apple

It's not just about growing apples

CANTEK

Foundation for Science, Culture & Education

Apple "It's not just about growing apples"

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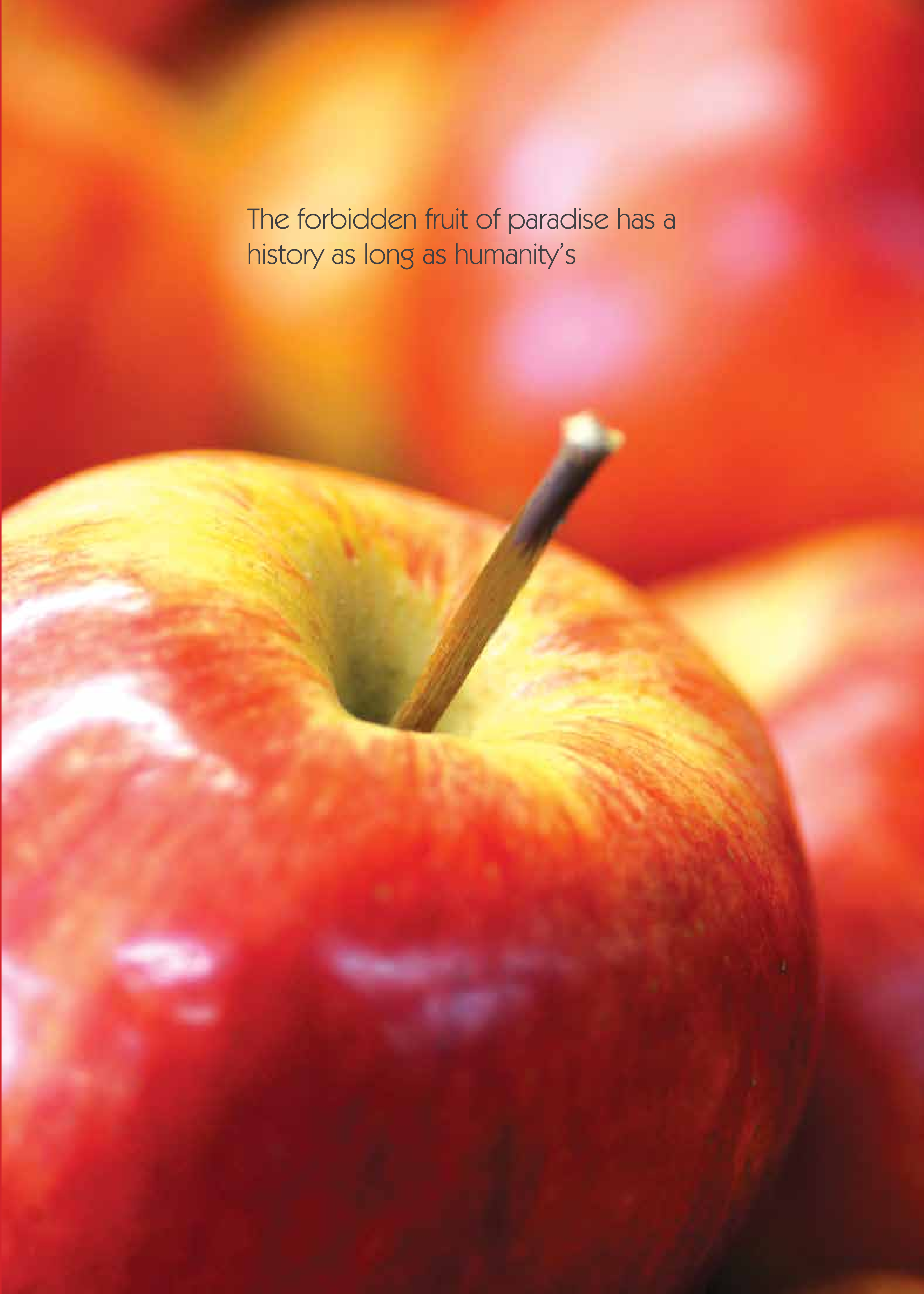

The forbidden fruit of paradise has a
history as long as humanity's

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THE APPLE ECONOMY

Prof. Dr. Rahmi TÜRK

Have you ever noticed

Apples have important properties not found in any other fruit.Apples grow in every climate, with the exception of the pole regions. Pollination and other biological functions are straightforward and their physical and chemical properties allow for easy picking, transportation, storage and packaging, something that cannot be said of many other fruits.

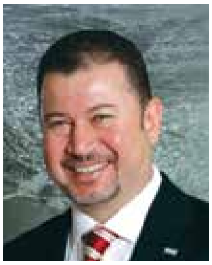
To give you an example: apples are not as soft as strawberries, or as delicate as pears, or as small and easily separated from their stem as whine, or as easily squashed as an orange, or as short-lived as a banana. For this reason, with the exception of certain regions of the world, apples are the most stored, most consumed, and most widely distributed fruit that has no features, such as seeds or a peel that hinder its direct consumption. In addition to that apples are the fruit with the best cost-benefit ratio. When we compare apples to other fruits, the following features stand out:

An apple

* has less peel than a banana,
* fever seeds than a cherry,
* needs less pesticides than a pear
* is cheaper than a kiwi,
* has a smaller stem than whine, and
* is more easy to eat than a quince.

There is no other fruit that has adapted so well to unfavourable conditions, that is so effortlessly consumed, that keeps the eater satiated for a long time due to is nutrients, and that can be processed in so many ways. For these reasons, cultivation and consumption of apples show the fastest upward trends among fruits. As legend has it, Paris, the son of the king of Troy, choose the most beautiful goddess by presenting her with an apple. Also in the future the apple is the most promising candidate of the fruit to be presented to the most beautiful people on earth.

Prof. Dr. Rahmi Türk



Can Hakan KARACA
Mechanical Engineer

Producing is a hardwork

In general, production is no easy task; when it concerns an agricultural product, the challenge is even greater. You put your heart and soul into it, you care about the soil and its produce as if they were your children while battling the forces of nature. Harvest is a particularly stressful time; you must not only pick the fruits on time and you must find ways to ensure the best price and to collect your money. Agriculture is a difficult business anywhere in the world, and it is subject to speculative operations. Produce finds its true market value only in the consumer prices. Farmers for whose produce the consumer is not ready to pay a good price will never earn good money.

After the banana the apple is the second most consumed fruit in the world. Apples can be grown in the most diverse climates, they can be stored in cold storages for long periods of time, and their physical and chemical properties allow them to be processed into a large variety of products on an industrial scale. These characteristics have made the apple the most beloved and most widely cultivated fruit on earth.

However, it is not enough to just grow apples...

Because during harvest time prices tend to drop to their lowest level. To achieve better prices in future, they should be put into storage. Advances in apple storage technologies developed in the USA, China and the countries of the European Union allow us to store apples over long periods of time in a state of pristine freshness, as if plucked straight from a tree.

In those countries even high-priced out-of-season apples find their buyers in the retail market. Overall, prices remain stable because of the steady supply of apples that have preserved their natural freshness in cold storage. This situation is favourable both for the apple grower and the consumer.

The most important link in this chain of happiness is the cold storage facility. Its quality affects both the grower and the consumer because storage quality determines the retail price and thus directly the earnings of the grower.

This book has three chapters dedicated to the correct storage of apples in cold storage facilities.

The first chapter introduces the apple and explains the products that can be made from them. The second chapter describes the world's most advanced methods of apple storage, while the third chapter addresses the cost issue of apple production, processing and storage under the heading of "The Apple Economy".

This book introduces you to apple mythology, to products made from apples, to apple storage methods from simple to the most advanced storage techniques, and to the economics of apples from the establishment of an orchard to the world apple trade. Every chapter has its own interesting story to tell, and by the time you have finished the book you will understand how correct and efficient storage affects the price of stored products.

I hope that this publication of the Science, Culture, Information and Education Foundation Cantek will be of benefit to the industrial apple industry.

Can Hakan Karaca

President of the Cantek Foundation for Science, Culture and Education

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CHAPTER 1

THE STORY OF APPLE

STORY OF APPLES

The apple goes as far back as the Genesis and the Garden of Eden, and plays a fateful role in the story of Adam and Eve. Ever since it has been the subject of mythology and folk tales and inspired the most diverse works of art.

In the following chapters we will, to the best of our ability, describe the journey of the apple from the tree to market, and the economy it has created on its way. You will read about the laborious cultivation process, the harvesting process and about the distribution to retailers of either fresh fruits or - after a months-long interlude at a storage facility - stored fruits, where they finally realise their true value.

MYTHS AND SYMBOLS

> "For once let us tell a Turkish fairy tale backwards: "And three apples fell from the sky." The first was picked up by Eva and handed to Adam, the second was eaten with great appetite. But what happened to the third? After having spent some time in cold storage it will be gifted to those who read these lines…"

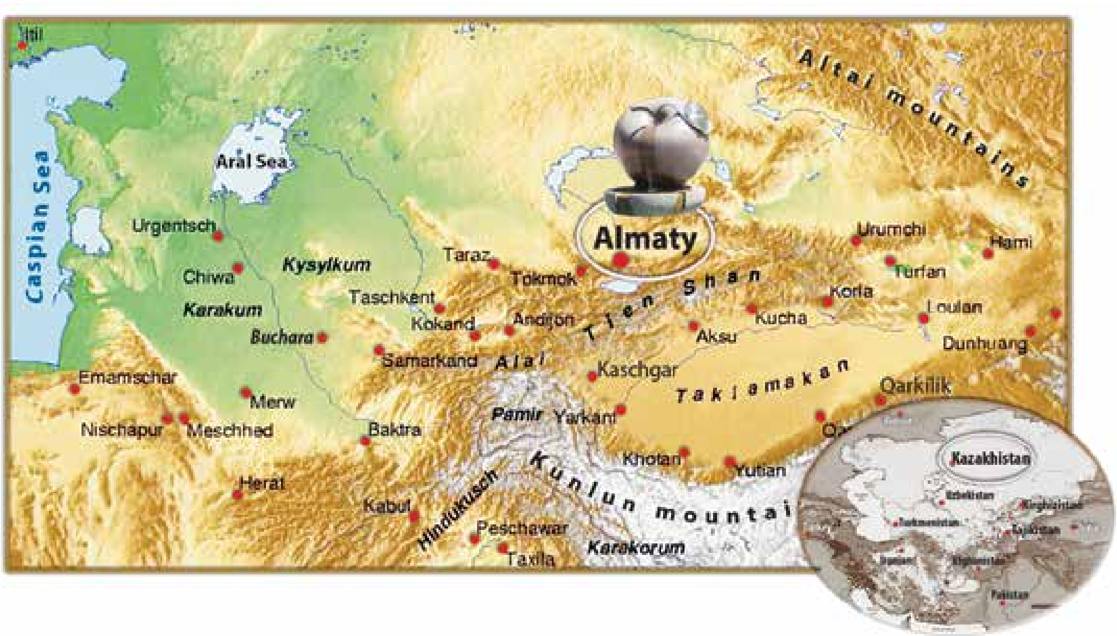
Studies on apple DNA have revealed a region in central Asia, known as "The Celestial Mountains" or Tian Shan, situated along the border between today's Kazakhstan and China, as the birthplace of the first edible sweet apple. The fruit grows at a height of 2,000 m where air masses from the Atlantic Ocean have created favourable growth conditions.

At a height of 3,000 m the soil of the Celestial Mountains is frozen, but just 500 m below its peaks, the rain clouds of the ocean water the soil and vitalise it so that apple trees can take hold. The Kazakh city of Alma-Ata bears witness to the valuable fruit with the first half of its name "alma" which means "apple" in Turkic and Hungarian languages. While the word is still in use in Hungarian, in modern Turkish it is pronounced "elma".

The apple is a symbol of love and power.

It is a recurring theme in countless verses of poetry and has inspired songs and ballads. Its power image has been reinforced in many legends; and the apple is even known as the favourite fruit offered to the gods.

The apple is central to the mythology surrounding the Trojan war. God Father Zeus fails to invite the Goddess of Chaos, Eris, to a wedding celebration. In response, Eris sends a golden apple with the request to present it to the most beautiful goddess.



Paris gave the Golden Apple to Aphrodite standing for beauty. Botticelli & workshop. The Judgement of Paris. c.1485-88.

In Scandinavian Mythology, Idunn represents Eternal Youth Goddess. James Doyle Penrose (1890)

The three candidates are the mother goddess Hera and Zeus' daughters Athena and Aphrodite. The task of selecting the most beautiful among them falls to Paris, son of the king of Troy. He gives the fruit to Aphrodite, known to this day as the goddess of beauty and love, who promised him the love of the most beautiful woman on earth, Helena.

Rosh Hashanah , literally "head of the year" is the Jewish New Year, and is celebrated on a day between September and October.

For Jews, Rosh Hashanah is a day of introspection, of a review of the past year, of the mistakes made that year and of promises and plans for the next year.

Rosh Hashanah

It is an opportunity for families to gather and celebrate. On this special day, it is customary to eat apples dipped in honey to evoke a sweet new year.

Scandinavian mythology tells of apples presented to the gods who in return granted youth.

In **former times, in Britain** the apple was a symbol of fertility and fecundity. On the 19th of August of every year, people in Russia, Belarus and Ukraine celebrate the Apple Feast Day in honour of the transfiguration of Christ when he learned about his mission as saviour of mankind. On that day it is customary to eat apples or food prepared from apples. Many centuries old celebrations coincide with harvest time.

In **Swiss folklore** Wilhelm Tell is forced to shoot an apple from the head of his son with a crossbow.

For us, the perfect halves of an apple hold the promise of an exceptional love and harmonious partnership.

And what kind of world would we live in if an apple had not dropped on Newton's head?

For how much longer would we have held on to our pre-scientific beliefs. We bow before the magnificent history of the apple that sprung into life in Alma-Ata, also known reverently as the "paradise gardens", from where it spread into the wide world inspiring myths, legends and symbols.

ITS BENEFICIAL EFFECTS ENDEARED HUMANITY TO THE APPLE

"An apple weighs on average 150-200 g. A large apple has about 95 calories and a small apple 60."

İIn the course of human history, in times of penury, war and epidemics the apple came to the rescue of man. After the 1950s the world went through a phase of fast development. In its wake the apple became widely known and people immediately fell in love with the fruit. Better transport technology meant that local fruits could easily be distributed to regions where they were previously unknown, and become part of people's daily lives. The revolution behind this improvement was the establishment of cold storages and cold chain networks.

The number of apple varieties is estimated to be between 7,500 and 10,000 worldwide. Thanks to advanced storage methods they are freshly available all year round.

However, despite this wealth of different apples the number of commercially successful varieties is very limited. The selection process began at the end of the 19th century in the orchards of Europe, Russia, North America, New Zealand and Australia. They provide the stock for today's commercial apples.

Qualities sought after by modern commercial apple plantations are colour, texture, taste, transport resistance, long storage life, high productivity per unit area, resistance to pests and diseases, and of course flavour. North Americans and Europeans favour sweet and slightly acidic varieties. There is, however, also a strong minority who love sour apples. Asians want their apples to taste sweeter and more sour respectively. The apple orchards of tomorrow with be dominated by varieties that require less pesticides, that are more resistant, easier to store or process into apple juice, and that are rich in minerals and vitamins with known health benefits. All apples will be supplied to consumers in a harvest-fresh state all year round.

"Come out when I say apple, don't come out when I say pear!"

When children in Turkey play hide-and-seek, in the most funny reply the apple assumes the role of the lead character. Or think of the saying "An apple a day keeps the doctor away". It is one of the best advices to promote the consumption of apples for health reasons. In industrialised countries the nutritional value of apples inspires campaigns to encourage and increase their consumption in particular among children of primary school age.

The benefits of apples

Apples contain vitamins of the groups A, C, E and B; they are rich in minerals such as calcium, potassium, magnesium, phosphor and sodium, and they are a source of various organic acids. A medium-size apple contains about 8 mg of vitamin C; with a daily requirement of 90 mg on average that corresponds to 12% of the recommended daily intake. A significant share of these beneficial ingredients is located right under the apple skin. Nutrition experts therefore advise to eat apples raw and unpeeled.

Apples help to reduce the cholesterol level; two medium-size apples a day are enough to lower it by about 16%. The soluble fibre pectin, found in apples, filters out the "bad" cholesterol while at the same time enhancing the concentration of the "good" type.

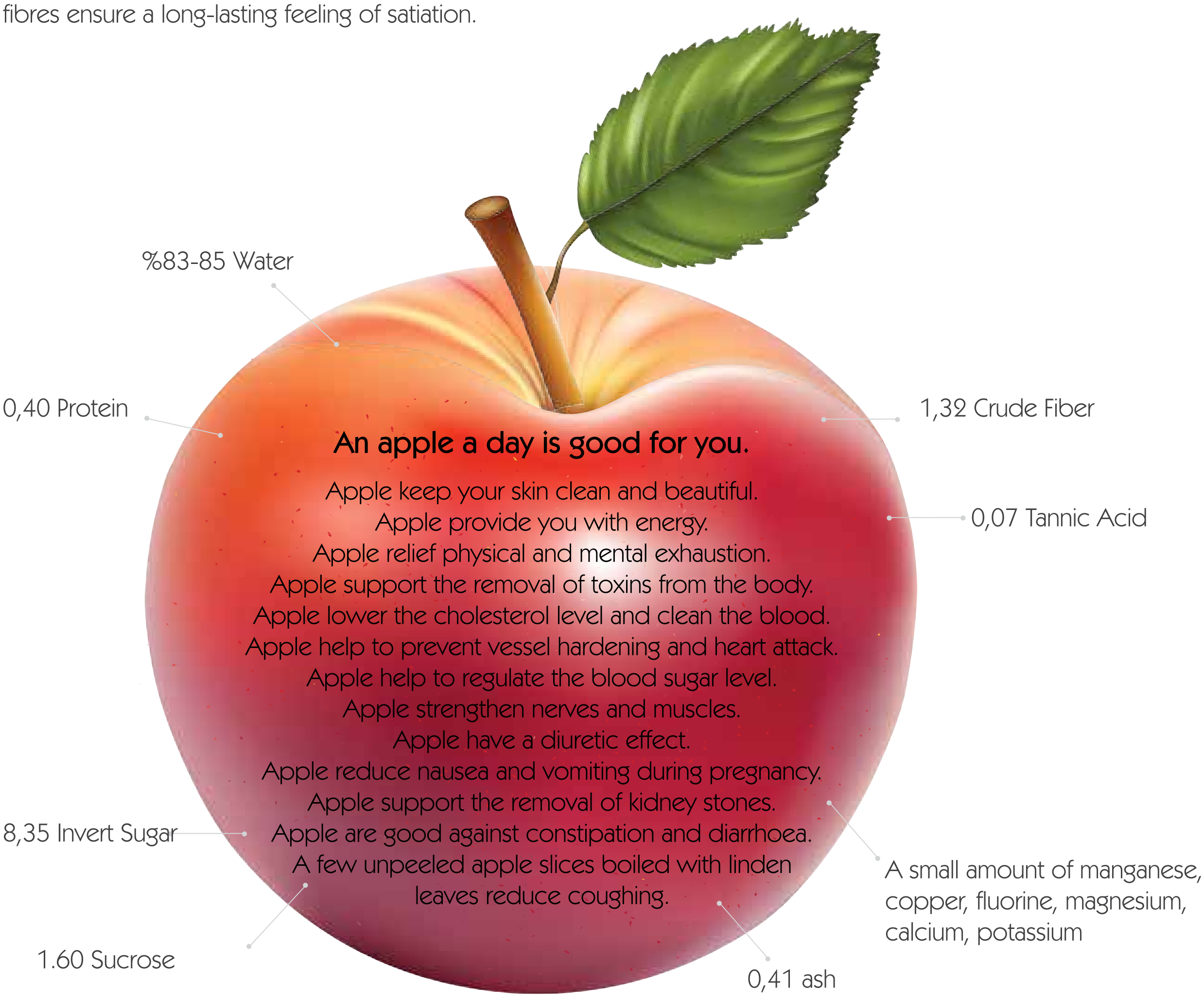
For a food stuff to be considered a good fibre source it must contain at least 2.5 – 3 g. In a medium-size apple the amount is about 4 g. The fibres ensure a long-lasting feeling of satiation.

The soluble and insoluble fibres contained in apples support the removal of harmful substances from our body and thus act as cancer protection agents. Apples are also a source of quercetin, an antioxidant that is mainly found in the apple skin.

Five or more apples per week improve our lung functions. Scientific studies have found that the children of mothers who regularly ate apples had a lower risk of developing asthma.

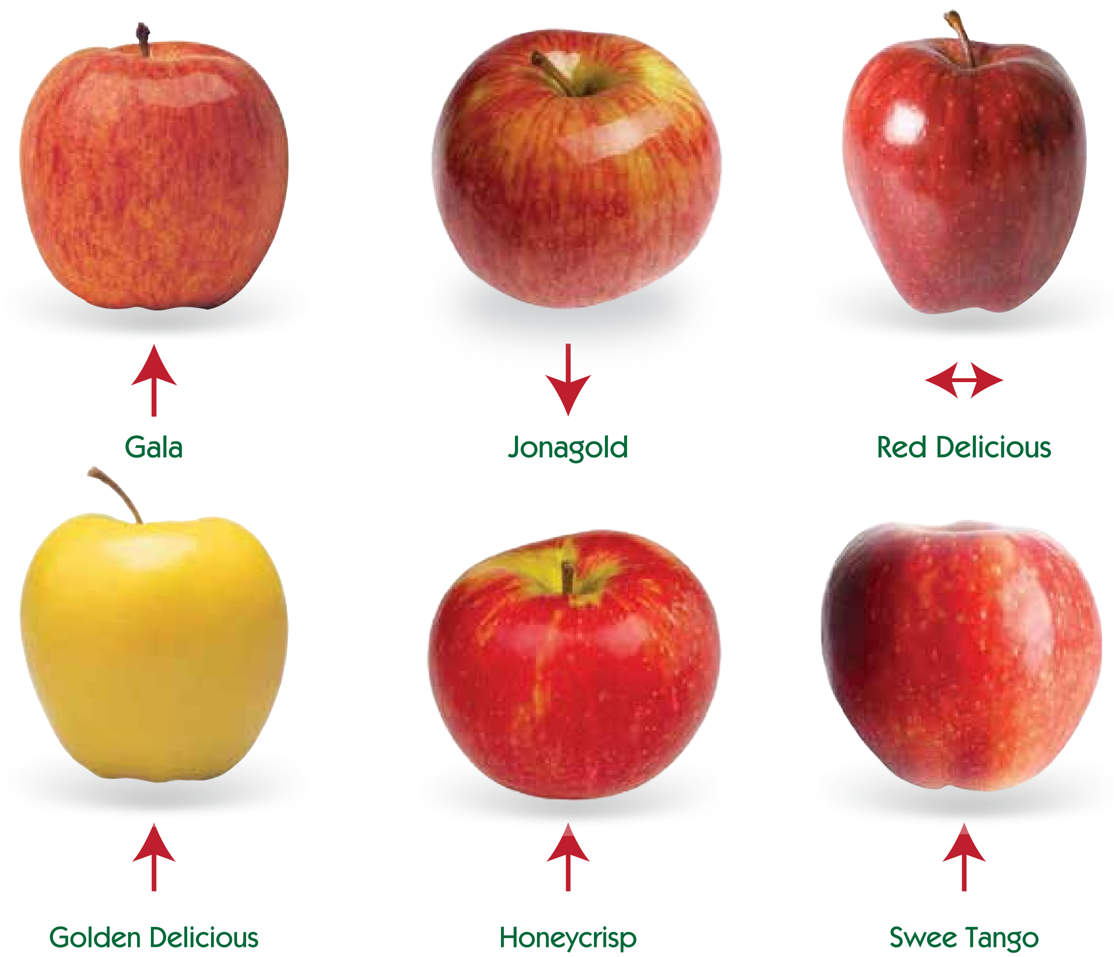
Apples also increase the production of acetylcholine, a neurotransmitter molecule that ensures the communication between nerve cells. It slows down the development of Alzheimer, one of the most serious afflictions of our time, and improves memory functions.

Other substances found in the apple help to prevent colon cancer. The so-called triterpenoids found in the apple skin are known to prevent and fight lung, colon and breast cancer.



Trends in the world apple market

Apples out, Apples in



THE WORLD'S FAVOURITE APPLE VARIETIES

Most favorite apples in the world market in descending order...

Golden Delicious

An apple cultivar originated in the United States of America. It develops into an upright, semi-upright and medium-strong tree with a diffuse crown. The fruit is of large size, juicy, slightly sour and of yellow colour; the average weight is 136 g. The skin colour is greenish yellow, and the flesh cream coloured. The apple is sweet, juicy and the eating quality is high. The fruits are harvested in the second week of September and can be stored in cold storage until the end of March. The time span between full bloom and harvest is 145-155 days.

Normal Atmosphere Values

Set °C	Diff.	hum. (%)	Storage in mth.
-0,5;+1	2	90-92	6

Controlled Atmosphere Values

Set °C	Diff.	Storage in mth.	% / CO	% / O_2
0	1	6-8	2-3	1-2

*All data may vary according to local conditions.

Gala (Royal, Galaxy, Mondial)

This apple cultivar from New Zealand is grown in many countries. The tree is strong and broad and quite productive. The fruits are of medium-large size, sweet, juicy, firm and crisp; their eating quality is high. The Gala cultivar family is extensive. Pollinators are the varieties Fuji, Golden Delicious, Red Delicious, Granny Smith, Braeburn and Jerseymac. The time span between full bloom and harvest is 125-135 days.

Normal Atmosphere Values

Set °C	Diff.	hum. (%)	Storage in mth.
0 ;+3	2	85-90	2-3

Controlled Atmosphere Values

Set °C	Diff.	Storage in mth.	% / CO	% / O_2
+1 ;+2	1	4	2-3	1-2

*All data may vary according to local conditions.

Granny Smith

This cultivar was bred in Australia in 1898. The tree is slender, of medium strength, semi-straight and broad; the yields are abundant year after year. The tree is self-pollinating. The fruits are of medium-large size and of green colour with a light dull yellow hue. The apples have a nice quality look. The fruit flesh is greenish-white. They are firm, juicy and slightly acidic. The apple is sensitive to mildew, fire blight and physiological peel blight. The time span between full bloom and harvest is 180-190 days. When stored under normal atmospheric conditions, the peel darkens which is an important physiological defect. For this reason long-term storage must be under controlled atmosphere conditions with additional 1-MCP fumigation.

Normal Atmosphere Values

Set °C	Diff.	hum. (%)	Storage in mth.
-0,5;+1	2	90-92	4-5

Controlled Atmosphere Values

Set °C	Diff.	Storage in mth.	% / CO	% / O_2
-0,5;+1	1	8-10	0,5-2	1,5-2

*All data may vary according to local conditions.

Starking Delicious

The cultivar was developed in the United States in 1952 and is a widely grown apple variety. The tree is semi-straight, of medium strength and productive. The peel is a dark red colour with a purplish hue. The fruits are of medium-large size, the fruit flesh is white, juicy and sweet. Recommended pollinators are Golden Delicious, Granny Smith, Fuji, Braeburn, Galaxy Gala and Mondial Gala. The time span between full bloom and harvest is 145-155 days.

Normal Atmosphere Values

Set °C	Diff.	hum. (%)	Storage in mth.
0;+2	2	85-90	6-8

Controlled Atmosphere Values

Set °C	Diff.	Storage in mth.	% / CO	% / O_2
0;+1	1	9-10	2	0,7-2

*All data may vary according to local conditions.

Starkrimson Delicious

The tree is of medium strength and semi-straight. The fruits are of medium-large size and of good quality. The basic peel colour is yellow with a coating of a bright red-purplish hue. The fruit flesh is white, juicy, firm and tasty. Golden Delicious, Granny Smith, Gala group, Brauburn and Stark Spur Golden Delicious varieties serve as pollinators. The time span between full bloom and harvest is 140-150 days.

