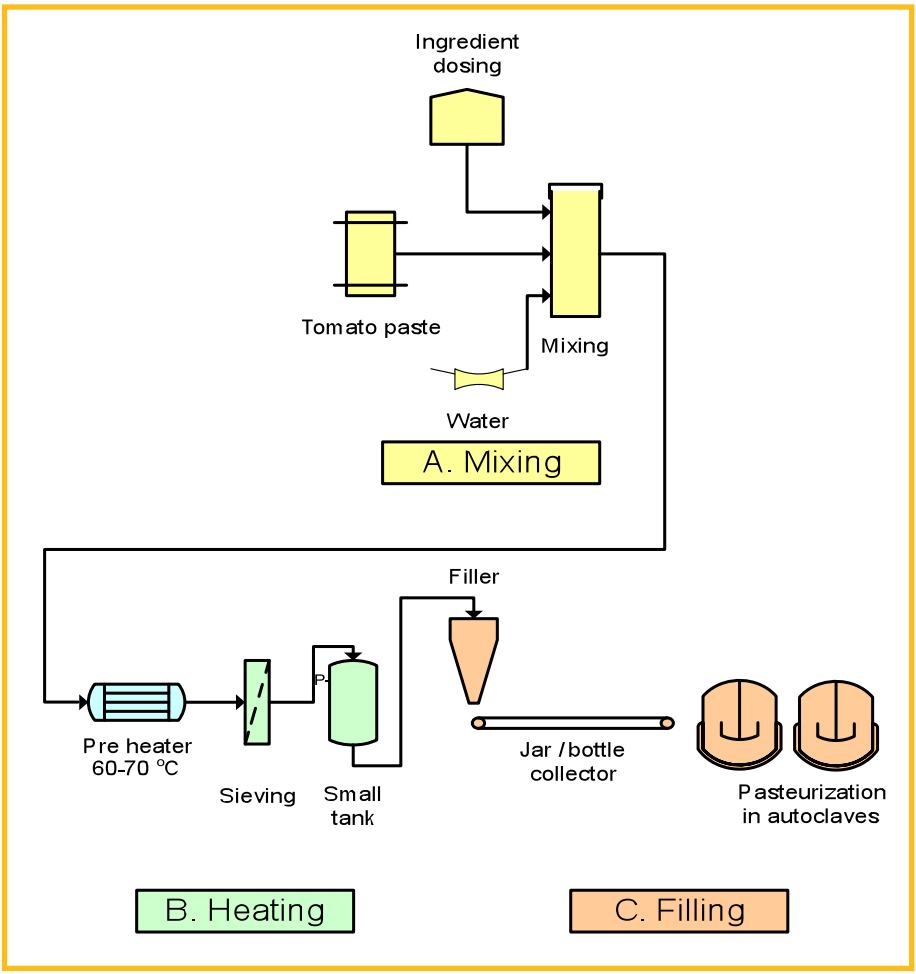
Product. Tomato ketchup is a sauce made from tomatoes or residues from the processing of tomatoes to which salt and spices are added as well as one or more nutritive sweetening ingredients, vinegar or onion, garlic or other vegetable flavouring ingredients.

Raw material. Tomato paste has a Brix of 28–36.

Processing ratio. 0.3–0.4 kg of tomato paste is needed for 1 kg of ketchup. The higher the sugar content (measured in Brix) of the tomato paste, the better/lower the processing ratio.

Production process. The product is made from concentrated tomato juice or tomato paste, to which ingredients such as vinegar, salt and spices are added, after which the product is boiled, fine sieved, placed in bottles and pasteurized in an autoclave.

Flow diagram 2 – Ketchup



Packaging. Ketchup for hotels and restaurants is packed in 3 – 10 litre tin containers. Consumer ketchup is filled in plastic or glass bottles of 250 – 1,000 ml.

Quality description. Ketchup must be red. It must be liquid but not too fluid with a good aroma of tomato and ingredients and be free from off-tastes or smells.

Quality problems. The main processing problem is related to the issue that the product turns black at the contact zone with air due to the action of iron on the tannins. This can be prevented by avoiding the use of iron equipment, avoiding the crushing of tomato seeds and sealing the bottles in a vacuum.

Marketing issues. Ketchup is a branded product and the recipe is the key secret of the producer. The product knows strong international labels such as Heinz and is heavily promoted via marketing efforts. Year-round availability on the shelves is a must to achieve customer loyalty.

Cigar Box benchmarks (for tomato ketchup packed in 800 g plastic bottles).

- **Variable costs:** VC = USD 600 (78% of TC); VC1 = 50%; VC2 = 10%; VC3 = 40%.
- **Fixed cost:** FC = USD 86,000; FC1 = 29%; FC2 = 14%; FC3 = 57%.
- **Break-even:** Minimum sales volume = 220 tons; minimum raw material = 70 tons.
- **Profitability:** Ketchup is a real value-added consumer item with high profitability for the processor. Capacity utilization (year round production is a must) must be over 50%. Profitability (2007) for 150 tons of paste into 500 tons of ketchup = 20–24%.
- **Sensitivity:** Gross margin = 40%. Robust: no particular production issues; marketing is more difficult than production. Cost and quality of packing must be watched.

Table 2: Investment benchmarks derived from the Cigar Box for tomato ketchup (classic) (in 900 g plastic bottles, sold in carton boxes of 12 (10.8 kg))

CIGAR BOX – Tomato ketchup					
	USD /ton			USD /year	
Price (C&F)	1,220		Total revenue	493,083	
VAT 20%	203		Total cost	383,862	
Transport, sales commission 3%	31		Profit before tax	109,221	
Price (EXW)	986		Profit %	22%	
Price (RM, delivered factory)	700		Asset value	250,000	
Processing ratio	0.30		Depreciation %	10.0%	
Raw material cost	210	35%	FC1	25,000	29%
Other ingredients	95	16%			
VC1	305	51%	Debt (40% of asset value)	100,000	
			Interest rate	12%	
Production cost per hour	5.3		FC2	12,000	14%
Production volume per hour	0,093				
VC2	57	10%	Number of FTE employed	10	
			Salaries permanent staff incl, social taxes	35,000	41%
			Other overhead, repairs, maintenance	14,000	16%
Cost of packing	2.52		FC3	49,000	57%
Number of packs per ton	93				
VC3	233	39%	FC	86,000	100%
			FC % attributed to product	100.0%	
VC	596	100%	FC (attributed to product)	86,000	
Gross margin	390		Break-even volume	220	
Gross margin %	40%		Volume sold q (in ton)	500	
			Raw material needed (in ton)	150	
FC / q	172	22%			
			Output capacity per hour in ton	0.093	
TC / q	768	100%	Working hours per day	22	
			Length of production season in days	330	
Profit / q	218		Max, output capacity per year	675	
			Capacity utilization %	74,1%	

Note: Cells in blue are assumptions, orange is a link to another sheet, cells in light blue are calculations.

Main investment risks. The challenge for tomato ketchup is year-round tomato supply. Direct production from fresh tomatoes in season is cheaper, but must be supplemented by more expensive indirect production from paste out of season. The need for strong marketing is often neglected.

Key players in the regions. See: http://www.eastagri.org/agribusinesses/

World market (2007): 900,000 tons of ketchup

Main exporting countries (tons)		Main importing countries (tons)	
United States	180,000	United Kingdom	116,000
Netherlands	130,000	France	105,000
Canada	71,000	Canada	98,000
Italy	61,000	United States	91,000
Spain	57,000	Germany	81,000
Germany	57,000	Russian Federation	25,000
Ukraine	15,000	Ukraine	15,000
Russian Federation	13,000		

4.3 Fruit juice concentrates and purées

Product. Fruit juice is obtained by extracting cellular juice from a single fruit. All seeds, stones, skin and intercellular walls are removed. A *single strength* juice has the same sugar level as the original fruit. It has a short shelf life and is packed aseptically or frozen. To reduce transport cost and increase the shelve life with high Brix levels, the single strength juice is concentrated by evaporation. This is done for all fruits and berries. The term "concentrate" is used for fruits that give clear juices, without particles, e.g. apple juice concentrate and cherry concentrate. Concentrates have a high Brix of 60–70[1]. The term "purée" is used for fruit types that produce cloudy juices, containing fruit pulp, e.g. apricot purée and peach purée. When a single strength purée is concentrated, the term ''double strength'' or ''triple strength'' is used.

Raw material. Concentrates and purées are made from leftover fruit or fruit that cannot be sold on the fresh market due to damage. Fruit has natural sugar levels, which differ between varieties, but which increase towards maturity (see Section 6).

[1] *An exception is cloudy apple juice concentrate, which contains evenly-distributed small pulp suspensions and has 45 Brix.*

Apricot (14–22 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 apple juice concentrate (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.

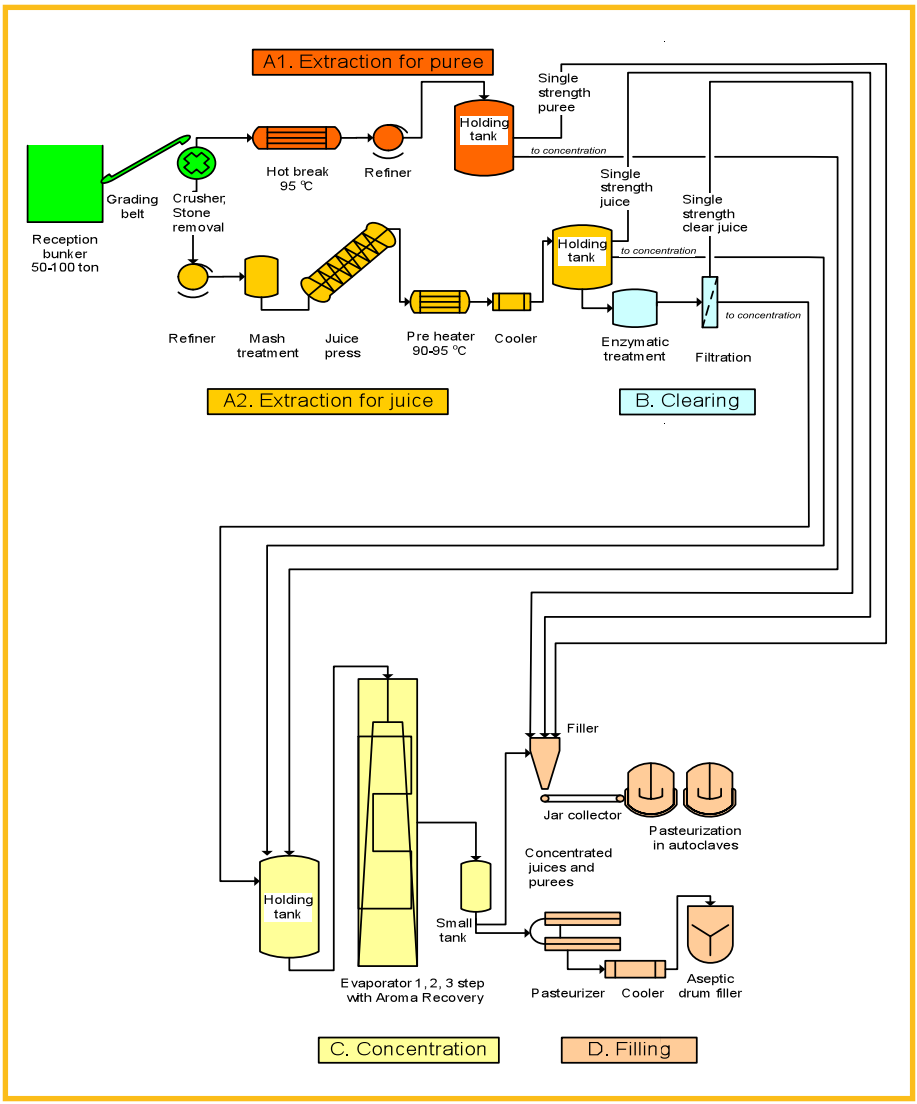
Yield benchmarks

	Fruit	Actual yield (not/partially irrigated, poor 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 tons/ha	15–25 tons/ha	30–80 tons/ha
2	Apricot/peach	2–4 tons/ha	5–8 tons/ha	9–16 tons/ha
3	Cherry	3–8 tons/ha	10–15 tons/ha	20–30 tons/ha

Processing ratio. It depends on the desired concentration. The higher the sugar content (measured in Brix) of the fruit, the better/lower the processing ratio. For instance, 6–8 kg of apples of 12 Brix are needed for 1 kg of AJC of 70 Brix; 1.7 kg of apricot of 16 Brix are needed for 1 kg single strength purée of 16 Brix.

Production process. Heavy pressing equipment is needed to juice an apple. After pressing, the juice is evaporated in a vacuum up to a concentration of 70 Brix. To produce clear apple juice concentrate, two additional treatments have to be performed on the cloudy product, namely treatment with enzymes and filtration of the final product. Modern installations recover aromas that may be returned back into the product.

Flow diagram 3 – Fruit juice concentrates and purées



Packaging. Concentrates and purées are intermediate products for industrial use and are thus packed in aseptic bags of 15–200 litres. Big containers are also in use, carrying up to 1,000 litres.

Quality description. Clear apple juice concentrate must be clear golden brown with no impurities (turbidity = <5 NTU) and with a standard Brix of

around 70%. There are three acidity levels: low = 0.8–2%; medium = 2–4%; high = 5–7%. Peach and apricot purée must have the original fruit colour and original aroma with no deviations, no impurities, and the standard Brix, e.g. double strength apricot purée has a Brix of 28.

Quality problems.

- Poor filtration causes concentrates and purées to lack clarity (with an NTU greater than 70).
- A bad or yoghurty smell indicates the presence of lactic acid bacteria, which is caused when the fruit is left standing for too long before being processed.
- Too low concentrate causes concentrates and purées to be too liquid and this leads to an inferior product.
- Bad recovery of aroma leads to the product having an aroma that is too weak.
- The concentration or purée will have a too dark appearance if it is overheated during evaporation and/or pasteurization.
- Browning of the final product and unwanted change of taste is caused by loss of sterility.

Marketing issues. Concentrates and purées 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. Being a commodity makes it possible to sell under warrant. Processors can ship the goods to, for example, Rotterdam, store them there and receive 50–80% of the value prior to concluding the final sale.

Cigar Box benchmarks.

1. Apple juice concentrate in aseptic bags of 200 litres in steel drums.

- **Price range:** USD 600–1,400 C&F Rotterdam.
- **Variable costs:** VC = USD 610 (84% of TC); VC1 = 75%; VC2 = 10%; VC3 = 15%.
- **Fixed cost:** FC = USD 440,000; FC1 = 31%; FC2 = 15%; FC3 = 54%.
- **Break-even:** Minimum sales volume = 2,750 tons; minimum raw material = 22,000 tons.
- **Profitability:** AJC gives low to moderate profitability to the processor. Capacity utilization (seasonal) must be over 75%. Profitability (2007) for 30,000 tons of apples into 3,800 tons AJC = 5–9%.
- **Sensitivity:** Gross margin = 21%. Risky: since 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 neighbourhood of the factory, preferably with medium/high acidity apple varieties.

Table 3: Investment benchmarks derived from the Cigar Box for apple juice concentrate (70 Brix, in aseptic bags of 220 kg in steel drums)

CIGAR BOX – apple juice concentrate					
	USD /ton			USD /year	
Price (C&F)	1,200		Total revenue	2,933,600	
Transport, sales commission 3%	236		Total cost	2,763,509	
Import duties, 16%	192		Profit before tax	170,091	
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 volume per hour (ton/ hour)	2.5				
VC2	58	10%	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%	
VC	610	100%	FC (attributed to product)	446,200	
Gross margin	162		Break-even volume	2,751	
Gross margin %	21%		Volume sold q (in ton)	3,800	
			Raw material needed (ton)	30,400	
FC / q	117	16%			
			Input capacity per hour in ton	20	
TC / q	727	100%	Working hours per day	22	
			Length of harvesting season in days	90	
Profit / q	45		Max, input capacity per year	39,600	
			Capacity utilization %	76.8%	

Note: Cells in blue are assumptions, orange is a link to another sheet, cells in light blue are calculations.

Key players. China (low acidity apples), Poland (high acidity apples).

World market (2007): 1,447,000 tons of apple juice concentrate (HS 200979).

Main exporting countries (tons)		Main importing countries (tons)	
China	670,000	United States	391,000
Poland	206,000	Germany	146,000
Austria	80,000	United Kingdom	110,000
Switzerland	70,000	Japan	107,000
Chile	60,000	Russian Federation	96,000
Argentina	60,000	Kazakhstan	7,000
Republic of Moldova	11,000		
Uzbekistan	5,800		
Georgia	2,300		

2. Apricot purée (10 Brix, in 2-litre glass jars).

- **Price range:** USD 600–900 C&F Rotterdam.
- **Variable costs:** VC = USD 430 (84% of TC); VC1 = 52%; VC2 = 12%; VC3 = 36%.
- **Fixed cost:** FC = USD 120,000 (50% attribution); FC1 = 42%; FC2 = 25%; FC3 = 33%.
- **Break-even:** Minimum sales volume = 1,000 tons; minimum raw material = 1,700 tons.
- **Profitability:** Apricot purée gives moderate profitability to the processor. Capacity utilisation (seasonal) must be over 75 %. Profitability (2007) for 2,900 tons of apricot into 1,700 tons of purée = 7–11%.
- **Sensitivity:** Gross margin = 22%. Risky: in the Cigar Box example below, a 21% increase in the price of apricot from USD 130 to USD 159 per ton will reduce the profit to zero.

Table 4: Investment benchmarks derived from the Cigar Box for apricot purée (20 Brix double strength, in glass jars of 2 litres)

CIGAR BOX – apricot purée					
	USD /ton			USD /year	
Price (C&F)	670		Total revenue	934,830	
Transport, sales commission 3%	120		Total cost	848,715	
Import duties, 0%	0		Profit before tax	86,115	
Price (EXW)	550		Profit %	9%	
Price (RM, delivered factory)	130		Asset value	1,250,000	
Processing ratio	1.71		Depreciation %	8.0%	
Raw material cost	222	52%	FC1	100,000	42%
Other ingredients	-	0%			
VC1	222	52%	Debt (40% of asset value)	500,000	
			Interest rate	12%	
Production cost per hour (steam, electricity)	155		FC2	60,000	25%
Production volume per hour	2.92				
VC2	53	12%	Number of FTE employed	15	
			Salaries permanent staff incl, social taxes	50,000	21%
			Other overhead, repairs, maintenance	28,600	12%
Cost of packing (jar, cap)	0,31		FC3	78,600	33%
Number of jars per ton	500				
VC3	154	36%	FC	238,600	100%
			FC % attributed to product	50.0%	
VC	429	100%	FC (attributed to product)	119,300	
Gross margin	121		Break-even volume	987	
Gross margin %	22%		Volume sold q (ton)	1,700	
			Raw material needed (ton)	2,907	
FC / q	70	14%			
			Input capacity per hour in ton	5,0	
TC / q	499	100%	Working hours per day	22	
			Length of harvesting season in days	35	
Profit / q	51		Max, input capacity per year	3,850	
			Capacity utilization %	75.5%	

Note: Cells in blue are assumptions, orange is a link to another sheet, cells in light blue are calculations.

Main investment risks. The market for concentrates and purées is large. When this standard commodity can be produced, it can always be sold. The main risk is to secure sufficient volumes of low-priced fruit. Many orchards are old and neglected and yields per ha are low. 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 bring in much lower prices.