Normal Atmosphere Values

Set °C	Diff.	hum. (%)	Storage in mth.
0;+1	2	90-92	5-6

Controlled Atmosphere Values

Set °C	Diff.	Storage in mth.	% / CO	% / O_2
0-5	1	8-9	2	2-3

*All data may vary according to local conditions.

Jonagold

A juicy and sweet apple originated in the United States. The cultivar is planted widely all over the world. The tree is strong and broad, with very good branching properties and a good yield. The fruits are very large and of round and conical shape. The basic peel colour is a greenish yellow with a coating of red and purple. In places with a lot of sunshine, the peel becomes more red. The fruit flesh is cream coloured, of medium firmness, juicy, sweet and crisp. Pollinators are Fuji, Gala group, Red Delicious, Granny Smith and Melrose cultivars. Over the last couple of year mutations such as Red Jonagold, Jonagold 2000, Jonagold Hightwood and Welmuta Jonagold have been bred. In the new varieties, the peel is of a darker and brighter red. The time span between full bloom and harvest is 135-145 days.

Normal Atmosphere Values

Set °C	Diff.	hum. (%)	Storage in mth.
0;+1,5	2	85-90	3

Controlled Atmosphere Values

Set °C	Diff.	Storage in mth.	% / CO	% / O_2
0;+1	1	5	2-3	1,2-3

*All data may vary according to local conditions.

Braeburn

This apple variety from New Zealand has been on the market since 1952. The tree is of medium strength and broad. The fruits are medium-size and of round and conical shape. The basic peel colour is green with a dull-red hue and stripes. The fruit flesh is of cream colour, juicy and firm. Besides New Zealand, the apple is grown in large quantities in Argentina and Chile. In recent times, Americans and Europeans have begun to cultivate the tree. The cultivar is sensitive to venturia inequalis and fire blight. The apple can be stored for long periods of time. Golden Delicious, Red Delicious, Fuji and Gala are the recommended pollinators. The time span between full bloom and harvest is 160-170 days.

Normal Atmosphere Values

Set °C	Diff.	hum. (%)	Storage in mth.
0 ; +2	2	87-92	7-8

Controlled Atmosphere Values

Set °C	Diff.	Storage in mth.	% / CO	% / O_2
0;+1	1	9-10	0,5 - 1,5	1,5 - 2

*All data may vary according to local conditions.

Fuji

The Fuji is an apple variety breed in Japan. The cultivar has over 100 sub-varieties. The tree is strong and semi-broad. Its fruits are of medium-large size, even, round and flat at the poles. The peel exhibits large lenticels; its colour is a dull-red on yellow. The fruit flesh is of cream colour, firm, sweet, crisp and aromatic. Because of colouring problems it is recommended to harvest the apple in several stages. The cultivar is self-pollinating. It is, however, recommended to use diploid varieties and Golden Delicious, Mondial Gala and Breaburn as pollinators. The time span between full bloom and harvest is 170-175 days. The apple is suitable for storage.

Normal Atmosphere Values

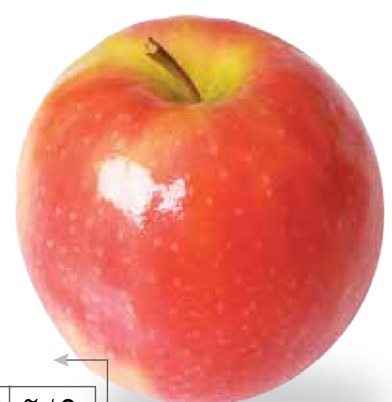
Set °C	Diff.	hum. (%)	Storage in mth.
0;+1	2	86-92	6-9

Controlled Atmosphere Values

Set °C	Diff.	Storage in mth.	% / CO	% / O_2
0;+1	1	10-12	0,5	1,5 - 2

*All data may vary according to local conditions.

Cripps Pink (Pink Lady)



The countries of origin of this cultivar are Australia and New Zealand. The tree is of medium strength and semi-straight. It is known in Turkey to harmonise and develop well on dwarfing rootstocks. The peel exhibits large lenticels; its colour is purple on green. The fruit flesh is of cream colour, firm, crisp, juicy, sour-sweet in taste and with an intensive aroma. Due to the apple's very long storage life this variety can be found in all seasons. Pollinators are varieties of the Gala group, Granny Smith, Stark Crimson Delicious, Red Delicious and Fuji. The time span between full bloom and harvest is 195-205 days.

Normal Atmosphere Values

Set °C	Diff.	hum. (%)	Storage in mth.
0 ;+1	2	85-90	7-8

Controlled Atmosphere Values

Set °C	Diff.	Storage in mth.	% / CO	% / O_2
0	1	9-11	1	1,5 - 2

*All data may vary according to local conditions.

Summer Red

This cultivar is widely used and an early apple variety. Its country of origin is Canada. The tree is strong and semi-broad. This variety is very productive and harmonises with all rootstocks. The fruit is of medium-large size and cylindrically round in shape. The peel is red on bright yellow, and has yellow spots. The fruit flesh is white, firm, crisp, juicy and slightly acidic. The recommended pollinators are Golden Delicious, Granny Smith, Vista Bella, Gala, Fuji and Jerseymac varieties. As its name indicates, this variety is harvested in the summer. The time span between full bloom and harvest is 110-120 days. To prevent fruit fall it is recommended to harvest 2-3 times.

Normal Atmosphere Values

Set °C	Diff.	hum. (%)	Storage in mth.
0;+3	2	87-92	1-2

Controlled Atmosphere Values

Set °C	Diff.	Storage in mth.	% / CO	% / O_2
0;+1	1	2	0,5 - 1,5	2-3

*All data may vary according to local conditions.

Red Chief

This cultivar originated in the United States. The tree is slender and straight. The fruits are of medium-large size and have a flat shape. The fruit flesh is sweet, firm, juicy, tasty and highly aromatic. The peel colour is a bright red on yellow. Golden Delicious, Granny Smith, Fuji and Gala group varieties are recommended pollinators. The time span between full bloom and harvest is 145-155 days.

Normal Atmosphere Values

Set °C	Diff.	hum. (%)	Storage in mth.
0;+1	2	90-95	6-7

Controlled Atmosphere Values

Set °C	Diff.	Storage in mth.	% / CO	% / O_2
0	1	8-9	3	1

*All data may vary according to local conditions.

Vista Bella

The Vista Bella is an early apple variety originated in the United States. The tree is strong and broad. The peel is red to purplish in colour on a basic tone of whitish green. The fruit flesh is juicy and slightly acidic. Pollinators are Golden Delicious, Jerseymac, Prima, varieties of the Gala group, Red Delicious and similar cultivars. Being an early apple its storage life is close to zero. The Vista Bella is usually consumed fresh. The time span between full bloom and harvest is 89-95 days.

Normal Atmosphere Values

Set °C	Diff.	hum. (%)	Storage in mth.
1;+3	2	85-90	2

Controlled Atmosphere Values

Set °C	Diff.	Storage in mth.	% / CO	% / O_2
0;+1	1	3-4	2,1	2,2

*All data may vary according to local conditions.

Jersey Mac

This variety's tree is strong and semi-broad. Among the early cultivars it is rather productive, but shows tendency to develop periodicity. The Jersey Mac is a semi-dwarf apple variety. The tree develops strongly and begins to carry fruits at an early age. The fruits are medium-size and of round-cylindrical shape. The peel is thin and brilliant red in colour on a yellow basic tone. The fruit flesh is white, very juicy and gives off a pleasant smell. Its eating quality is high. The fruit is prone to bruising. Its storage life is short; just like the other early varieties it must be marketed quickly. Common pollinators are Granny Smith, Vista Bella, Summer Red and Golden Delicious varieties. The time span between full bloom and harvest is 100-110 days.

Normal Atmosphere Values				Controlled Atmosphere Values				
Set °C	Diff.	hum. (%)	Storage in mth.	Set °C	Diff.	Storage in mth.	% / CO	% / O_2
0;+2	2	85-90	2	0;+2	1	2-3	2,1	2,2

*All data may vary according to local conditions.

Amasya

This apple variety originated in Turkey and is very productive. However, it bears fruits only every second year. The cultivar develops into a straight, strong tree with small to medium-size fruits of conical shape. The peel is a pale red on greenish-white with stripes. One face of the fruits is red while the obverse face is greenish to yellow in colour. The peel is thin and the fruit gives off a pleasant smell. The apple is firm, resistant and suitable for long-time storage. There are two Amasya varieties, one is small and sweet which earned it the name of "muscat apple" in some regions of Turkey. The larger and bitter variety is also called "pumpkin apple" in Turkey. Recommended pollinators are Golden Delicious, Granny Smith and Starking Delicious varieties. The time span between full bloom and harvest is 155-165 days.

Normal Atmosphere Values				Controlled Atmosphere Values				
Set °C	Diff.	hum. (%)	Storage in mth.	Set °C	Diff.	Storage in mth.	% / CO	% / O_2
+2 ; +4	2	85-90	6-7	+2	1	8-10	3	4

*All data may vary according to local conditions.

Honeycrisp (Honey Crunch)

This variety originated in the United States, and is known for its juicy and crisp texture. The fruit flesh is firm, sweet and slightly acidic. Budding properties and stem strength are good. To protect the apples' taste and quality thinning is recommended. Harvest begins on the 15th of September and lasts until the 10th of October. The flowers are not self-pollinating, therefore a pollinator variety is required and must be considered during orchard establishment. No discolouring occurs during storage. The Honeycrisp is resistant to pests and diseases.

Normal Atmosphere Values				Controlled Atmosphere Values				
Set °C	Diff.	hum. (%)	Storage in mth.	Set °C	Diff.	Storage in mth.	% / CO	% / O_2
0 ; +2	2	85-90	5-6	0;+1	1	7-9	2	1-2

*All data may vary according to local conditions.

THE RANGE OF APPLE PRODUCTS

Apples are not only eaten raw or consumed as apple juice. The range of products derived from apples is both very wide and historically old… In a fiercely competitive environment retailers try to outdo each other with the creation of innovative apple products.

There are apple puree-containing infant formulas for health-conscious mothers or vacuum-packaged apple slices offered as sweet and sour snacks in between meals. Or how about some apple vinegar to add some flavour to your salad? Or dried apple chips as snack while watching a film or working. They provide healthy energy and are so much fun to eat. Another delicacy to please our taste buds is dried pieces of apple either as juicy addition to a crunchy musli or dipped in chocolate sauce as a snack on the go.

> " The apple is such a fruit, even when it is about to perish it is still useful. We can process them into jam, marmalade, pekmez, dried apples, or convert them into apple vinegar and other products that enliven our lives! "

Another invention is the apple tea, a product of the recent trend toward a healthier lifestyle. While apple jam adds a new colour and flavour to a traditional breakfast table, apple pie on the other hand has been a staple dessert for ages. In short apple puree, apple juice, dried apple rings, apple chips, vinegar, wine, pekmez and pestil (dried apple pulp) and many more apple-based products that could easily be added to a long list of products prove just how versatile and rich a fruit the apple is.

Apple Marmalade

Apple juice

Apple juice is the unrivalled number one among the fruit juices! Apples are the most widely used fruit of the fruit juice industry. In a number of countries, subject to international standards (codices) fruit juices and similar products are classified in accordance with their fruit content. A genuine apple juice must be made 100% from the juice of apples. In the 10 biggest global fruit juice markets, apple juice is second only to orange juice.

Other fruit beverages are “fruit nectars” and “fruit-containing beverages”. The favourite of consumers, however, is the pure apple juice. Another important trend in the apple juice market is the rise of the natural, turbid apple juice which contains more antioxidants than its clear cousin which is clarified through filtration and pasteurised in order to extend its shelf live.

In Europe, 21 litre of apple juice are consumed on average per person per year. In countries like Germany and Holland the per capita consumption is well above the European average. For the USA the figure is over 45 litres. Researchers have even found a direct relationship between fruit juice consumption and the degree of social development of a society. In Russia, for example, the amount is over 20 litres per person per year, while in India it is just 200 ml. Another interesting figure is reported from China: While the country is the world leader in the production of apple juice and concentrates, consumption of apple juice is negligible!

Apple Juice

Apple vinegar

CH_3-CH_2-OH + O2 $^1/_2$ CH_3COOH + H_2O

The chemical formula above may not mean much for most of our readers, but if you try the mixture in your salad you will taste the difference! Because the formula describes the generation of vinegar or acetic acid. Vinegar is a fermentation product of apple and used as a preservative just like brine.

Apple vinegar is rich in the water soluble fibre pectin and has gained in importance, both in Turkey and worldwide, because to its health benefits. Pectin is known to slow down the digestive system and to prevent the absorption of cholesterol by sticking to the colon walls.

Apple Cider Vinegar

Freshly cut apple slices: "Fresh-Cut"

Demand Creates Supply…

We live in a world that runs at a maddening speed. To keep up, consumers turn to healthy food. One such product is vacuum-packaged, cut and sliced, ready-to-eat portions of apples. Its availability has created demand. In industrialised countries, the "fresh-cut" segment of the fresh product market has grown into a business of its own. Today, specially packaged cut or sliced fresh apples with a relatively long shelf life are no longer sold in supermarkets alone but also through sales channels at hospitals, sports facilities, school canteens or salad bars.

Apple Pekmez and Pestil

When slightly fermented apple juice is boiled, the result is pekmez. Pestil is a thicker form of pekmez which is spread out thin and dried to obtain a non-sticky gum-like substance called "fruit leather" or "fruit roll-ups" in international markets. Pestil is a staple snack in Turkey. Not so long ago the pestils or gums offered on foreign markets contained artificial colouring agents, sugar and only a small amount of real fruit. With the trend to natural, functional and healthy snacks, pestils are now offered with attractive labels promising "sun dried", "vitamin and minerals"-containing, "vitamin-fortified", and "100% natural" products.

Fresh Apple Slices (Fresh-Cut)

Apple Pekmez

Apple Sauce / Apple Puree

Apple sauce is a food product widely consumed in Britain, the USA and some continental European countries. It is made from peeled or unpeeled apples, apple juice or water, with the optional addition of sugar, honey or spices. The mixture is cooked, and the final product has the consistency of apple puree. It is used as a flavouring agent to meat and grilled food or it is consumed as a sweet snack in its own right. Apple sauce is traditionally homemade and can be stored for a long time. The sales volume is considerable, and apple sauce is usually among the low-priced products on supermarket shelves. Infant formula producers, one of the major industrial sectors, process large quantities of apple puree.

Apple Beer / Apple Wine

Fermentation of apple juice yields a traditional alcoholic apple drink of beer strength called cider or cidre in Britain, American and France, and "Apfelwein/Most" – apple wine – in Germany, Austria and Switzerland. The beverage comes in many varieties with alcohol contents of 1.2 - 12%. The story about the origins of apple wine may be true or not, but it sounds plausible. Usually wine is made from grapes or "vitis vinifera" in Latin. In the year 1860, just when wine had achieved popularity, the grapes suddenly disappeared in Europe. The culprit was a tiny insect called "phylloxera vastatrix" which first emerged in vineyards in France and then quickly spread all over Europe. At that time Europeans looked for a new fruit source for their wine and turned to apples. This tradition is continued to this day. Even today, Europe is the continent where most apple wine is consumed.

Dried Apples - “Kak” and Chips

What to do with fruits that cannot be consumed immediately after harvest has been a common problem of mankind everywhere. The methods of preservation people developed have a long history. One of the most important procedures is drying. In the old times apples would be stored in the pantry or cellar where they would slowly shrivel. Today they are dried peeled or unpeeled and cut into cubes or slices and can be found in many different products on offer in the retail market. They are served as chips or added to breakfast musils or cereal bars to eat on the go. “Kak” is the Turkish name for dried apple slices which are used by the food industry to produce vinegar and wine.

Drying of left over apples for later consumption is an old tradition in apple growing regions. They serve as snacks in between meals and help people on a diet. Apple chips are another type of snack that has conquered the market shelves. They are good additions to cereals served with milk.

Apple Pectin

Pectin are polysaccharides found in the cell walls of certain plants. They are a natural ingredient of our nutrition. Pectins are soluble fibres that bind carbohydrates during digestion and thus slow down the sugar metabolism. They also bind to cholesterol and thus help to reduce its concentration in the blood.

Some fruits like apples, pears, citrus fruits and plums contain high amounts of pectin. Commercially it is offered in power form and widely used by the food industry for jams, in sweets, milk products, yoghurt, ice-cream, bakery products, meat products, sausages, etc. as gelling agent or thickener.

Other products like starch, cellulose gum, carrageenan and alginates serve the same purpose, however, thanks to a growing demand for quality convenience food, the pectin market grows at an annual rate of 5-6%.

Apples are the second most important source for pectin after citrus fruits. Europe and North America are mature markets for pectin while in emerging markets like China and India an increase in demand is expected with the emergence of more individual lifestyles.

APPLE CULTIVATION

"Make sure that the saplings for your orchard, which will serve you for a long time, are from a certified and trustworthy source."

Climate Requirements

The apple is a fruit of the cool and temperate climate zones. Temperatures of over 40 °C are not suitable for its cultivation which is limited to the area between 30 - 50 degrees latitude.

In regions with temperate winters, saplings must be planted in the autumn, in regions with cold and very rainy winters, in the spring.

During the winter rest the wooden texture of apple trees resists temperatures of - 35 °C to - 40 °C, its flowers withstand freezing temperatures of - 2.2 °C to - 2.3°C and small fruits are resistant to temperatures of +1.1 °C to - 2.2 °C.

Research has established that, depending on the variety, apple trees need to be cooled to temperatures below +7.2 °C for an average of 2,322 to 3,648 hours. If the air temperature in the orchard drops below 0 °C they need only between 1,081 to 2,094 hours.

Soil Requirements

The soil composition of the future orchard is important. The soil must be drained to prevent that the tree roots stand in water, and in order to facilitate root spreading. Many soils are suitable for apple cultivation. The most fertile are humid, sandy and loamy soils with a pH of 6.0 - 6.5, normal lime content and humus.

Apple rootstocks, rootstock selection and spacing

The rootstock is the underground part of a plant; it holds the soil together, absorbs water and minerals, which it supplies to the other parts of the plant, and it ensures that the products of photosynthesis are resupplied to the roots. The rootstock has great influence among others on the development of the grafted varieties (scion), on whether they bear fruits late or early, on the productivity and quality of the fruits, on the ability to adapt to different soil types, and on the plants` resistant to environmental stress factors.

Dwarf and semi-dwarf

If the intention is to increase the yield per unit area then dwarf or semi-dwarf saplings should be used. The trend to smaller trees facilitates pruning, irrigation, soil cultivation, fertilisation, intervention against pests and harvesting procedures, which in turn helps to reduce labour and other costs to a minimum.

Dwarf trees

Dwarf saplings can be planted at closer distances of each other which increases the yield per unit area, and improves adaptation and maintenance. The result is improved product quality. For this reason, over the last year dwarf tree cultivation has found more and more followers. One of the most important aspects to consider when establishing an apple orchard is the selection of a rootstock that is suitable for the climate and soil composition at the location. This requires detailed knowledge of the rootstock properties.

Sapling planting distance

The planting distance depends on the apple variety, the rootstock, climate features and soil properties. In humid places it is recommended to plant the trees at such a distance that the crowns of the adult trees have a distance of one meter of each other.

This arrangement ensures an efficient air circulation and reduces the risk of fungal diseases.

İntermittent planted apple orchard

Thickset apple orchard

In dry, irrigated regions the trees, preferably full dwarf trees, should be planted at close distance in order to protect the humidity in the top soil. For strong and nutrient-rich soils a wider distance is recommended and for poor soils a smaller distance. The planting distance also depends on the strength of the rootstock-scion pair.

Compared with other moderate climate fruit species, the main advantage of apple cultivation is the existence of a range of rootstocks with different development characteristics. Their classification as "standard", "dwarf" or "semi-dwarf" does not refer to the size of the fruits they produce but to tree development. Depending on the rootstock type the trees will have different size but not their fruits.

While the number of orchards with full and semi-dwarf trees is on the increase in all cultivation regions, it has not yet reached the desired extent. In Turkey their share is just 35% of all orchards. The correct investment decision on dwarf and semi-dwarf plantations requires primarily knowledge and capital.

Full dwarf tree orchards require additional costs for covering nets and a trellis system, but they also offer great advantages such as higher yield per unit area, better protection against hale, cold, sunburn and similar impacts, and easier maintenance and harvest. Full dwarf tree orchards must be operated professionally by an orchard management. Growers who do not have the necessary qualifications and knowhow usually do not reap the expected gains.


Apple orchard (Dwarf trees)

Semi-dwarf trees do not require covering nets or a trellis system. For this reason the decision on what type of orchard to establish should be based on soil and environmental analyses, with due consideration of expert advice and financing aspects.

As has already been mentioned before, compared with other moderate climate fruit species, the main advantage of apple cultivation is the existence of a range of rootstocks with different development characteristics. A widely used rootstock is M9 which is resistant to root fouling; the type MM106, on the other hand, is sensitive to root fouling and yields semi-dwarf trees. It is important to select a rootstock that is suitable for the ecology at the location. As with every decision, it must be based on detailed knowledge of the rootstock properties.

Apple rootstocks widely used worldwide

A. Generative rootstocks (ungrafted sapling)

B. Clonal rootstocks

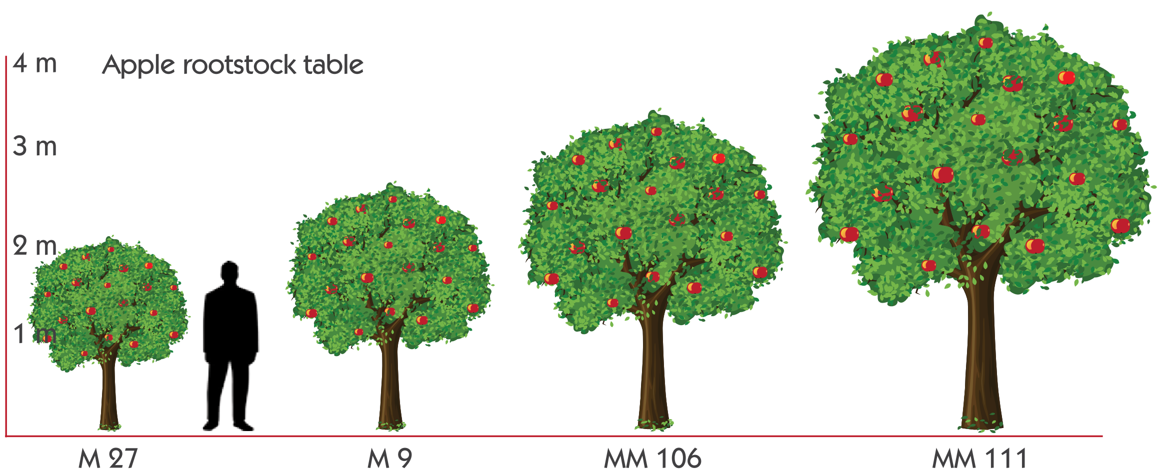
B.1. Full Dwarf rootstocks

B.2. Dwarf rootstocks

B.3. Semi-dwarf rootstocks

B.4. Semi-vigorous and vigorous rootstocks.

Because of their different properties, the rootstocks mentioned in the list above are used under different ecological conditions and for different purposes; that knowledge must inform the final decision of a grower. A correlation table of rootstock type and tree size is given below.



Irrigation

Depending on the climate and soil features at the location, irrigation is required from May to the end of September and may have to be carried out at 10 day intervals. A drip irrigation system is strongly recommended for its high efficiency and economic use of water.

Pruning

Pruning requirements are determined by the tree density. Pruning is absolutely necessary. There are four types of pruning: crown raising, thinning and reduction, and pollarding.

Flower thinning

Flower thinning is carried out in years of abundance in order to increase fruit size, improve colour, reduce branch braking, and to improve flowering in the next year. It is recommended before the fruit buds develop.

Fertilising

Before fertilising, the soil should be analysed to determine the fertiliser demand. Depending on the tree's age and state of development, in the spring, prior to flowering 100-250 g ammonium sulphate or nitrate per tree should be given, and in the late autumn 150-350 g DAP at a depth of 10 cm.
In the productive phase potassium and, based on soil analysis, micro elements should be given once the development phase of the trees begins.

Puring

Flower thinning

Irrigation

Fertiling

APPLE HARVESTING PERIOD

" As with every other fruit, harvest is a very important period of time. Collected too late, the ripe fruits will be less resistant and have shorter shelf lives. They will be more prone to bruising, their physiological properties will suffer and a reduced acid content will adversely affect their taste. "

Grasp the fruit without pressing

Pluck the fruit with thump by pushing the fruit stalk

Apple harvest with machines in Karaman

Starch test applied apples

There are many theoretical approaches to determine the correct harvest time for apples. The frequently used methods are the day count after full flowering, and the starch test. Picked too early, the apples will neither have gained enough weight nor have achieved the right shape. The consequences are small fruits and low harvest yields.

Picking immature fruits may cause branch breakage or bruise the fruits because they are more difficult to pluck from the branch. Immature apples also have a lower sugar content and still contain high amounts of acrid substances that adversely affect their taste. An immature peel structure causes quick water loss and aging which diminish the market value of the fruits.

Late and early harvests have both their disadvantages which makes it all the more important to choose the right time which, however, is different for every apple variety. Once the time has come for the individual variety, it is recommended to pick all fruits within 10 days.

The apples must be removed from the branch together with their stem. For this purpose the fruit is twisted slightly in an upward movement while the stem is pushed with the thumb.

In many regions in Turkey the picked apples are collected in hard metal buckets called “bakır”. This increases the risk of bruising. Experts recommend vessels with a soft texture. If metal vessels are used, they should be lined with a thick cloth.

APPLES OF ALL SHAPES AND SIZE

Sorting and Packaging

After plucking, the apples to be sold to markets are sorted. In small enterprises this is done manually, in large companies with the aid of machines. Sorting must be speedy and yet careful in order not to damage the fruits. In Turkey, sorting by size and quality is carried out in accordance with the principles of the Turkish Standards Institute.

Dessert apples are divided into three quality classes: extra, 1st class and 2nd class. The quality classes exclude fruits with shape deficiencies or blemishes. However, for 2nd class fruits a 2% tolerance is allowed.

Apples to be consumed freshly are packaged immediately after sorting. They are then stacked in crates with their sides on top of each other, or placed diagonally on moulded fibre trays. To identify the responsible party, the packages are labelled with the name and other information about the marketing company. The packaging also carries information about the type of product, its variety as well as its quality and size class.

Most of the apple harvest is directly packaged and sent to market; if not, the apples are immediately sent to a cold storage facility. Whatever the apple's fate, there is still a long way to the final consumer. For this reason, the fruits must be wrapped in well to reach the consumer both fresh and in an appealing state.

"Packaging has become a major issue of marketing and modern business management. The main driving forces behind this development are the enormous scale of modern international trade, changes in the retail trade and the spread of self-service shops."

Apples to be sold fresh are placed within viols of crates

For you the most appealing apple in the market!

The packaging design is different for every type of plant product. By law, the packaging must protect the product from harm, preserve its properties, ensure air circulation, and not harm the environment, but it must also be stackable for economic transport. Finally, the apples sorted and packaged according to defined standards will compete in the market with other apples arriving there from hundreds of different locations.

Not so long ago the main packaging materials were wooden crates and barrels, clay vessels, leather bags and sacks. Apples very mostly sent in crates. In recent years they have been replaced by plastic and paper-based materials. Apples are nowadays wrapped in paper and placed in cardboard boxes, to preserve their properties. The most commonly used materials are kraft paper or kraft paper imitations, straw, cellophane, parchment paper, wax and silk paper.

Packaging has become a dynamic and big industry in its own right that quickly and comprehensively implements technological, design and marketing innovations. Packages and packaging has become a symbol for the development of a country's market economy and its standard of living.

At the same time, the packaging design and its visuals can also be used to promote the product they protect.

Sorting apples in handling area of warehouse

TRANSPORTING APPLES TO OTHER CITIES AND COUNTRIES

" No marketing or production organisation can succeed without logistical support. Worldwide demand has contributed to a fast expansion of foreign markets. In recent years modern logistics has ensured that apples, like so many other agricultural products, can be exported to places far away from their place of production. „

Forwarding may be one of the oldest professions, its advanced form, "logistics", is still a young sector whose ascent to stardom has only just begun. Starting in the 1950s, global demand in supplies and forwarding capacities increased. In its attempt to adapt to the new conditions, the forwarding sector underwent a profound change.

Logistics services are defined as efficient planning, implementation, transportation, storage and tracking within a supply chain of all sorts of products, services and information flows from their point of origin to the point of final consumption.

Today hardly any product is sent directly from its place of production to the customer without some forwarding intermediary. In this sector, meeting expectations means fast, secure and economic transportation with a minimum of mechanical damage and minimal environmental pollution.

In the fresh fruits and vegetables sector logistics means joining the information on transportation, storage, materials management and packaging into a single chain. For agricultural produce forwarding means the transportation of the harvested products by land, sea or air to their place of processing or consumption. With the exception of certain special products, fruits are mainly transported by land to their national and, in particular, to their international destinations.

Sales to overseas countries require a combination of sea, land and railway transports. It is obvious, that a short distance between place of production and place of consumption constitutes a great competitive advantage.

The European Union, for example, imports a large share of its apples from South Africa and from Turkey. The determining factor here is transportation costs. While South Africa sends its produce via sea and land, Turkey forwards its goods by land only. Chile and Argentina which compete in the EU and in Russia face problems because of the great distance. However, markets are influenced by many parameters which affect the market share of individual countries. Most EU countries forward their apples by road, while distant countries like South Africa, China, Argentina, Chile, the USA, Australia and New Zealand rely on a combination of sea, land and rail transport.

Air freight is expensive and is used for apple forwarding, even to distant places, only under exceptional circumstances. After harvest, apples quickly release ethylene which initiates the irreversible aging process. The decay can only be stopped, or rather slowed down for some time, through cooling. Due to the ethylene emissions it is not advisable to store and transport early and late apple varieties together. The fast aging variety would otherwise accelerate the aging process of the other varieties.

As a rule, apples that are to be forwarded to locations far away from their place of production are stored in cold storage facilities. During transport great care must be taken that the cold chain is maintained. The means of transport must be readied as to comply with the required temperature, humidity and ventilation conditions. This is true in particular for refrigerated trucks. Before loading a written cooling plan must be established and strictly implemented along the road.

Modern land transport of apples to domestic and foreign markets is carried out with the aid of pre-cooled trailers equipped with temperature and humidity control devices. The most advanced types even have oxygen and carbon dioxide sensors. For transportation by sea special cold containers are used. At the port of destination the containers are loaded onto trucks and sent to the buyer.

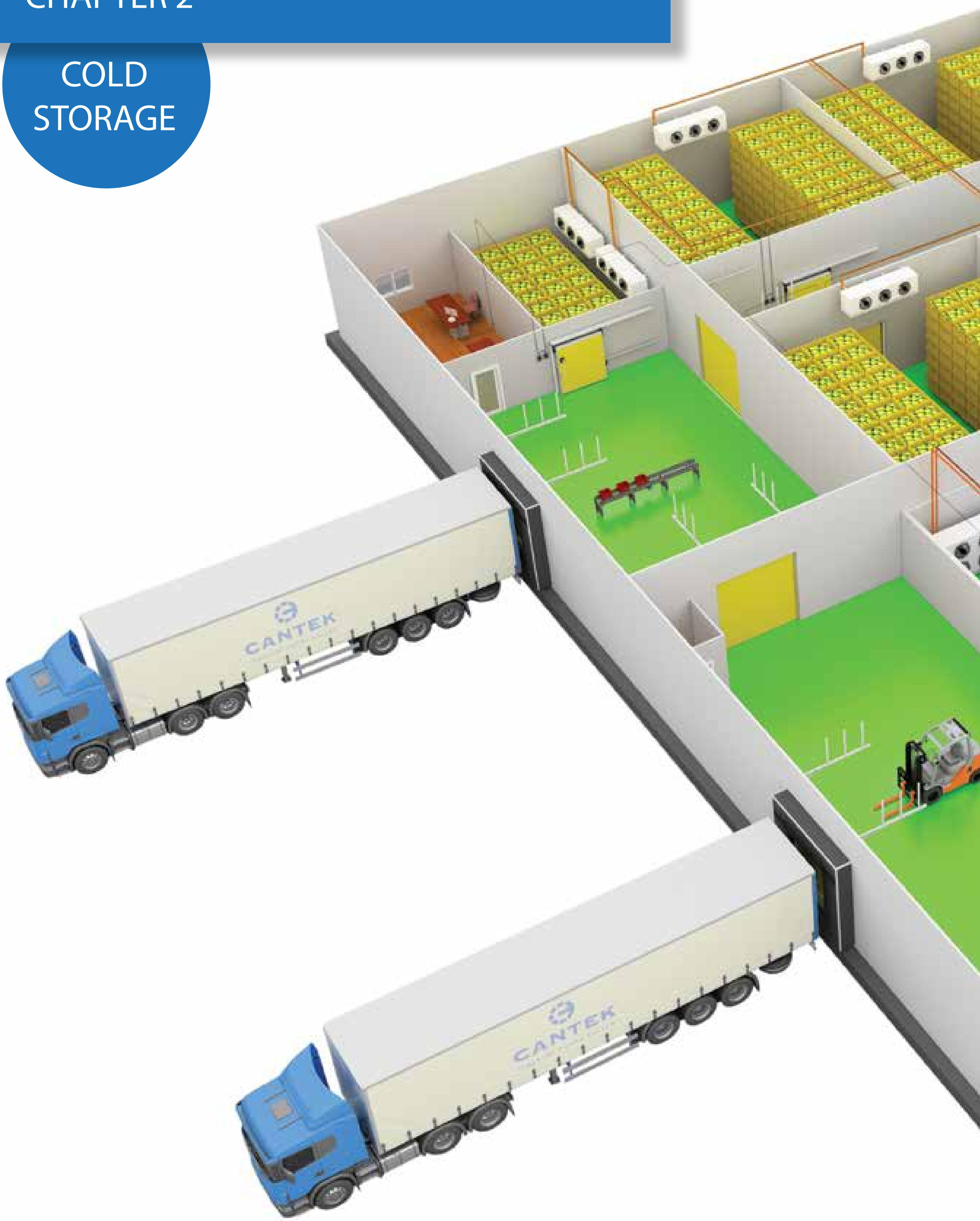
The dimensions and the weight of the packaging depend on the materials used and the means of transport. Apples are usually forwarded in wooden crates or boxes made of plastic or cardboard. Any contact and friction between the fruits during transport must be prevented; any possible shock impact must be minimised through good planning and placement. The pallets or packages must be tightly stacked to prevent shifting or tumbling.

Apple Transport Conditions

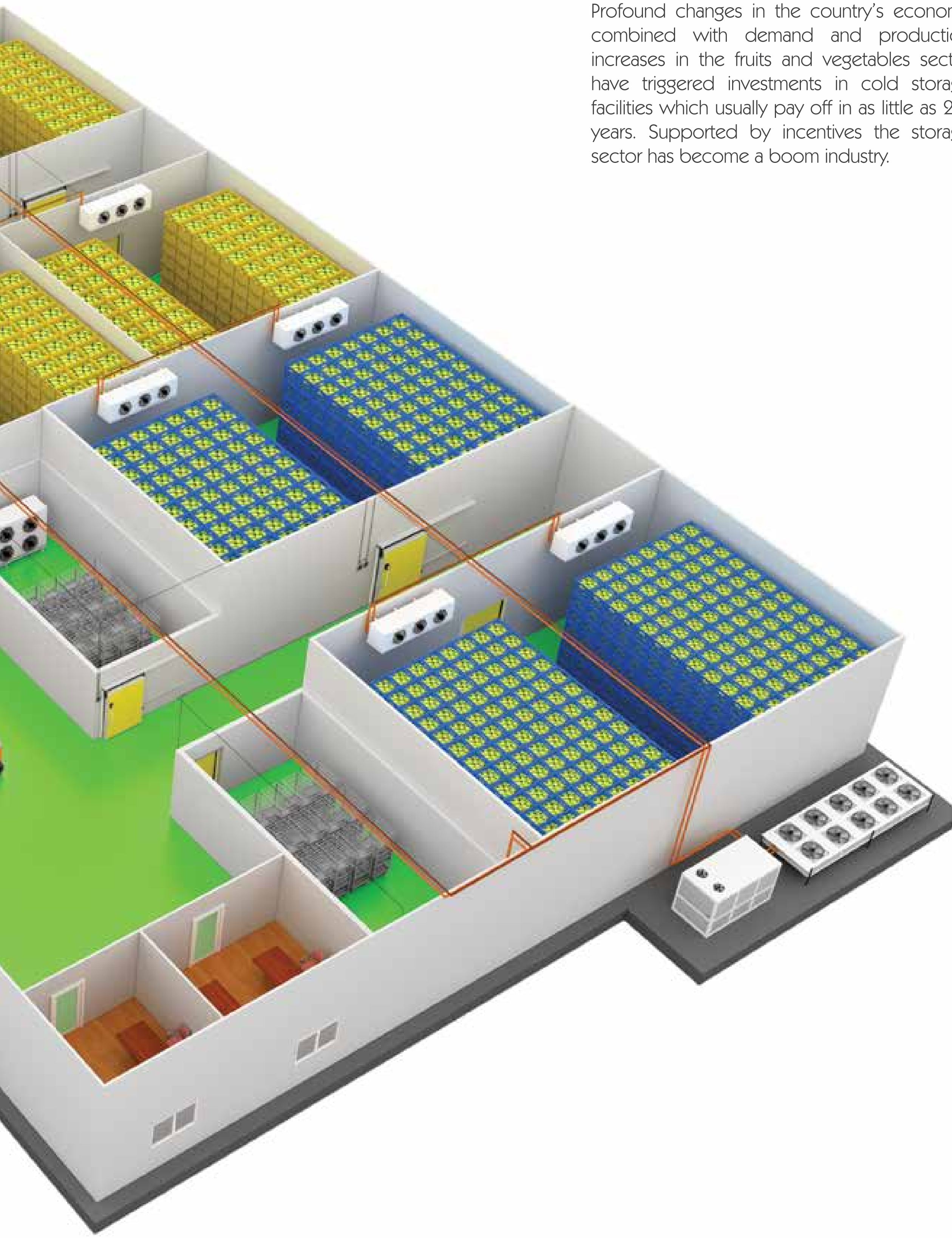
Temperature	Days	Freezing point (^{0}C)	Humidity (1/1)
0-4 °C	6 - 8	-2 ,8 °C	85 - 90

CHAPTER 2

COLD STORAGE



Profound changes in the country's economy combined with demand and production increases in the fruits and vegetables sector have triggered investments in cold storage facilities which usually pay off in as little as 2-3 years. Supported by incentives the storage sector has become a boom industry.



THE SECTOR THAT ENSURES RECHING REAL VALUE OF APPLE: STORAGE

The Mill built by George Milton Morse in 1846 was used as a first cotton textile factory and then used as apple storage warehouse by local farmers. Brooklyn-A

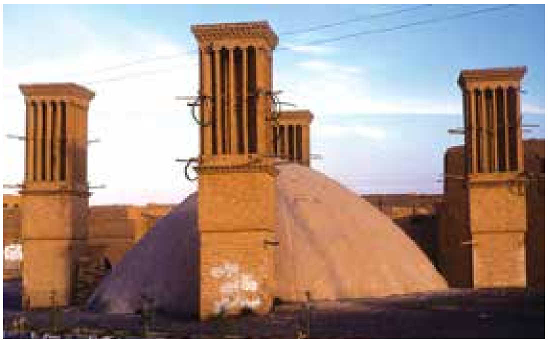
" Low temperatures reduce the activity of microorganisms and thus slow down the decay of foods. This was already known to our forefathers who buried food in snow in order to preserve its freshness. "

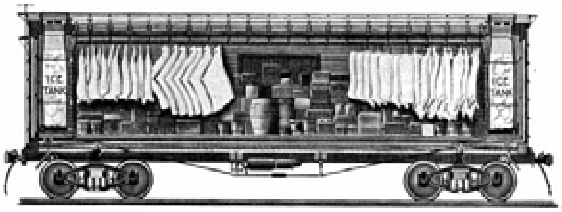
The history of food storage begins in natural caves

In old times, just like today, humans stored the food they did not consume right away to be eaten at a later date. For this purpose they have develop the most diverse preservation methods. The cave was the first storage room of our forefathers, or they buried the food in snow, or transformed the food into other, more stable food products.

According to some sources, sometime before the beginning of the common era, people in China developed a sort of freezer. They filled snow in deep holes, compacted it and stored fresh food products there. Similar methods were invented and further advanced by the Jews, Greeks and Romans. The Romans introduced an inventive construction of their own which is still in use. The design of these first storage facilities makes use of the low night temperature to achieve a cooling effect. Since the storage temperature is dependent on the ambient temperature, this type of storage rooms was usually established at locations high above sea level. They were built either above ground, or partly or fully underground.

In the Middle Ages, the Persians built cisterns coupled with wind towers for cooling purposes. The cisterns collected rain water in a large artificial pool. The wind towers used temperature differences to create a steady stream of air which entered through the tower windows and was directed toward the pool where the wind gave off its heat causing evaporation. The resulting cool air flow was then used to cool the building. The wind towers are architectonic marvels of the Middle Ages and served as inspiration for our modern storage technologies.


Medieval Wind Towers in Iran



In 1870 food transporting wagons were cooled with ice tanks.

Cooling with ice

In the 16th century the use of ice for cooling purposes spread in the Mediterranean and in South America. Traders sold ice brought down from glaciers in the Alps to townspeople. Russians stored winter snow gathered in the surroundings of St. Petersburg in snow collection houses along the river Neva and distributed it from there as far as Mexico. On the American continent the Canadians were the main suppliers of ice. For hundreds of years natural ice cooled the food and drinks of the rich elite.

Industrial scale ice production began in the first half of the 19th century. Ice was launched as a miracle product and used as cooling agent in transport vehicles to keep food stuffs fresh.

Cooling technology owes a lot to scientists who established a measuring scale (Gabriel Fahrenheit in 1709), invented a measuring instrument, the thermometer (Galileo 1597), and discovered a way to achieve a cooling effect with mechanical means (Joseph Priestly 1773). It was then only a matter of time until a clever inventor joined the elements.

Finally the efforts of hundreds of years of work, passed on from one generation of scholars to the next, began to bear fruits. The pioneers in the art of cooling developed a method to achieve cooling through evaporation. The discovery of Dr. William Cullen in 1748 was continued by the likes of Oliver Evans, Michael Faraday and Jacob Perkin

The beginning of mechanical cooling

In 1834 it was discovered that the transition of ammonia gas from the liquid into the gaseous state can be used to absorb heat. Finally the individual components of the cooling chain only had to be connected to build the first closed circuit cooling machine. This happened in 1876, when the German engineer Carl von Linden applied for a patent for a gas liquifying machine. It makes temperature adjustments in modern refrigerators, deep freezers, air-conditioning and dehumidifying devices possible.

In 1902, Willis Carrier, the father of air-conditioning, discovered the "law of constant dew-point depression". Eight years later, in 1910, J.M. Larsen presented the first automatic refrigerator.

Based on centuries of knowledge and knowhow the cooling sector entered a phase of rapid advancement. In 1923 the frozen food industry comes into being. In 1928, Carrier introduced his "weathermaker", an air-conditioning unit for home use. Until that date ammonia gas was used as cooling agent. However, being a poisonous gas, leaks had already caused serious accidents. Scientists began to look for a less dangerous alternative. The company Frigidaire, then owned by General Motors, was the first to take up the matter in 1928. Three years later the cooling agent Freon-12 was registered.

Today, supported by excellent engineering and technology, cooling has developed into a major industry. Today the preservation of fruits and vegetables is no longer limited to keeping them in a cool place. With the development and spread of controlled atmosphere systems the breathing process of produce is at the centre of control techniques which have considerably extended their storage life. Technological developments today permit easy establishment of cold storages anywhere in the world. They ensure that agricultural products can be safely stored until consumption and thus contribute to our quality of life.

During the 1 st world war, food were transported via ice-laden cars

First industrial cold storage warehouse in Milwaukee, the biggest town of Wisconsin State in USA

Primitive warehouses still in use in And Mountains, in West Coast in South America

THE STORAGE OF APPLE

It is an open secret that fruits cannot be consumed immediately after harvest but most be stored, preferably under conditions that preserve their freshness and quality. Cold storage is such a method. This form of food preservation is economic and a promising way to obtain a higher price for the product. Storage extends the time a product can be offered for sale. When, at the end of the season, the supply of fresh produce declines and prices start to rise, stored products profit from this upward trend. When we look at the entire business cycle, it becomes obvious that growing produce is only part of the story. It achieves its full potential only with the proper application of post-harvest procedures, the most important of which is cold storage.

Aided by smart engineering solutions cooling has become a major and very profitable industry. Modern cold storage facilities play a fundamental role in national economies. For apples they have become the storage medium of choice on a world-spanning scale.

Cooling systems work on the principle of homogeneous low temperature distribution in the entire storage space. This is achieved by removing the heat from the space. For this process to be efficient, the space must be thermally isolated against the environment, and the isolation must be of high quality. The basic technical equipment for this process are a thermostat to set the desired temperature, an evaporator to cool the storage space, and ventilators, mounted behind the evaporator, for the distribution of the cold air inside the space.

The apple is a “climacteric” fruit, which means, that it continues to live on for a certain period of time after plucking from its branch. After harvest, apples quickly release ethylene stored which initiates the irreversible aging process. The decay can only be stopped, or rather slowed down for some time, through cooling. Due to their physiological properties, and in contrast to other fruits, the apple is a fruit that is highly suitable for storage in a cold environment, provided certain conditions are maintained to a high degree of precision.

To prevent quick decay of apples after plucking, the ensuing biochemical process must be reduced to a minimum and without delay. This is achieved by cooling to a temperature a little above their freezing point.

“Right after harvesting, the fruit releases ethylene that present already in the fruit’s body and the irrepressible aging process starts. Aging process cannot be totally stopped but can be postponed through cooling„

Storage quality depends directly on preceding processes such as pre-harvest treatment, harvest, preparation for storage and transfer into the storage facility. Only if all steps are carried out as required, will the desired storage result be achieved. In other words, the fruits must be clean, well developed, harvested in time, be free of pests and diseases, and suffer no physiological damages; and the transfer into storage must be carried out speedily. Careful, complete and competent harvesting and post-harvest handling reduce losses and ensures both a high market value and a long shelf live.

The most important factor for healthy long - term storage is the temperature. The other parameters, even if they are of a supportive nature, are only of secondary importance. Suitable conditions are ensured with appropriate temperature and relative humidity settings. The parameter settings depend however on the apple variety and the environmental conditions of their cultivation.

For example; when a Cox Orang Pippin is stored in Britain at 3.0 ˚C, the fruits develop frost damage; in New Zealand, on the other hand, the same variety could successfully be stored at 0.0 ˚C. These data show that the soil and climate at the location of their cultivation is reflected in the fruits' storage behaviour. It has been found that in general apple varieties originated in America can be stored at temperatures of - 0,5 to 0,0 ˚C, while the best temperature range for European apples is 0.0 - 1.0 ˚C.

Correct determination of the optimal storage temperature is of great importance for the apples' storage life. Temperature increases activate the fruits' breathing process and thus reduce their lifespan. Studies show that a temperature increase of as little as 1 degree Celsius can reduce storage life by 20%. Depending on the solid substance amount in the fruits' cells, they freeze at temperatures below 0.0 ˚C. A frozen apple turns mushy and watery when thawed, and completely loses its market value.

It has been found, for example, that a Starking Delicous originated in the United States stored under normal atmospheric conditions at 0.0 ˚C has a storage life of 192 days, stored at +1.0 ˚C its lifespan is reduced to 165 days, while at room temperature (25.0 ˚C) the apple decays after only 21 days.

The fundamental secret of high-quality apple storage is slowing the fruits' breathing process immediately after plucking by cooling them down to low temperatures. Studies have shown that, if apples are allowed to remain at room temperature for only one day after harvest, their storage life is reduced and their quality suffers. After cold storage apples will maintain their quality for a certain period of time, depending on storage parameters such as temperature, relative humidity, air circulation and air composition. It should be noted, however, that storage time is also variety dependent.

Apples intended for long-time storage should be pre-cooled in a pre-cooling chamber before being transferred to the main storage room. Such a procedure has proved to be beneficial and very effective in preventing decay. To explain the practice of pre-cooling let us look at a 500 ton capacity storage facility comprising 6 rooms. One room is used for pre-cooling. This room is equipped with a cooler of higher capacity than the other rooms. Fruits to be stored must be cooled down fast to the desired temperature, if possible within one day. After pre-cooling the fruits are transferred to the other rooms for long-term storage.

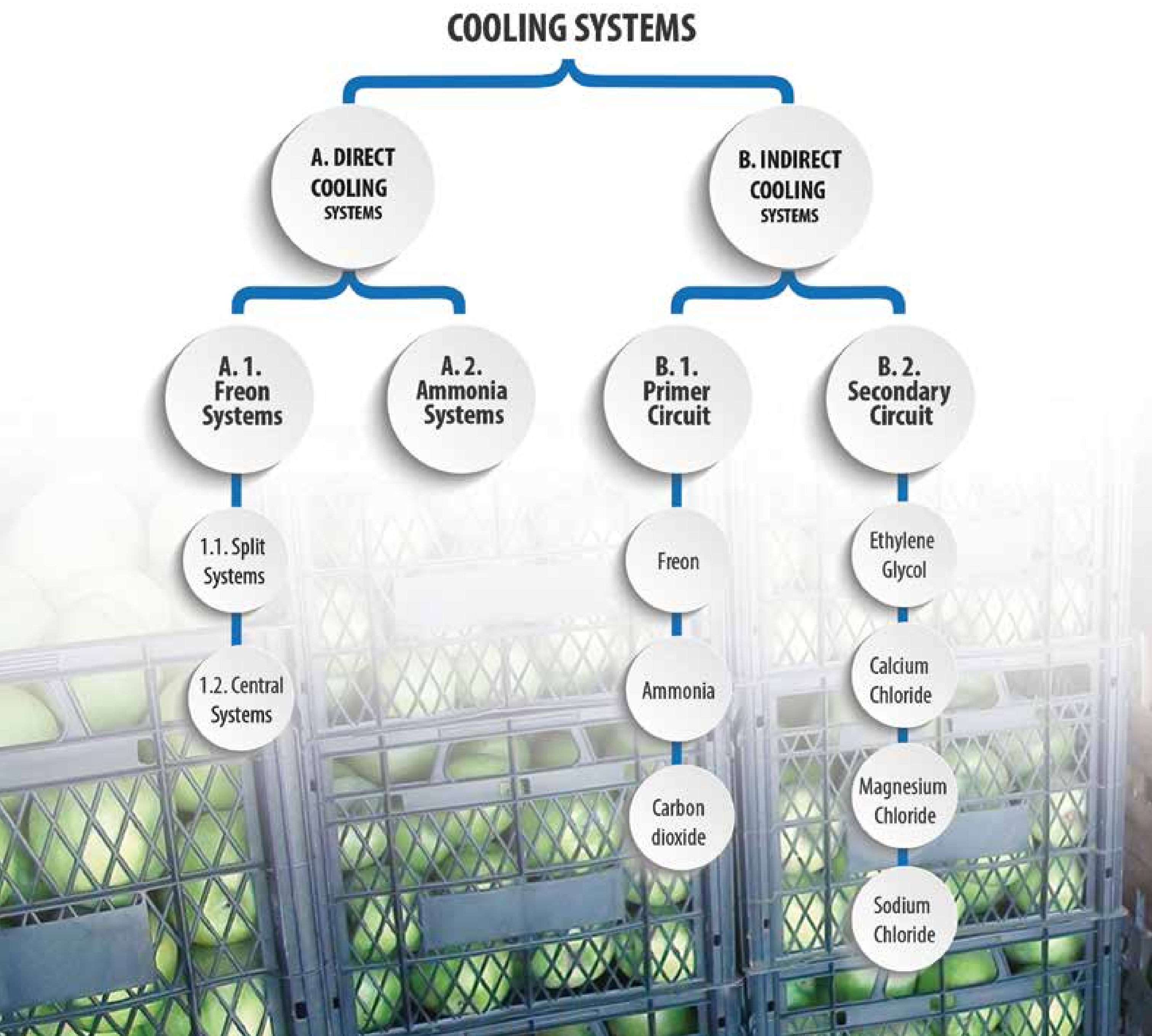
The dry storage boxes absorb humidity and act as desiccants. Each box can absorb between 100-150 g of water. For 10,000 boxes, this amounts to 1-1.5 tons of water. If this water is not supplied externally, it will be drawn from the fruits. Therefore, the storage rooms must be equipped with humidifiers.

To achieve effective cooling requires a careful capacity selection. Another important factor is correct stacking of the fruit boxes. The arrangement of boxes must not prevent optimal cooling air circulation in the room.

HOW TO SELECT A SUITABLE COOLING SYSTEM FOR AN APPLE STORAGE

Energy consumption is the largest operating cost item of cold storages. The reason for this is the need for very powerful cooling devices. After initial investments, with 80% of total expenses the main cost item is electrical power bills. This must be considered in the long-term investment planning.

> "Two main criteria determine investments in cooling systems. The first is initial investment costs, the second energy and operating costs."



A. DIRECT COOLING SYSTEMS

With these systems, the cooling energy is transmitted directly into the rooms to be cooled. From an energy efficiency perspective it is an optimal solution; 90% of cold storages worldwide apply this method. The systems use freon or ammonia gas as cooling agent. In the cooling cycle, the gas is first compressed with the aid of a compressor and then liquefied in a condenser, giving of the heat stored in the gas. The liquid is pumped into the evaporator where heat is absorbed from the air passing through the evaporator, thus cooling it down. In the process the liquid refrigerant evaporates and the cooling cycle begins all over again.

The use of ammonia is not economic for small storage facilities; they use freon gas instead.

Direct cooling system

A.1. Freon systems

Freon is a synthetic gas, a so-called hydrofluorocarbon compound (HFC); its technical name is R-404 A. It is widely used in industrial cooling. Another common HFC derivative is known as 134 A. Freon is the refrigerant of choice for cold storages of up to 2,000 ton capacity. Freon systems come in two designs.

1.1. Freon split systems

The most straightforward and most widely used cooling systems are split systems, they are also the oldest.

The systems consist of individual units of compressor and cooler (evaporator). The system can be easily expanded by adding new units.

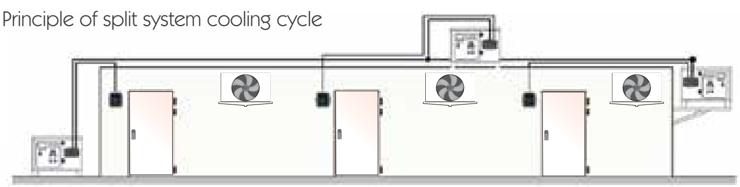
However, with the increase in units and the associated electrical wiring and distribution boards, the probability of defects also increases. Another disadvantage is high power consumption.