Key players in the regions. See: http://www.eastagri.org/agribusinesses/

World market (2007): 150,000 tons of apricot purée (HS 200850)

Main exporting countries (tons)		Main importing countries (tons)	
South Africa	25,000	France	48,000
Spain	24,000	Germany	38,000
Greece	24,000	Belgium	36,000
Netherlands	16,000	Netherlands	13,000
Morocco	14,000	Russian Federation	12,000
Uzbekistan	400		

World market (2007): 139,000 tons of cherry concentrate (HS 208860)

Main exporting countries (tons)		Main importing countries (tons)	
Hungary	37,000	Germany	43,000
United States	14,000	Russian Federation	13,000
Germany	10,000	France	12,000
Serbia	7,000	Bulgaria	8,000
Poland	7,000	Japan	5,000

World market (2007): = 796,000 tons of peach purée (HS 208870)

Main exporting countries (tons)		Main importing countries (tons)	
Greece	297,000	United States	102,000
China	149,000	Germany	94,000
Spain	77,000	Mexico	61,000
South Africa	69,000	Japan	58,000
Chile	55,000	Thailand	38,000
Republic of Moldova	230	Russian Federation	35,000

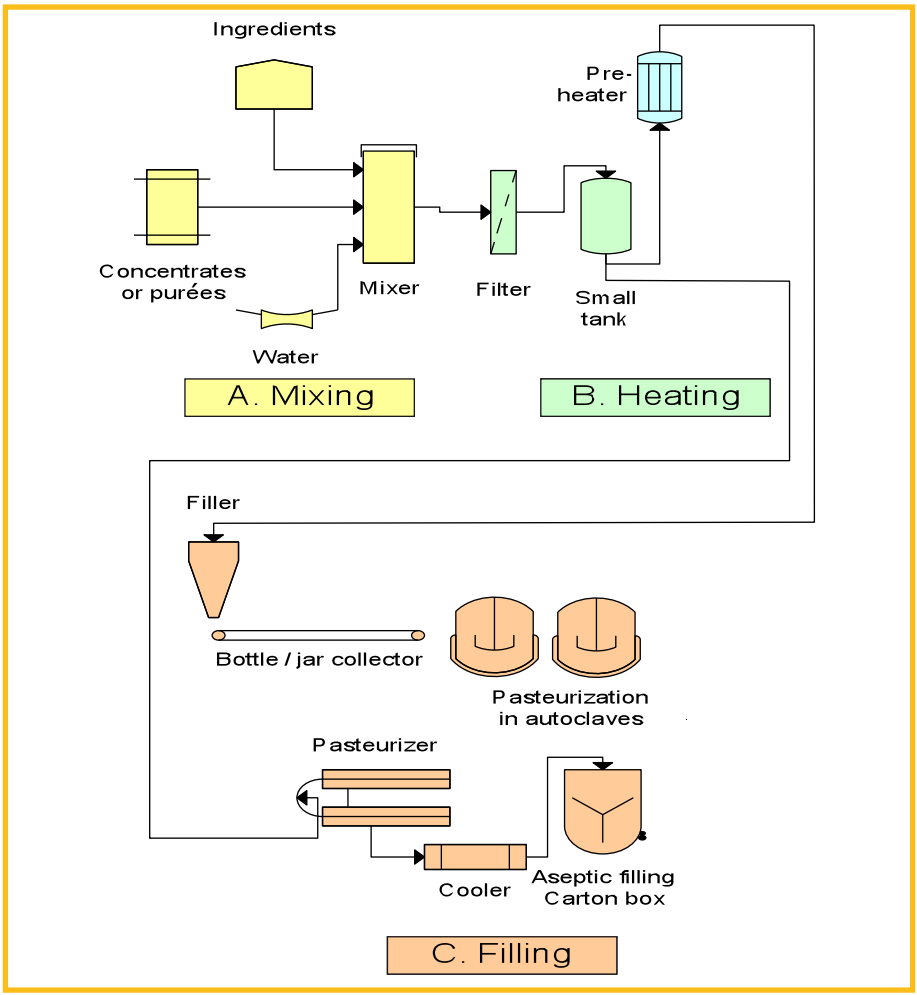
4.4 Juices, nectars and drinks

Product. Juices and nectars are single strength products (that is 100% fruit juice) obtained from the extraction of cellular juice from a single fruit or from a mixture. Nectars contain fruit pulp, while juices are clear and without pulp. Both can be produced with or without the addition of sugar and other ingredients. Drinks are mixtures of juice or nectar with water and have a fruit content of less than 100%. Drinks usually contain 15–35% of fruit. The taste can be boosted with natural or synthetic aromas, sugar and other ingredients.

Raw material. Fruit purée is used to produce nectar and fruit juice concentrate is used to produce juice.

Production process. Production starts with blending purées 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 self 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 4 – Juices, nectars, drinks



Packaging. Non-sterile products are packed in glass or PET bottles and the aseptic (sterile) products in special cartons (Tetrapak, Purepak, SIG). Cartons and bottles of 150–2,000 ml are used.

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

Quality problems.

- Inflation/exploding containers is caused by gas formation during storage, which in turn is caused by 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 or a deviation in colour is caused by a bad recipe or by cheap raw material.
- Adulteration of raw material supplied may result in the aroma being incorrect.

Marketing issues. Clients want a broad assortment, usually more than ten aromas in two to three different sizes or 20–30 SKUs. In addition to larger volumes of regular products (for example apple, orange, apricot, peach, and cherry), more exclusive fruit flavours in small volumes must be offered (for example, pomegranate, blackcurrant, pineapple and national red fruit). The juice containers require proper labelling 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 the private label of the importer/ wholesaler or supermarket.

Cigar Box benchmarks (for fruit juice from concentrate).

- **Variable costs 1 litre:** VC = USD 500 (77% of TC); VC1 = 61%; VC2 = 14%; VC3 = 24%–150 ml; VC = USD 580 (77% of TC); VC1 = 53%; VC2 = 12%; VC3 = 35%.
- **Fixed costs:** FC = USD 1,000,000; FC1 = 20%; FC2 = 18%; FC3 = 63%.
- **Break-even:** Minimum sales volume = 4,200 tons; minimum raw material = 1,000 tons.
- **Profitability:** Fruit juices give high profitability to the processor. Capacity utilization (year-round) must be over 70%. Profitability (2007) for 10,000 tons from 3,800 tons of concentrates = 17–20%.
- **Sensitivity:** Gross margin = 33%. Normal/desirable: 20% price fluctuations will not lead to losses.

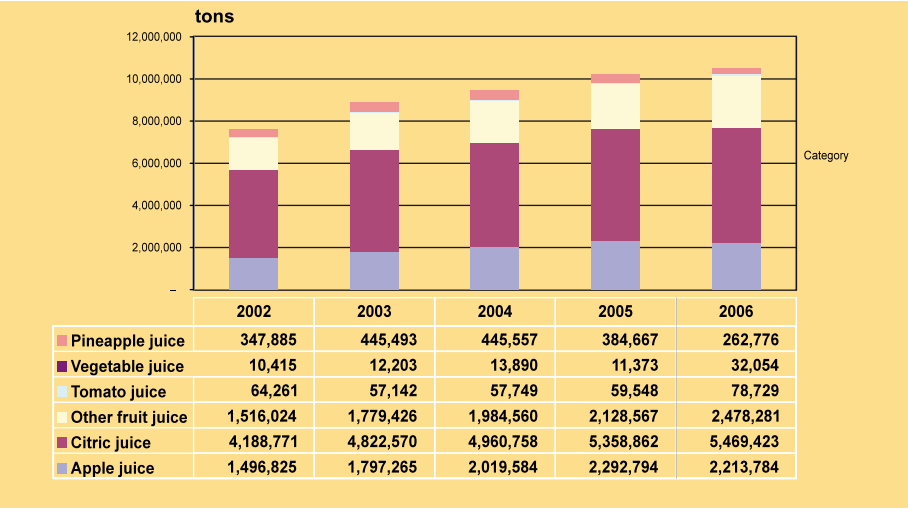
Table 5: Investment benchmarks derived from the Cigar Box for fruit juice (100%) from concentrates (in 1 litre carton brick, 6 in shrinkwrap (6 kg)

CIGAR BOX – fruit juice (100%) from concentrates					
	USD /Ton			USD /Year	
Price (C&F)	985		Total revenue	7,462,083	
VAT 20%	164		Total cost	6,027,418	
Transport, sales commission 3%	75		Profit before tax	1,434,665	
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 volume 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%	
VC	499	100%	FC (attributed to product)	1,037,600	
Gross margin	247		Break-even volume	4,197	
Gross margin %	33%		Volume sold q (ton)	10,000	
			Raw material needed (ton)	3,846	
FC / q	104	17%			
			Ouput capacity per hour in ton	3.0	
TC / q	603	100%	Working hours per day	16	
			Length of production season in days	300	
Profit / q	143		Max, output capacity per year	14,400	
			Capacity utilization %	69.4%	

Note: Cells in blue are assumptions, orange is a link to another sheet, cells in light blue are calculations.

Main investment risks. The juice business demands creative marketing. Manufacturing is not at all difficult, especially when using (imported) concentrates and purées. 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 because 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!

Figure 2: Breakdown of world exports of juices, excluding grape juice, over time



	2002	2003	2004	2005	2006
Pineapple juice	347,885	445,493	445,557	384,667	262,776
Vegetable juice	10,415	12,203	13,890	11,373	32,054
Tomato juice	64,261	57,142	57,749	59,548	78,729
Other fruit juice	1,516,024	1,779,426	1,984,560	2,128,567	2,478,281
Citric juice	4,188,771	4,822,570	4,960,758	5,358,862	5,469,423
Apple juice	1,496,825	1,797,265	2,019,584	2,292,794	2,213,784

Source: http://www.trademap.org/

Key players in the regions See: http://www.eastagri.org/agribusinesses/

World market (2007): 12,746,000 tons, of which citrus juices 52% and apple juice 21%.

Main exporting countries (tons)		Main importing countries (tons)	
Brazil	2.165,000	United States	2,583,000
China	1,140,000	Germany	1,158,000
United States	1,076,000	France	1,040,000
Germany	927,000	Belgium	845,000
Belgium	927,000	United Kingdom	787,000
Ukraine	146,000	Russian Federation	377,000
Republic of Moldova	33,000	Kazakhstan	78,000
Tajikistan	13,000		
Uzbekistan	13,000		

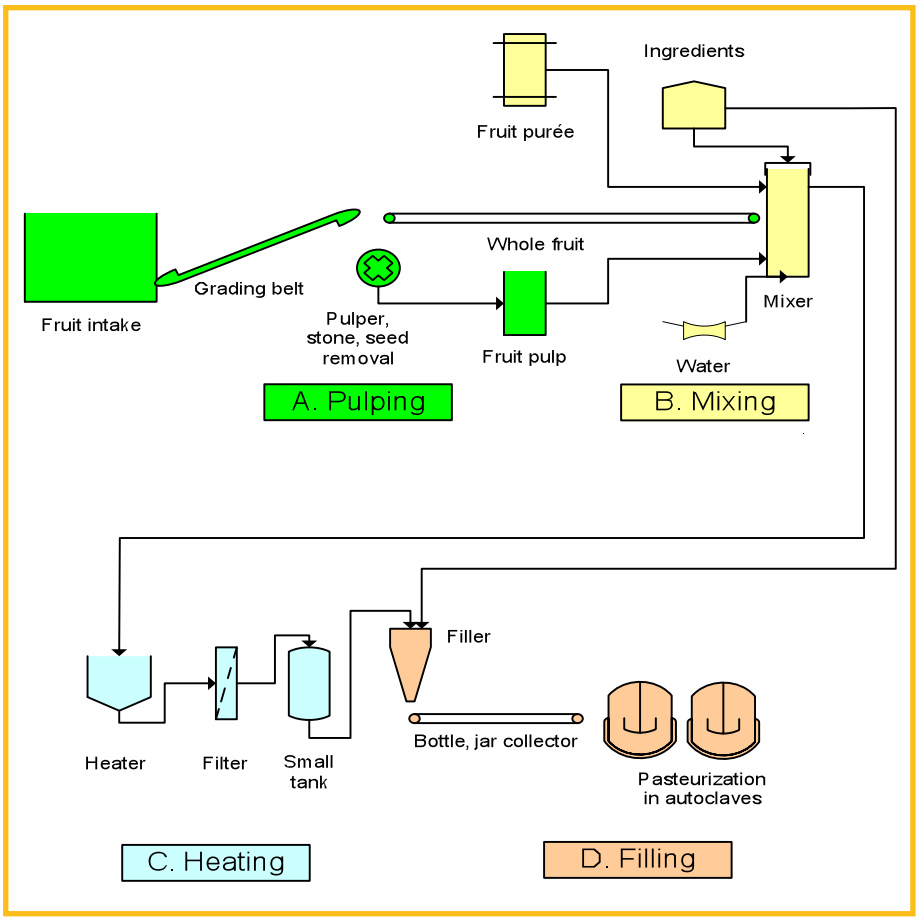
4.5 Preserves, jams, syrups and compotes

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 (with a Brix of 60–70). Syrup is condensed, sweetened fruit juice (60–70 Brix). Compote is a drink made by extracting aromas from whole fruits in water, and adding sugar to taste (30–50 Brix).

Raw material. Most types of fresh fruits, berries and vegetables. Different grades are used (see Section 6, Table 3).

Production process. Fresh or precooked 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 than 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; the viscosity is higher than in juices because part of the water is evaporated and sugar is sometimes added. In the hot boiling of the products, micro-organisms are destroyed and the products are bottled hot to achieve a natural vacuum under the caps.

Flow diagram 5 – Preserves, jams and syrups



Packaging. Traditionally, preserves, jams, syrups and compotes are packed in 200–3,000 ml glass jars, mostly with Twist-Off, although the Soviet style 1-, 2- and 3-litre jars are still used. Hotels and restaurants demand larger volumes packed in 1- to 5-litre jars and tins. The containers require proper labelling with a list of ingredients, net weight and contents and the whereabouts of the manufacturer.

Quality description. The product must reflect the original colour and flavour of the fruit and be free from impurities.

Quality problems.

- A caramel taste indicates a too high processing temperature.
- Weak aroma is caused by a too low or too high processing temperature or poor quality fruit.
- Improper sealing of the cap leads to a loss of vacuum and results in mould.

Marketing issues. Clients want a broad assortment, usually more than 50 SKUs. In addition to larger volumes of regular products (for example, apricot, peach and cherry), more exclusive fruits in small volumes must be offered (for example, sea buckthorn, green walnut or 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 the private label of the importer/ wholesaler or supermarket.

Cigar Box benchmarks (for organic green walnut preserve).

- **Variable costs:** VC = USD 1,366 (49% of TC); VC1 = 59%; VC2 = 12%; VC3 = 30%.
- **Fixed costs:** FC = USD 46,000 (5% attribution); FC1 = 19%; FC2 = 17%; FC3 = 63%.
- **Break-even:** Minimum sales volume = 20 tons; minimum raw material = 12 tons.
- **Profitability:** High, provided sales volumes for all SKUs are good.
- **Sensitivity:** Gross margin = 62%. Very robust.

Table 6: Investment benchmarks derived from the Cigar Box for organic green walnut preserve (400 gr, in 314 ml glass jar, 18 jars in carton box (7.2 kg))

CIGAR BOX – Organic greenwalnut preserve						
	USD /ton			USD /year		
Price (C&F)	4,980		Total revenue	114,176		
VAT 20%	830		Total cost	90,120		
Transport, certification 8%	582		Profit before tax	24,056		
Price (EXW)	3,568		Profit %	21%		
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	59%	Debt (40% of asset value)	900,000		
			Interest rate	18%		
Production cost per hour (steam, electricity)	155		FC2	162,000	17%	
Production volume 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	5,0%		
VC	1,366	100%	FC (attributed to product)	46,400		
Gross margin	2,202		Volume sold q (ton)	32		
Gross margin %	62%		Contribution	70,456		
			Break-even volume (sales)	21		
FC / q	1,450	51%	Break-even volume (raw material)	19		
TC / q	2,816	100%	Input capacity per hour in ton	0.56		
			Working hours per day	22		
Profit / q	752		Length of harvesting season in days	17		
			Max, input capacity per year	211		
			Capacity utilization %	8.9%		

Note: Cells in blue are assumptions, orange is a link to another sheet, cells in light blue are calculations.

Main investment risks. Many SKUs must be produced in small volumes and each SKU must contribute to the fixed costs (in this example, 5% was attributed to organic green walnut preserve). This has to be monitored continuously as raw materials and SKUs are always changing. Excellent procurement and production planning is imperative and the owners must invest in building this capacity.

Key players in the regions. See: http://www.eastagri.org/agribusinesses/

World market 2007: 1,188,000 tons of jams and fruit jellies (HS 2007).

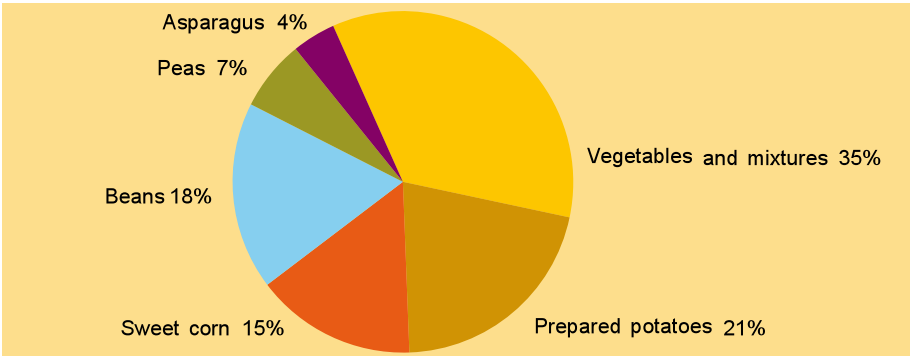
Main exporting countries (tons)		Main importing countries (tons)	
China	93,000	Russian Federation	146,000
Netherlands	83,000	France	104,000
France	81,000	Germany	81,000
Chile	74,000	United States	79,000
Italy	72,000	United Kingdom	54,000
Republic of Moldova	8,200	Kazakhstan	12,000
Uzbekistan	5,400		
Bosnia & Herzegovina	3,000		
Serbia	3,000		

4.6 Canned vegetables

Product. Industry vegetables are low-value, large-volume vegetables that are grown in open fields. When processed, they are canned or frozen (see Section 5.7). Canned vegetables can be boiled in water, salt 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 Section 6, Table 3). Common canned products are beans, green beans, peas, (sweet) maize, carrots and cabbages.