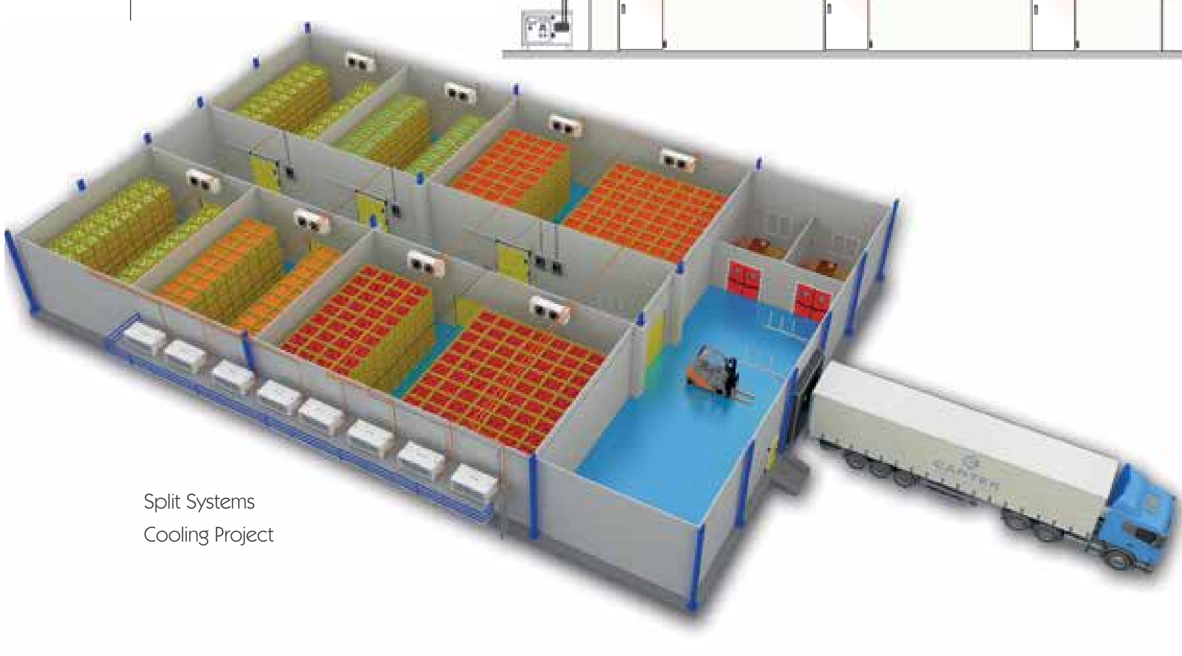
For this reason, split systems are most suitable for small scale storage facilities. If one unit breaks down, this does not affect the others. Maintenance and repair of the systems is relatively easy, and competent servicing personnel can be found anywhere in the world.

1.2. Freon-based central cooling systems

Technological advances in industrial cooling systems in the last decade, in particular in the area of ever more powerful screw and piston compressors, and the development of start-up systems, have made the construction of freon-based central systems possible, an area of application that was previously dominated by the cooling agent ammonia.

Principle of split system cooling cycle



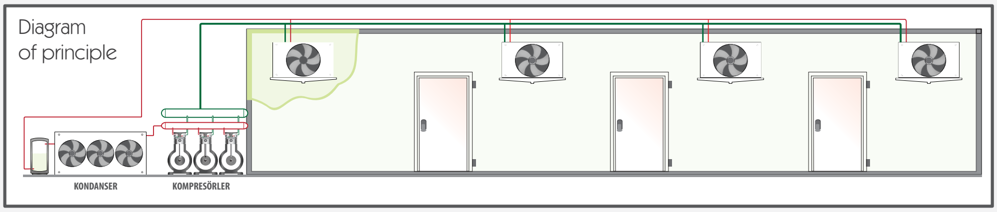


Split Systems
Cooling Project

These central systems are organised in the form of parallel operating compressors that are switched on and off in accordance with refrigeration demand. In this system the compressors age in unison, which is a great advantage; another is its energy efficiency. Previously 10,000-ton capacity storage facilities had to use ammonia as refrigerant, today freon-based systems are emerging as excellent alternatives.

Split System Application in Aktau (Kazakhistan)

Principle of central system cooling



A.2. Ammonia-Based Systems

Ammonia is a widely used and established cooling agent in industrial applications. Ammonia has a high heat of evaporation and a low flow rate in liquid form. This low flow rate limits the use of ammonia for small-size refrigeration capacities. Anhydrous ammonia (chemical formula: NH_3) is technically known as R717. It is a cheap and abundant chemical substance. It is not corrosive and has all the properties expected of a good cooling agent. However, in the presence of humidity it destroys non-ferrous metals such as copper or the alloy brass. For this reason steel pipes must be used. Ammonia is widely employed in storage facilities of over 2,500 tons.

Ammonia cooling warehouse machines

B. INDIRECT COOLING SYSTEMS

These refrigeration systems have two separate cycles. The cooling energy is generated in the primary cycle, which cools the cooling agent of the secondary cycle via a heat exchanger. In this system, brine with a very low freezing point is used as refrigerant. A pump circulates the brine through the system. For the primary cycle a different coolant is used. Indirect cooling systems are also known as "brine systems". Such double cycle systems were preferred where direct use of cooling agents was problematic. Their main area of application was in ice and ice cream production. They have fallen out of favour in recent years, however. Ideas to revive the use of carbon dioxide in the refrigeration sector may turn out to be good news for the brine systems.

In practice, the brine cycle is installed in the cold storage room, from where it removes heat which is then transferred via a heat exchanger to the primary cycle installed in the machine room. The primary cycle uses refrigerants such as ammonia, freon or carbon dioxide. Its purpose is to cool the brine in the secondary cycle. The main disadvantage of these systems is the 10-25% energy loss at the heat exchanger which connects the two cycles.

Indirect cooling systems

B1 Primer Circuit

A. Freon

B. Ammonia

C. Carbon dioxide

B2 Secondray Circuit

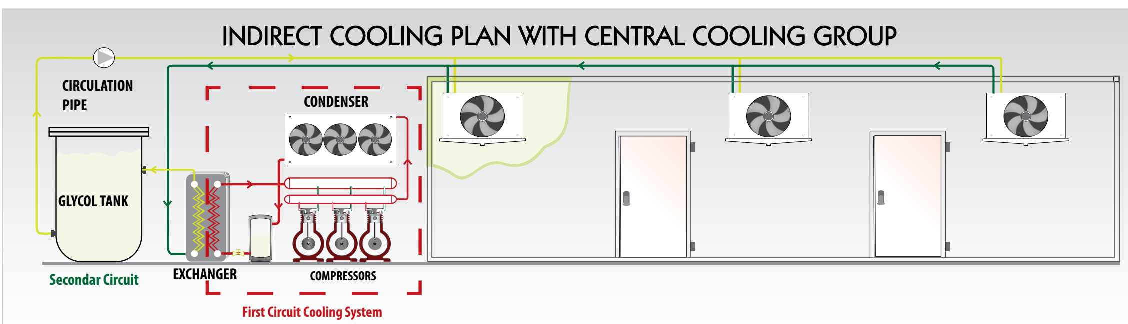
(with lower freezing point)

A. Ethylene Glycol

B. Calcium Chloride

C. Magnesium Chloride

D. Sodium Chloride



Granny Smith Apple stored in atmosphere controlled (freon based) warehouse of 5 000 tons capacity

A frozen evaporator to defrost urgently

COOLING AND HUMIDIFICATION IN STORAGES

" The evaporator is the most important component of a cold storage because of generates the cooling effect. "

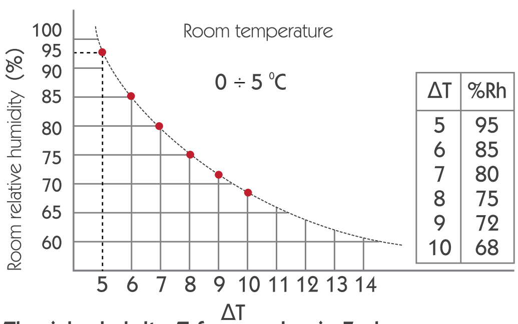
Temperature is the single most important factor with an impact on the quality of products stored in a cold storage facility. Whatever the cooling agent of our system, freon, ammonia or brine, the cooling quality is determined primarily by the evaporator (cooler) design.
The evaporator's function is to cool down the ambient air and blow it back into the room where the lower air temperature is passed on to the products via convection. Since the heat is transported by the circulated air from the products to the evaporator unhindered air circulation is imperative. When selecting and placing an evaporator the most important criterion is assuring optimal circulation of the air inside the storage room. Devices with insufficient capacity lower the level of humidity inside the room; in other words, the air becomes too dry. Combined with defrosting, the damage becomes even larger. Because the defrost water is water removed from the room; and the source of this water is the products stored inside. The amount of defrost water equals the weight loss suffered by the fruits. Like with other produce stored freshly, the ideal relative humidity for apple storages is in the order of 85-90%.

The most critical design feature of an evaporator: The temperature difference ΔT

The difference between the temperature of the air passing through the evaporator and the evaporation temperature inside the evaporator is called delta T (ΔT).

The ideal value for delta T depends on the correct determination of the cooler size (with the cooling capacity expressed in Watt), which in turn depends on the design of the cooling battery surface and the distance between the lamella. As explained below, under constant conditions with ΔT = 5ºC ambient humidity is 95%. When ΔT is increased to 10 ºC, ambient humidity is automatically reduced to 68%. This simple example shows what large effects changes in ΔT can cause.

Without a sufficiently large cooler it is impossible to achieve the ideal ΔT value. If the evaporator is too small, Δ T increases uncontrollably making it impossible to achieve the desired humidity level. Too low humidity can be countered to a certain degree with the aid of humidifiers. However, water that has evaporated from the apple cannot be restituted and this loss will have a negative impact on the apple's quality.



ΔT	%Rh
5	95
6	85
7	80
8	75
9	72
10	68

The ideal delta T for apples is 5 degrees

Cold Rooms Humidification

Humidity control in apple cold storage facilities with the aid of the cooler alone is not possible. Because of its impact on apple quality, humidifying devices are strongly recommended. If the water quality is not suitable for humidification, a purification device may become necessary. Other important parameters are water droplet size (must be in the order of microns), and the amount of water (in kg) sprayed into the room. It must also be ensured that the artificial mist is homogenously distributed, and that wetting, dripping or condensation are prevented.

The following three main humidifier systems are in use:

1-Nozzle systems

They require demineralised water, because sand and "hard water" (high calcium content) can cause nozzle blockage. Nozzles were used in the first humidifier devices. They cannot be applied in controlled atmosphere storage facilities.

2.Centrifuge systems

Heater-equipped models of this humidifier type are placed inside the storage room. They are suitable for apple cold storages. The systems' main parameter is their spray capacity in kg. Devices must be selected in accordance with the storage room volume.

3.Ultrasonic systems

Ultrasonic humidification is an excellent solution for temperatures at and around zero degrees Celsius. With this technology, high-frequency sound waves stimulate small vibrating membranes which generate a mist of tiny droplets. These droplets have a diameter of between 0.5 – 1.0 μm and (just like the droplets in natural mist) they neither precipitate nor freeze. They are small enough to directly evaporate in the air. They are ideal systems for controlled-atmosphere storage.

THE BEST WAY TO STORE APPLES: CONTROL IT'S ATMOSPHERE

Normal Atmosphere

> "The storage time of apples under normal atmosphere conditions is 4-5 months, under controlled atmosphere conditions they can be stored for up to 12 months."

Normal Atmosphere Storages

Under suitable storage conditions apples preserve their nutritional value after harvest, maintain their freshness and do not suffer quality deterioration. In other words, storage is the art of maintaining apple quality until their time has come to be distributed to markets and sold to the final consumer. Normal atmosphere storage facilities are thermally insulated spaces that are mechanically cooled and whose temperature and humidity are controlled. Such storages are widely used.

Besides the temperature the composition of the ambient atmosphere is another factor which influences the breathing process of fruits and vegetables. Stored apples, just like other produce, give of ethylene and other aromatic gases which must be removed from the ambient atmosphere in case of long-term storage, because these gases trigger early maturing and the development of undesired flavours and tastes. Such events considerably reduce the market value of the fruits. To prevent the accumulation of such gases, aspirators and ventilators are mounted on doors and external walls which replace the air inside with fresh air several times a day. Two types of ventilators are used, one set to blow in fresh air, and one set to blow out the stale air inside. Modern facilities use central air-conditioning systems that automatically purify the air of every storage room. Controlled atmosphere storages have no need for the air-conditioning systems used in standard storage rooms. They use ethylene absorbing devices instead. Modern cooling technology is more than just refrigeration, it also addresses the issue of gas exhalation of fruits.

Controlled Atmosphere Storages

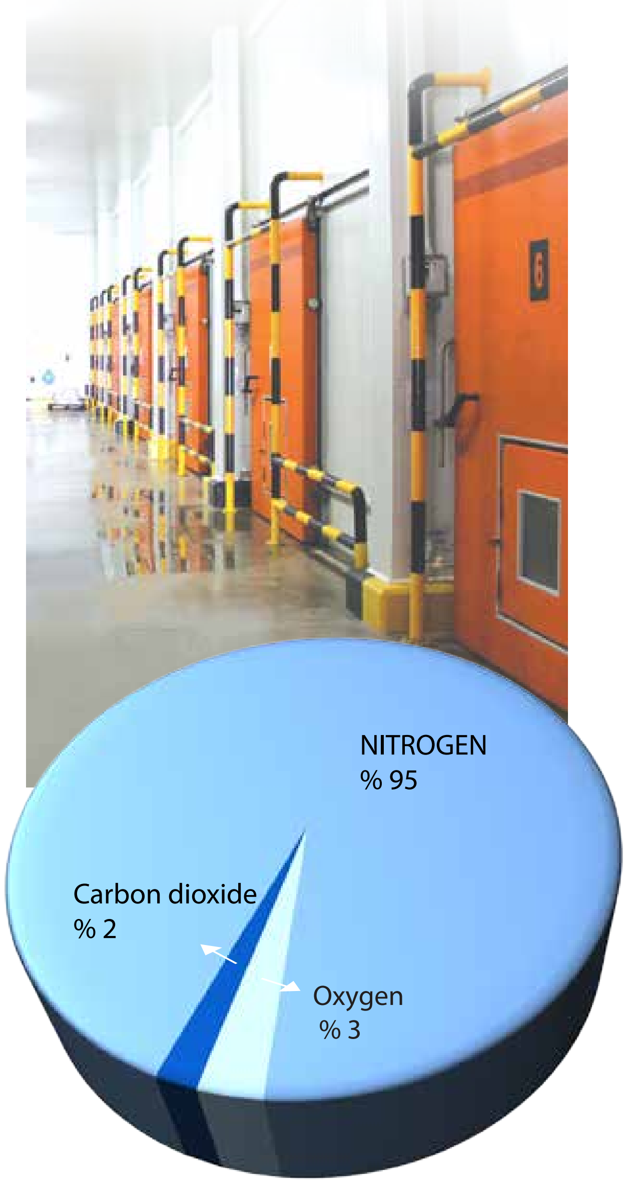
In a standard storage facility the air inside is not different from the ambient normal air and contains 78.08% nitrogen, 20.95% oxygen and 0.03% carbon dioxide. The high oxygen content of our normal air increases the respiration rate and thus speeds up the apples' ageing process. In controlled atmosphere storages the ratios of the gas components are changed creating a conditioned atmosphere. Nitrogen, generated with the aid of a special device, is pumped into the storage room. In the process, the oxygen share is reduced to 3% while the carbon dioxide share is increased to 3-5%.

The construction of controlled atmosphere storages requires special technology, equipment and expertise. One important condition is that they must be air-tight. To achieve this, the abutting edges of insulation panels must sealed with a special, viscous, paint-like material.

The application of a controlled atmosphere extends the storage life of apples and maintains their harvest freshness until the day they are distributed to market. It also slows down decay and diseases. This advanced storage technology controls both the storage temperature and the ambient air composition inside the storage room with the purpose of influencing the fruits' breathing process thus slowing down their physiological aging. A precondition for the successful application of this superior technique is complete air-tight sealing of the storage room. Under controlled atmosphere condition the oxygen content of the air is decreased and the concentration of CO^2 increased, while the ethylene given off by the fruits is removed.

Controlled atmosphere storage of fruits and vegetables has been in use for almost 70 years, however, its breakthrough only began in the 1960s. In industrialised countries almost all apples are stored under controlled atmosphere conditions. To monitor what is going on inside the storage room, small air-tight windows are used; they are mounted either on the doors or the walls at the location where the machinery is installed.

" Controlled atmosphere storage facilities ensure both an ideal cooling environment and suitable conditions that restrict fruit breathing thus slowing down the aging process. Controlled atmosphere conditions also prevent the occurrence of storage diseases. "



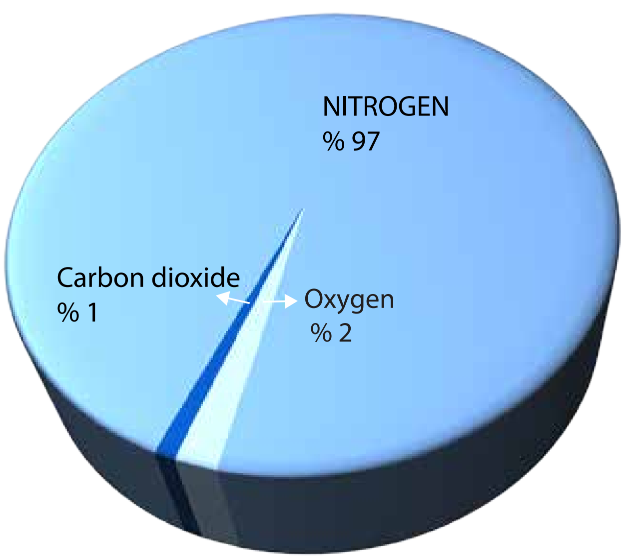
Controlled Atmosphere

Types of controlled atmosphere (CA) applications

Ultra-low oxygen CA

In this application, the oxygen content is lower than in regular CA storage. Under low oxygen conditions the fruit flesh remains firm for a long time and internal breakdown (seen in particular in Granny Smith varieties) is prevented. The oxygen concentration is held constant at a level just above the anaerobic threshold of the fruits.

With an O_2 concentration of 0.9-1% ultra-low atmospheres contain about half as much oxygen as normal controlled atmospheres (2%). CA storage requires more expertise than normal or traditional storage applications. The gas measuring devices must be correctly calibrated at all times and capable of measurements with a high degree of sensitivity. Air-tightness requirements for ultra-low CA rooms are also more strict than for normal CA. If these conditions are met, produce can be stored for longer and at a higher quality.



Ultra Low Oxygen

The most advanced controlled atmosphere systems dynamically controlled atmosphere systems (DCA)

The most advanced systems have a dynamically controlled atmosphere. The atmosphere values are monitored and adjusted in real time. This is why they are called dynamic. Such systems can reduce the oxygen concentration in the storage room to as low as 0.4%. Under these conditions the fruits are momentarily brought close to the threshold of aerobic-anaerobic breathing. This causes stress and brings the breathing mechanism to a hold.

The functioning of the system can be summarised as follows: Under normal atmospheric conditions, fruits breath aerobically; in other words, they consume the ambient oxygen and produce carbon dioxide, water and heat. If the atmosphere is low in oxygen, they switch to the anaerobic process, take up carbon dioxide and produce alcohol. To determine the threshold of this metabolic change, a phenomenon called chlorophyll florescence is used. It describes the process of light absorption by the chlorophyll in plant material and its re-emission into the environment. The ratio of absorption and emission dramatically changes at the aerobic-anaerobic threshold. Devices provided by the company HarvestWatch are used to monitor the process.

DCA storage rooms must not only be air-tight but also protected from external light sources for the HarvestWatch device to work properly. The measuring device contains 6 apples which are illuminated with special LEDs. The reflected light is measured by a sensor in their centre. The signals are then processed by a computer and graphically displayed. The transition point for aerobic to anaerobic breathing is found by stepwise reduction of the oxygen content in the atmosphere.

Pre-conditions for successful DCA application

1. Gasproof storage rooms
2. Special CO^2 capturing devices

The concentration of free oxygen and available carbon dioxide must be maintained below 1%. The best solution for this purpose is nitrogen generators.

3. Only one apple variety per room. Their quality and level of maturity must be homogeneous. Loading time is important; the fruits must be placed in the storage room as fast as possible.

4. The oxygen concentration must be maintained above the stress level of the apples (> 0.4%) determined with the aid of the chlorophyll florescence sensor.

5. Cooling and the ultra-low oxygen level must be set and adjusted in accordance with research results for the particular apple variety.

Advantages

- Longer storage and shelf life
- The fruits are firmer, more juicy and tasty
- The acidity of the fruits is preserved
- Colour loss is reduced to a minimum
- The fruits maintain their resistance to pathogens, rotting is prevented
- Internal breakdown is prevented
- Skin spots in Elstar apples are reduced.

Disadvantages

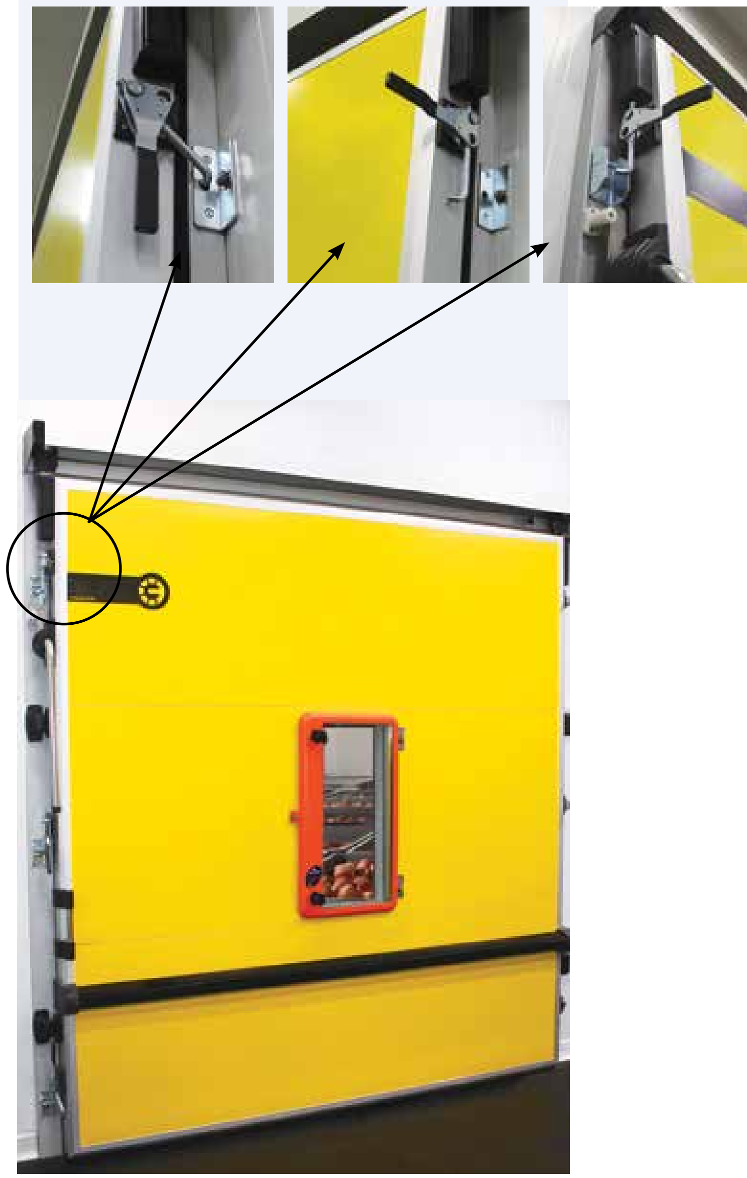
- The 24 apples (6 per measuring device) do not represent the entire harvest
- Not more than one variety must be stored in a single storage room
- Initial investment costs
- Qualified labour is scarce
- Elevated fermentation risk
- In cooperative-type storages more than one person stores produce in the same room which causes additional homogeneity problems.

Even their doors are special

Special door seals ensure that the storage rooms are closed gas proof. For this purpose they are pressed shut with special mechanisms on all four sides. Once in DCA mode the doors are locked and not opened again with the exception of very special situations.

With its very low oxygen and very high carbon dioxide concentration the atmosphere inside the storage room is deadly for humans, and the rooms must only be entered after thorough ventilation.

Door accessories of atmosfer controled storages



The main equipments of controlled atmosphere systems

Nitrogen Genarator

Carbon Dioxide (CO_2) filter

It removes the excess amount of CO_2 generated in the breathing process of the fruits. For this purpose the air is filtered through active carbon which absorbs the CO_2. When the active carbon is saturated with CO_2 it is purged with normal air.

Nitrogen Generator

A device that removes the oxygen from the room's atmosphere and enriches the nitrogen concentration up to 99.9 %. The air is circulated with the aid of a compressor. The nitrogen generator is equipped with special filters that separate the oxygen in the normal air from its nitrogen content on a molecular level. The purified nitrogen is stored in a tank from where it is pumped back into the storage room gradually reducing the share of oxygen in the atmosphere.

Pressure Regulator

It is used to counterbalance air pressure variations due to temperature changes in the room. The device is equipped with valves and a storage tank. Through the valves necessary air is sucked in from outside. But the valves do not give off air to the outside.

Once the room is sealed air tight, manometers are used to measure the pressure inside and trigger commands to the nitrogen storage tank to balance pressure variations.

Gas Analysis Device

At certain intervals gas samples are taken to measure the CO_2 and oxygen content in the room. The results trigger the nitrogen generator and the carbon dioxide purger.

Ethylene Absorbers

Ethylene absorbers come in two types.

1.Potassium Permanganate

Most ethylene absorbers use potassium permanganate ($KMnO_4$) as purging agent. Potassium permanganate is a strong oxidant that transforms the ethylene first into acetaldehyde, then into ascetic acid and finally into carbon dioxide and water. In the course of the process the $KMnO_4$ is consumed and must be replenished at certain intervals.

2.Catalytic Converter Systems

These systems catalytically oxidise the ethylene at 250°C to CO_2 and H_2O. Catalytic converters are widely used in the automobile industry. In a car, the catalytic systems either oxidise not completely combusted fuels to carbon dioxide and water or reduce pollutants such as nitroxides to harmless nitrogen and water. In DCA systems the catalytic converters are installed outside the storage room. The air in the room is passed through the converter in a closed loop and any ethylene present in the air is catalytically combusted at 250°C to carbon dioxide and water ($C_2H4 + 4O_2 => 2CO_2 + 2H_2O$).

Pressure Balancing Balloons

Ethylene Absorber

The installation layer above the loading corridor of the atmosphere controlled apple storage room

An urban legend about controlled atmosphere storage

“The doors of CA storage may only be opened once.”

This information is not correct.

It is not recommended to treat CA storage rooms in the same way as classical storage facilities which are opened and closed every other day. Reasonably you should not enter the room more than 4-5 times per season to take out product. The reason why CA storages should not be accessed frequently is based on the fear that the level of humidity inside may drop too much below standard conditions. The humidity level inside is of vital importance. If the level falls, it must be replenished with the aid of humidifiers.

It should also be considered that any water losses suffered by the apples cannot be restituted and will negatively affect their quality. You can also always return from controlled atmosphere conditions to normal atmospheric conditions should it no longer be possible to maintain CA conditions.

Atmosphere Controlled Warehouse Plan

1. If, O_2 is very high, N2 is added.
2. If, O_2 is very low, O2 or air is added.
3. If, CO_2 is very high, CO2 is washed.
4. Air circulation area is left.
5. Adequate capacity for cooling evaporator must be used.
6. KA/ ULO air flow valves from the unit.
7. Low-High Pressure entry/exit valve, balanced balloon.
8. Ethylene washer.

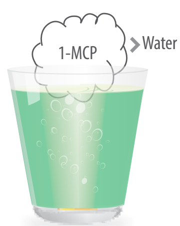
IF YOU WANT TO FULFILL THE QUALITY-STORAGE OF APPLES YOU MUST PREVENT THE RELEASE OF ETHYLENE

" In addition to controlled atmosphere systems, the quality of apples are maintained with the best standards through the 1-MCP treatment in the US, Europe and China,. Where there isn't a controlled atmosphere system, 1-MCP has to be used alone in order to maintain the crispness of apples and extend their shelf life; however this system is sufficient to some extent. "

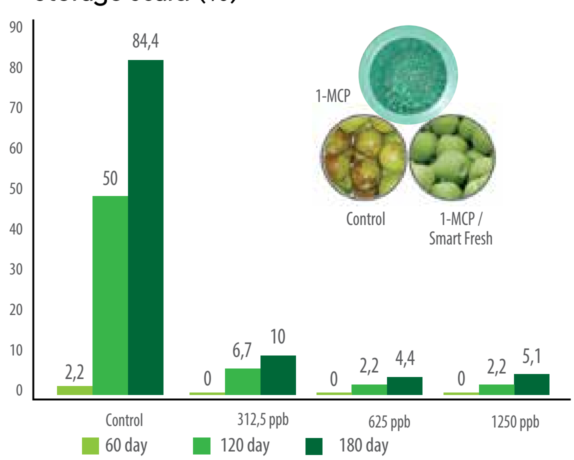
In USA, Europe and China a method called 1-MCP is used in addition to CA. It ensures storage of apples at the highest quality. In places without CA storage, out of necessity this method is used alone in order to maintain the crispness of the products and to extend their shelf life. However, as a stand-alone method 1-MCP has a limited effectiveness.

1-MCP (Methyl cyclopropane) fumigation

The apple is a "climacteric" fruit, which means, that it continues to live on for a certain period of time after plucking from its branch. After harvest, such fruits quickly release ethylene which initiates the irreversible aging process. In the case of apples, the gas liberated by the apples speeds up the maturing and aging process thus reducing their storage life. This process depends on the concentration of ethylene and the fruits' exposure time to the gas. Various systems have been developed to remove the gas from the air.



Storage scald (%)



Fuji Zhen Aztec / stored 6 months at 0°C with 1-MCP

Fuji Zhen Aztec / stored 6 months at 0°C as control
Storage scald ratio (%)

The most successful system, however, is 1-MCP, which follows a different approach. While the other methods are designed to purge the gas by removing it in a chemical reaction, 1-MCP suppresses ethylene generation and the sensitivity to the gas already present in the atmosphere.

In a scientific study the amount of ethylene generated by 1-MCP treated and untreated apples was measured. The untreated fruits were found to produce 10-15 times more than the treated ones. 1-MCP is a chemical that suppresses ethylene generation and thus the aging process which begins in the apple core. This process is initiated with the emission of ethylene. Normally, 1-MCP is applied for 12-24 hours. The most common time span is 24 hours. 1-MCP is used at room temperature and at a very low dosage.

The above-mentioned study found that 1-MCP treatment extends the fruits' freshness by 1-2 months. At the same time, treated fruits maintained their quality (firmness, crispness, juiciness, etc.) during distribution from the storage facility to the final consumer, and had a longer shelf life.

In Turkey 1-MCP was first commercially used for apples in 2005-2006 and then quickly spread.

Under normal storage conditions, 1-MCP-treated apples are stored at a temperature interval of 0.0 to + 2.0°C, with a temperature differential of 1.0°C. For Granny Smith apples the lowest permissible temperature is +1.0°C. This limit must be maintained in order to prevent CO^2 accumulation.

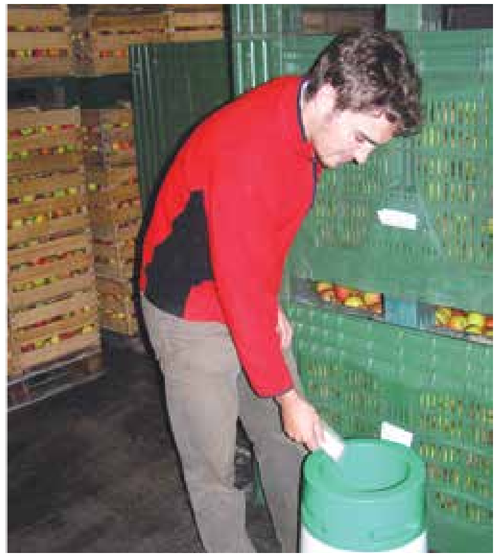
1-MCP is not suitable for the apple variety Granny Smith. This is a conclusion arrived at from experience. Worldwide, 1-MCP is used in powder form which is dissolved in water to liberate the gas. Different companies offer different methods of dissolution in water, the basic principle, however, is always the same.

Application in Turkey: A bucket called "generator" is filled with water. The water is then stirred with a simple air pump while the powder added to the water is turning into gas.

Organic farming

The use of 1-MCP is certified as good agricultural practice in European countries and in Turkey, it is however not certified as organic farming practice. In 2010 the substance was approved in Japan which is considered as the country where the approval of agricultural chemicals is most difficult. In the USA, 1-MCP is certified as a chemical that leaves no residue (not traceable in produce with MRL – Maximum Residue Limit) in the treated produce.

1-MCP Application



PHYSIOLOGICAL STORAGE DISEASES

> "In general, physiological storage diseases are caused by inadequate technical practices while the apple is still on the tree in the orchard."

Early or late plucking, the method of irrigation, wrong pruning and unbalanced use of pesticides are frequently made mistakes that invite diseases. Texture damages affect the apple's looks. As long as no pathogens are involved, there is no risk of contagion. To avoid any damages, technical procedures such as pruning, irrigation, fertilisation, pesticide application and harvest must be implemented as recommended.

When putting fruits into storage they should be carefully inspected to detect defects that are visible to the eye. Any doubtful apples must be sorted out. Another factor favouring the emergence of diseases is wrong storage conditions. While strict adherence to optimal storage condition is known to suppress the development of diseases, removal of damage fruits prior to storage is of no less importance.

Sunburn

Physiological defects seen in controlled atmosphere storages

Low oxygen damage

When the oxygen level under CA storage conditions drops too low, the fruits switch to anaerobic breathing. As a consequence the apple begins to ferment, producing acetaldehyde, ethyl acetate and ethanol (alcohol) in the process, which negatively affects the taste. If such fruits are subject to high CO^2 concentrations over a longer period, the deterioration in smell and taste becomes permanent. If detected early, the changes can be reversed by returning to normal atmosphere conditions. Similar defects are also frequently seen in fruits coated with a thick wax layer.

Resistance to low oxygen is variety-dependent and not the only risk factor. Other pre- and post-harvest factors can cause damages as well. The time until the damage becomes visible and its intensity depend, besides the low oxygen content, on other undesirable storage conditions (temperature, humidity, smells, etc.), and are also variety-dependent. Some varieties suffer heavy damage if subjected to 0.0% oxygen levels over a period of six weeks.

Storage scald - Peel blight

It is the most important physiological disease and frequently seen in storages. In affected apples, the peel turns brown and the fruits die. In less severe cases only the peel is affected; in severe cases also the flesh below is damaged. It is impossible to detect the disease during placement in storage; the fruits must be carefully inspected before because the damage usually only becomes visible in the 4th or 5th month of storage. Peel blight becomes most severe when taking the apples out of storage and bringing them in contact with normal atmospheric conditions.

Bitter pit

This disease infects apples while they are still on the tree; it becomes visible only in the 4th to 6th week in cold storage. Affected fruits develop brown depressions in their peel. The disease is not contagious. A few weeks after harvest the disease causes the death of groups of fruit flesh cells, the peel turns brown, and the taste assumes a bitter note. The symptoms are most frequently seen around the calyx.

The disease is a consequence of calcium deficiency. In calcium poor soils, calcium fortification yields positive results. The varieties Amasya, Starking, Canada Renet, Mutsu, Hüryemez and Cox Orange are sensitive to bitter pit. Under suitable storage conditions, Golden and Starking varieties are less prone to develop it. The disease can be contained through regular irrigation, age-appropriate pruning, calcium-fortified fertilisation of the soil and in particular the leaves with a 0.5-1% dosage, and harvesting when the fruits have reached the right degree of maturity.

Low temperature breakdown – Browning of the flesh

This defect is seen in apple varieties that are stored for a certain period of time slightly below their variety-appropriate storage temperature. It begins at temperatures just above the apples' freezing point (-2.80C); the lower the temperature the more pronounced its severity. The chilling effect causes the browning, not the fruits' congelation. The damage may go as deep as 10-15 mm.

The affected section of the external peel turns brown, and from there the damage spreads. In diseased fruits, the fruit flesh between the core and the endocarp dies and changes its colour to brown.

The main cause for this damage is too low storage temperatures. It can be prevented by ensuring that the fruits are stored under optimal temperature conditions. Calcium fortification is also known to have a positive effect.

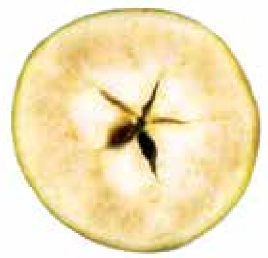
Water core

The severity of this defect depends on the variety, the climate and the calcium content of the fruits. Varieties such as Jonathan, Delicious, Granny Smith and Fuji are known to be very sensitive. One of the main causes is excessive irradiation. For this reason, the disease is most severe in dry and hot years. To avoid water core, apple varieties must be selected that are suitable for the location. Other preventive measures are balanced pruning and protection against excessive sunlight. Calcium fortification is also strongly recommended. The fruits must be harvested at the right maturity and stored under optimal conditions.

Storage scald

Bitter Rot

Water Core



Darkening of the Flesh

DESIGNING A SUITABLE COLD STORAGE

"We know how to grow apples and harvested them properly, and also we have made up our mind about which cooling system to use. Now is the time to build the storage facility."

There are three ways for investors in cold storage facilities to earn money:

1. They only store and trade their own products.
2. Besides their own products they make storage space available for others against payment.
3. They rent out the entire cold storage facility.

The decision on building a cold storage facility should only be taken after the owner has devised a plan on how to operate it.

In cold storages with a roof height of 7.5 m, 1.5 tons of apples can be stored per sqm. The investor's first decision regards storage capacity.

Project Planning

After the decision about the facility's dimensions, choice of region and location, and the construction steps remain. Each of these choices and steps is of great importance.

Then follow architectural design, construction plans, outlay of the mechanical and electrical installations; building permits must be obtained, road connections established and the electricity supply secured. If all is thoroughly planed and, most importantly, implemented as planned, the storage facility should be up and running without delay. This service is not part of the core business of companies that manufacture and install industrial cooling systems. Therefore, the following guidelines are no more than suggestions.

Choice of Location

The storage should be built close to apple orchards in order to save transport costs and ensure storage after harvest without delay. The location should also be well connected by road for easy access and unimpeded deliveries. It must not be forgotten that a storage facility is associated with serious truck traffic. The ground for the building should be as flat as possible because levelling means additional costs. After selection of region and location, the next important issue is electricity supply. Addressing this issue at a later stage often causes problems. Since storage facilities are scalable enterprises, future electricity demand should be part of the planning process. The energy demand for the entire facility must be calculated correctly in advance and a stable energy supply to the construction area must be ensured as early as possible.

Type of Building

There are two types of constructions: concrete and steel. You must opt for one of them. Both are suitable for cold storage facilities. Your decision should be based on a feasibility study assessing general and regional conditions.

A modern apple orchard and service buildings/Korkuteli

In concrete buildings all components except the link beams and sockets are much cheaper than steel constructions.

In steel buildings those beams and sockets are much cheaper. Consequently, the decision must be based on a comprehensive cost analysis considering the total of every single cost item of columns, beams, binding rafters, sockets and link beams.

Steel Structures

Concrete Structures

Thermal Insulation

Thermal insulation which maintains the mechanically generated cooling conditions inside the facility is very important with respect to energy and economic considerations. Previously walls and ceiling were covered with polystyrene panels. They were glued to the surface with hot bitumen, followed by a layer of plaster mesh, a top layer of plaster and a finishing paint layer.

They were cheap to build, but the plaster would soon crumble, and the condense water that collected inside the insulation layer would strongly increase electricity consumption. With the development of spray polyurethane in the 1990s a better alternative was finally available. Thanks to this material many easy to operate cold storages were built in a short period of time. The next improvement was sandwich panels which became very economic to produce with the drop in polyurethane and sheet steel prices. The trend began in Europa and the USA and spread from there to other countries.

Fire Classes of Panels

Polyurethane is made from two components: a polyol and a diisocyanate. Depending on their proportions in the final material they are called PIR or PUR.
Polyurethane foam is an inflammable substance and requires special measures to ensure its safe use. The classification, established in test laboratories, distinguishes between the amount of smoke generated by burning panels and the speed of flame propagation. Construction material (roof and façade panels) must be inflammable (fire class A or B); for cold storages class B is sufficient.
In apple cold storages the temperature is around zero degrees Celsius. To maintain this temperature an insulation panel thickness in the range of 8 to 12 cm is required. When selecting the thickness of the layer all dimensions of the storage space must be considered, in particular its height. If the storage room's ceiling cannot be insulated in one piece a holding construction for the additional panels must be mounted on the ceiling. The thickness of the ceiling's thermal insulation must be calculated with this in mind.

Fire classification for sandwich panels insulation materials				
Insulation Material	Fire Class	Thermal Conductivity (λ)	Insulation Density	Standard
Polyurethane	B s2 d0	0,018-0,022 W/m K	40-42 kg/m^3	TS EN 13501
Polyisocyanurate	B s1 d0	0,020-0,022 W/m K	40-42 kg/m^3	TS EN 13501
Glass wool	A2 s1 d0	0,040-0,043 W/m K	100-110 kg/m^3	TS EN 13501
Rockwool	A2 s1 d0	0,035-0,038 W/m K	48-52 kg/m^3	TS EN 13501
EPS	E	0,035 W/m K	16-22 kg/m^3	TS EN 13501

Interlocking Panel Systems

Two types of thermal insulation systems are available: continuous and discontinuous panel systems. Continuous systems are designed for mass production; discontinuous systems are manufactured for specific projects. As a consequence continuous systems are cheaper than discontinuous ones. However the production speed can cause adhesion problems between the polyurethane and the steel sheet, as well as with the precision of the “male-female” interlocking system. Taylor-made discontinuous systems, on the other hand, take longer to produce, and they are a little more expensive because of the higher labour input. The thermal insulation panels are equipped every meter with an eccentric locking mechanism that ensures a rigid structure with high insulation performance.

Storage Room Height

Modern apple storages usually have an internal height of at least 7.5 m. The important criterion here is the number of pallets or crates you intend to stack in the room. Once this parameter has been decided, the design phase of the storage facility begins. You must leave at least 1 m space above the maximum stacking height. This space is necessary for air circulation and must not be filled.

Door Dimensions

The door dimensions depend on the way you intend to transport the apples in and out of the storage room. If you use a forklift, the pallet and forklift dimensions determine the door size; if the crates are loaded manually the transpallet and pallet dimensions are the determining parameters. The doors must have no threshold. Another important factor is sufficient air circulation.
The doors must be protected, inside and outside, with barriers against forklift impact. The net door size must be a compromise between comfortable product movement in and out, and the requirement for good thermal insulation. The larger the doors, the larger the temperature loss at each opening. Large doors are also more difficult to operate, and they wear out faster. A frequently used net door size is 200 x 270 cm.

Corridor Width

The corridor leading to the cold storage must be at least 4.5 m wide; the standard is 5 m. Sometimes the corridor is divided at the height of a low sliding door thus creating space for installations and packaging materials. The corridor ceiling is also usually thermally insulated and remains closed, for this reason, small dimensions are preferred. There is, however, a tendency to equip the corridors with coolers and use them for pre-cooling purposes.

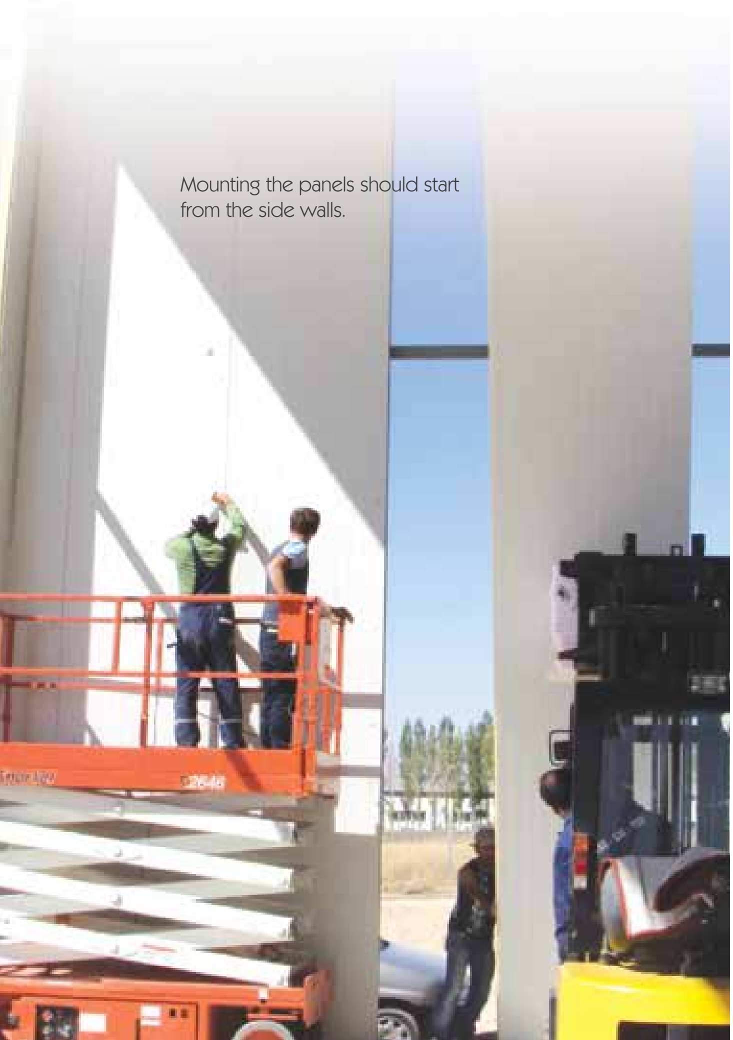
Use of storage corridors

Ceiling suspender and joints used to connect the ceiling panels

The attic of an atmosphere controlled storage

Roof of the cold storage

If water is collected on the roof, there is a risk of it dripping into the storage room below. Therefore, the roof must be well-insulated against water. Where possible, insulated panels should be used as roofing material. There is no risk of water penetrating the storage walls. Additional water insulation of the roof is, however, required as the thermal insulation is only designed to reduce the heat exchange.



Mounting the panels should start from the side walls.

Roof Pace

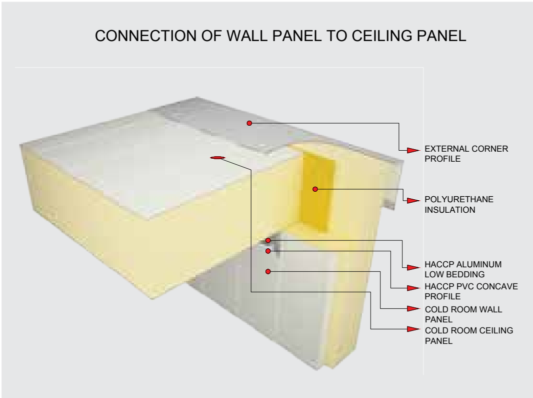
In large cold storage facilities, the ceiling panels are usually placed in a holding structure which is itself connected to the roof beams. The electrical and cooling devices are also installed on the ceiling. When mounting the ceiling panels, care must be taken that those installations can be easily mounted and maintained later on. For this purpose enough space must be left between ceiling and storage space.

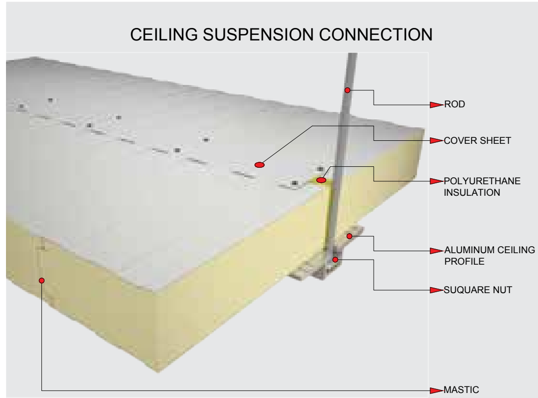
Mounting of the cold storage panels

At first "U"-profiles are fixed on the floor as indicated in the construction plan. Then begins the wall build-up. The walls are covered in sequential order, starting in one corner of the first wall.
Apple cold storages are relatively large buildings and require large coolers. After the ceiling has been mounted, the coolers are placed on the ceiling. Their holding constructions are connected to the roof beams. Care must be taken that the load is well balanced and that no load lies on the ceiling itself. The holding constructions must be mounted before the panels are put in place. Openings must be left in the right places for cables and piping.

The mounting of the cold storage is complete when the ceiling has been mounted.

The storage sections will be mounted after the side walls have been placed.





Surface Area

The surface area ranges from 50 sqm to 500 sqm and depends entirely on the user's economic expectations and the technical equipment of the storage. Controlled atmosphere storages are usually smaller and more numerous which translates into better user friendliness.

Floor Insulation

In apple cold storages panels are mounted after roofing. However, before panel mounting you must decide how to construct and insulate the floor.
You can choose one of two alternatives:


Laying the concrete floor before the panels are fitted

Alternative 1: First the panels are placed, then the floor insulation is applied and the floor concrete poured. With this method, the concrete hardening will take time. The advantage is a single slap concrete floor without any additions or patching. During concrete pouring, the side walls must be protected.

Alternative 2: Prior to panel mounting the floor is at first insulated and then the concrete is poured. With this method, concrete pouring takes less time, and it hardens quickly. However, this method requires precise formwork; because the poured concrete must not enter the panel area. After panel mounting, the space between panels and concrete must be carefully filled with additional concrete. Since the storage room floor consists of an insulation and a concrete layer, care must be taken that the final room floor is level with the outside corridor. For the floor, two overlapping layers of 28-32 (XPS) density material must be applied, and to avoid seepage of the concrete slurry into the layer below, a 100-120 micron thick nylon sheet must be laid out in order to separate the layers.

The concrete must be of C20 quality, and the concrete floor must be at least 15 cm thick.

Details of the cold storage room floor insulation


Laying the concrete on the floor after the panels have been fitted

Lighting in the cold storage

Lighting in the cold storage

The most commonly used types are Hg vapour lamps or spot halogen lamps. These lamps have several disadvantages such as high energy consumption, reaction time, low light efficiency in cold rooms, heat load and negative impact on the fruits' physiology. For these reasons LEDs are nowadays preferred. They are more versatile and consume much less energy.

Cooler placement

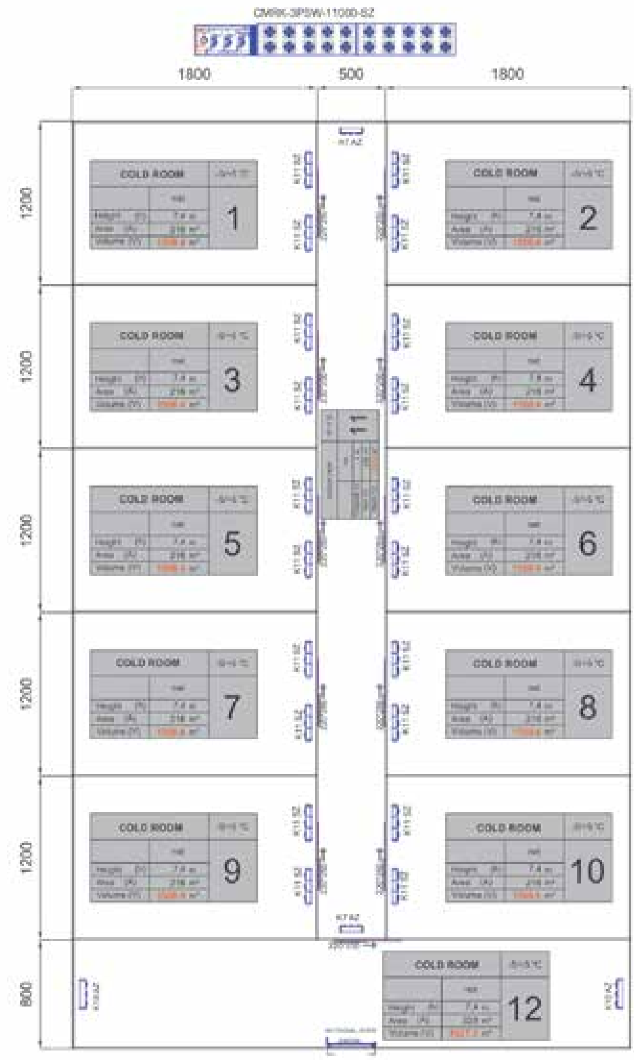
The coolers are placed in such a way above the apples that optimal air circulation is assured. The best place is right above the door and side by side. This arrangement permits easy access and control. Depending on the room's capacity and geometry, 1-4 coolers are placed in one room.

Placement of the external units

The decision depends on the choice of cooling technology. Freon systems do not require a machine room. All they need is a base. A shade should be mounted above the external units and the condenser; protection against external weather conditions is also advisable. Ammonia systems require quite a large machine room which must be considered in the planning phase.

Processing and loading area

It must be considered that the processing area requirement increases proportionally with storage size expansion. If the area is equipped with processing machinery, its size depends on the space requirement of the machinery. You should also consider that crates will be stored in the area and require space of their own.



Example of central cooling system 2500 tons capacity cold storage project

The area must have platforms that facilitate the loading and unloading of trucks. The area's design is usually based on crate height. Hydraulically or mechanically adjustable platforms are available.

Inner ünit

Installing the exterior unit

Processing and loading area

DETERMINATION OF STORAGE CAPACITY

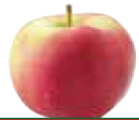
" If you want to store apples under hight quality conditions for a long time, then rapid cooling of the fruits must be your first priority. By using scientific methods for determination of the cooling capacity guarantees storage of apple under ideal conditions "

After initial placement of the apples in the storage facility, they must immediately be cooled down to their optimal storage temperature. This requires a large amount of cooling energy. The cooling capacity must be determined to achieve just that, and to maintain the apples at their optimal storage temperature. No matter what cooling system you choose, if your cooling capacity calculation is wrong, long-term quality storage will be impossible. The optimal theoretical situation is quick pre-cooling followed by immediate long-term cold storage. In practice, however, the apples are brought in batches from the orchard to the storage facility. This prevents homogeneous cooling of all apples and confounds all theoretical considerations.

The cooling capacity is calculated by adding up the contributions of the individual heat sources

1. Heat transmission through the walls
2. Heat generated by changes in the storage environment
3. Heat given off by the fruits
4. Various other heat-generating events inside the room.

This value is divided by the daily working hours of the compressor. The result is the hourly cooling capacity need. Your cooling system, irrespective of the type you have chosen, must be capable of meeting this demand. The most important heat source is the freshly plucked apples, which must be cooled down to storage temperature. A critical aspect in the calculation is the storage duration; another critical aspect the number of rooms you operate. These two data are combined under the assumption, that every apple variety will be loaded into storage within at most 15 days. The result is a more correct approximation of cooling capacity requirement. This calculation assumes a loading time per room of one day, and a maximal cooling period of three days.



HEAT GAIN CALCULATION (COOLING CHARGE CALCULATION)

Name / Place / Owner : ....

Calculated by : .... Office : .... Date : ....../....../......