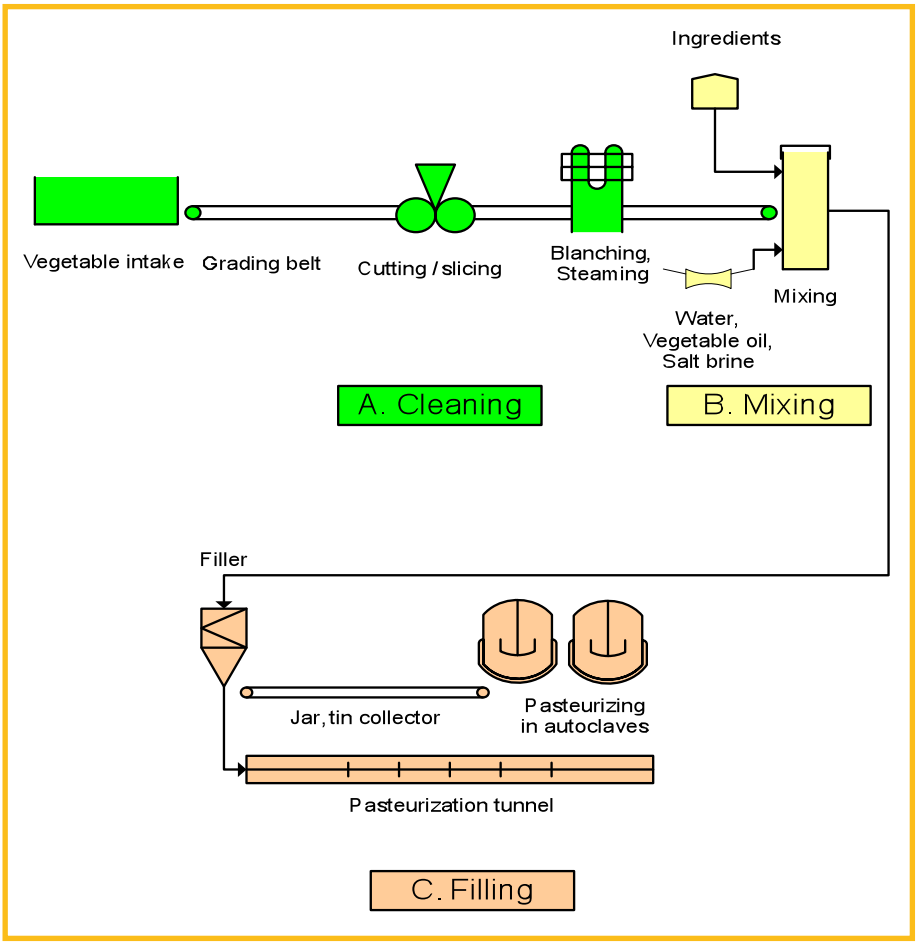
Figure 3: Breakdown of world exports of canned vegetables, excluding bamboo shoots and olives, 2007



Source: http://www.trademap.org/

Production process. The raw material is cleaned, washed and cut and subsequently blanched or steamed. It is then led to the filling line where it is packed in containers, hermetically sealed and pasteurized. After cooling, the container is labelled.

Flow diagram 6 – Canned vegetables



Packaging. Industrial canned vegetables (to be repacked or reused later) are packed in 1- to 5- litre containers. Consumer vegetables are packed in glass jars and tins of 50 to 1,000 ml.

Quality description. The product must reflect the original colour and taste of the vegetables. The product should not have lost its vacuum or be overcooked.

Quality problems.

- Improper sealing of the cap leads to loss of the vacuum, which can in turn lead to inflation/exploding, mould and browning.
- A weak aroma indicates a too low or too high processing temperature or 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 (for further details, see Section 6).

Cigar Box benchmarks (for canned peas).

- **Variable costs:** VC = USD 245 (91% of TC); VC1 = 72%; VC2 = 12%; VC3 = 16%.
- **Fixed costs:** FC = USD 490,000 (100% attribution); FC1 = 41%; FC2 = 37%; FC3 = 22%.
- **Break-even:** Minimum sales volume = 12,600 tons; minimum raw material = 16,000 tons.
- **Profitability:** Very low, 3–7%. Capacity utilization is key.
- **Sensitivity:** Gross margin = 14%. Very risky.

Table 7: Investment benchmarks derived from the Cigar Box for canned peas (in 340 ml twist-off lid glass jar, 400 g, 12 in shrink wrap (4.8 kg))

CIGAR BOX – Canned peas					
	USD /ton			USD /year	
Price (C&F)	420		Total revenue	6,000,000	
VAT 20%	70		Total cost	5,381,667	
Transport and distribution	50		Profit before tax	618,333	
Price (EXW)	300		Profit %	10%	
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	72%	Debt (40% of asset value)	1,000,000	
			Interest rate	18%	
Production cost per hour (steam, electricity)	120		FC2	180,000	37%
Production volume 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%	
VC	245	100%	FC (attributed to product)	490,000	
Gross margin	55		Break-even volume	8,842	
Gross margin %	18%		Volume sold q (ton)	20,000	
			Raw material needed (ton)	16,000	
FC / q	25	9%			
			Input capacity per hour in ton	3.20	
TC / q	269	100%	Working hours per day	22	
			Length of harvesting season in days	300	
Profit / q	31		Max, input capacity per year	21,120	
			Capacity utilization %	75.8%	

Note: Cells in blue are assumptions, orange is a link to another sheet, cells in light blue are calculations.

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 quality of vegetables. Large scale processors must run a product mix that keeps their capacity occupied. Break-even 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.

Key players in the regions. See: http://www.eastagri.org/agribusinesses/

World market (2007): 5,145,000 tons of canned vegetables (HS 2005).

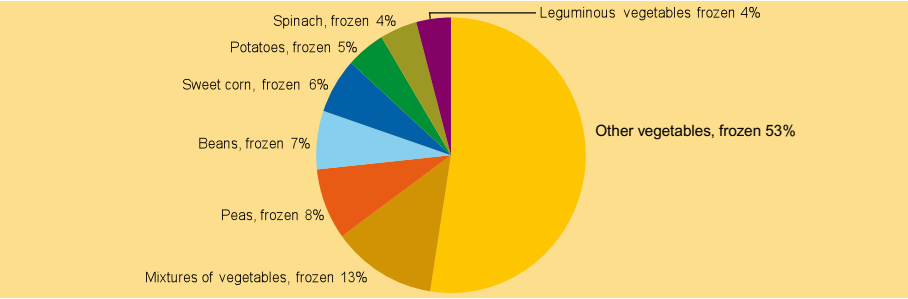
Main exporting countries (tons)		Main importing countries (tons)	
China	983,000	Germany	556,000
Belgium	426,000	United States	463,000
Netherlands	399,000	Japan	431,000
Spain	389,000	France	413,000
France	383,000	Russian Federation	343,000
republic of Moldova	20,000	Kazakhstan	30,000
Serbia	15,000		
FYR Macedonia	6,000		
Bosnia & Herzegovina	2,000		

4.7 Frozen fruits and vegetables

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

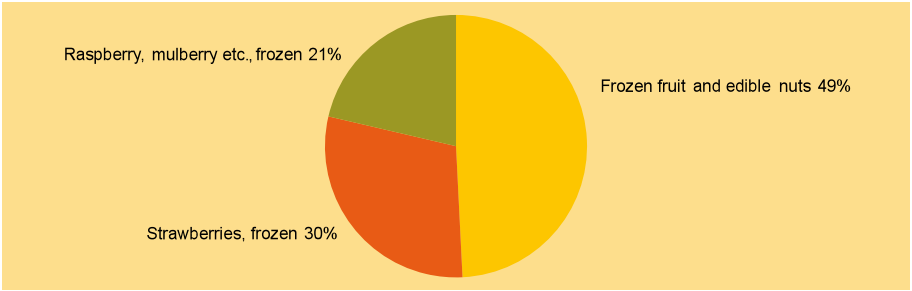
Raw materal. For vegetables, first-grade products are preferred (see Section 6, Table 3). Common vegetables are green beans, peas, (sweet) maize, broccoli, cauliflower, spinach and mixtures of these and other vegetables. Potatoes that are frozen without preboiling are also included in this category. Frozen potatoe for French fries 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).

Figure 4: Breakdown of world exports of frozen vegetables, 2007



Source: http://www.trademap.org/

Figure 5: Breakdown of world exports of frozen fruits and berries, 2007

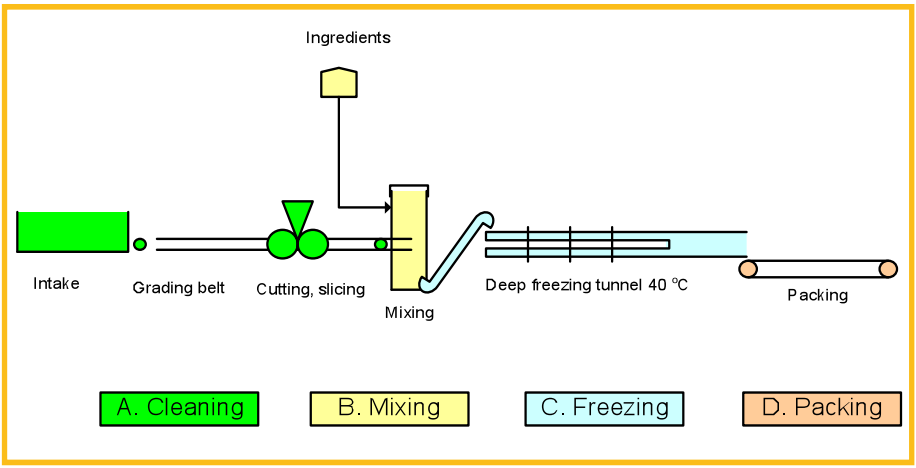


Source: http://www.trademap.org/

Herbs are also commonly deep frozen, but no detailed quantitative data are available from COMTRADE statistics.

Production process. The raw material is cleaned, washed, cut and subsequently blanched or steamed. It is then led to the filling line where it is packed in containers, hermetically sealed and pasteurized. After cooling, the container is labelled.

Flow diagram 7 – Frozen fruit and vegetables



Packaging. Frozen industrial vegetables and fruits (to be repacked or reused later) are packed in 10- to 25-kg plastic-lined cardboard boxes or in 200-litre drums. Consumer products are packed in rectangular cardboard boxes or printed plastic bags ranging from 200 to 1,000 g. Frozen fruits are sometimes packed in plastic cups of 250–500 ml, a small spoon is usually included.

Quality description. Fruits and vegetables must retain their original identity in shape, colour and aroma. When sliced or cubed, the original fruit must still be recognizable. It should not be smashed, pulped or broken as this will lower the grade.

Quality problems.

- Split or broken products can be caused by slow freezing or rough handling.
- Cheap raw material can result in small-sized products.
- Uneven sizes or products indicate poor grading.

Marketing issues. Recently, here has been controversy as to whether frozen vegetables are better or worse than fresh ones. Generally, reports show that frozen vegetables are nutritionally little different from fresh ones.

Perceived advantages are:

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

Perceived disadvantages are:

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

Cigar Box benchmarks (for organic frozen blackberry, individually quick frozen – IQF).

- **Variable costs:** VC = USD 1,387 (78% of TC); VC1 = 76%; VC2 = 17%; VC3 = 7%.
- **Fixed costs:** FC = USD 466,000 (100% attribution); FC1 = 30%; FC2 = 27%; FC3 = 43%.
- **Breakeven:** Minimum sales volume = 700 tons; minimum raw material = 900 tons.
- **Profitability:** High, provided sales volumes for all SKUs are good.
- **Sensitivity:** Gross margin = 33%. Normal/desirable.

Table 8: Investment benchmarks derived from the Cigar Box for organic frozen blackberry – IQF (12 kg in plastic lined carton box)

CIGAR BOX – Organic frozen blackberry					
	USD /ton			USD /year	
Price (C&F)	2,446		Total revenue	2,343,439	
Transport, sales commission 3%	323		Total cost	2,130,436	
Cost of certification, 8%	170		Profit before tax	213,003	
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	76%	FC1	140,000	30%
Other ingredients	–	0%			
VC1	1,049	76%	Debt (40% of asset value)	700,000	
			Interest rate	18%	
Production cost per hour (labor, electricity)	144		FC2	126,000	27%
Production volume 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%	
VC	1,387	100%	FC (attributed to product)	466,000	
Gross margin	566		Volume sold q (ton)	1,200	
Gross margin %	29%		Contribution	679,003	
			Break-even volume (sales)	824	
FC / q	388	22%	Break-even volume (raw material)	1,536	
TC / q	1,775	100%	Input capacity per hour in ton	0.77	
			Working hours per day	22	
Profit / q	178		Length of harvesting season in days	120	
			Max, input capacity per year	2,028	
			Capacity utilization %	75.8%	

Note: Cells in blue are assumptions, orange is a link to another sheet, cells in light blue are calculations.

Key players in the regions. See: http://www.eastagri.org/agribusinesses/

World market (2007): 1,656,000 tons of frozen fruits and berries (HS 0811).

Main exporting countries (tons)		Main importing countries (tons)	
Poland	273,000	Germany	317,000
China	192,000	Unied States	236,000
Serbia	129,000	France	236,000
Chile	104,000	Netherlands	119,000
Mexico	91,000	Belgium	85,000
Turkey	16,000	Russian Federation	52,000
Bosnia & Herzegovina	6,700	Kazakhstan	162
Kyrgyzstan	3,600		
FYR Macedonia	3,200		

Cigar Box benchmarks (for frozen sweet maize and peas mixture).

- **Variable costs:** VC = USD 581 (79% of TC); VC1 = 66%; VC2 = 17%; VC3 = 17%.
- **Fixed costs:** FC = USD 466,000 (100% attribution); FC1 = 30%; FC2 = 27%; FC3 = 43%.
- **Break-even:** Minimum sales volume = 2,000 tons; minimum raw material = 2,600 tons.
- **Profitability:** Average, provided sales volumes for all SKUs are good.
- **Sensitivity:** Gross margin = 30%. Normal/desirable.

Table 9: Investment benchmarks derived from the Cigar Box for frozen sweet corn and peas mixture (packed in PE bag of 500 g, 10 bags per carton (5 kg))

CIGAR BOX – Frozen sweet corn and peas mixture					
	USD /ton			USD /year	
Price (C&F)	1,050		Total revenue	2,475,000	
VAT 20%	175		Total cost	2,209,268	
Transport and distribution	50		Profit before tax	265,732	
Price (EXW)	825		Profit %	11%	
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 volume 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%	
VC	581	100%	FC (attributed to product)	466,000	
Gross margin	244		Volume sold q (ton)	3,000	
Gross margin %	30%		Contribution	731,732	
			Break-even volume (sales)	1,911	
FC / q	155	21%	Break-even volume (raw material)	3,900	
TC / q	736	100%	Input capacity per hour in ton	1.95	
			Working hours per day	22	
Profit / q	89		Length of harvesting season in days	120	
			Max, input capacity per year	5,148	
			Capacity utilization %	75.8%	

Note: Cells in blue are assumptions, orange is a link to another sheet, cells in light blue are calculations.

Key players in the regions. See: http://www.eastagri.org/agribusinesses/

World market (2007): 4,469,000 tons of frozen vegetables (HS 0710).

Main exporting countries (tons)		Main importing countries (tons)	
Belgium	1,058,000	United States	616,000
China	783,000	Germany	472,000
Poland	329,000	France	468,000
Spain	277,000	United Kingdom	413,000
Mexico	269,000	Japan	389,000
Turkey	68,000	Russian Federation	116,000
FYR Macedonia	8,800		
Uzbekistan	3,900		

5.1 Different types of fruits and vegetables

Fruits and vegetables are highly adaptable to climate and soil conditions but the types of produce and yields will vary greatly depending on these conditions. Because of the perishability of fruits and vegetables, the geographical location of planted areas in relation to markets, processing units and consumers are more important than with other crops. Maintaining post-harvest quality of fruits and vegetables is essential.

Table 10: Different types of fruits and vegetables

Botanic cycle	Carrier	Kernel	Biological name	Common name	Examples
Perennial	Tree	Seed	Seed fruit	Fruit	Apple, pear
Perennial	Tree	Stone	Stone fruit	Fruit	Apricot, 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, potatoe
Annual	Leaf		Herbs	Herbs	Parsley, dill, basil
Perennial	Leaf		Herbs	Herbs	Rosemary

5.2 Ripeness or harvest readiness

Ripeness or harvest readiness depends on physiological and commercial maturity. The former is reached when development is over and is normally followed by the ripening process to achieve commercial maturity required by the market. Harvesting time is also a function of the distance to the destination market. Climacteric fruits can ripen after being picked. This facilitates transport and storage. Examples are tomatoes, apples, apricots, peaches, pears, plums, mangos and, of course, bananas. Non-climacteric fruits such as peppers and citrus obtain commercial maturity only on the plant. Changes in colour are the most apparent external symptoms of ripening. They are the result of chlorophyll degradation (disappearance of green colour) 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 normally undertaken in the field or under shelters.

5.3 Post-harvest actions

Because of their perishability, fruits and vegetables are usually sold immediately after harvest at field level and dispatched directly through marketing channels, so that they 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 is subjected to an industrial process to suit consumer demands and extend shelf life. Industrially processed vegetables are usually preserved within seven to ten hours after harvesting. This treatment is more immediate than handling of fresh products so less deterioration will have taken place and more nutrients and taste will have been preserved, provided the right technology has been 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 50% are processed into canned, frozen or dehydrated consumer products; 20% are processed in Western Europe; and 13% are processed in Eastern Europe.

5.4 Preserving food

Preservation is creating an environment that prevents harmful micro-organisms (i.e. bacteria, viruses, moulds and yeasts) from multiplying. Methods are: 1) pasteurization; 2) boiling; 3) refrigeration; 4) freezing; 5) drying; 6) vacuum treatment; 7) antimicrobial agents; 8) ionizing (UV) radiation; 9) submersion in a strongly saline, sugary (Brix > 50%), acid (pH < 4.2) or base environment; and 10) combinations of these methods. No method is perfectly reliable as a preservative. For example, spore-forming thermal-resistant micro-organisms, such as Clostridium botulinum (which causes botulism), are not killed when boiled at 100 ºC; however, Clostridium dies when the pH is below 4.6.

In the fruit and vegetable industry, four methods are common:

- Canning. Canning is a method in whereby the food is processed, packed and sealed in an airtight container and then heat-treated and cooled down (hot fill). The process was first discovered in the French military. Usual containers are jars, bottles, tins made of glass and PET or aluminium. For useful background information on canning, see http://ucanr.org/freepubs/docs/8072.pdf.
- Aseptic packing. Aseptic packaging is a method whereby food is processed, heat treated, cooled and then packed and sealed in an airtight container

(cold fill). Usual containers are multiliner plastic bags or cartons (Tetrapak, Elopak, SIG, etc.).

- IQF. IQF fruits and vegetables are preserved by deep freezing. In IQF, the product remains free-flowing while rapidly deep freezing in an environment at -50 ºC. The core of the product will reach -18 ºC within two to three 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.
- Drying. Drying is a method whereby food is processed after which 90–95% of the water is removed. Water is usually removed by evaporation (air drying, sun drying, smoking or vacuum drying) or freeze-drying, where by food is first frozen under vacuum and then water removed by sublimation.

Table 11: Overview of fruits and vegetables 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	50,000
Semi-industrial	Medium	2–5 ton/hr	Batch	By hand/ capper	Autoclave	50,000	1,000,000
Industrial medium-scale	Large	5–10 ton/hr	Continuous	Filler/ capper	Autoclave/ aseptic	500,000	1,500,000
Industrial Large-scale	Very large	10–20 ton/hr	Continuous	Filler/ capper	Aseptic	2,000,000	5,000,000

Table 12: Overview of product categories in the fruit and vegetable processing sector

No.	F&V	Product category	Brix	Raw material grade	Prod. use	Processing level	Process	Preservation method	Storage	Weight	Packing material	Use
1	F	Fresh fruit		1	whole		none	none/cooling	ULO, 6 °C	10–25 kg	crates	FP
2	F	Frozen fruit		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, prepacked		1/2	whole/sliced	semi–indus	cutting, mixing	cooling	7–8 °C	200–1,000 g	pet	FP
5	F	Compotes	14–16	2	whole	artisanal	heat	pasteurized	ambient	1–3 litre	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	Syrop	54	3	pulped	artisanal	heat	pasteurized	ambient	1–3 litre	jar	FP
9	F	Juices	12–13	3	pulped	semi–indus	heat	pasteurized	ambient	250–1,500 ml	carton, pet, jar	FP
10	F	Puree, single strength	12	3	pulped	semi–indus	heat	pasteurized	ambient	1–3 litre	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	200–1,000 g	jar	FP
17	V	Marinades, pickles		1	whole/sliced	artisanal	heat	pasteurized	ambient	200–1,000 g	jar	FP
18	V	Fresh vegetable mix, Prepacked		1/2	whole/sliced	semi–indus	cutting, mixing	cooling	7–8 °C	200–1,000 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	200–1,000 g	jar	FP
21	V	Sauces, ketchup	18–25	2/3	pulped	semi–indus	heat	pasteurized	ambient	200–1,000 g	jar	FP
22	V	Tomato puree, paste	18–25	2/3	pulped	semi–indus	heat	pasteurized	ambient	200–1,000 g	jar	FP
23	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 product, "pol fabrikat", needs additional processing = IP
Finished product, ready to consume = FP

Table 13: Processing ratios for selected fruits by product category

no.	Fruit	Product category	Use	Processing ratio	No.	Fruit	Product category	Use	Processsing 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	Potatoe	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	Walnut	Preserves	FP	0.67
28	Peach	Preserves	FF	0.80					
29	Peach	Yoghurt fruit preparation	IP	0.71					

ANNEX. IMPORT AND SUPPLY MARKETS OF PROCESSED FRUIT AND VEGETABLES FOR SELECTED COUNTRIES, INCLUDING ETCs AND WBCs

Table 1: Import and export values of processed fruits and vegetables[1] for selected countries (thousand USD)

Country	2005		2006		2007	
	Exports	Imports	Exports	Imports	Exports	Imports
World	31,588,344	31,979,110	35,775,236	35,499,928	44,300,584	42,766,076
Commonwealth of Independent States (CIS) Aggregation	301,340	1,070,017	341,984	1,406,771	513,283	1,781,881
Russian Federation	60,484	778,917	72,256	975,153	82,911	1,186,287
Ukraine	118,969	110,308	135,023	193,200	245,155	256,396
Kazakhstan	3,325	66,059	15,387	89,086	3,460	134,229
Belarus	10,973	58,816	13,881	80,893	16,890	106,503
Azerbaijan	16,773	13,141	19,054	16,916	28,413	29,505
Republic of Moldova	46,497	13,596	42,730	14,469	79,480	20,851
Georgia	5,445	10,373	6,829	13,963	15,681	19,398
Armenia	7,312	7,889	9,962	11,326	10,428	16,754
Kyrgyzstan	2,076	4,462	1,472	5,161	2,393	8,424
Uzbekistan	22,843	1,412	18,486	730	22,595	1,278
Turkmenistan	65	3,864	40	4,175	28	1,256
Tajikistan	6,578	1,180	6,864	1,699	5,849	1,000

Sources: FAOSTAT, ITC calculations based on COMTRADE statistics

[1] *In this annex, "processed fruit and vegetables" refer to a selection of 20 fruit and vegetables as per COMTRADE statistics.*

Figure 1a.
Main exporting markets of processed fruit and vegetables from Albania

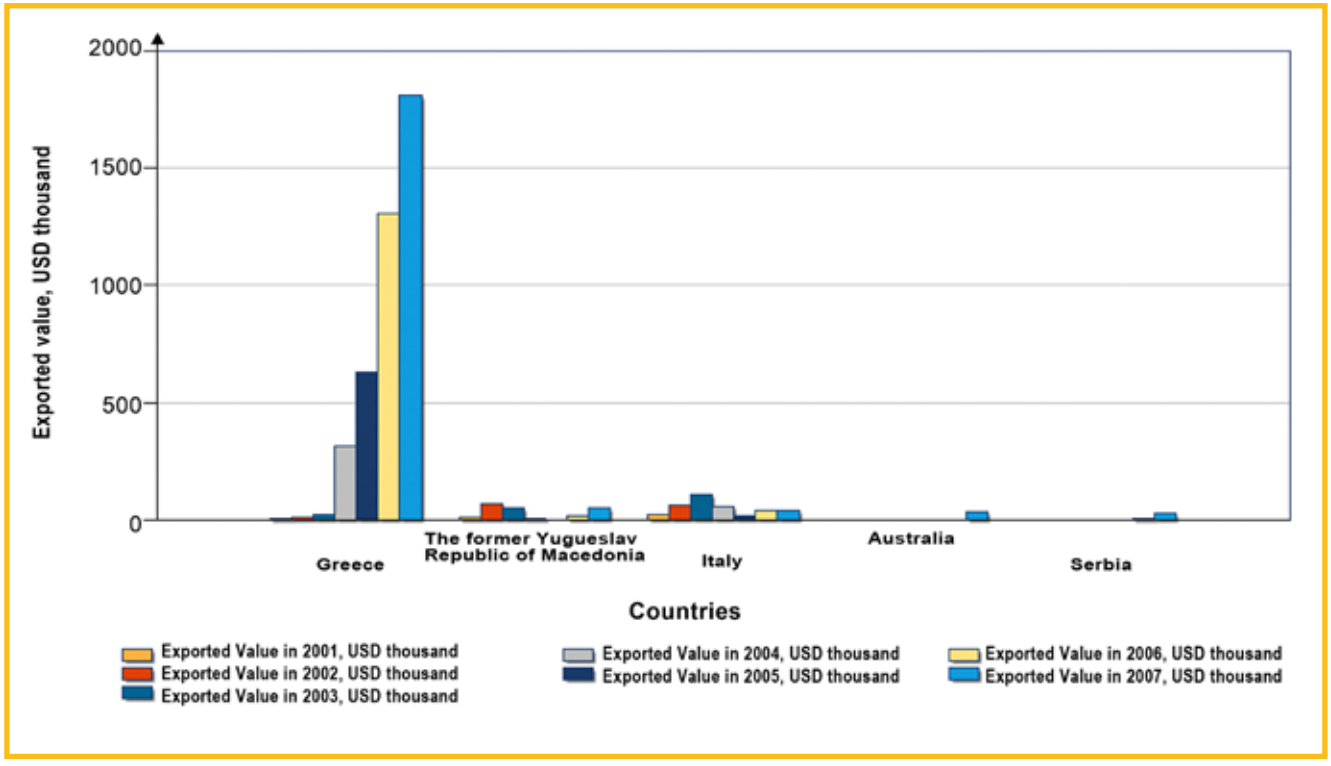


Figure 1b.
Main supplying markets of processed fruit and vegetables to Albania

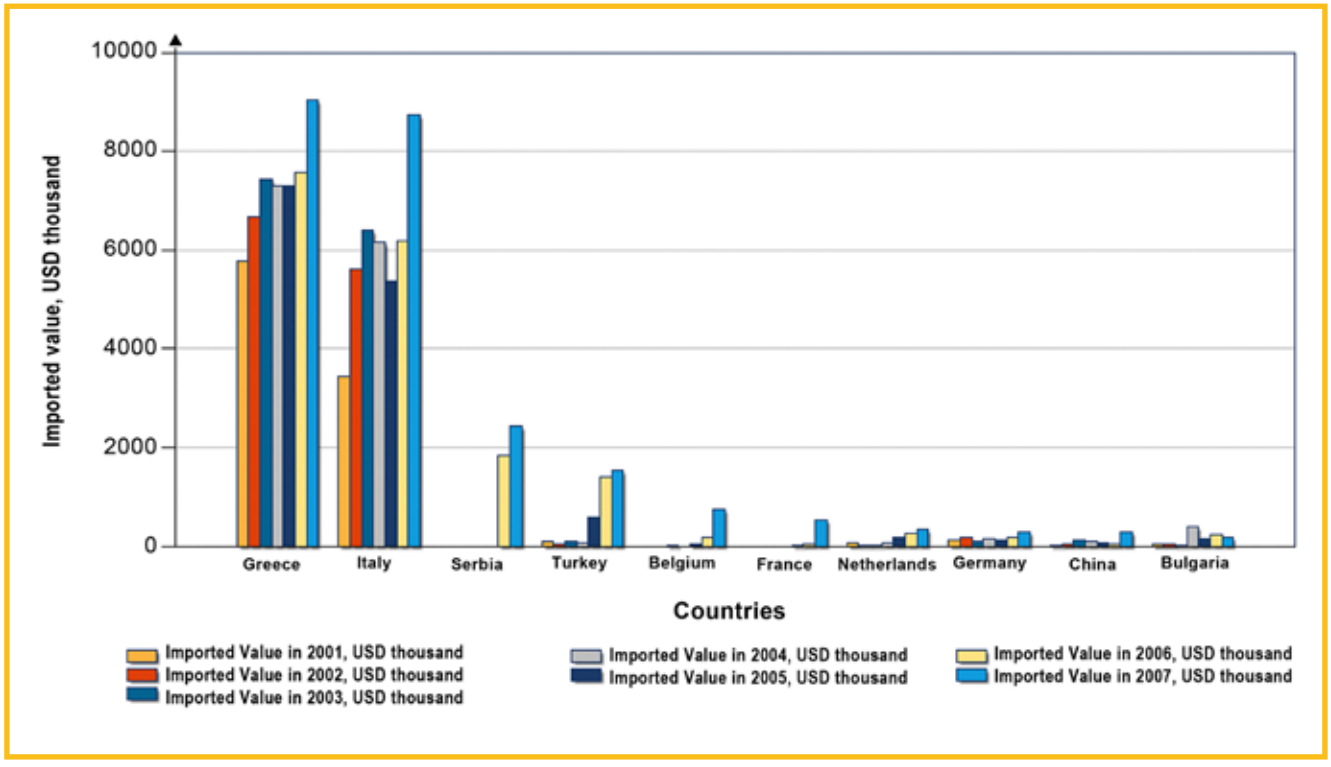


Figure 2a.
Main exporting markets of processed fruit and vegetables from Armenia

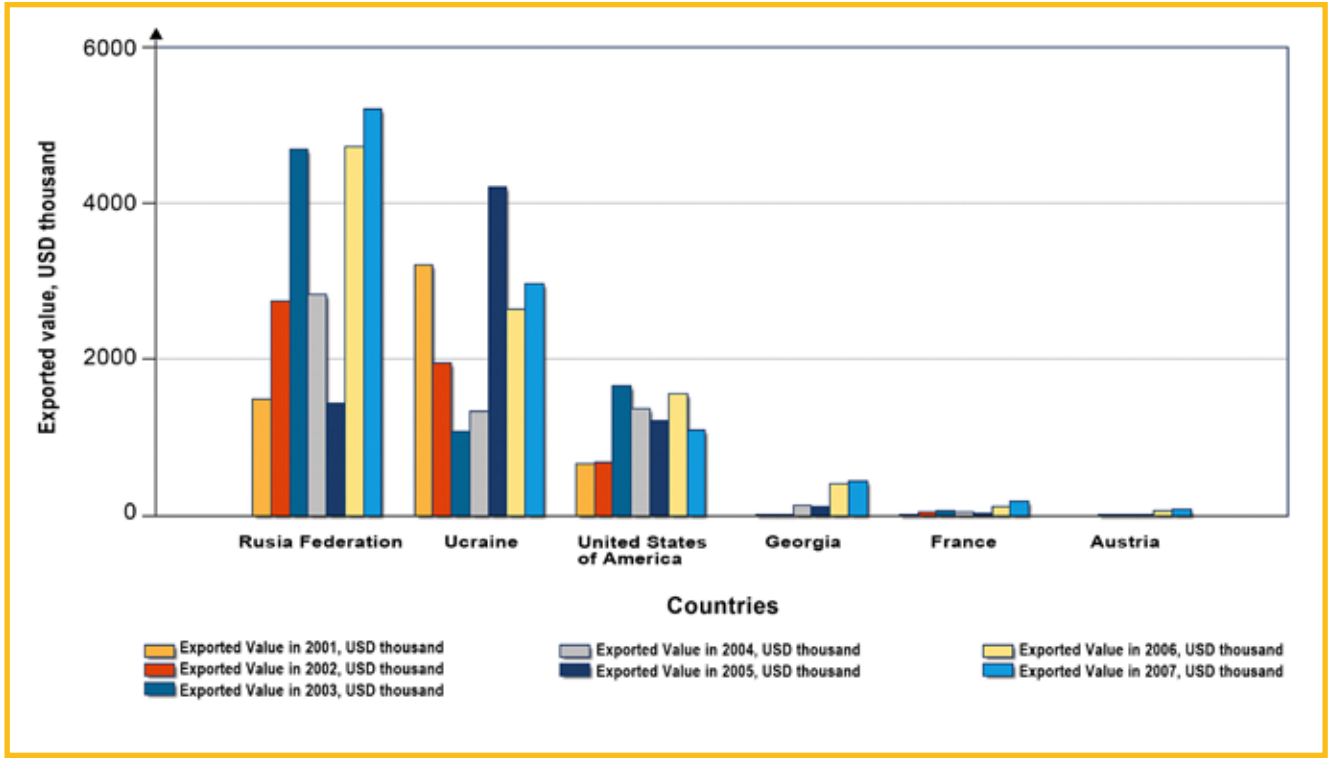


Figure 2b.
Main supplying markets of processed fruit and vegetables to Armenia

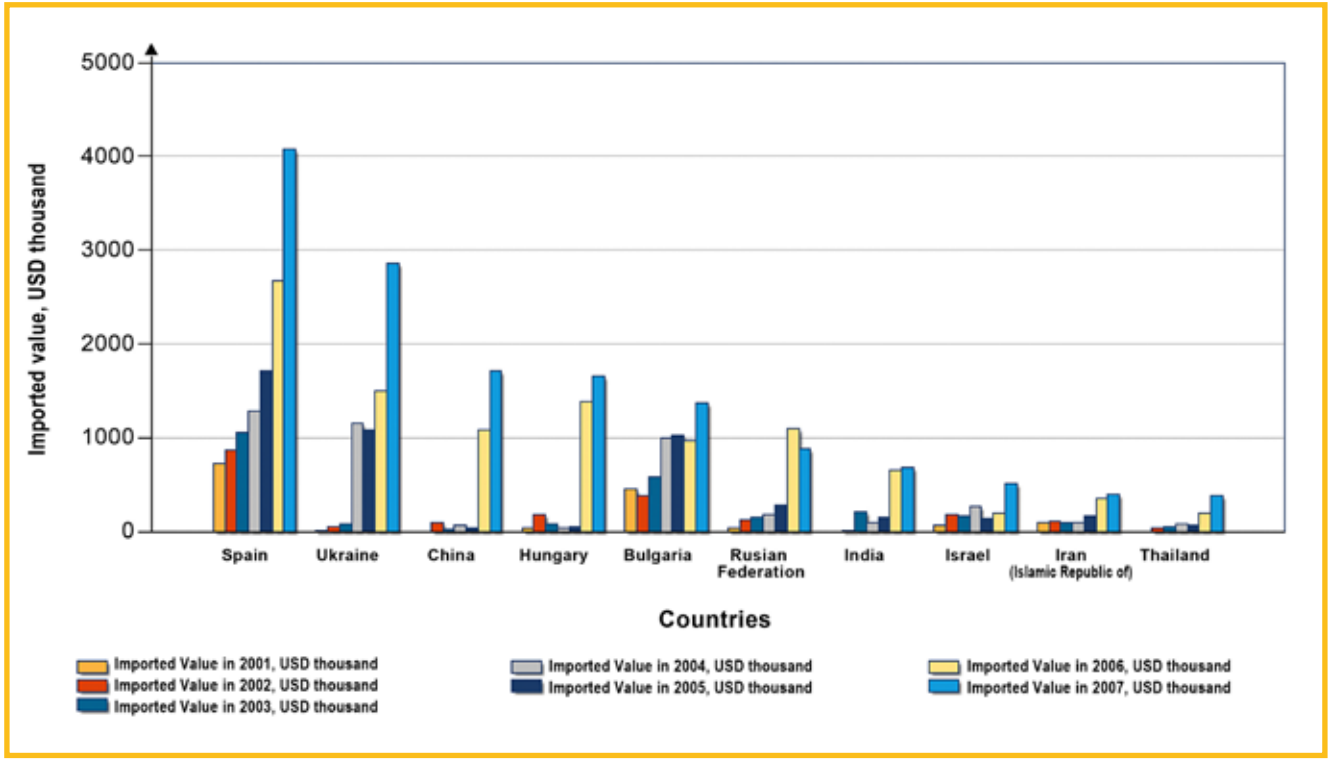


Figure 3a.
Main exporting markets of processed fruit and vegetables from Azerbaijan

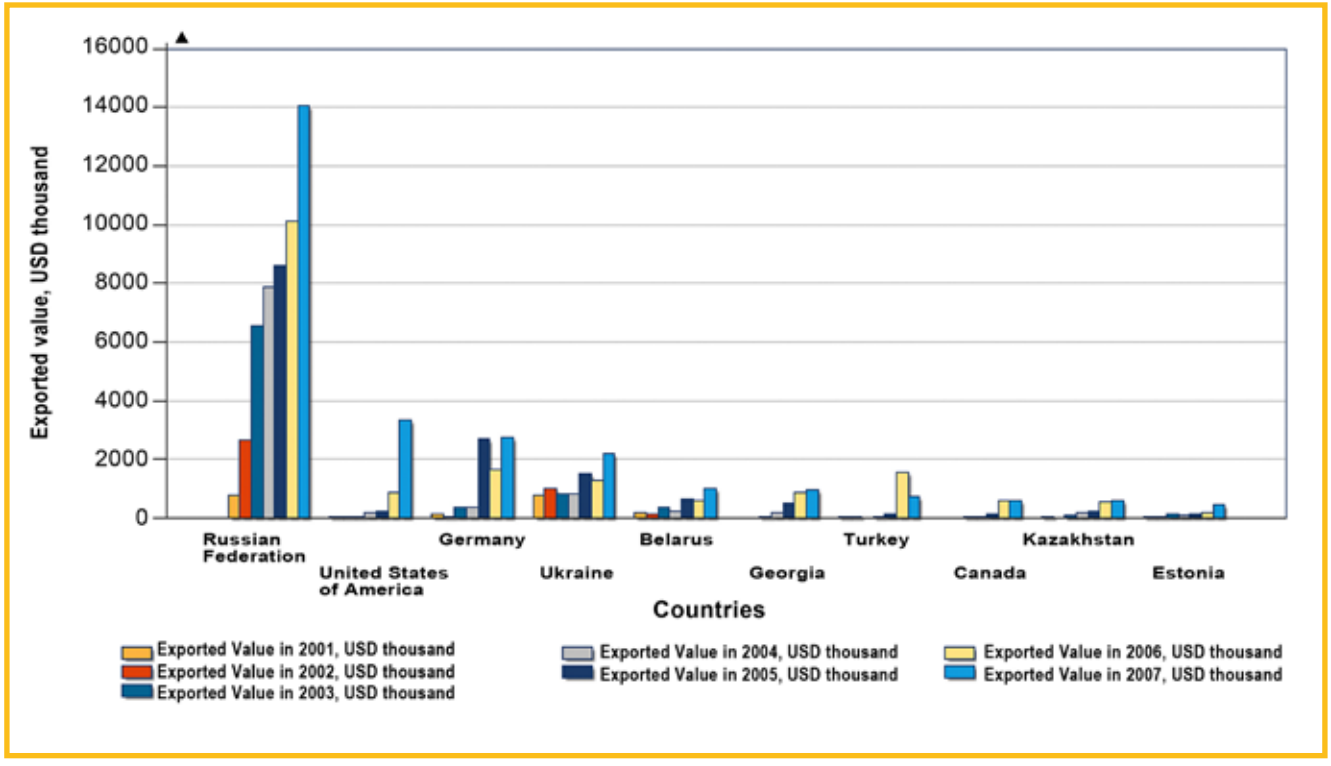


Figure 3b.
Main supplying markets of processed fruit and vegetables to Azerbaijan