Room No, Name / Purpose : Apple storage

Ext. °C and humidity : 35 °C, 30 %; internal room temp.; +2 °C, 90 % humide

Neighbouring volume °C : a) 30 °C; b) 35+10 °C; Floor 15 °C; Roof 35 + 11 °C

Room dimensions (mt)-no-insulated : 20 w x 10 L x 4 h = volume : 800 m^3

1- Heat Transmission (wall, ceiling, floor)

(*) heat difference must be added for solar places.

Symbol	Width (mt)	Lenght (mt)	Surface (mt)	Qty	Insulated	Accounted	K_u	Δt (*)	Heat/h (kcal/h)	Daily Heat gain
DD (D)	4.0	20	80	1	-	80	0.30	36	864	
DD (G)	4.0	10	40	1	-	40	0.30	35	420	
ID (a)	4.0	20	80	1	-	80	0.29	28	650	
ID (b)	4.0	10	40	1	-	40	0.29	43	499	
TA	10.0	20	200	1	-	200	0.30	44	2640	
ZE.	10.00	20	200	1	-	200	0.31	13	806	

TOTAL TRANSMISSION GAIN .... 24X5879 kcal/h — 141.096 kcal/day

2- Heat generated by medium change :

$\dot{I}_d$: Ext. heat 15.6 kcal/kg

$\dot{I}_o$: Int. heat 3.0 kcal/kg

Room volume : 703.7 m³ x Medium change in 24 hours 3 times x (15.6 $\dot{I}_d$ - 3.0 $\dot{I}_o$ x 1.143 kg/m³ = 30.402 kcal/day

3- Heat generated by products:

Heat type	Product	Weight(kg)	Δt (*)	Heat Freezing Maturation	Cooling duration (hour)	Heat Gain/h (kcal/h)	Daily Heat Gain
Freezing point	Apple	300.000	30-2	0.88	72	102.667	
Note	**LOADING COEFFICIENT IS NOT CALCULATED SINCE IT IS A COLD STORAGE**						
Maturation	Apple	300.000		0.20	24	2.500	
Lateral product heat	Crates, boxes etc.	300.000 /20	30-2	0.50	24	2.500	
	Others				72	2.917	
					TOTAL	**108.084**	

TOTAL PRODUCT HEAT (kcal/day) : .... x 24 = **2.594.016** kcal/day

4- Various heat types in cold rooms:

a) Human	: 10 pers. x 235 kcal/h x 10 hours/day	23.500
b) Lighting	: 100 watt x 10 pcs x 0.86 x 10 hours/day	8.600
c) Motor	: 0.5 HP x 8 x 2 pcs x 1070 kcal/h.HP x 24 hours/day	205.440
d) Elect. Defrost	: pcs x watt x 0.86 x hours / day x 0.5	13.760
e) Hot gaz Defrost	: 2 pcs x 10 hours x 2500 kcal/h = kcal/days	-
f) Others	: Forklift 2 pcs x 10 hours x 2.500 kcal/h = kcal/day	50.000
	other unknown heat types 10 %	305.306

TOTAL DAILY HEAT GAIN (kcal/day) .... **3.358.360** kcal/day

3.372.120

Loading charge to be considered for cooling equipment selection :

$$\frac{\text{TOTAL DAILY HEAT GAIN}}{\text{DAILY WORKING HOURS (14 - 20 hours)}} = \frac{3.372.120}{16} = \frac{\textbf{211.000}}{\textbf{kcal/h}}$$

MONITORING AND MANAGING OF A COLD STORAGE

"Without monitoring you cannot measure; without measuring you cannot manage"

"Smart energy usage does not only afford a financial gain, it also prevents wastage of natural resources and is thus an obligation towards humanity."

Technology reminding us of science fiction that has entered our lives; its roots, however, are not that old actually. The modern history of food storage is almost as fresh as the products that are still stored inside. But new technologies are not just mind boggling they also make our lives so much easier. Technology allows you to monitor your cold storage from your office or from anywhere else in the world with an internet connection. All sorts of data are available in real time, and the application is as cheap as it easy to use. Given all these advantages, there is no reason not to make use of it. You can even choose between own monitoring or commissioning an external provider with this task. The system reports the data that are generated in the storage facility and forwards them to your computer or even to your cell phone.

Storage monitoring can be summarised under two main headings:

Cooling equipment performance (compressor, evaporator, condenser, etc.) and storage room conditions (humidity, temperature control). Both are important if you want to maintain product quality.

In controlled atmosphere facilities oxygen and carbon dioxide concentrations are also monitored and adjusted if and when required. Real time monitoring also permits timely intervention in case of unforeseen situations.

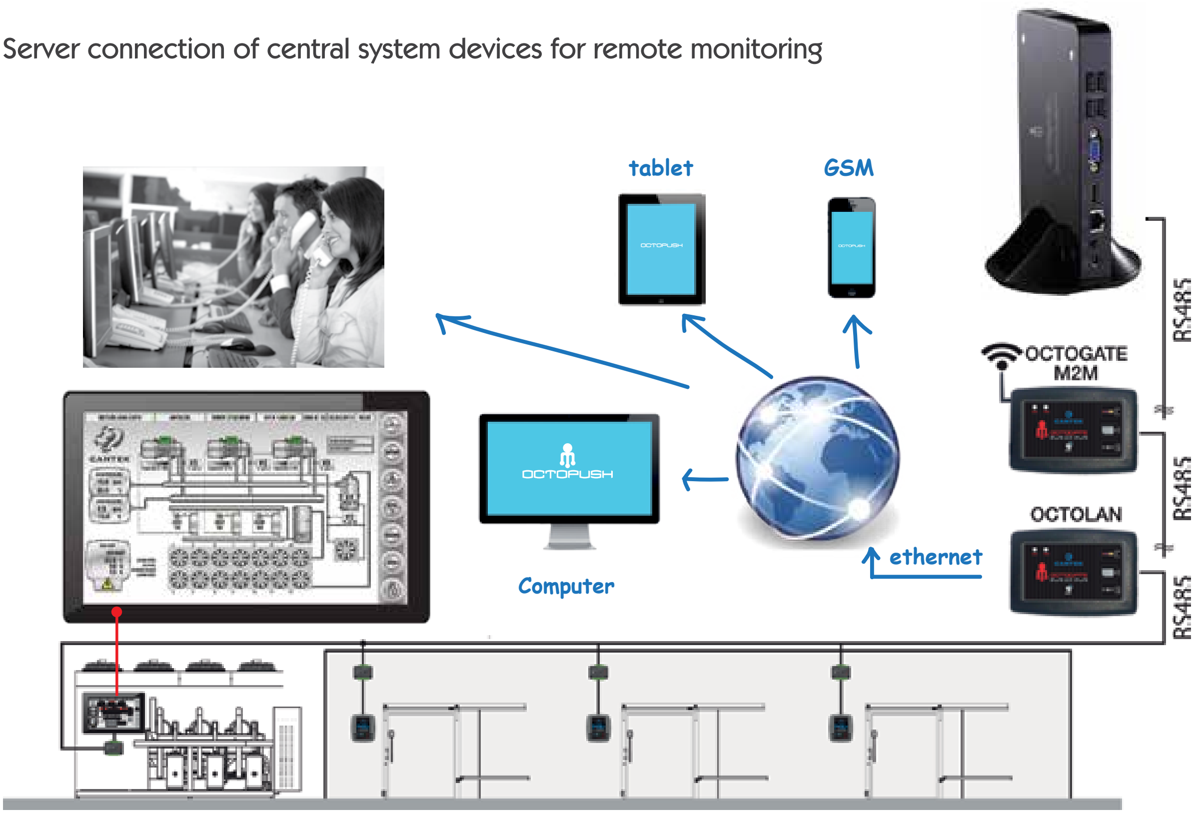
In cooling systems, the compressor consumes the largest share of electrical power (70%), followed in second place by energy losses when the storage doors are opened. Compressor monitoring allows immediate identification of icing events as well as immediate intervention. With a proper door opening-closing discipline, temperature fluctuations can be prevented and stable thermal conditions maintained.

Server connection of central system devices for remote monitoring

Revolutionary monitoring methods allow you to follow the daily going-ons in your storage facility and to manage it with the aid of sensitive feedback measurements. Modern remote monitoring systems can also easily be installed in already established facilities.

Monitoring Centre

Server connection of central system devices for remote monitoring

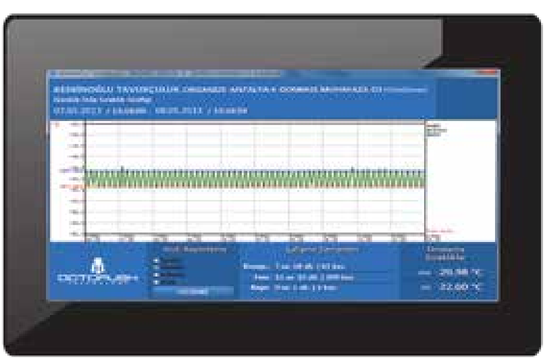


With respect to energy consumption, many countries have long since begun to implement a range of measures. They include energy efficiency and controlling the energy consumption per cubic meter. Even compulsory legislation is being passed on this issue. The advantages of central monitoring become obvious in the energy bill at the end of the month. Optimising the energy side of the business will reduce your most important cost item and make the enterprise a bit more profitable.

Smart control panels

Smart control panels watch over your storage facility and check its processes with the aid of sensitive measuring systems. They prevent unnecessary compressor operations and unnecessary defrosting, thus saving energy. Best of all, they prevent a nasty surprise at the end of the month in the form of unexpectedly high power bills. The system allows you to monitor your energy consumption on a daily basis. Smart devices can also easily be installed in already established facilities.

Energy Consumption Report



Daily Room Temperature Graph

CHAPTER 3

THE APPLE ECONOMY

The most entertaining section of the book begins here.

The state of the art in technology makes investments in apple orchards attractive; nothing else yields such a high added value. This final chapter is dedicated to the financial analysis of the journey the apple takes from storage to consumers anywhere in the world.

EXEMPLARY ESTABLISHMENT COSTS OF A 10-HECTARE APPLE ORCHARD IN TURKEY

Soil Preparation

SOIL PREPARATION

If the land for the orchard has not been tilled for a long time, the soil must first be broken, then ploughed deeply and left idle until the end of the summer season to soak up air and sunlight. If the land had been under cultivation before, the soil must be ploughed deeply in the spring or summer months. Before any saplings are planted, the soil must be analysed to determine is contents and properties.

Soil preparation costs of a 10-hectare apple orchard
$ 3.000

DRIP IRRIGATION

In many regions water is distributed by water cooperatives. The best way to use the water quota, or the water drawn from own wells, is by drip feeding it to the saplings. The fertilisers, the soil may need as determined by a soil analysis, can be supplied to the plants using the same system, thus reducing water demand by 50%. Another advantage of drip irrigation is that the tree trunk is not soaked in water, which reduces fungal diseases. The system also needs only little labour input for its operation. Since a 10-hectare size orchard would require a large quantity of water feeding valves their opening and closing should be automated. The vales can be programmed for daily, weekly and monthly operations, which saves time.

"The first dwarf plants were bred in Britain and spread from there. Today, dwarf trees are the plants of choice as they allow more plants per unit area and thus higher yields per sqm."

Drip irrigation system costs of a 10-hectare
$ 350 X da = $ 350.000

DWARF TREE SAPLING

The most important aspect to be considered when selecting saplings is consumer trends; another important issue is the choice of varieties with different harvesting times. Smart spacing of maturity times improves quality and prevents losses, because all fruits can be picked within the optimal timeframe. It also reduces traffic in the orchard. The global trend in rehabilitated and newly established orchards is towards dwarf varieties; the same applies to Turkey.
On a 10-hectare area about 380 saplings can be planted. The exact number is variety-depended. Gala, Golden, Granny Smith, Fuji, Braeburn and Pink Lady varieties make for a good orchard composition as they include early and late apple trees. The harvesting season would begin in July and continue for 120 days until October. This allows for continuous operation and provides a range of different products.
Modern gardens have increased tree density even further to 500 per dönüm.

The Trellis System

THE TRELLIS SYSTEM

To hold the dwarfs trees in an upright position and to spread their branches a wire system is used. This system does not impede the natural growth of the trees but is necessary for fruit development, and it facilitates the harvesting process.

Sapling costs of a 10-hectare apple orchard
38.000 pcs. x $ 1,5 = $ 57.000

Trellis system costs of a 10-hectare apple orchard
$ 80.000

MATERIALS COST

Equipment and tools costs of a 10-hectare apple orchard	
Garden Tractor	2 Pcs. x $ 18.000
Anchor machine	$ 1.800
Pesticide motor (Atomizer)	$ 5.600
Trailer	2 pcs. x $ 1.800
Plough	$ 700
Cultivator	$ 700
Total	**$ 48.400**

Average prices

Trailer

Garden Tractor

Rotavator

Plough

Atomizör

Cultivator

Set up cost analysis for a 10-hectare apple orchard	TOTAL
Trellis System	$ 80.000
Dwarf trees	$ 71.000
Material Cost	$ 48.500
Drip Irrigation	$ 350.000
Soil Preparation	$ 3.000
Total:	$ 552.500

Prices or average

Set up cost depreciation of a 10-hectare apple orchard (annual)	$ 11.000

*The annual depreciation has been calculated on the assumption of an economic lifespan of a full dwarf apple orchard of 20 years.

Set up depreciation (annual) per kg at full productivity	$ 0,014

How to optimise your investment: Some suggestions

Wind fans and their costs

In regions with frost risk it is advisable to install 2 automatically operated wind fans. Every fan covers an area of 6-hectare with a swivel angle of 70°C. When the air temperature drops below 1.6°C the fans are automatically switched on. An air temperature of 3.6°C switches them off again.

Wind fan costs of a 10-hectare apple orchard
2 pcs x $ 24.000

Covering net and its costs

A covering net offers advantages against natural events such as hail. It also provides some shade reducing evaporation losses after irrigation, and thus helps to save money.
The costs for a 10-hectare orchard are in the order of $ 28.000 Such a cover has a useful life of 6 years. During the 20 years of economic life of the orchards they must be changed three times.

Covering net costs of a 10-hectare apple orchard
$ 28.000

Covering net and wind fans are extra costs.

EXEMPLARY OPERATING COSTS OF A 10-HECTARE APPLE ORCHARD IN TURKEY

PESTICIDES AND FERTILISING COST

Pesticide costs in the year of planting can reach TL 30,000. The pesticide schedule comprises 8 treatment rounds: 3 times against venturia inaequalis, 1-2 times against mildew, 2 times against red spider. In total 80 tons of water-diluted pesticide will have to be sprayed (8 times 1 ton per 10 dekar). The tractor costs are extra.
A similar amount of money will have to be set aside every year for fertilisers (nitrogen, phosphor, potassium, magnesium and other nutrients must be added based on a leave and soil analysis).

Pesticide & Fertiliser costs for 10-hectare of apple orchard
$ 21.000

IRRIGATION COST

One way of bringing water to the orchard is by digging a well, another by obtaining it from a water cooperative. Digging a well is costly. Also, several wells need to be dug in different places around the orchard. Further cost items are electrical pumps and electricity. The best solution is to buy the water from an irrigation cooperative. Total costs depend on the irrigation frequency.
For 10-hectare it is in the order of $ 2.500

Drip irrigation for 10-hectare apple orchard
$ 2.500

PRUNING AND THINNING COSTS

With advancing age, the fruit buds must be thinned out manually or with the aid of chemicals. The costs for labour and materials are around $ 5.200

Cost of Pruning & Thinning for 10-hectare apple orchard
$ 5.200

LABOURERS COSTS: TECHNICAL STAFF AND PERMANENT

For a 10-hectare-size orchard at least one person must be employed who organises and supervises the temporary labourers, monitors irrigation and pesticide treatment, and may also guard the property.

Cost of technical staff and/or permanent labor for 10-hectare apple orchard
$ 6.200

ELECTRICITY COST

The compressors for the drip irrigation system and, if required, the lighting in the orchard, consume electricity.

Electricity cost for 10-hectare apple orchard
$ 3.200

FURITS PICKER COSTS

It should be noted that since orchards have low yields during the initial 4 years, the number and cost of temporary labourers will be low, too. Optimum yield begins from the 5th year onward.

Cost of picking for 10-hectare apple orchard
$ 28.000

SORTING COST

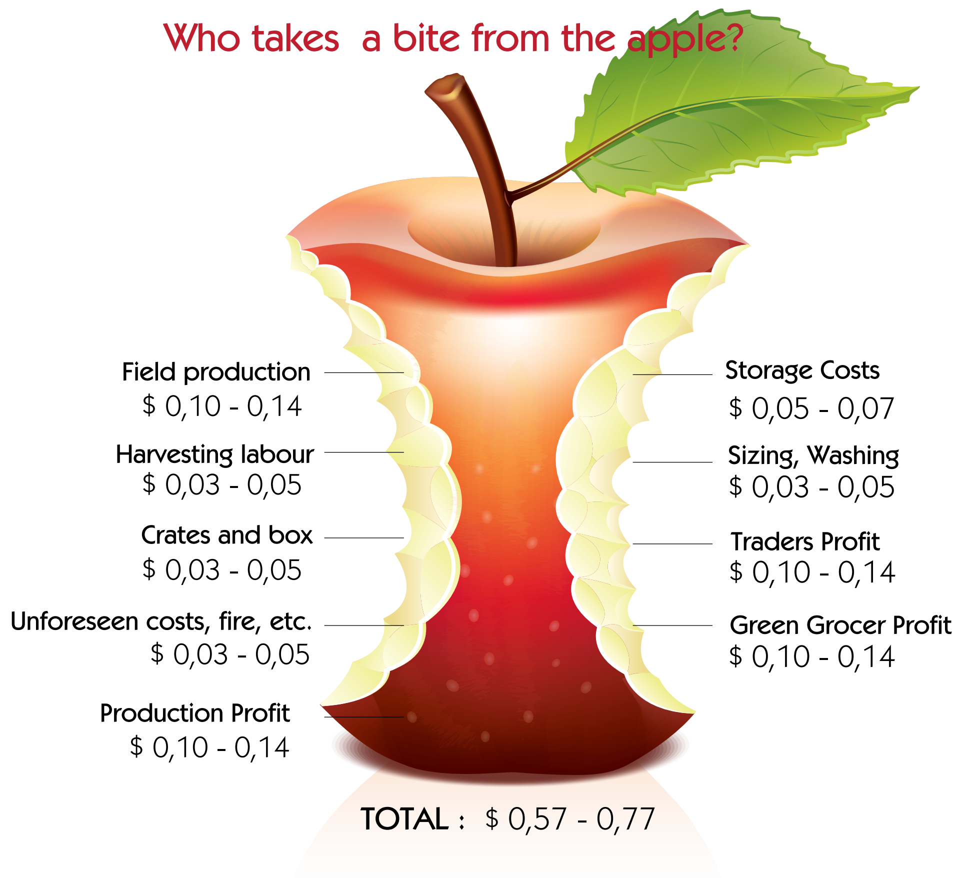
Sorting will be carried out manually. Beginning in the 5th year, a temporary workforce of 40 needs to be employed for two months to pick and sort the fruits.

Sorting Labor cost for 10-hectare apple orchard
$ 28.000

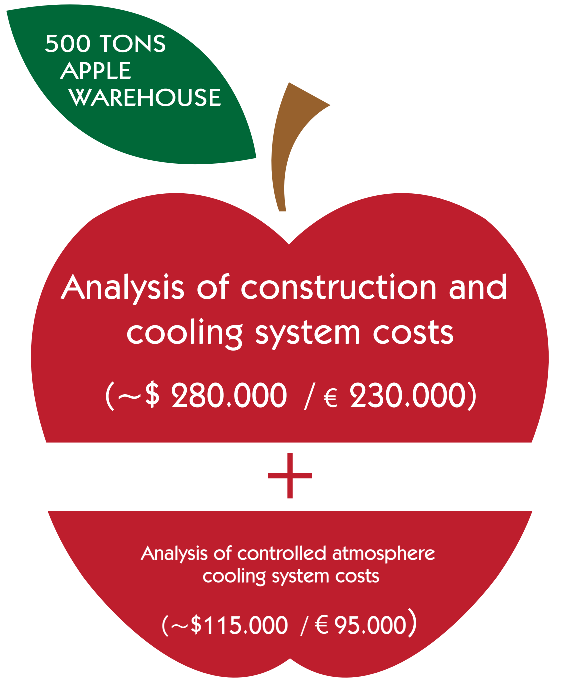
Operational costs of a 10-hectare apple orchard (annual)	TOTAL
Total labor	$ 28.000
Pesticide & Fertiliser	$ 21.000
Sorting labor	$ 28.000
Technicians & Permanent labor	$ 6.200
Pruning & Thinning	$ 5.200
General Maintenance	$ 5.200
Electricity	$ 3.200
Irrigation	$ 2.500
Consultancy fees	$ 2.100
	Average prices
Total:	**$ .101.400**
Set up cost depreciation of a 10-hectare apple orchard (annual)	$11.000
Average production capacity at full productivity (annual)	$ 800 Tons
Cost of 1 kg apples at full productivity	$ ~ 0,14

* In years with low productivity: 2nd year 38 tons, 3rd year 114 tons, 4th year 190 tons were added to the average Cost analysis was based on the 5th year (800 tons) at full productivity
** Set up depreciation x operating costs / production capacity
*** Depending on the region prices may vary by + / - 10%.

Who takes a bite from the apple?



GENERAL COST ANALYSIS OF A 500 TON COLD STORAGE FACILITY IN TURKEY



* Cost analysis was based on standard controlled atmosphere application
Price difference for advanced controlled atmosphere systems

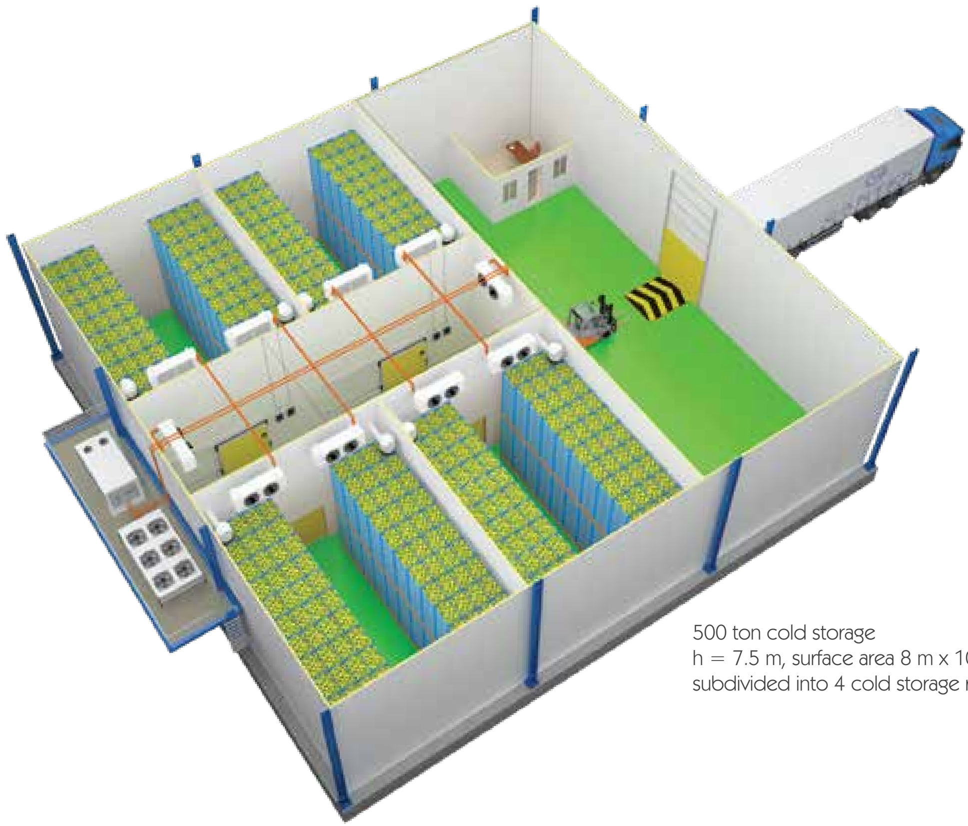
Total:	$ 395.000
	€ 325.000

Total covered area of the building is 650 m². The most important design criterion is the amount of product to be stored in the facility. In 7.5 m high apple storage rooms 1.5 tons can be stored per sqm. A 5 m corridor leads to the storage rooms. This space must also be cooled. In the front section is a 250 m² large processing hall. It is thermally insulated for future cooling purposes. The door dimensions are 220 cm x 250 cm. The cooling capacity calculation is based on the following assumptions: loading time per room: 1 day, cooling to storage temperature: 3 days.

At -5°C evaporation and +40°C condensation temperature the cooling capacity is 120 kW. The central cooling system comprises 4 compressors with 60 Hp power. For good air circulation each room is equipped with 2 coolers. The cost for the roof is the mean value of the cost sum of an insulation panel and a single layer trapezoidal roof. The cost for the insulation panels is the mean value of the cost sum of panels with and without a locking system. The detailed costing and other prices established on the basis of various assumptions are allowed to vary by plus/minus 30%. All prices are current Turkish market prices.

*Prices may vary by +/- 30%.

*Prices may vary by +/- 30%.



500 ton cold storage
h = 7.5 m, surface area 8 m x 10 m = 80 m², subdivided into 4 cold storage rooms.

General Cost analysis for a construction of 500 Tons cold storage
(Steel construction, Roofing, Concrete works, Electricity)

1	Budget for steel construction (columns, beams, ceiling profiles, door frames connections etc...)	$ 38.000
2	Budget for roofing, facedes coverings, connection of drainage and rain pipes	$ 10.400
3	Budget for mouldings, iron, concrete works, steel mesh and related labour	$ 22.500
4	Budget for electric works (transformers, compensation boards, distribution panels, internal power distribution and luminaires)	$ 17.300
5	Administrative offices, restaurant, WC / shower	$ 5.200
	Total:	$ 93.400

General Cost analysis for 500 Tons Freon Based Cooling System

1	Cooling Unit,	$ 58.700
2	Panel Installation (10 cm thick)	$ 53.500
3	Sectional and Sliding Doors (labor included)	$ 8.700
4	Ventilations and humidifiers / room (including installation labor)	$ 10.400
	Total:	$131.300

Notes:

- Prices are based on USD, exclude VAT and logistic cost.
- Forklift, crane, handling etc. are excluded in our calculations.
- Prices are on average.
- Prices are made on average and taken from 4 different suppliers and may vary +/- %30 per region.

GENERAL COST ANALYSIS OF A 1000 TON COLD STORAGE FACILITY IN TURKEY

1.000 TONS
APPLE STORAGE

Analysis of construction and cooling system costs

(~ $ 495.000 / € 405.000)

+

Analysis of controlled atmosphere cooling system costs

(~$130.000 / €105.000)

* Cost analysis was based on standard controlled atmosphere application
Price difference for advanced controlled atmosphere systems

Total:	$ 625.000
	€ 510.000

Total covered area of the building is 1,450 m². The most important design criterion is the amount of product to be stored in the facility. In 7.5 m high apple storage rooms 1.5 tons can be stored per sqm. A 5 m corridor leads to the storage rooms. This space must also be cooled. In the front section is a 580 m² large processing hall. It is thermally insulated for future cooling purposes. The door dimensions are 220 cm x 250 cm. The cooling capacity calculation is based on the following assumptions: loading time per room: 1 day, cooling to storage temperature: 3 days.

At -5°C evaporation and +40°C condensation temperature the cooling capacity is 260 kW. The central cooling system comprises 4 compressors with 150 Hp power. For good air circulation each room is equipped with 2 coolers. The cost for the roof is the mean value of the cost sum of an insulation panel and a single layer trapezoidal roof. The cost for the insulation panels is the mean value of the cost sum of panels with and without a locking system. The detailed costing and other prices established on the basis of various assumptions may vary by +/- 30%. All prices are current Turkish market prices.