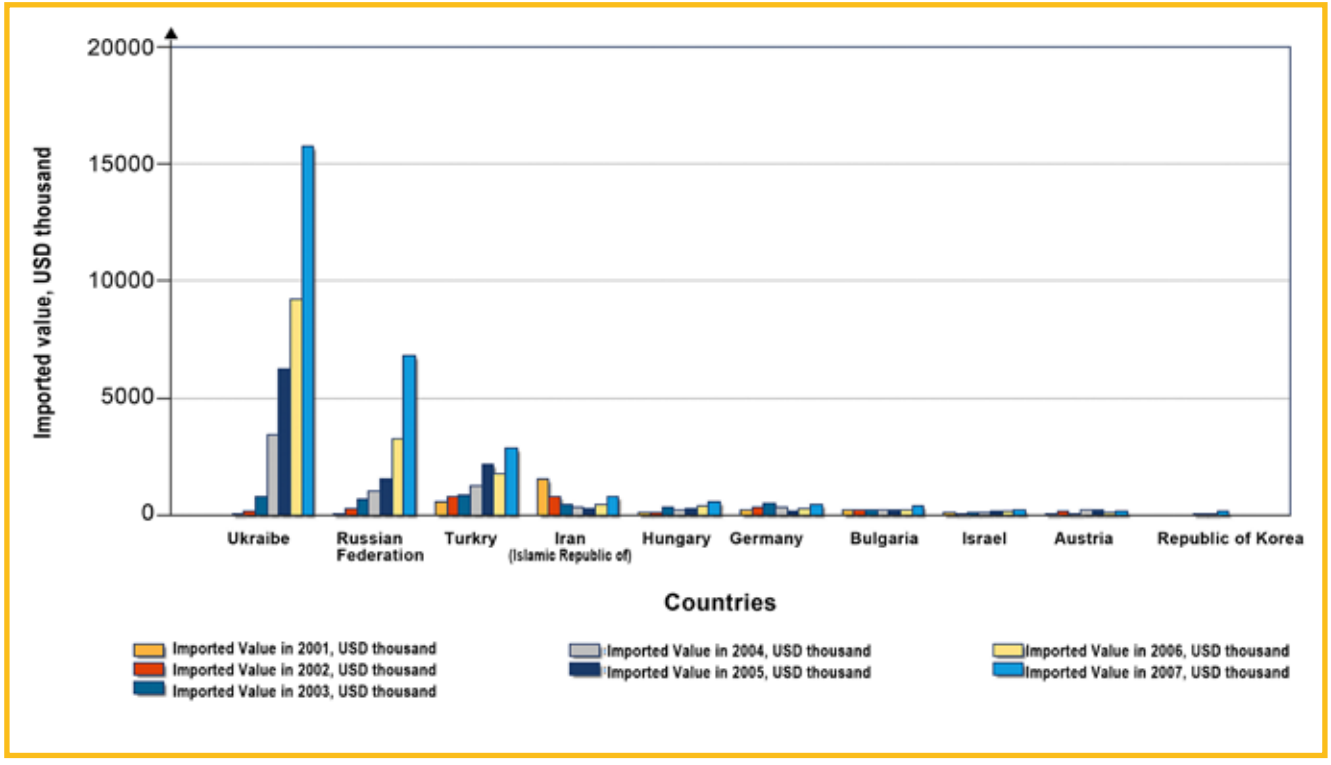


Figure 4a.
Main exporting markets of processed fruit and vegetables from Bosnia & Herzegovina

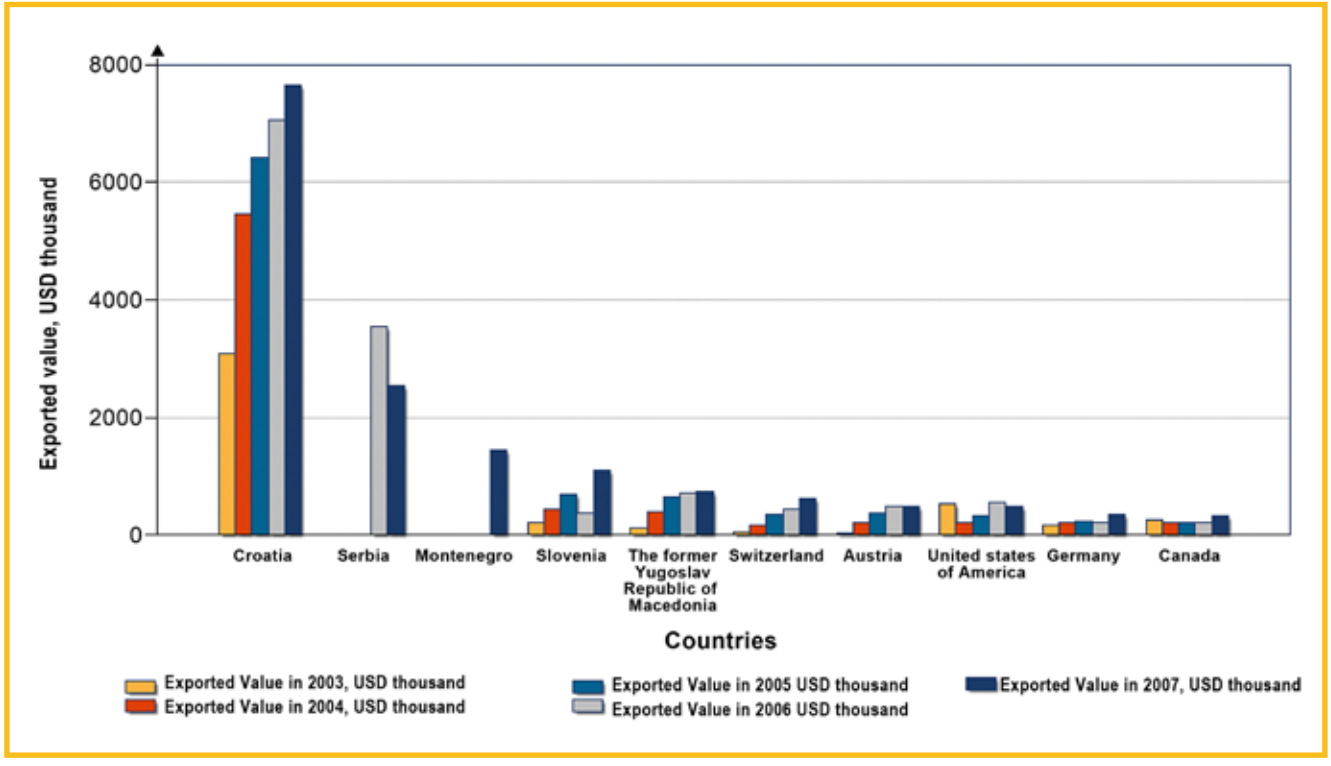


Figure 4b.
Main supplying markets of processed fruit and vegetables to Bosnia & Herzegovina

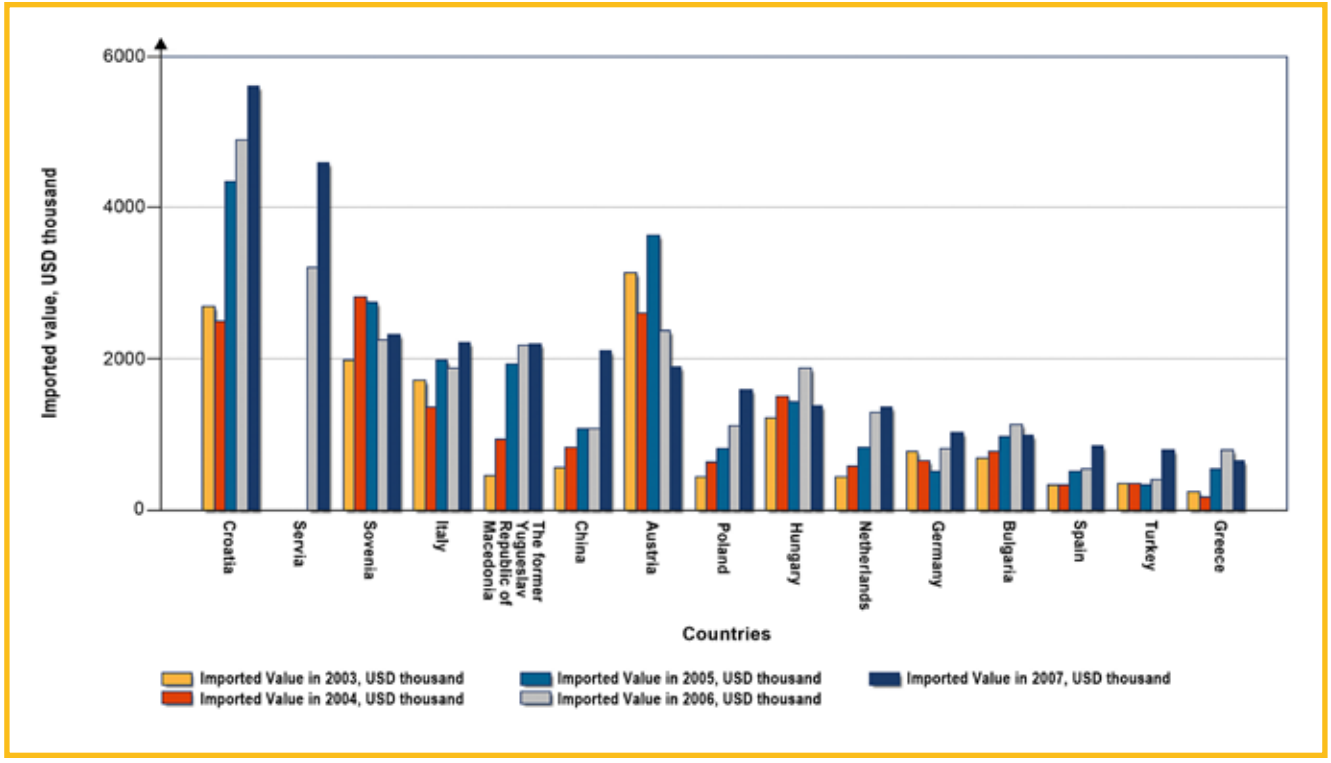


Figure 5a.
Main exporting markets of processed fruit and vegetables from Georgia

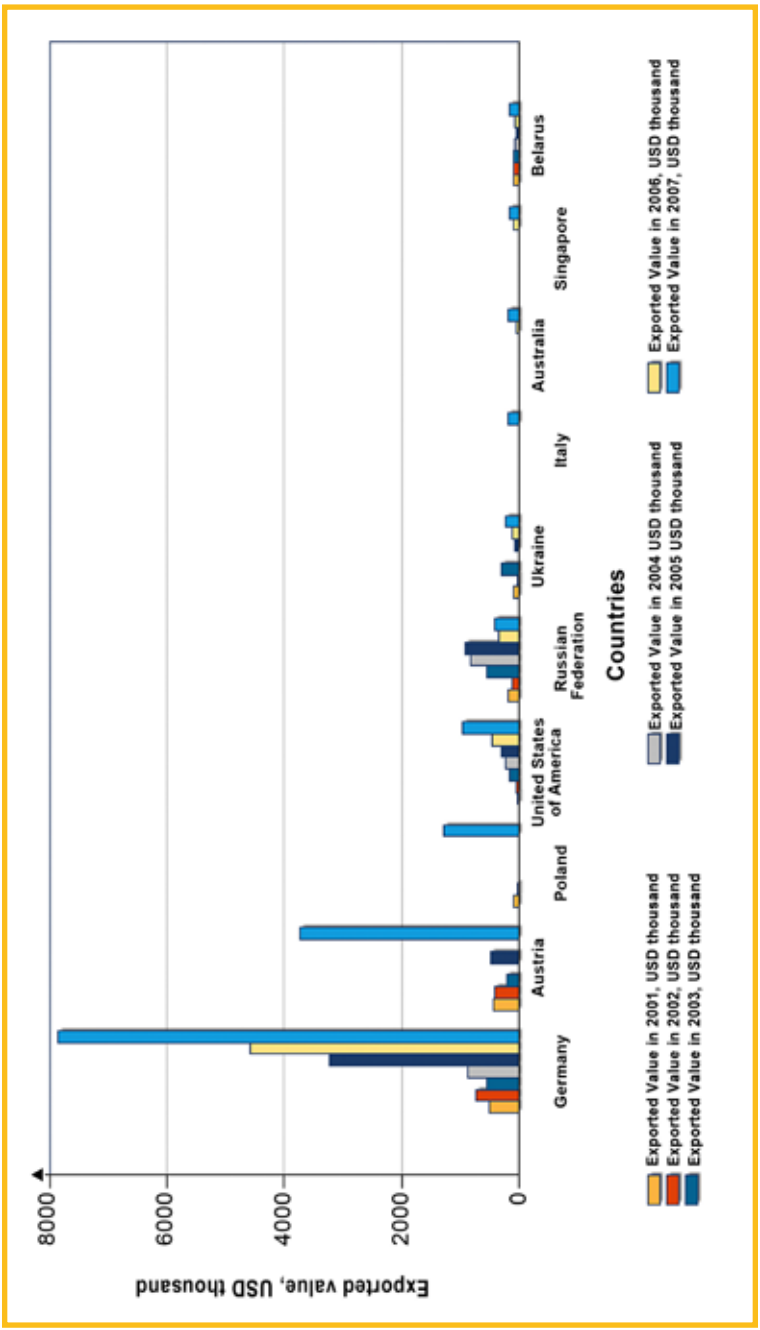


Figure 5b.
Main supplying markets of processed fruit and vegetables to Georgia

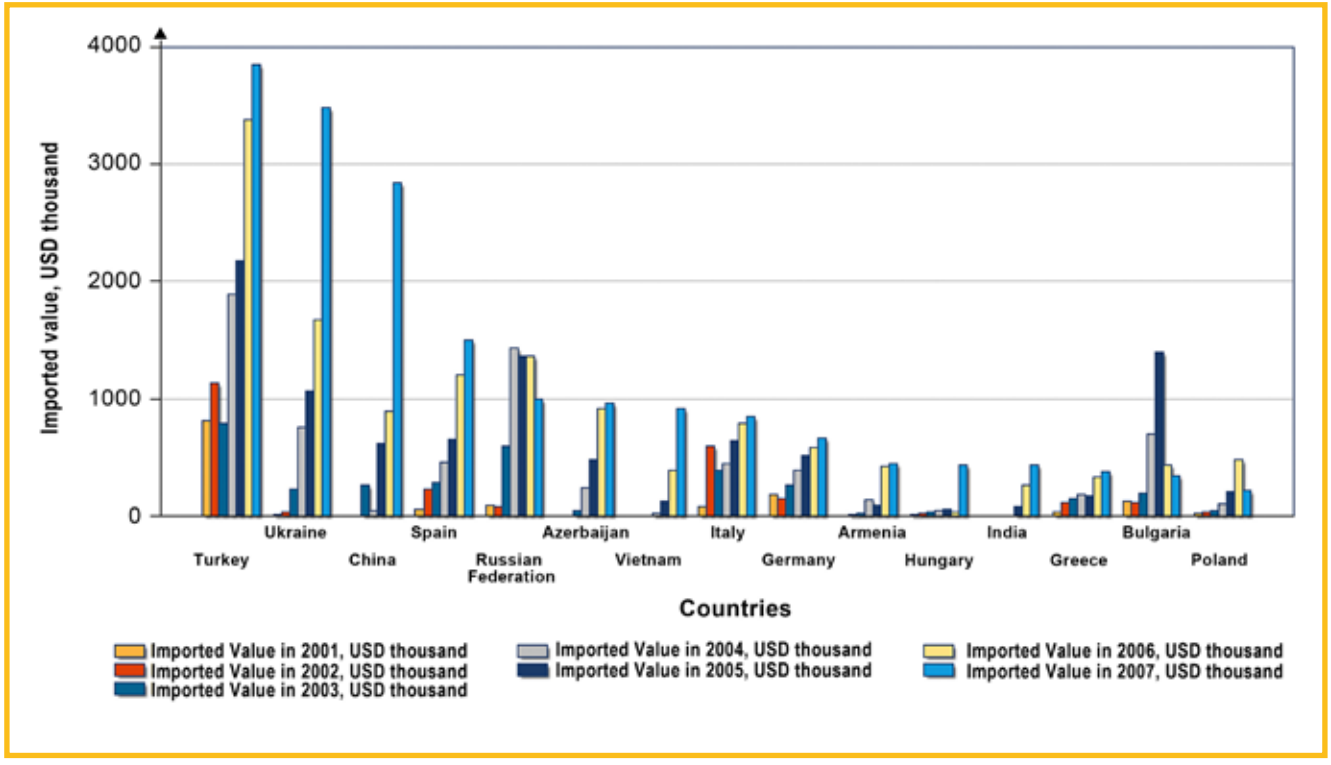


Figure 6a.
Main exporting markets of processed fruit and vegetables from Kazakhstan

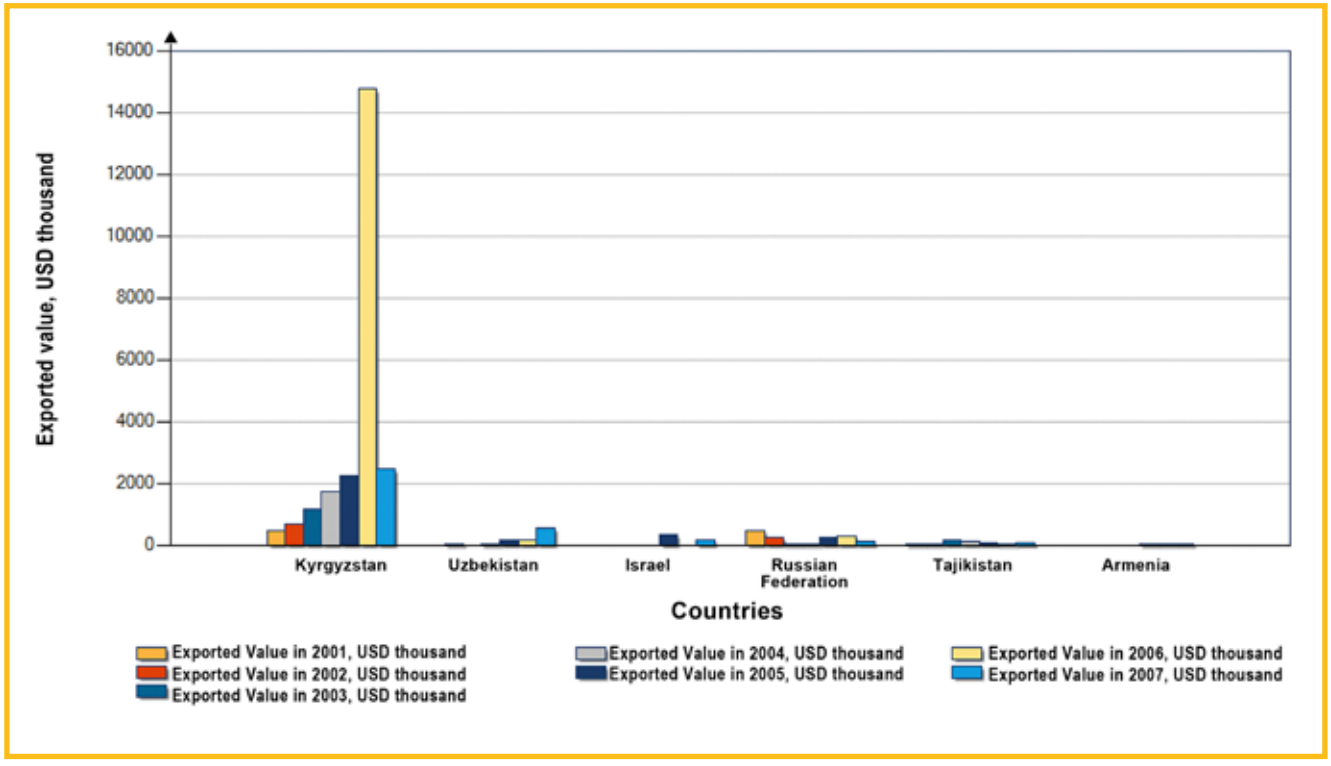


Figure 6b.
Main supplying markets of processed fruit and vegetables to Kazakhstan