Apple storage lease for one season

5

CENTS / kg

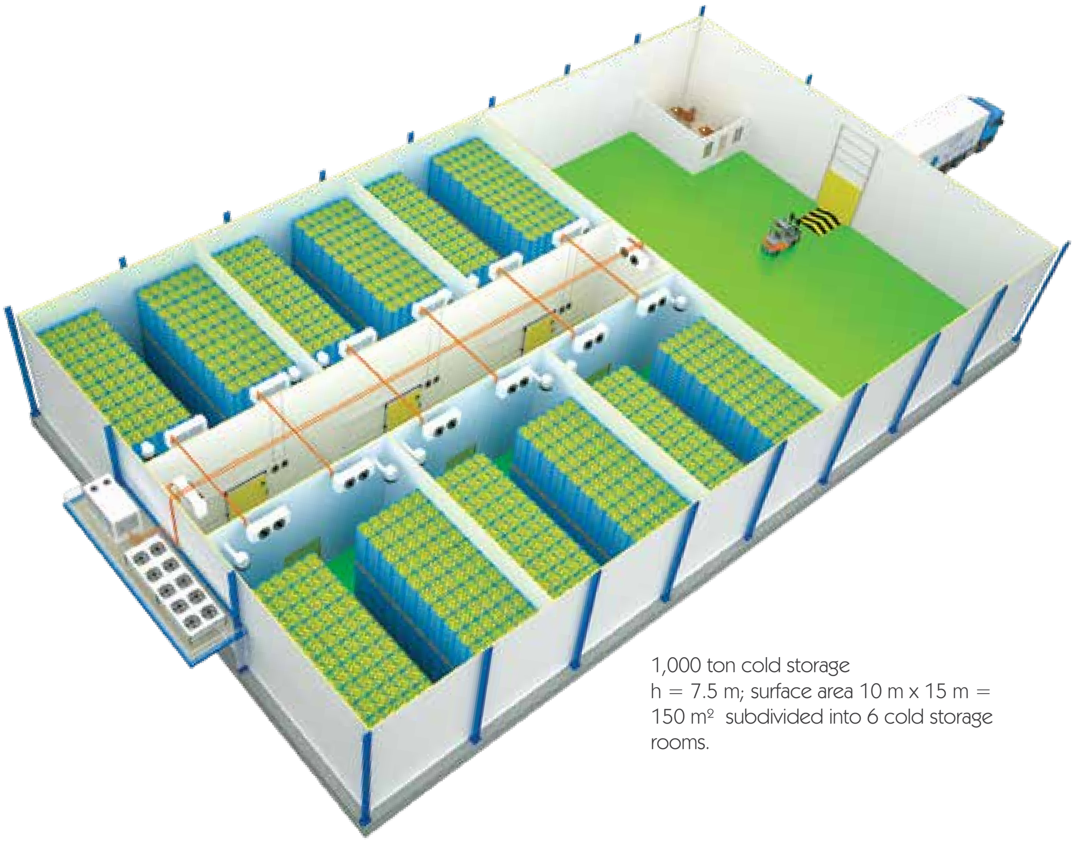
*Prices may vary by +/- 30%.

Energy cost for apple storage for one season

1

CENT/ kg

*Prices may vary by +/- 30%.



1,000 ton cold storage
h = 7.5 m; surface area 10 m x 15 m = 150 m² subdivided into 6 cold storage rooms.

General Cost Analysis for a Construction of 1.000 Tons Cold Storage
(Stell Construction, Roofing, Concrete Works, Electricity)

1	Budget for steel construction (columns, beams, ceiling profiles, door frames connections etc...)	$ 185.000
2	Budget for roofing, facedes coverings, connection of drainage and rain pipes	$ 50.000
3	Budget for mouldings, iron, concrete works, steel mesh and related labour	$ 105.000
4	Budget for electric works (transformers, compensation boards, distribution panels, internal power distribution and luminaires)	$ 80.000
5	Administrative offices, restaurant, WC / shower	$ 30.000
	Total:	$ 450.000

General Cost analysis for 1.000 Tons Freon Based Cooling System

1	Cooling Unit,	$ 300.000
2	Panel Installation (10 cm thick)	$ 320.000
3	Sectional and Sliding Doors (labor included)	$ 35.000
4	Ventilations and humidifiers / room (including installation labor)	$ 45.000
	Total:	$ 700.000

Notes:
- Prices are based on USD, exclude VAT and logistic cost.
- Forklift, crane, handling etc. are excluded in our calculations.
- Prices are on average.
- Prices are made on average and taken from 4 different suppliers and may vary +/- %30 per region.

OTHER COSTS OF A COLD STORAGE FACILITY IN TURKEY

PLATFORM BALANCE / WEIGHBRIDGE AND ITS COSTS

A 60 tons capacity weighbridge (max. loaded vehicle weight 45 tons) is necessary to check the amount of delivered product. For loading into and taking out of storage a 1.5 ton capacity pallet balance is required.

"Weighing and sorting by size of the apples transported to the facility adds considerably to the product costs."

Palette Scale | $ 1.210

Princes on average

Truck Scale | $ 12.100

Princes on average

CRATES AND THEIR COSTS

The cost of 20 kg crates to be used during picking and for storage is $ 4.- (VAT incl.). 20 kg crates used for storage only cost $ 1.-.

The price of single type 25 kg picking and storage crates is $ 4,5 - (VAT incl.). 250-300 kg container crates that can be used in the orchard and in the cold storage afford space advantages. They cost $ 70.- plus VAT.

Crates in picture 1 are disposable and named as oneway crates. These crates are cheap and do not last long.

Crates in picture 2 are named as multi-use crates. They can be used when more crates are needed in storage.

Crates in picture 3 are named as palletised crates or bulk. Mainly used in EU, producers and warehouse owners are renting them.


Picture 1

DIMENSION	CAPACITIY	PRICE
37* 53* 30	25 kg	$ 1,03


Picture 2

DIMENSION	CAPACITIY	PRICE
37* 53* 30	25 kg	$ 4,5


Picture 3

DIMENSION	CAPACITIY	PRICE
100* 120* 78	300 kg	$ 77+VAT

AUTOMATIC SORTING MACHINE AND ITS COSTS

Automatic sorting machines are an economic and speedy solution for apples stored in large containers. Non-automatic motor-driven models cost only a couple of thousand Dolars. More advanced machines are equipped with electronic sensors that sort the apples by weight and colour at high speed. A number of countries manufacture sorting machines with different features.

Sorting Machine	150.000 $

THE GLOBAL APPLE ECONOMY

"More than half of global production is successed in Asia. Which means apple has not moved very far from its place of origin. For the apple economy to grow, apples need to command a good price; that, in turn, depends on the offered quality."

More than 70 m tons of apples are produced worldwide. In the last 20 years production has increased by over 70%. Almost 90% of this increase is related to developments in China which have raised the average. China alone contributes 38 m tons to the global total. The country is expected to maintain its influential leading role also in the future. Some experts claim the announced production volume of 38 m tons does not reflect reality but is mere window dressing to look stronger.

Apples have been cultivated in Europe and Central Asia for more than two millennia. In the New World mass production only set in at the beginning of the 20th century. In the process the USA became a major producer, and apples were sold to the entire continent. Apples have adapted excellently to the conditions in America. For this first fruit, which is recognised as a "world heritage", acceptance on the new continent was important in itself. The seasonal differences, which also mean supply differences, engendered a world-spanning production and supply traffic.

In 2013 the main producers on the American continent were, in the northern half, the United States with 4,081,000 tons, followed by Mexico with 466,000 tons and Canada with 429,000 tons. In South America the leader was Chile with 1,871,000 tons, followed by Brazil with 1,180,000 tons and Argentina with 890,000 tons. In Africa, South Africa is the leader with 842,000 tons. New Zealand and Australia, which share the same hemisphere, reported a total production of over 500,000 tons.

At the end of the 20th century, the Russian Federation had achieved the status of a major apple producer. However, a large, apple-loving population saw to it that almost the same amount produced domestically had to be imported to satisfy demand. The 28-member zone of the European Union harvests 13 m tons a year, with Turkey the leader in the region. But also the Ukraine, Belarus and Azerbaijan are important apple growers.

The main reason for the apple's spread to all four corners of the world is its adaptability to the most diverse conditions. Apples can be cultivated in every country, no matter how small the production. Developments in transport, storage and processing technologies have fortified the apple's position in international trade and the global fruit processing industry. The most important contributing factor was doubtlessly the scientific proof of the apple's health benefits. Today, a world without apples is inconceivable.

In the light of this, countries show great efforts to increase their production. Of the hundreds of known apple varieties only a handful dominate the apple market. The favourite cultivars with a total global share of over 50% are Delicious, Golden Delicious, Mc Intosh, Idared and Janagold, bred in North America, Braeburn and Galain from New Zealand, the Australian cultivar Granny Smith, and the Japanese Fuji group of apples, and their derivatives. Delicious, Golden Delicious and Fuji group varieties alone account for over 40% worldwide.

The apples' share in total global fruit production is more than 12% and comes right after the leader fruit bananas. All the more reason for a global trade.

Apples are grown on 4,842,822 hectare with a total yield of 76,387,738 tons. In the last 50 years the use of dwarf and semi-dwarf trees has quickly spread and both increase apple production and the emergence of a strong industry. The biggest producers are China followed in declining order by the USA, Turkey, Italy, India, Poland, France, Iran, Brazil and Chile. The global value of the apple trade is estimated to be in the order of USD 144 billion. In the following section we will take a closer look at the major apple producers China, the United States of America, the 28-menber EU zone and the big market Russia.

FRESH APPLE CONSUMPTION IN THE WORLD (1.000 tons)

PRODUCTION	2010/11	2011/12	2012/13	2013/14	2014/15 (DECEMBER)	2014/15 (JANUARY)
CHINA	26,490	30,647	32,317	34,861	33,810	33,948
EU	7,508	8,072	7,933	8,044	8,664	8,123
USA	2,157	2,195	2,293	2,482	2,658	2,737
INDIA	2,985	2,381	2,087	2,366	2,370	2,340
TURKEY	2,325	2,517	2,762	2,609	2,112	2,054
RUSSIA	1,533	1,564	1,947	2,046	1,750	1,750
BRAZIL	1,224	1,112	1,160	1,225	1,245	1,195
OTHERS	6,334	7,030	6,820	7,113	6,364	7,332
TOTAL	50,554	55,517	57,319	60,746	58,974	59,480

IMPORT DATA OF APPLE IN THE WORLD (1.000 tons)

PRODUCTION	2010/11	2011/12	2012/13	2013/14	2014/15 (DECEMBER)	2014/15 (JANUARY)
RUSSIA	1,111	1,201	1,338	1,203	800	800
BELARUS	61	168	159	278	0	625
EU	620	518	567	625	550	485
MEXICO	219	216	266	228	260	280
UAE	147	166	223	189	180	240
CANADA	197	194	253	225	225	220
USA	149	173	195	213	190	185
INDIA	144	208	199	199	200	160
S. ARABIA	148	144	156	119	150	160
TAIWAN	149	119	139	161	160	160
OTHER	1,884	1,862	1,806	1,793	1,817	1,786
TOTAL	4,829	4,968	5,300	5,232	4,532	5,101

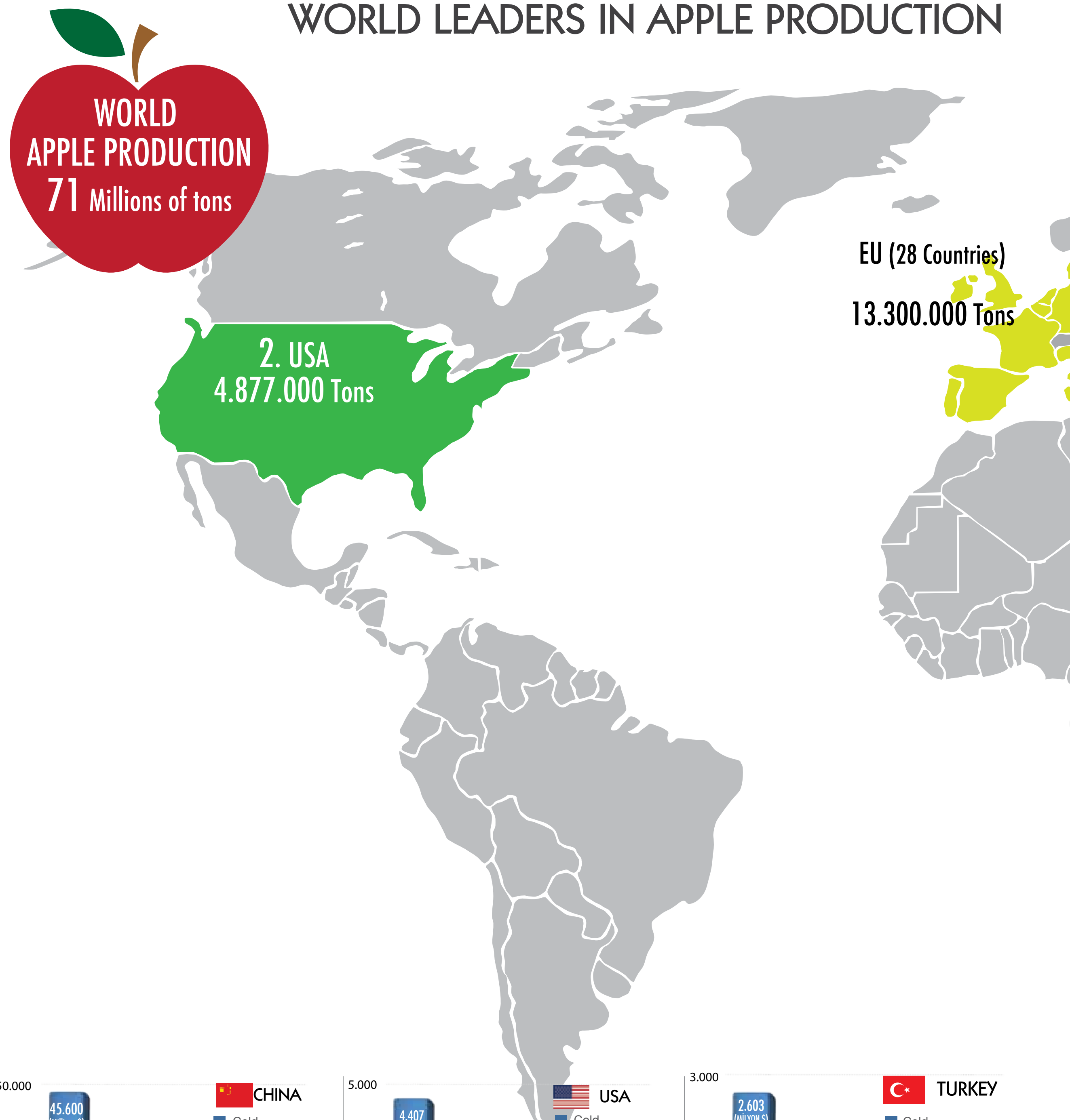
WORLD APPLE EXPORTS (1.000 tons)

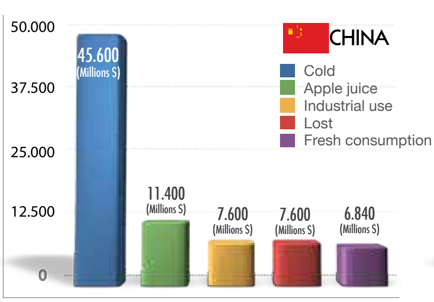
PRODUCTION	2010/11	2011/12	2012/13	2013/14	2014/15 (DECEMBER)	2014/15 (JANUARY)
EU	1,120	1,503	1,568	1,604	1,250	1,694
USA	827	841	893	843	875	930
CHINA	1,087	1,012	1,026	994	880	750
CHILI	831	792	836	883	834	740
S. AFRICA	335	389	459	382	400	420
N. ZEALAND	300	285	322	311	325	315
SERBIA	110	132	40	143	150	150
ARGENTINA	233	134	162	144	145	140
TURKEY	80	87	41	193	40	100
BRAZIL	52	72	89	47	60	60
OTHER	294	241	213	188	187	201
TOTAL	5,269	5,487	5,650	5,733	5,146	5,500

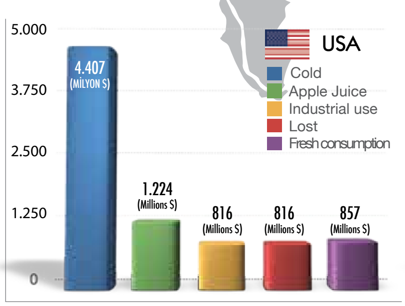
NOTE: The market data for the USA and Mexico refer to the period August – July. The data for the other countries on the northern hemisphere refer to the period July – June.

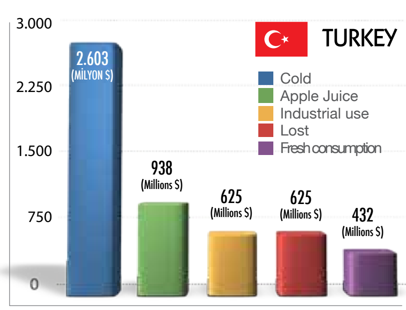
The data for the southern hemisphere refer to half a calendar year. Source: USDA Foreign Agricultural Service / FAO / Prepared on the basis of TÜİK data. 2014/15 data are estimates.

WORLD LEADERS IN APPLE PRODUCTION

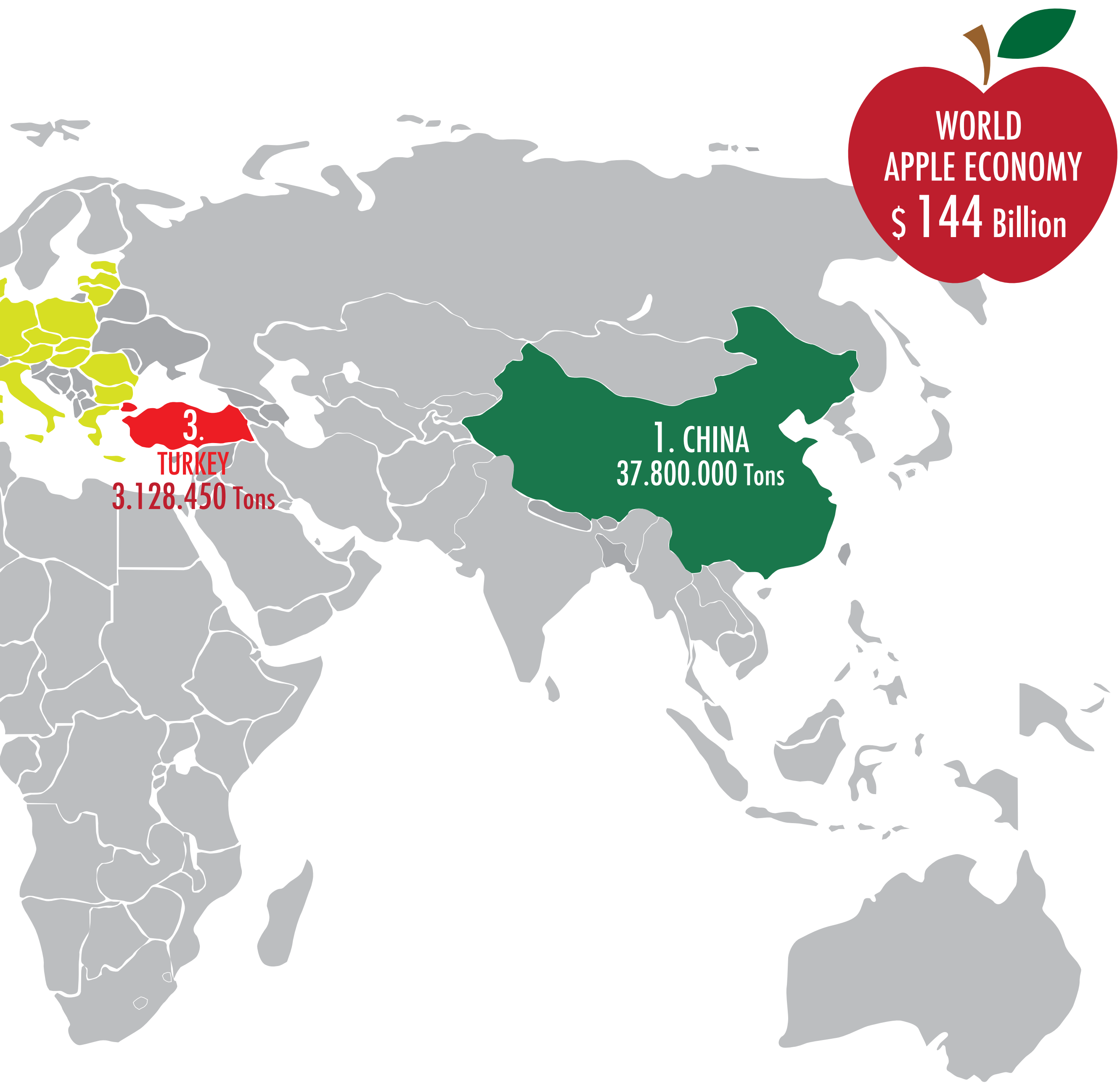


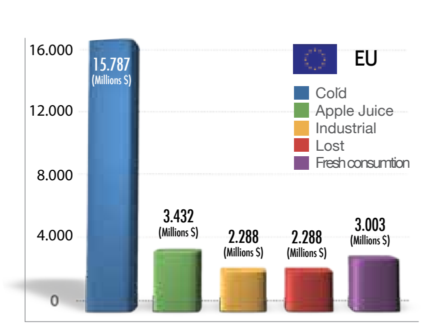


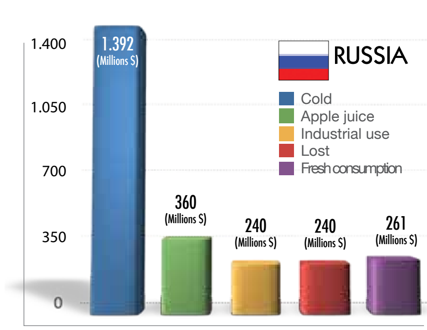


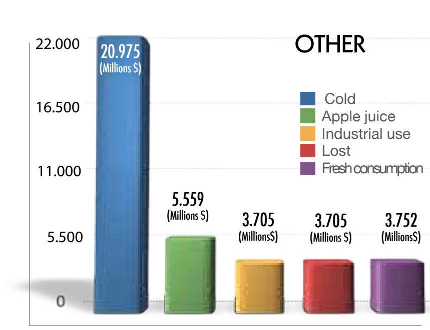


* The sense of earning money from apple stands for the total price issued at the end of the process.
For example China paid $ 6,8 billion of for fresh apple consumption, 45.6 billion of $ for cold stored apple consumption, $ 11.4 billion + for apple juice, $ 7.6 billion $ for industrial use. China lost $ 7.6 billions.









Source: USDA Foreign Agricultural Service / FAO / TÜİK. Data are from years 2014/2015.

Apple Production and Trade in China

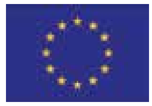
China is a country with a huge landmass situated in the moderate climatic zone. This creates favourable conditions for the large-scale cultivation of all kinds of garden fruits. In 2013 China reported the production of 38 m tons of apples alone, and a year-on-year increase of 6%. The driving factors behind this growth were better agricultural practices and state incentives.

In China, 2.25 m hectares are dedicated to apple cultivation. But despite being a bumper year, the country exported only 0.9 m tons in 2013. More than 70% of the Chinese production is Fuji varieties.

Blessed with abundant fertile land and favoured by the climatic conditions on the northern hemisphere, China will continue its leadership in fruit cultivation. The country's biggest problem is the lack of storage capacity which also hampers its export efforts. In 2013, 8 m tons of apples were stored in modern and another 3 m tons in simple facilities; in other words, less than one third of the total harvest.

In China field production costs are USD 0.49 while the field price is USD 1.03. With the introduction of dwarf plants average yields per 1000 sqm will rise to 6.8 tons. The Chinese like apples; annual per capita consumption is 24 kg, apple juice consumption however is only 2.2 litres per person. In 2013 China imported as little as 40,000 tons from transoceanic countries. Of the total harvest of 38 m tons, 4.2 m tons were industrially processed to apple juice, chips, vinegar and wine.

July 2014 Guangzhou market $3,24 / € 2,42



Apple Production and Trade in The EU

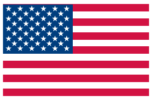
The 28-member European Union is the second largest apple grower in the world after China. The EU operates advanced cold storage facilities and exports what is not consumed within the Union. Almost half its harvest is stored in modern facilities. The favourite varieties are Golden Delicious and Gala. While in 2013 544,600 hectares were reported as commercial cultivation area, only 531,000 hectares were harvested. Total commercial production that year was 9,956,435 tons. Non-commercial gardens added another 1,439,870 tons. Total yield was 11,439,870 tons, an increase of 2.6% over 2012.

Thanks to dwarf and semi-dwarf trees, new orchards yield more than 8 tons per 1000 sqm. Golden Delicious is the number one in Italy, France and Spain, while Germany and Holland favour the Elstar variety. In Poland and Hungary Jonathan varieties dominate; Holland, on the other hand, is also home to varieties such as Pink Lady, Kanzi, Rubens and Tentation

Europeans are the most avid consumers of fresh apples. They are also known to be more health conscious and more aware of the benefits of a healthy diet. Another study has found a growing tendency among Europeans for a vegetarian lifestyle.

Some European countries are both globally leading in fresh fruit production and are champions in fresh apple consumption; they are Italy (21%), France (17%), Germany (8%), Spain(23%) and Poland (23%).

In 2013 the EU exported 1,572,289 tons of apples, of which 865,908 tons went to Russia. In 2014 exports to Russia dropped by 200,000 tons. The country also announced not to buy fresh fruits and vegetables from the EU for an entire year. The reason for this souring of relations is the Ukraine conflict. Apple suppliers to the EU are Chile, South Africa and New Zealand. Average per capita consumption is 18 kg apples and 4.5 litres apple juice. On the tree an apple costs USD 0.51, while the retail price in the season is USD 1.75. In the months January to July prices can rise to over USD 6.00.



Apple Production and Trade in The U.S

The United States are the number two behind China. As a technologically advanced country with a long cold storage history, it is little wonder that in America a large share of the apple harvest is stored under controlled atmosphere conditions. The subsidies paid to the apple industry since 1995 amount to USD 689 m.

In 2014, total harvest yielded 4,081,000 m tons on 557,665 hectare, an increase of 14% over the preceding year. With a yield per 1000 sqm of almost 10 tons, the USA is the most productive country in the world. Most of the apple trees are of dwarf size.

July 2014 Texas, $3,28 / € 2,45

The most widely consumed varieties are Red Delicious, Gala, Fuji, Golden Delicious, Granny Smith, Honeycrisp, McIntosh, Rome and Pink Lady. On average every American eats 16 kg apples and drinks 45 litres apple juice a year. A large share of the harvest is processed by industry and the ready-meals sector. Apple slices are found on the menu of restaurants and cafeterias, and are often used as garnish. The catering sector alone accounts for a share of 30%.

The USA import about 6% of the freshly consumed apples in the country. The main suppliers are Chile, New Zealand and Canada. The main export countries of the USA are Mexico, Canada and Russia.

In the United States field production costs are USD 0.60 while the grower sales price is USD 0.85. The final consumer, on the other hand, pays USD 1.85 and more for fresh apples. In December and July prices rise to USD 3.00 and more.

Apple Production and Trade in Russia

In 2013 Russia harvested a record 1.2 m tons (+ 8%). In 2014 the government invested USD 15.5 m in new orchards. In four years time an even larger harvest is anticipated. For now, however, domestic demand can only be met by imports. In 2013 Russia bought 865.908 tons in the EU. Almost the entire amount was supplied by Poland. Other important suppliers are Moldova and Azerbaijan.