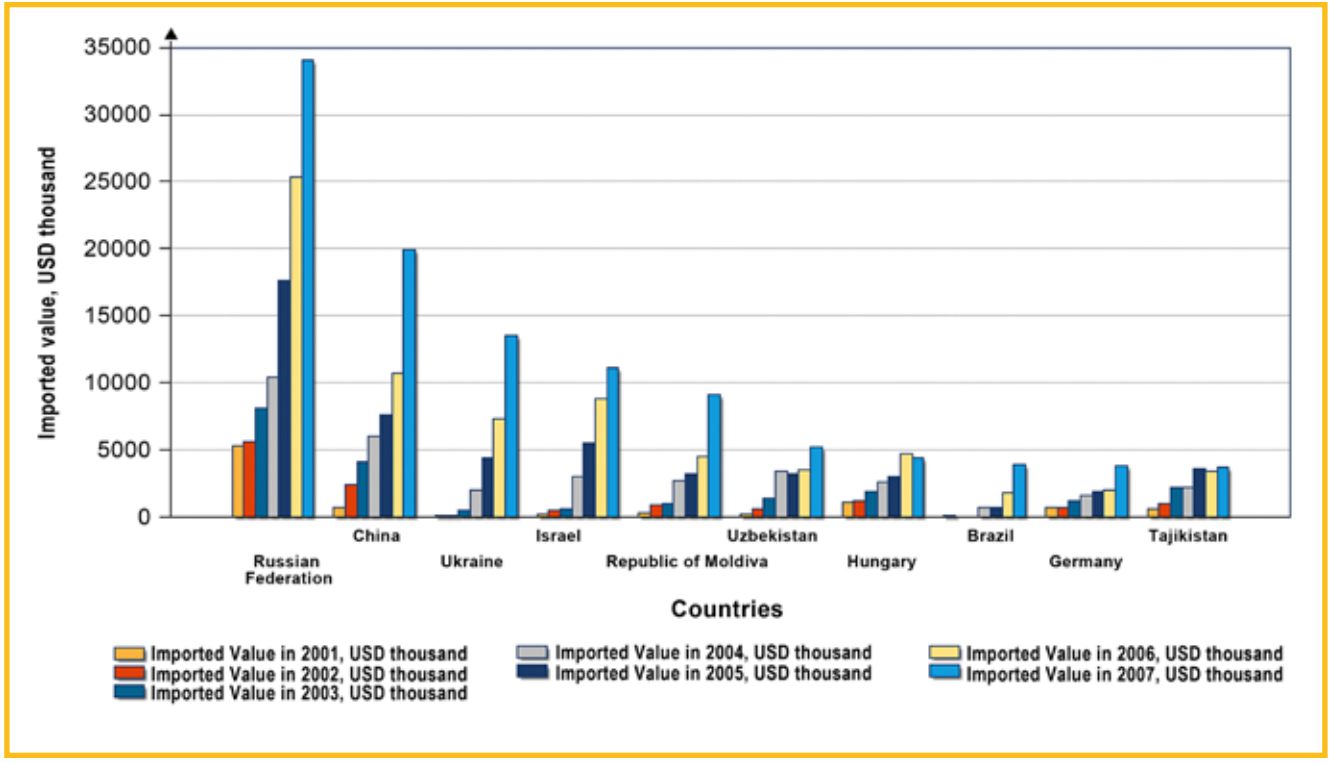


Figure 7a.
Main exporting markets of processed fruit and vegetables from Kyrgyzstan

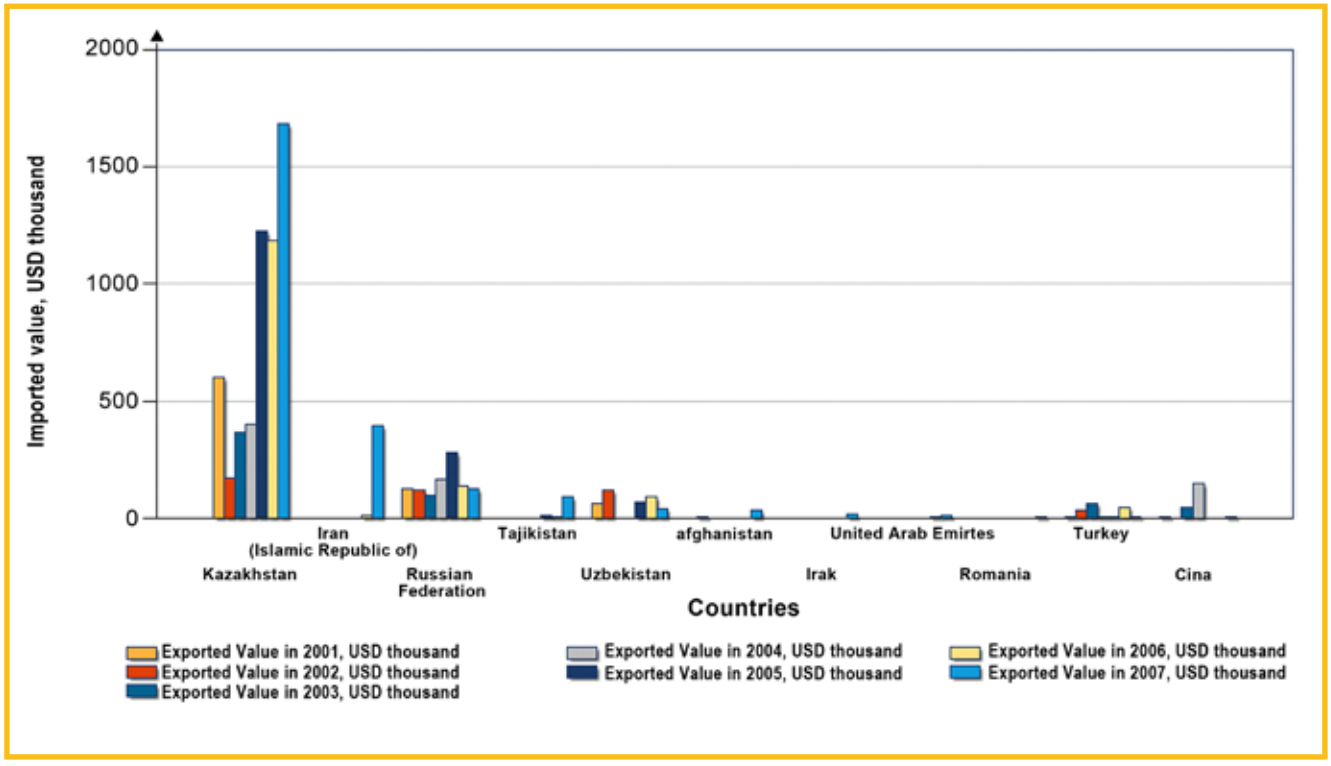


Figure 7b.
Main supplying markets of processed fruit and vegetables to Kyrgyzstan

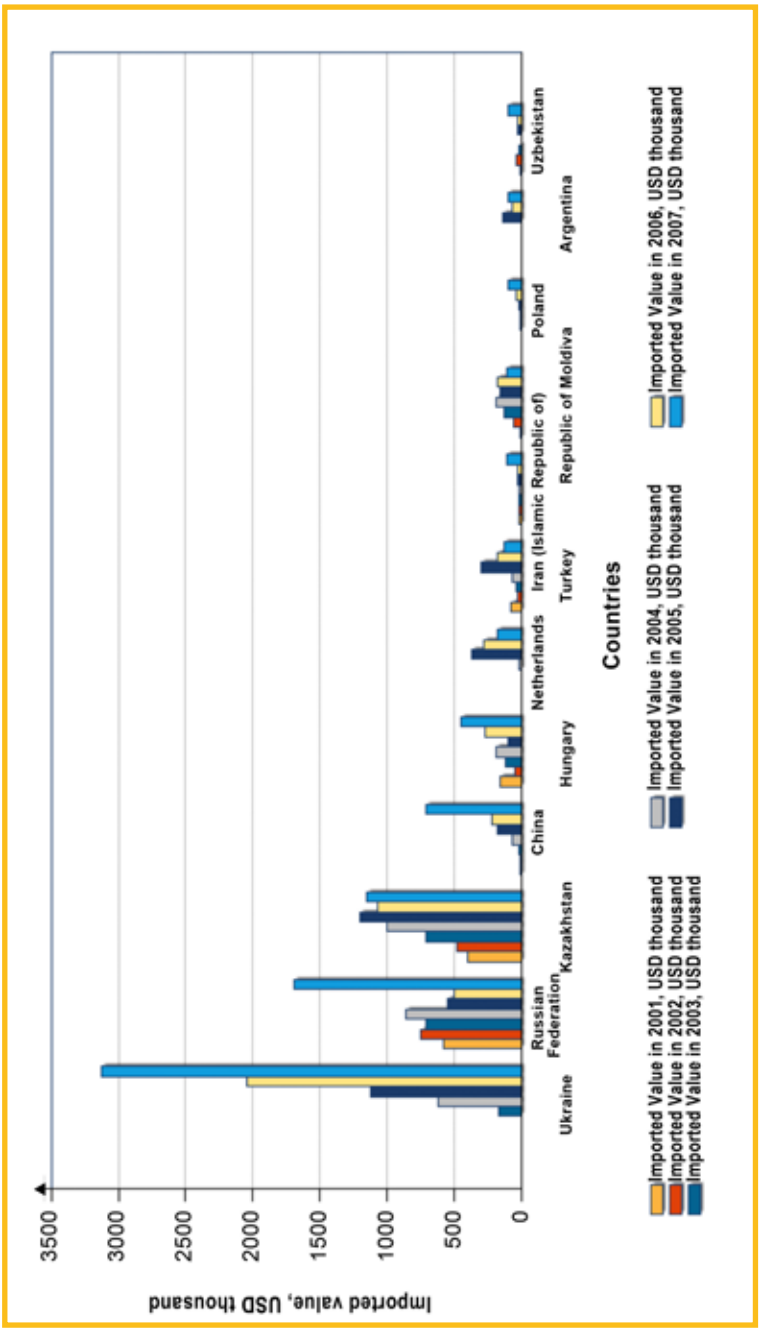


Figure 8a.
Main exporting markets of processed fruit and vegetables from the former Republic of Macedonia

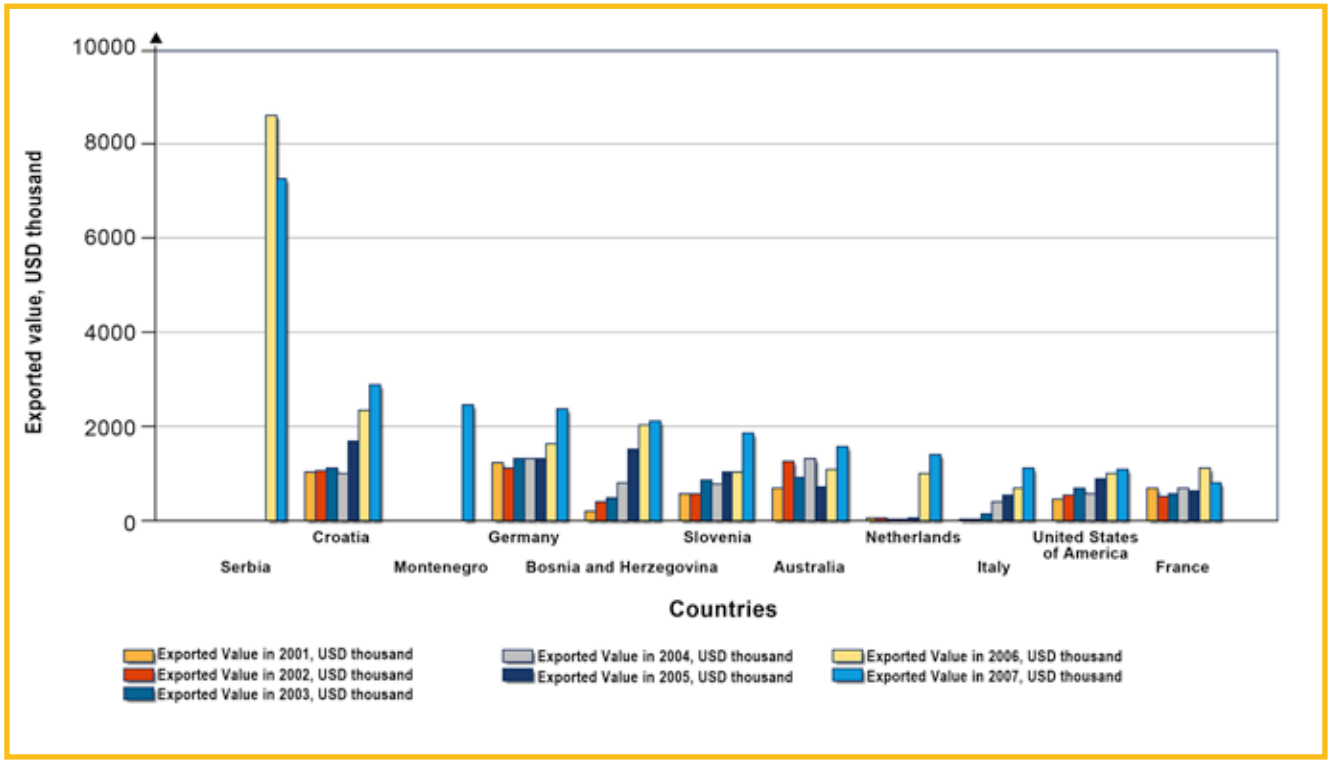


Figure 8b.
Main supplying markets of processed fruit and vegetables to the former Republic of Macedonia

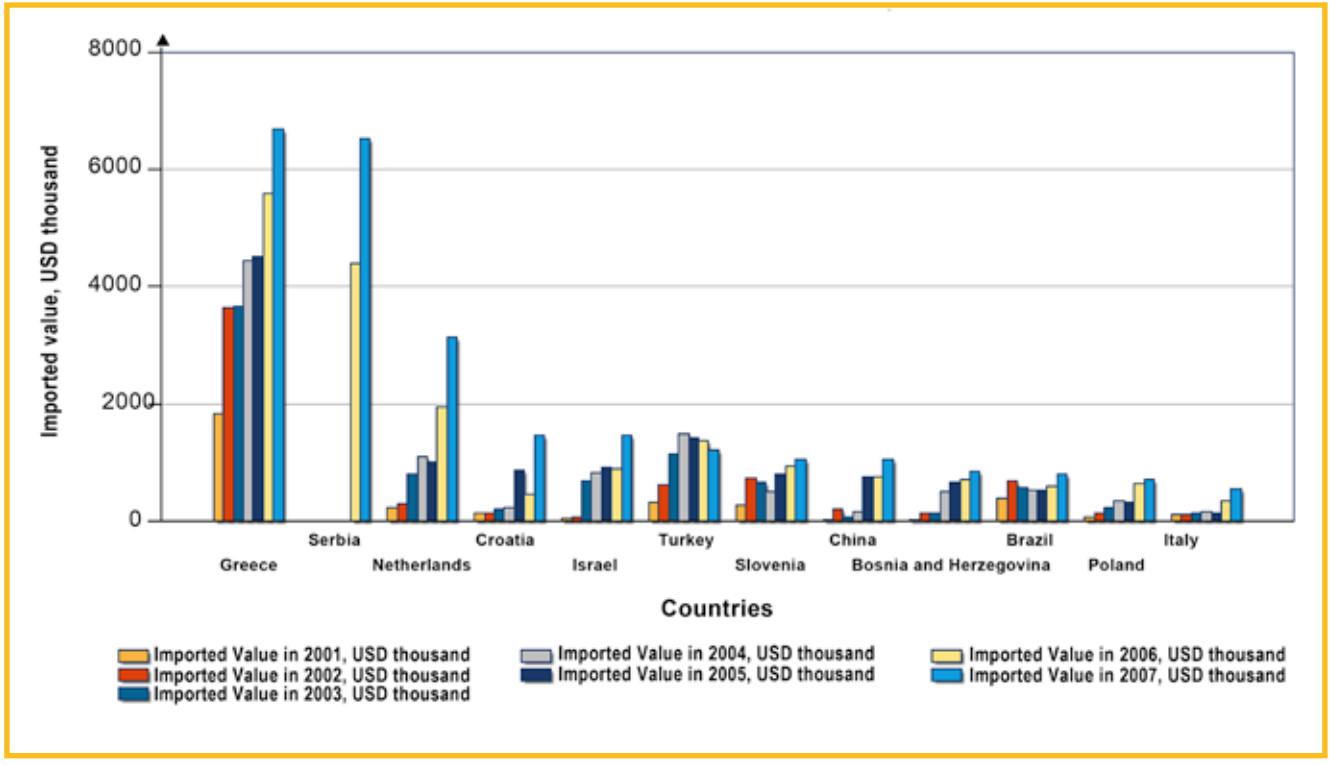


Figure 9a.
Main exporting markets of processed fruit and vegetables from the Republic of Moldova

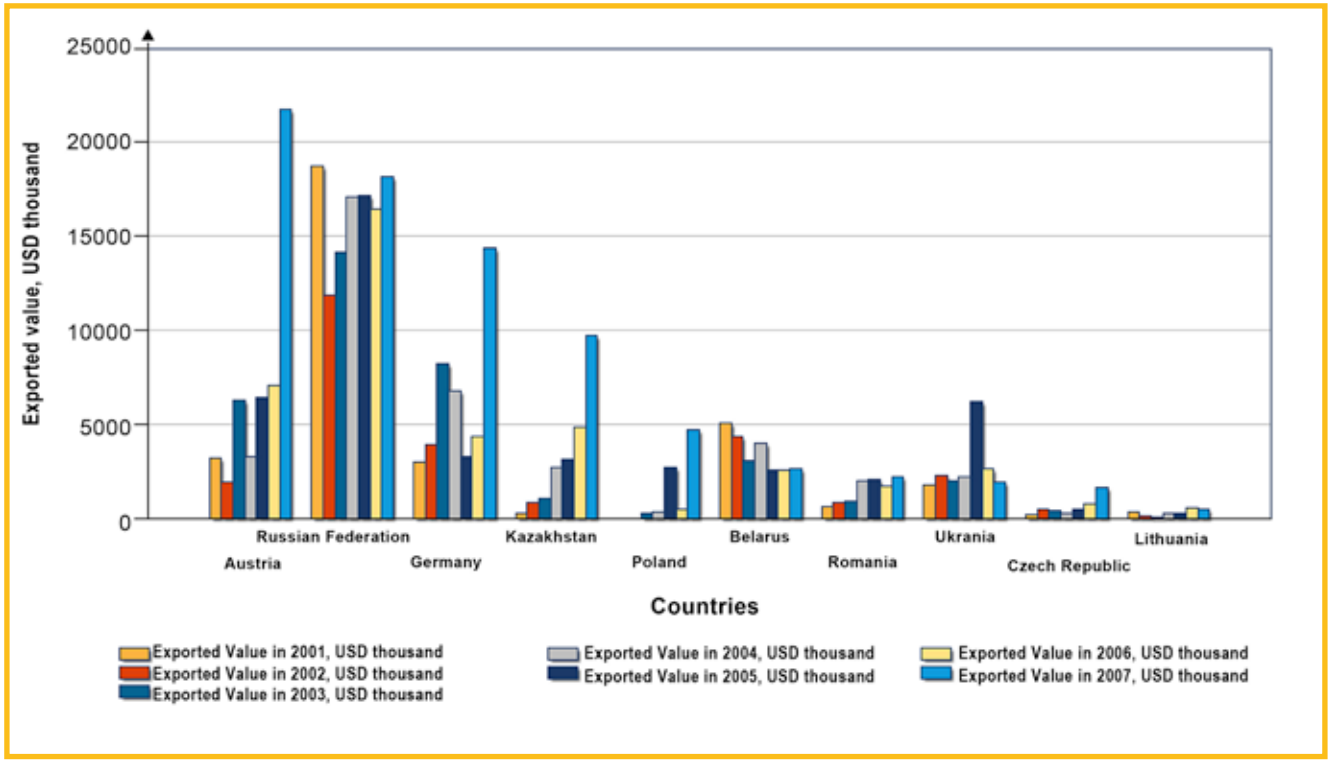


Figure 9b.
Main supplying markets of processed fruit and vegetables to the Republic of Moldova

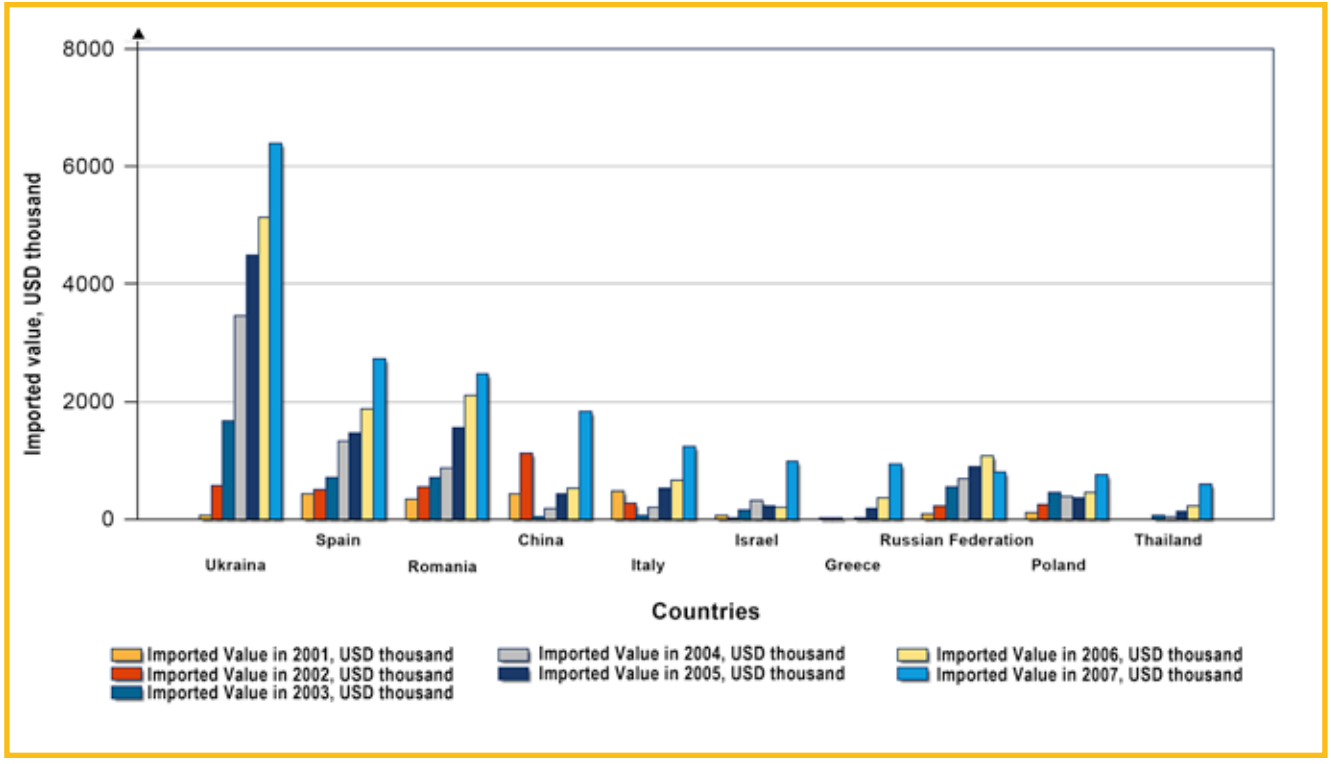


Figure 10a.
Main exporting markets of processed fruit and vegetables from Mongolia

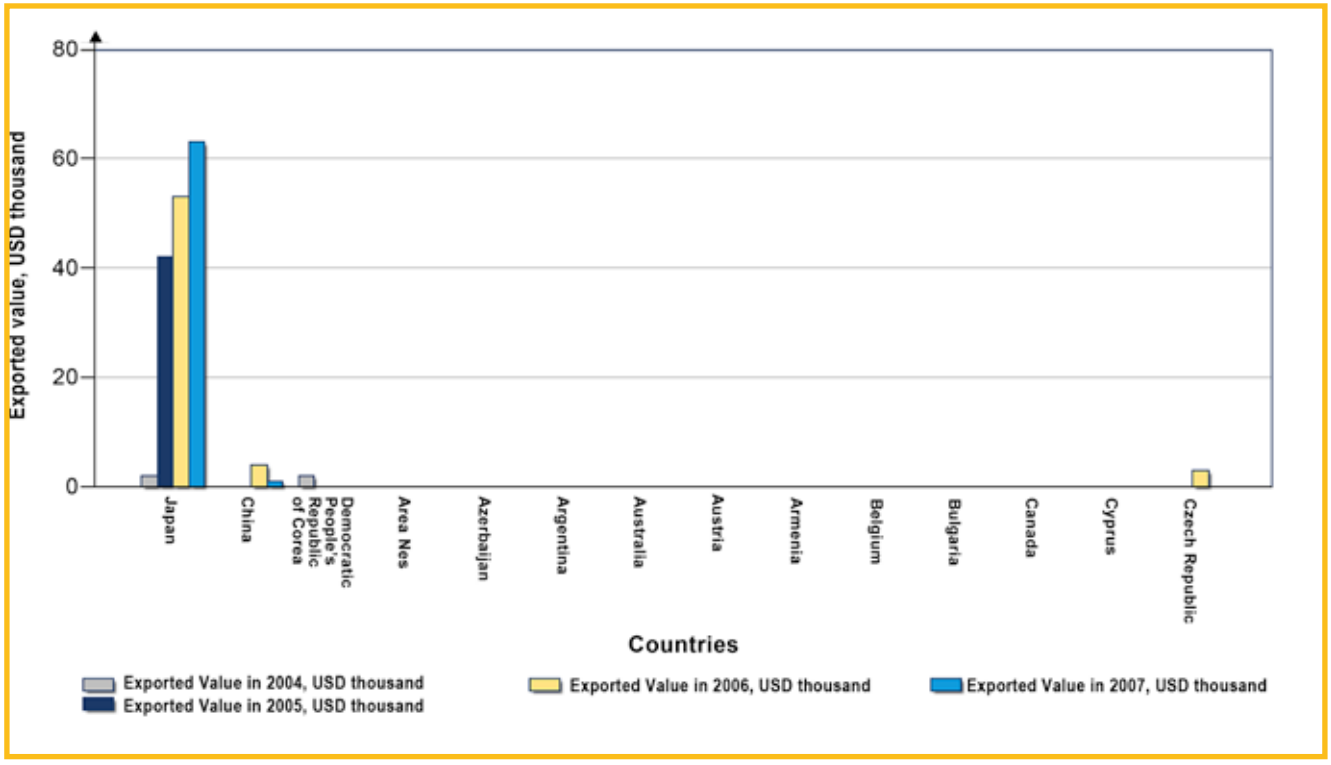


Figure 10b.
Main supplying markets of processed fruit and vegetables to Mongolia

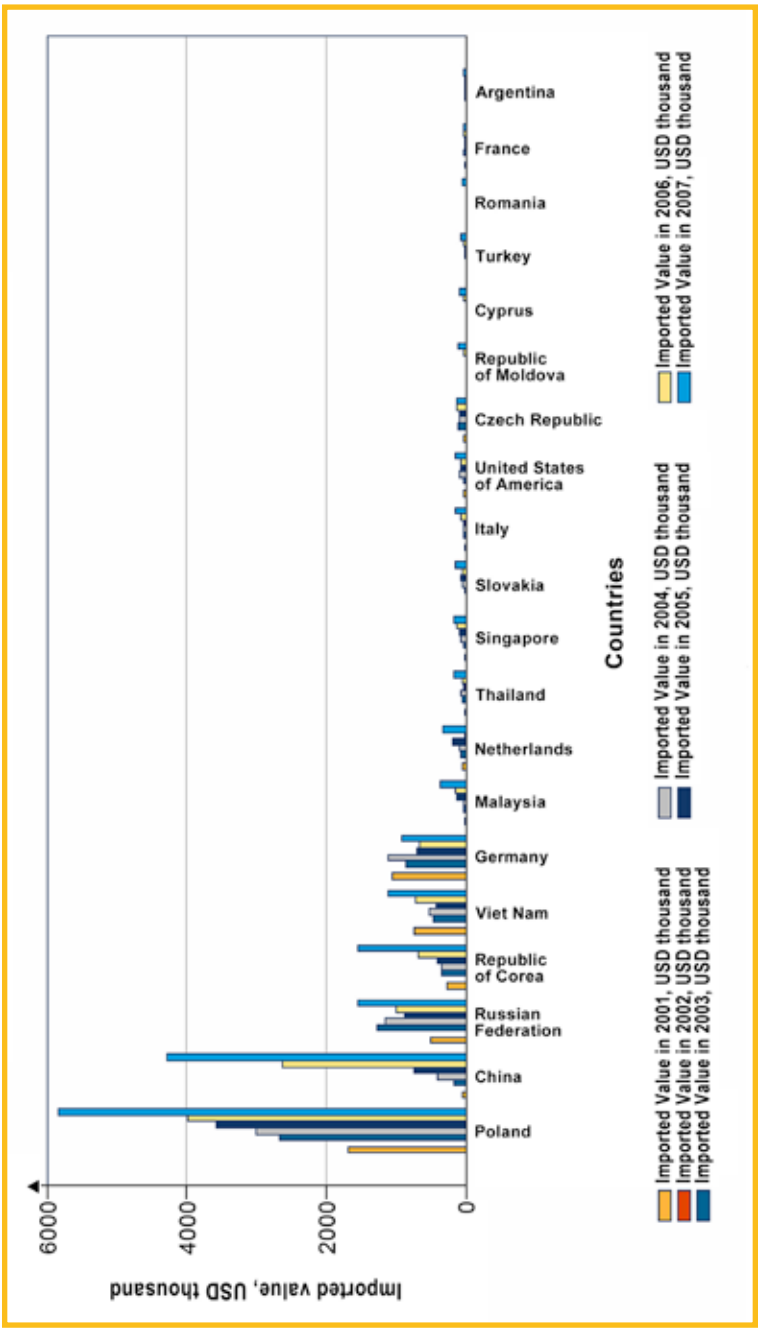


Figure 11a.
Main exporting markets of processed fruit and vegetables from Serbia

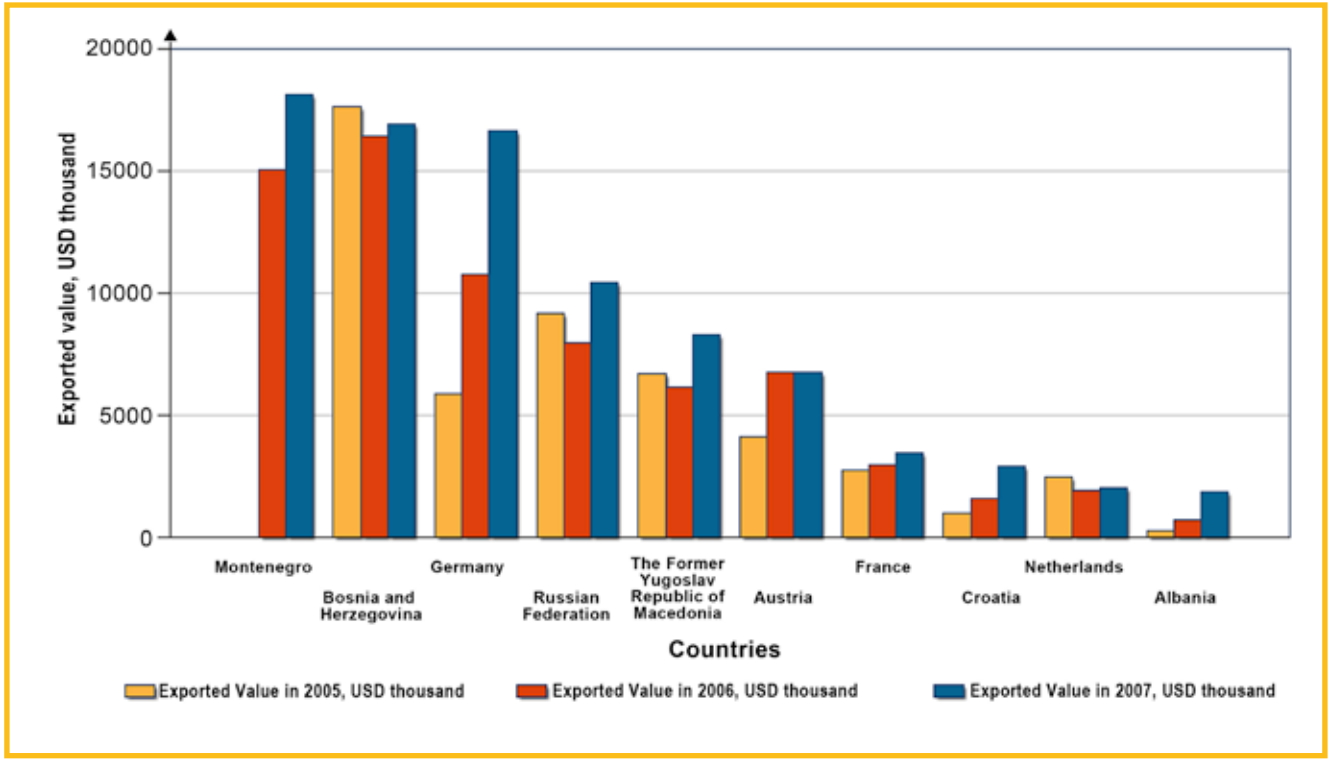


Figure 11b.
Main supplying markets of processed fruit and vegetables to Serbia

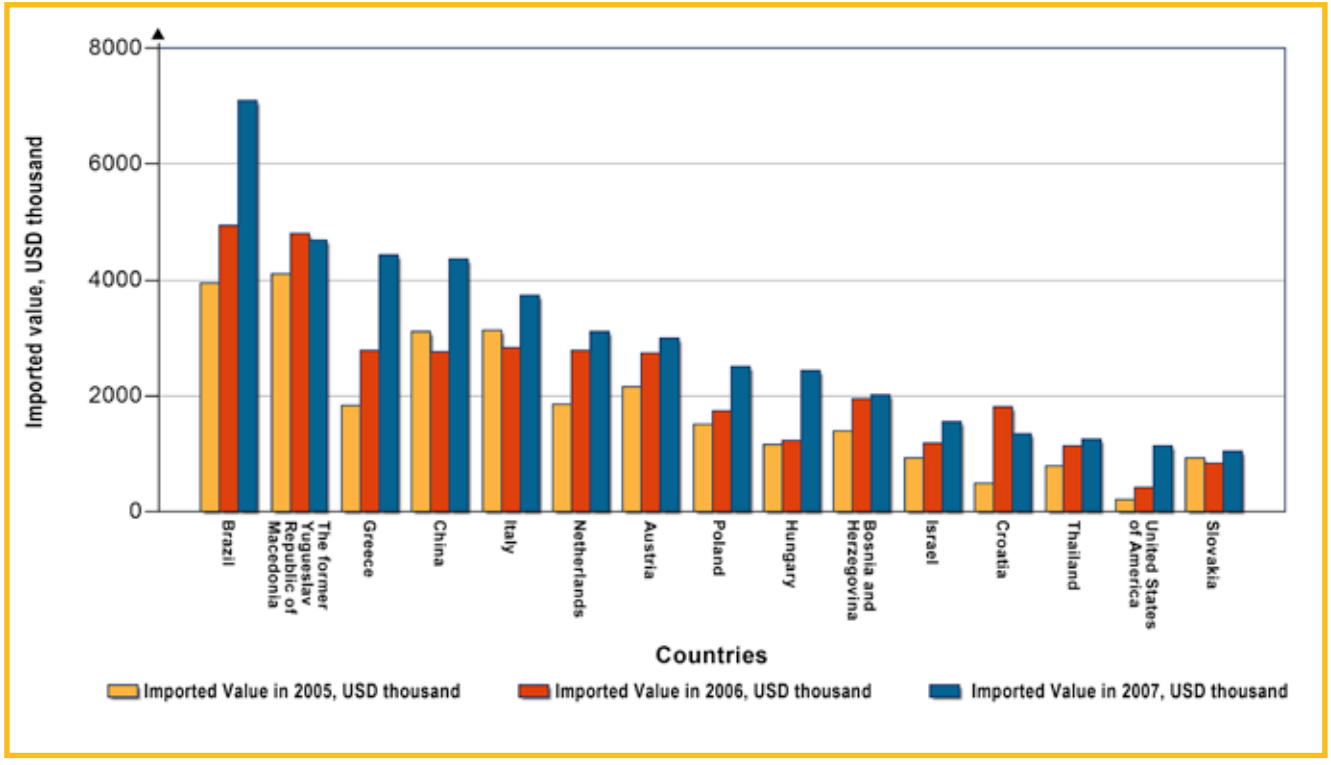


Figure 12a.
Main exporting markets of processed fruit and vegetables from Montenegro

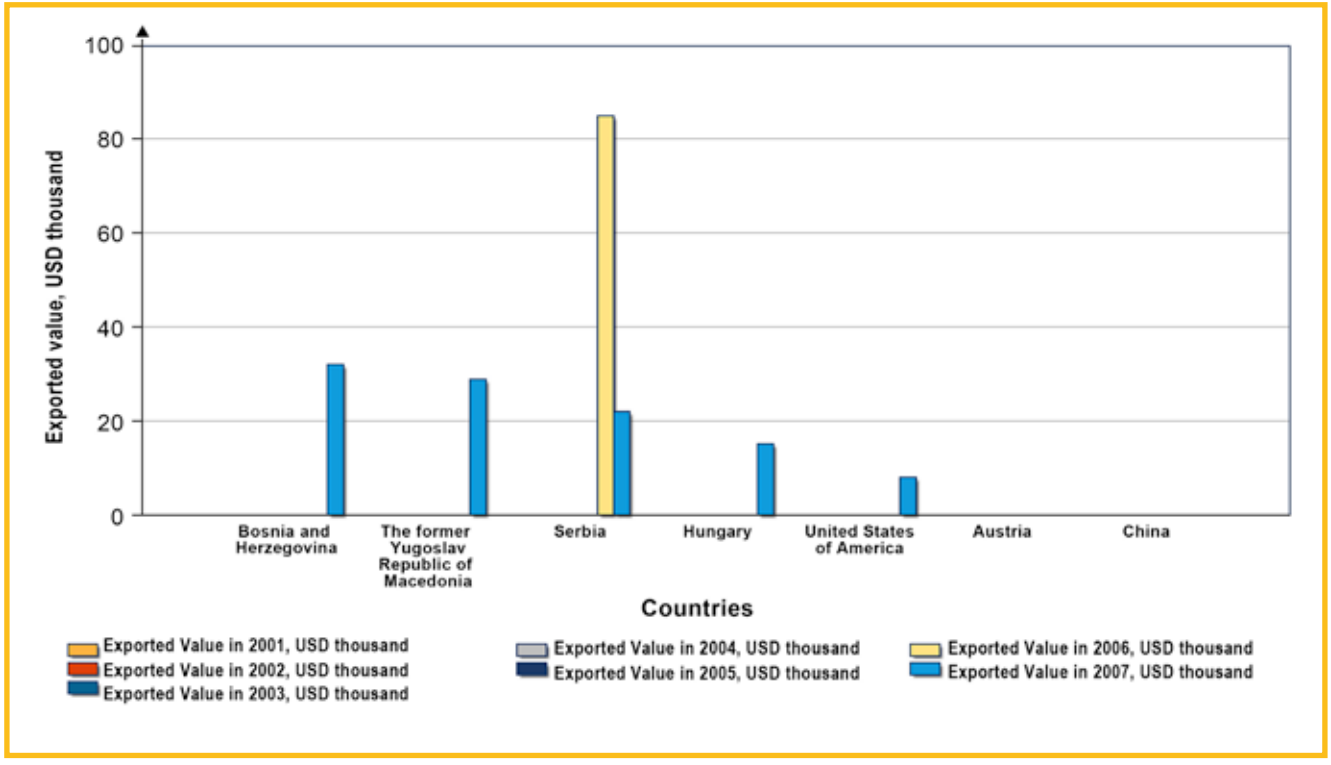


Figure 12b.
Main supplying markets of processed fruit and vegetables to Montenegro

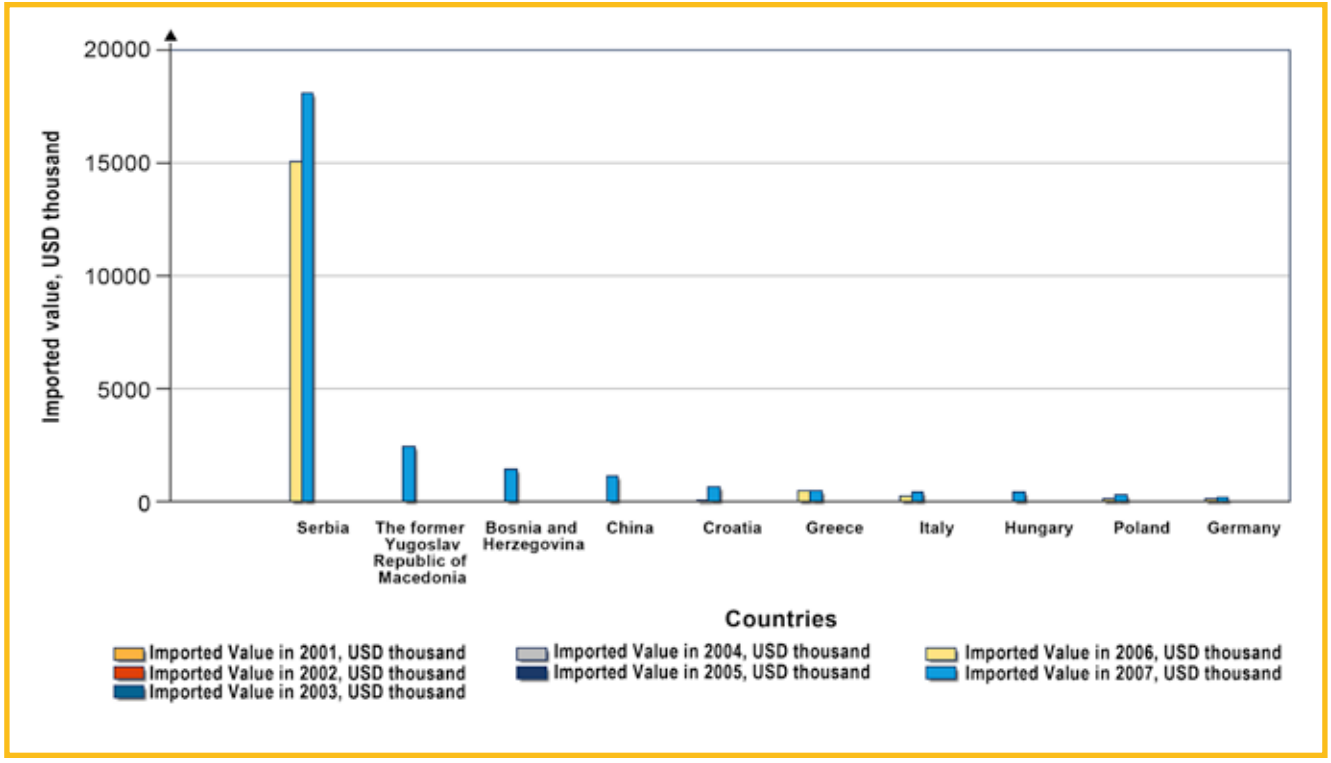


Figure 13a.
Main exporting markets of processed fruit and vegetables from Tajikistan

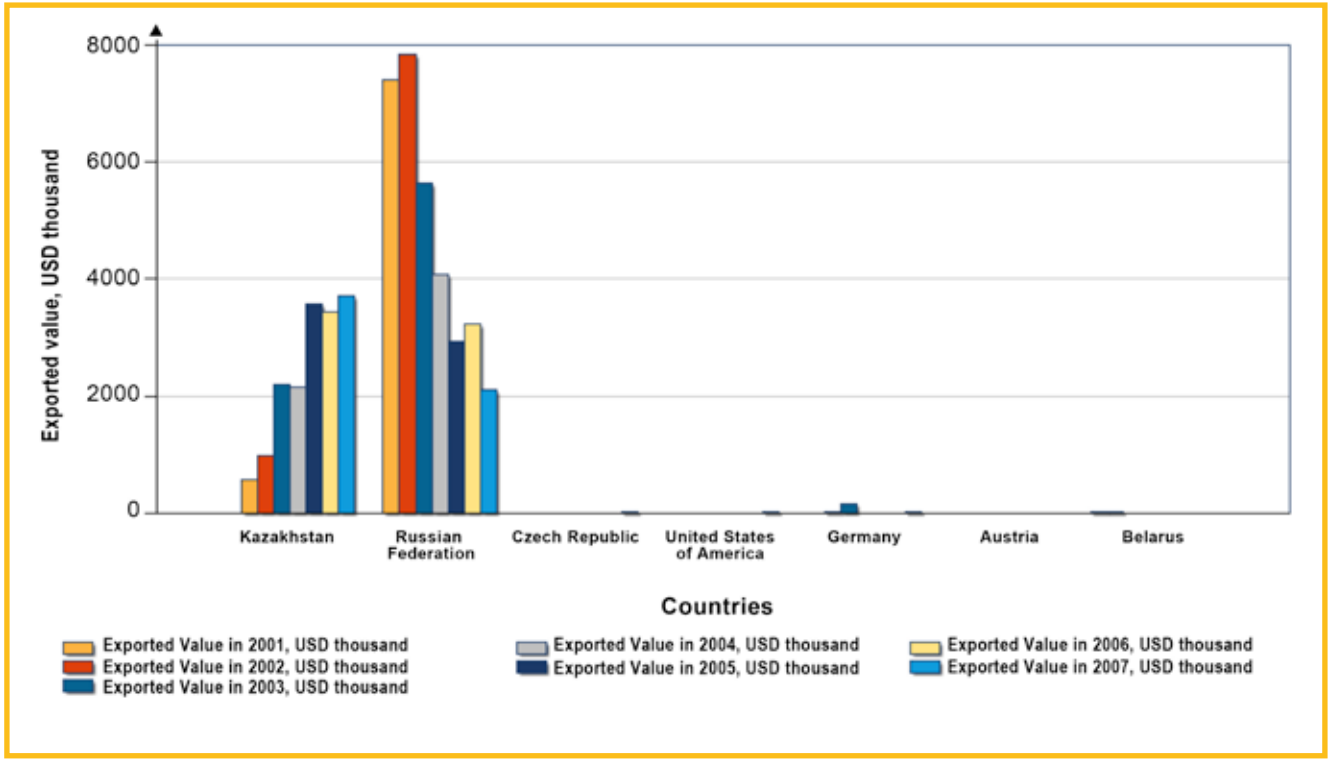


Figure 13b.
Main supplying markets of processed fruit and vegetables to Tajikistan

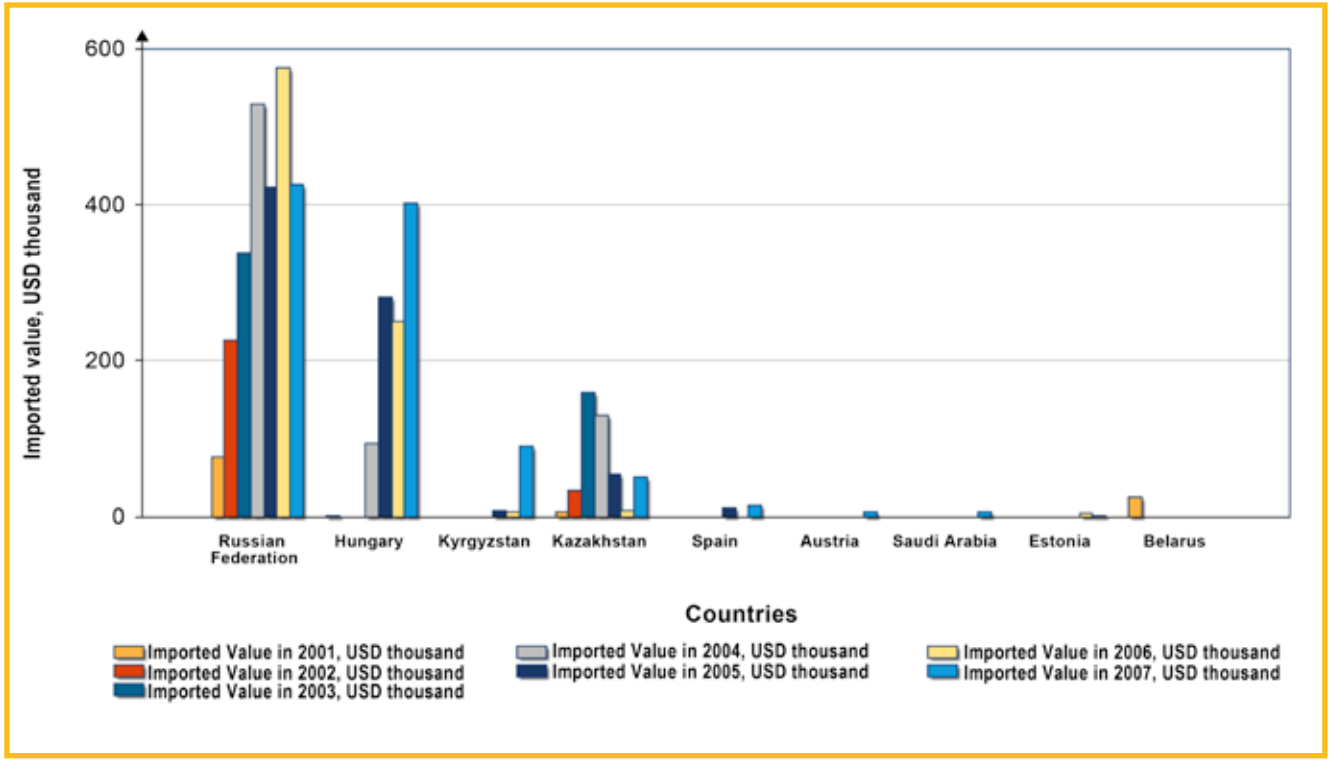


Figure 14a.
Main exporting markets of processed fruit and vegetables from Uzbekistan

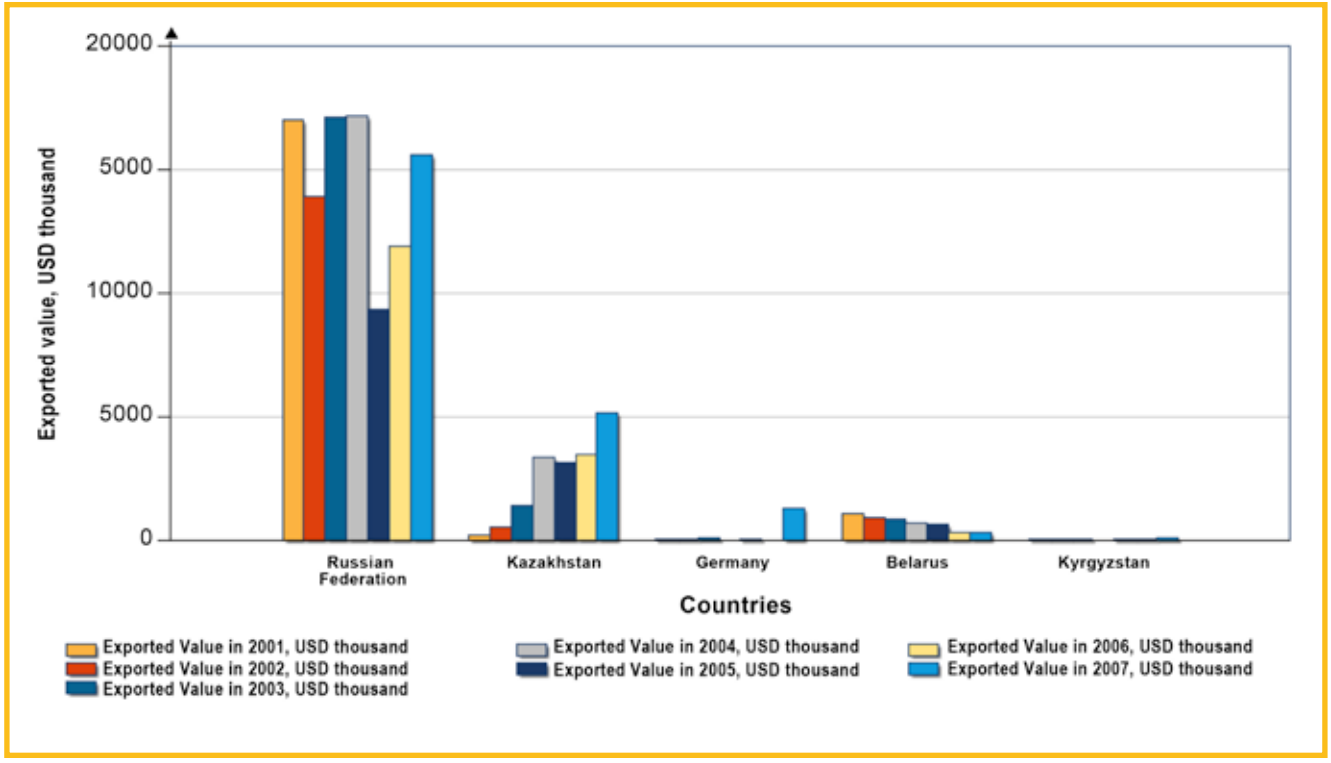
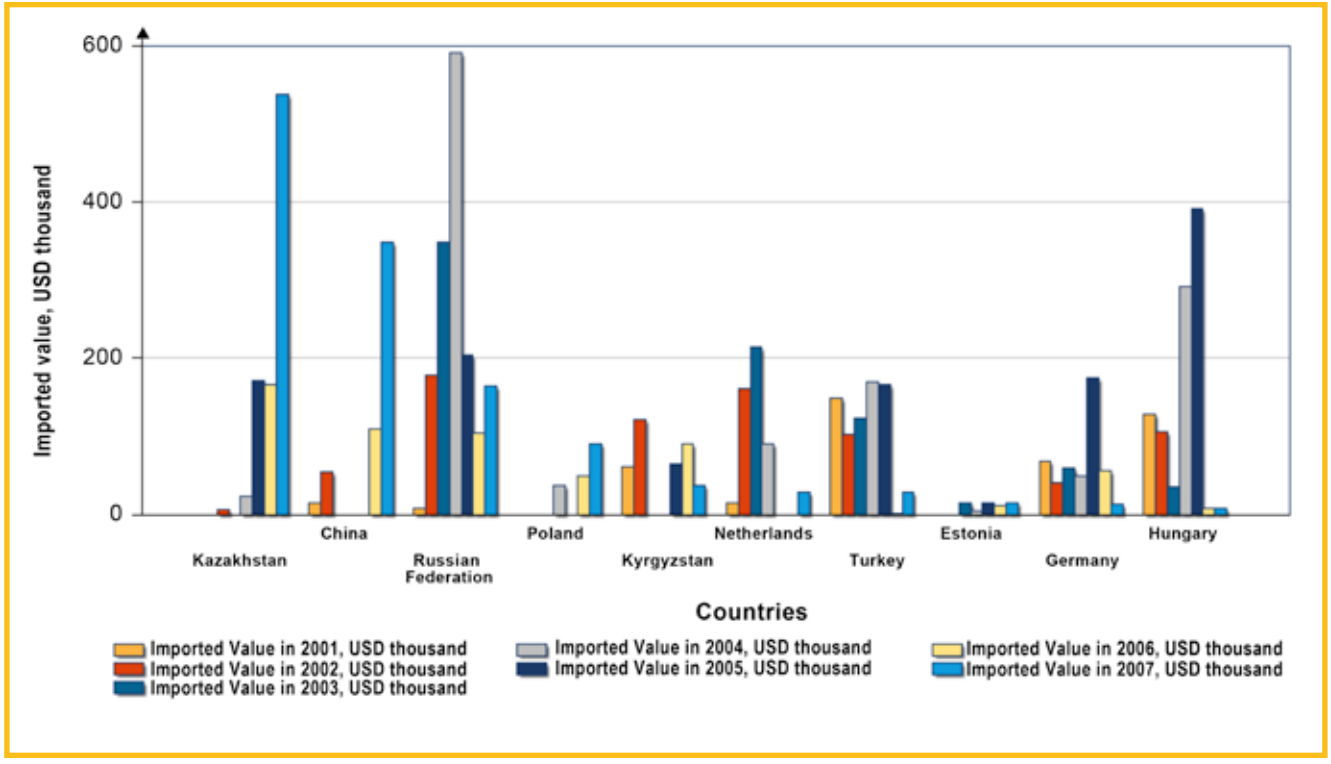


Figure 14b.
Main supplying markets of processed fruit and vegetables to Uzbekistan



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