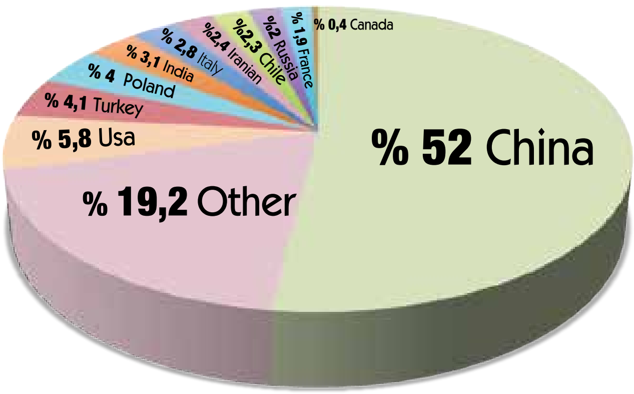
The field cost is USD 0.50, and average yields per 1000 sqm are 6.9 tons.

The apple is Russia's most popular fruit and accounts for 20% of the market. Russian consumers buy both domestic varieties such as Slava Pobeditelyu, Semerenka and Bolshevik, and foreign varieties such as Golden Delicious, Red Chief, Granny Smith and Gala.

In 2012 annual per capita consumption was 13.6 kg. Their fresh price is on average USD 1.45. Prices fluctuate during the year and can exceed USD 3.00. Half of production is processed by the fruit juice industry. Apple juice is the fruit juice market leader with a share of 50%.

July 2014 Texas, $3,28 / € 2,45

Major Apple Producers Worldwide



(FAOStat, 2014)

More than half of all apples are consumed in industrial countries by just 20% of the world population. Consumers in those countries are less affected by price, unless in times of crisis, and more interested in new varieties, certified organic production, etc.

Every year 15 m tons of apples are lost because they cannot be consumed fresh. Total global cultivation area for apples is 5 m hectare.

According to data from 2013, after China and the USA, Turkey is the world's third largest producer with a total harvest of over 3 m tons. Of the total global production, 15% are consumed fresh, but only 40% are stored to spread consumption over the year. A rough calculation shows that almost 20% of all apples are wasted. This figure underlines once more the importance of cold storage.

APPLES FOR THE PROCESSING INDUSTRY(1.000 tons)

PRODUCTION	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15
AB	2,973	3,281	3,273	2,950	3,868	3,900
CHINA	5,760	4,400	5,200	3,850	3,150	3,150
USA	1,341	1,368	1,058	1,561	1,534	1,597
RUSSIA	458	721	570	491	515	515
CHILE	434	403	392	295	380	380
S. AFRICA	216	215	246	200	295	270
ARGENTINA	500	450	420	250	520	220
OTHER	819	870	754	834	831	831
TOTAL	12,500	11,708	11,912	10,431	11,092	10,863

World Exports data of Exporter countries

COUNTRY	Total Exports (kg)	Export Price ($)	1st importer Country	Total Imports (kg)	Import Price ($)	2d Importer country	Total Imports (kg)	Import price ($)	3d Importer country	Total Imports (kg)	Import price ($)
POLAND	1,026,593,329	441,766,469	Belarus	268,232,443	133,438,500	Germany	78,879,899	18,355,095	Kazakhistan	63,519,912	29,148,342
ITALY	975,249,431	975,630,099	Germany	226,876,002	252,579,735	Spain	68,109,651	78,102,023	Algeria	50,146,333	43,051,832
USD	889,954,029	1,088,368,935	Mexican	229,454,128	270,311,678	Canada	181,477,264	191,698,691	India	51,572,884	67,691,554
CHINE	865,048,013	1,027,578,921	Thailand	85,302,628	110,747,224	India	82,433,826	86,501,386	Philippines	58,566,116	75,938,518
CHILI	820,183,858	822,347,141	USD	119,722,757	164,138,630	Netherlands	71,246,346	89,138,326	Ecuador	60,854,346	49,216,403
FRANCE	695,865,261	719,953,994	England	158,433,800	153,769,716	Spain	116,043,084	78,575,596	Algeria	79,804,072	69,645,819
S. AFRİCA	381,865,334	353,652,315	England	61,582,542	93,039,869	Malaysia	41,410,408	31,386,518	Zambia	29,117,819	7,397,669
NEW ZELAND	336,784,833	425,374,274	England	41,695,460	143,967,085	USD	41,383,771	72,503,422	Netherlands	35,618,941	63,913,618
BELARUS	307,530,414	86,537,300	Kazakhistan	20,614,428	5,813,149	Lithuanian	97,512	22,327			
NETHERLANDS	227,701,116	272,135,567	Germany	80,265,131	72,318,508	Belgium	35,333,911	28,343,874	Lithuanian	21,598,428	11,531,054
BELGIUM	174,321,546	149,271,159	Netherlands	81,334,830	40,384,414	Germany	34,095,141	29,302,855	France	25,056,468	14,166,067
ARGENTINA	144,417,777	137,386,583	Brazil	49,718,864	52,308,550	Netherlands	14,080,691	18,617,374	Algeria	10,240,579	7,116,784
SERBIA	135,982,209	81,307,485	Belarus	22,381,195	14,420,300	Montenegro	1,953,302	833,650	Romania	1,752,585	442,382
TURKEY*	2,761,423	2,732,521	Jordan	3,773,379	3,594,267	Belarus	2,565,768	1,629,100	Egypt	2,176,992	10,231,789

*Türkiye (16th exporter country)

Source: ITC calculations based on un comptrade statistics. 2014

World exports data of Importer countries

COUNTRY	Total Imports (kg)	Import Price ($)	First Exp. Country	Total Exports (kg)	Export Price ($)	2d Exp. Country	Total Exports (kg)	Export Price ($)	3d Exp. Country	Total Exports (kg)	Export Price ($)
GERMANY	622,277,858	587,744,761	Italy	282,510,125	297,173,621	Netherlands	115,655,928	143,006,733	Poland	62,820,558	15,544,424
ENGLAND	446,117,085	540,529,004	France	123,063,052	161,824,931	S. Africa	65,197,284	67,508,610	New Zeland	45,322,780	52,239,726
BELARUS	414,677,064	216,679,900	Poland	260,932,532	101,166,264	Lithuanian	68,312,923	18,376,088	Moldova	64,252,331	10,976,520
NETHERLANDS	356,209,078	350,496,014	Chili	64,816,939	75,002,26	France	52,816,255	44,492,270	Belgium	42,257,346	25,544,661
SPAIN	247,167,039	215,510,689	France	112,607,518	85,712,820	İtaly	71,246,346	80,186,180	Portugal	12,910,054	9,404,856
MEXİCAN	235,502,059	277,467,258	USD	236,453,252	267,431,467	Chili	4,861,217	4,583,750	Canada	986,635	723,436
CANADA	222,058,078	250,224,072	USD	144,920,391	209,042,146	Chili	18,854,917	21,910,967	New Zelanda	8,302,333	9,049,018
USD	207,993,824	283,754,414	Chili	120,898,810	143,967,085	New Zeland	44,306,190	63,835,902	Canada	37,183,408	33,094,809
INDIA	204,569,614	234,375,879	Chine	75,399,744	90,928,053	USD	59,466,108	68,175,800	Chili	47,907,326	37,498,217
FRANCE	153,701,703	128,369,858	Belgium	41,922,444	39,032,182	SPAİN	30,579,928	15,807,886	Italy	18,656,620	13,095,041
ALGERIA	152,428,803	130,224,290	France	78,962,437	65,569,986	Italy	47,681,747	41,492,868	Spain	12,691,372	10,548,450
KAZAKHSTAN	147,232,632	65,574,538	China	66,542,920	51,800,876	Poland	60,870,224	24,013,064	Belarus	57,291,666	14,061,100
BELGIUM	133,327,888	151,517,610	France	3,120,538	54,791,664	Netherlands	17,398,349	25,068,894	Poland	8,380,451	2,191,279
TURKEY*	2,761,423	2,732,521	Greece	9,980,806	6,359,784	Italy	2,651,209	2,649,436	Moldova	1,169,539	230,480

*Turkey (78th importer country)

Source: ITC calculations based on un comptrade statistics. 2014

Summary and conclusion

The global apple industry, led by China, the USA and the 28-member EU, and with Russia as a huge market, is worth USD 144 billion.

The apple is one of the world`s most favourite fruits. Its trade volume is the second largest after bananas. Thanks to cold storage, the apple is on offer all year round. The supply of the fruit resembles a relay race: from branch to storage, from storage to market, from market to final consumer.

To keep up with this race and with competition, new investors must monitor the latest advances in technology and incorporate it in their facilities. After all, the latest technology offers the most juicy profits.

World production is about 76.5 m tons, 15% of which is consumed fresh. The greatest losses are suffered during harvest time because only half of production is preserved in modern facilities for later consumption.

Controlled atmosphere storages offer longer storage times and reduce storage diseases to a minimum. They are characterised by low oxygen contents that slow down the fruits` breathing process and thus extend their storage life.

Global apple production over the years (in 1,000 tons)

PRODUCTION	2010/11	2011/12	2012/13	2013/14	2014/15 (DECEMBER)	2014/15 (JANUARY)
CHINA	33,263	35,985	38,500	39,680	37,800	37,800
EU	10,981	12,338	12,207	11,974	13,300	13,300
USA	4,175	4,231	4,049	4,673	4,877	4,877
TURKEY	2,500	2,700	2,900	2,900	2,250	2,250
INDIA	2,891	2,203	1,915	2,200	2,200	2,200
RUSSIA	910	1,124	1,264	1,416	1,550	1,410
BRAZIL	1,339	1,336	1,335	1,335	1,335	1,550
CHILI	1,431	1,360	1,420	1,310	1,410	1,335
UKRAINE	954	1,127	1,120	1,120	1,120	1,120
S. AFRICA	767	813	908	793	910	910
OTHER	4,314	4,567	4,047	4,359	4,081	4,081
TOTAL	63,525	67,784	69,665	71,759	70,833	70,894

NOTE: The market data for the USA and Mexico refer to the period August – July. The data for the other countries on the northern hemisphere refer to the period July – June. The data for the southern hemisphere refer to half a calendar year.

Source: USDA Foreign Agricultural Service / FAO / Prepared on the basis of TÜIK data. 2014/15 data are estimates.

They form part of a cold chain necessary for export and supplies to industry.

Stored apples command a much higher price than fresh fruits and constitute a huge trade volume.

Even though initial investment in cold storage is quite high, longer storage life means higher out-of-season prices, high returns on investment and short depreciation periods. Apples out of storage are sold on average for USD 2.69 with prices rising as high as USD 4-5.00 and higher. The determining forces behind these fluctuations are, of course, the big market players.

WORLD FRUIT PRODUCTION

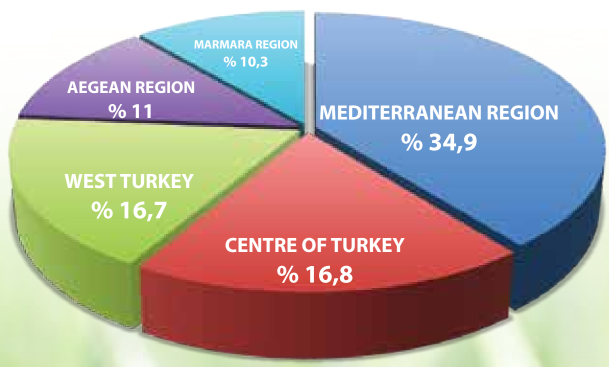
NO	PRODUCT	PRODUCTION QUANTITY (Tons)	(%) IN PRODUCTION
1	Banana	139.150.000	22
2	Apple	76.380.000	12
3	Grapes	67.070.000	11
4	Orange	62.220.000	10
5	Mango	42.140.000	7
6	Mandarin	27.060.000	4
7	Pear	23.580.000	4
8	Ananas	23.330.000	4
9	Peach & Nectarines	21.080.000	3
10	Lemon & Lime	15.120.000	2
11	Papaya	12.410.000	2
12	Plumes	10.700.000	2
13	Grapefruit	8.040.000	1
14	Dates	7.550.000	1
15	Strawberry	4.520.000	1
16	Persimmon	4.470.000	0,5
17	Avocado	4.360.000	0,5
18	Apricot	3.360.000	0,5
19	Pomegranate	3.000.000	0,5
20	Blackberry	2.260.000	0,5
21	Kiwi	150.000	0,2
	Other Fruits	75.410.000	12
	Total	630.810.000	100

Source: 2013 TUİK

APPLE IN TURKEY

" The productivity of old orchards is between 2-4 tons per 10 - Hectare. Most apple trees are old. On the other hand, modern agricultural techniques are spreading, the number of dwarf and semi-dwarf trees is increasing."

In Turkey research institutes and universities are working on the adaptation of over 100 apples varieties. Varieties of the Golden Delicious group such as Stark Spur, Golden Delicious, Lutz Golden, Golden Sel B., Golden Smoothere and Golden Reinders dominate apple production. In new orchards we find new varieties such as the early-season Granny Smith, Anna, Dorset Golden, Vista Bella, Jersey Mac, Summerred and William's Pride Prima, the medium-season Gala group and Ozark Gold cultivars, and the late-season breeds of the Jonagold group, Topaz, Idared, Fuji, Pink Lady and Braeburn group varieties.



Regional Apple Production in Turkey (%)

In small orchards we also find domestic varieties such as Arap Kızı, Ferik and Hüryemez. The Eğirdir Research Institute for Garden Cultivation and the Yalova Atatürk Research Institute for Garden Cultivation hold over 400 domestic and foreign breed samples in their gen banks. Apple consumption in Turkey took off after 1965 with production increasing from 362,000 tons to 3 m tons in 2013. Consumption per capita per year has reached 30 kg.

With this value Turkey is one of the leading apple consuming countries in the world. The regional distribution of apple cultivation is as follows: Mediterranean Region 34.9%, Central Anatolia 16.8%, Western Anatolia 16.7%, Aegean Region 11%, Eastern and Western Marmara Region 10.3%.

Almost 90% of all apples are grown in those regions. The main locations are the provinces of Niğde, Nevşehir, Karaman and Konya in Central Anatolia, Amasya in the Black Sea region, Isparta, Antalya and Burdur in the Mediterranean Region. New plantations in Denizli and Çanakkale promise to transform the provinces in apple growing centres of the future. Dwarf trees show excellent adaptation in the main cultivation regions; and their use is expected to increase fast.

Well-organised plantations yield up to 9-10 tons per dönüm on average. According to FAO data from 2012, that year Turkey had 2.889 m dönüm under cultivation with a yield per dönüm of 1.9 tons. In 2013 the total number of apple plants in Turkey was 47,077,000 trees (State Statistics Institute – TÜIK). A further 16,305,000 trees had not yet borne fruit.

In the light of this data it is fair to say that the poor yield of 1.9 tons per 1000 sqm is a thing of the past and that productivity will increase with the new dwarf varieties.

Currently, 30-35% of all apple orchards in Turkey use dwarf varieties. If all trees were replaced by dwarfs, yields per 1000 sqm would rise to 8 tons and total production to 23,112,000 tons.

This development deserves further close monitoring. After all dwarf and semi-dwarf trees can be planted more densely than their big brothers, and their small size facilitates maintenance and harvesting. They are also small enough to be covered by netting to protect them against hail and too much sun.

Opening of covering in dwarf trees orchard

THE APPLE ECONOMY IN TURKEY

" In 2013 Turkey produced 3,128,450 tons of apples and ranked third in the global league table of apple producing nations.

The country is not only one of the world's biggest producers but also the number one in terms of costs, with production costs of 30 Kurush (10-11 cents), down from 50. However, while apple prices in international markets are around 2 dollars, in Turkey they do not exceed 1 dollar. "

The economic opportunities of apples stored long term are increasing. Annual world cultivation is 70 m tons with a value of USD 140 billion. Turkey produces 3 m tons with a value of USD 3 billion.

In order to benefit from the much higher apple prices on international markets they must be supplied harvest-fresh in all seasons. Thanks to its cold storage facilities European producers and consumer already enjoy the benefits. The supply of out-of-season varieties has reached a high trade volume there.

The annual per capita consumption of apple-loving Turks is around 25-30 kg. In Turkey, 17% of total fruit cultivation is dedicated to apples.

Apple purchasing places in Turkey

In recent years the range of cultivars has been extended, however, only a handful of varieties dominate the market. In first place comes Starking (1,353,733 tons), followed by Golden (825,935 tons), Amasya (245,849 tons) and Granny Smith (122,508 tons); other varieties account for 580,425 tons overall. Fuji, Granny Smith and Pink Lady command higher prices than the other varieties.

According to official data 310,000 tons are consumed freshly right after picking, 200,000 tons are stored in simple storage facilities, 1,55 m tons in modern facilities and 645,000 tons are supplied to industry.

In 2013, half a million tons were wasted; less than before but still far too much. The main reason for this loss was climatic conditions, but harvesting, packaging, transport and – most importantly – problems with the cold chain also took their toll.

To put the losses into perspective, their quantity equals the total production of countries such as Hungary, Greece, Australia and New Zealand. The final stop of the apples is supermarkets with wide supply networks and small retailers, where they are offered to the final consumer.

Unfortunately, the state has no plans for apple cultivation. Project support is random. What is needed is incentives for new varieties, such as sapling support, and for the modernisation of old cold storage facilities. Producer associations should be supported to protect growers, and the establishment of cooperatives should be encouraged.

> " In Turkey, the road ahead is open for the apple. With the right varieties and suitable storage, the apple economy can reach $ 15 billion by 2023.
>
> This amount is equal to the turnover of three organised industrial zones or the output of 600 industrial plants. In the new world order agriculture only has a chance if it is large-scale. "

Starking
1.353 bin 733 ton

Golden
825.935 ton

Amasya
245.849 ton

Granny Smith
122.508 ton

Fresh Consumption

This term describes that share of the apples that is directly consumed without entering into cold storage. According to official data, 310,000 tons of apples fall into this category. Fresh consumption is particularly attractive because it spans the entire harvesting period of four months, transport to markets is less demanding and, last but not least, because the fruit is a consumer favourite.

In Turkey, almost 75% of fresh apples are supplied to three major cities, primarily to Istanbul. This does not mean however that the rest of the country consumes fewer apples. It is assumed that a large quantity is grown in private gardens, in particular in the regions of Anatolia with a favourable climate. These non-commercial apples are consumed by friends and family. The remaining apples are sold on street markets to complement the family income.

FRESH APPLES	310.000 Tons
PRODUCTION COST	$ 0,13
FIELD SALES	$ 0,29 - 0,31
WHOLESALE ENTRY	+8,+12 %
WHOLESALE EXIT	$ 0,35
RETAIL	~ $ 0,52
FRESH APPLES CONSUMPTION ECONOMY	$ 160.345.000

Average prices

*Production economy
310,000 Tons X $ 0,31 = $ 96.100.000

Exports

Exports depend on an uninterrupted cold chain. Despite being a good grower, Turkey has never been a strong seller. In 2013 just 127,374 ton were sold abroad.

The exported varieties were Starking (79%) and Golden (21%). In the international cost league, Turkey is one of the stars; apple production in the country is very cheap. The problem is sales prices. Domestic growers may complain about costs, but the reality, seen from an international perspective, is very different!

APPLE EXPORTS	127.374 TONS
PRODUCTION COST	$ 0,13
FIELD SALES	$ 0,29-0,31
TRADERS-EXPORTERS	$ 0,66
EXPORTED APPLE ECONOMY	$ 83.500.000

Average prices

*Production economy
127.374 TONS X 0,31$ = $ 39,5 MILLIONS

Apple Juice

In 2013 a total of 460,000 tons were industrially processed, with one section of industry producing intermediate products, such as fruit juice concentrate and puree, for the other, which turns them into final products. In Turkey, among all fruits apples have the highest share in the fruit juice industry (43.5%).

In international practice the most juicy apple varieties are turned into juice (2.5 kg apples afford 1 litre). In Turkey windfalls, small and misshapen fruits are used for this purpose. On average, 6.5 kg apples yield 1 litre of juice. In the chase of pasteurised concentrates the ratio is 172 g for 1 litre of reconstituted juice.

The trade volume of stored apples

Apples stored under CA conditions have a longer storage life than those kept under normal atmospheric conditions. In Turkey the latter is still the norm. Some of the storage facilities operate inefficiently. The reasons are their old age or wrong capacity calculations at their establishment.

The global trend is toward controlled atmosphere storage in conjunction with 1-MCP fumigation to maintain the apples` harvest freshness for longer. With these methods shelf life can be doubled without quality loss. The advantage is a much higher sales price.

The establishment of controlled atmosphere storages requires an advanced infrastructure and a high trade volume. Growers in Turkey currently rely only on 1-MCP for improvement. However, CA and 1-MCP offer different advantages and should be combined to realise the apples` full potential.

Until March, apples stored in standard storages have the same quality as those in CA storage, but shorter shelf life. The advantages of the advanced methods become obvious only in the following months as the quality gap widens considerably.

In May and June 2014, Starking apples achieve a price of TL 4.50 – 5.50 in Turkey, while in Europe, consumers were prepared to pay over euro 3.00 (TL 9).

APPLE JUICE ECONOMY	460.000 TONS
COST OF APPLE	$ 0,08
1 CONCENTRATE COST /LT	6,5 x 0,08=$ 0,52
1 CONCENTRATE PRICE /LT	$ 0,98
PREPARED APPLE JUICE	424,000 TONS
RETAIL PRICE OF APPLE JUICE	2,35 LT
APPLE JUICE CONSUMPTION ECONOMY	$ 344.140.000

Average prices

*Production economy
460,000 TONS X $ 0,08 = $ 36.800.000

STORED APPLE	1.550.000 TONS
PRODUCTION COSTS	$ 0,13
FIELD SALES	$ 0,29-0,31
COLD STORAGE	$ +0,04 - 0,05
WHOLESALE COST	+% 8-12
RETAIL	~$ 1,03
STORED APPLE ECONOMY	$ 1.603.000

Average prices

*Production economy
1,550,00 TONS X 0,31 = $ 480.500

Dried apples and “Kak”

In 2013, 150,000 tons of apples were processed into dried products. The yield is about 0.15 kg per 1 kg fresh apples (15%). Dried apples are a healthy natural product of high nutritional value. They can be consumed without further processing or used for compote, vinegar, sweets, pasta and wine production.

DRIED APPLE	150.000 Tons
PRODUCTION COST	$ 0,18
DRYING PROCESS	$ 7.800
DRIED APPLE RETAIL PRICE	$ 8,63 / KG
ECONOMY OF DRIED APPLE	$ 193.695.000

Average prices

*Production Economy
150.000 TONS X $ 0,18 = $ 27.000.000

Vinegar

In Turkey, about 35,000 tons of apples are processed into vinegar. The yield is in the order of 65-70% per kg. It takes 6 weeks to ferment the juice. If the product is pasteurised it can be safely stored for years.

APPLE FOR VINEGAR	35,000 Tons
PRODUCTION COST	$ 0,13
BOTTLING PROCESS	$ 5.175
RETAIL PRICE	$ 1,38 / Lt
ECONOMY of APPLE FOR VINEGAR	$ 20.690.000

Average prices

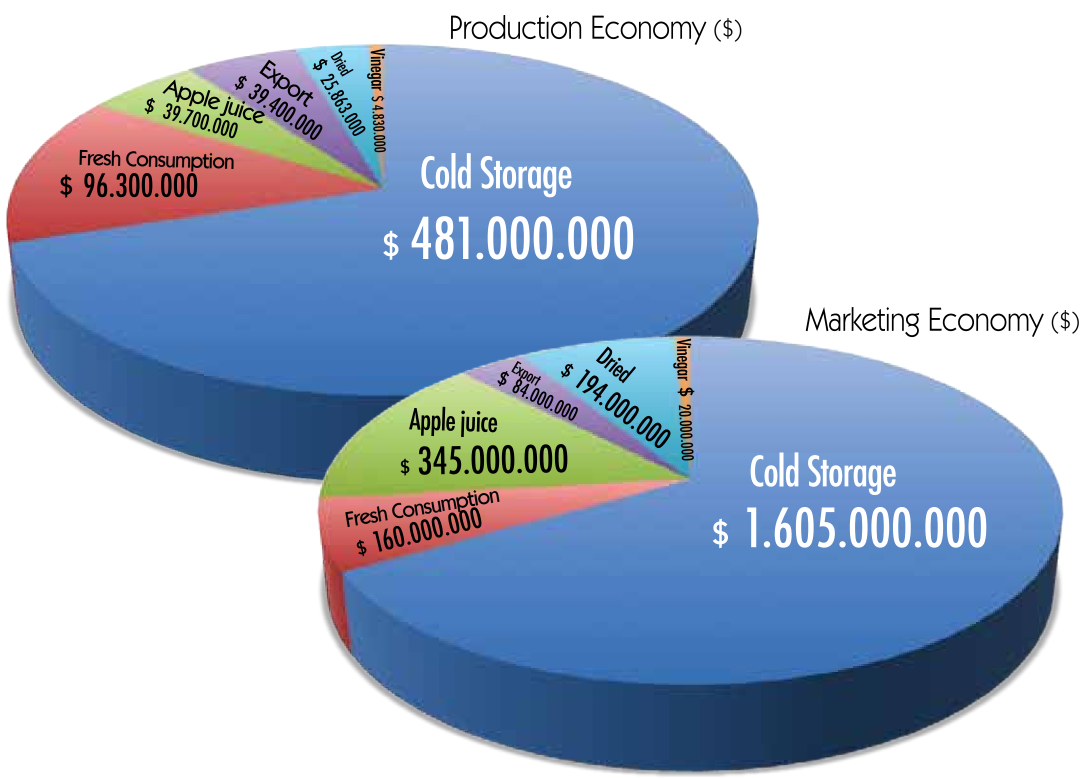
*Production Economy
35.000 TONS X $ 0,13 = $ 4.550.000

TURKISH FRUIT PRODUCTION

NO	PRODUCT	PRODUCTION Quantity (tons)	SHARE IN PRODUCTION (%)
1	Grape	4.011.409	22,00
2	Apple	3.128.450	17,20
3	Orange	1.781.259	9,80
4	Mandarin	942.226	5,20
5	Apricot	780.000	4,30
6	Lemon	726.283	4,00
7	Peach	637.543	3,50
8	Hazelnut	549.000	3,00
9	Cherry	494.325	2,90
10	Pear	461.826	2,80

NO	PRODUCT	PRODUCTION Quantity (tons)	SHARE IN PRODUCTION (%)
11	Pomegranate	384.905	2,30
12	Strawberry	372.498	2,20
13	Plum	305.393	1,10
14	Fig	298.914	1,60
15	Grapefruit	228.799	1,30
16	Banana	215.472	1,20
17	Walnut	212.140	0,20
18	Quince	139.311	0,90
19	Kiwi	41.635	0,20
	Total	222.055.719	100

Source: 2013 TUİK



Distribution of the annual apple production by sector (tons)

Cold Storage	Fresh Consumption	Apple juice	Export	Dried	Vinegar	Loss
1.550.000.000	310.000.000	460.000.000	127.374.000	150.000.000	35.000.000	500.000.000

THE FUTURE OF APPLE IN TURKEY

" Modern storage systems require about 25% higher initial investments. The reward is a good quality and price difference of 100% for the stored apples. Good quality out-of-season apples command higher prices and benefit the grower while the consumer enjoys a healthy product. "

Agriculture is a strategic, dynamic, lively and changing sector of the economy that needs constant monitoring. Adaptation to its dynamism requires comprehensive information. Turkey currently passes through a phase of restructuring of its agro-industry which, to achieve its goals, needs reliable statistical data, because the necessary private and public sector investments depend on it.

The future of the apple, on the other hand, will be determined entirely by the consumer! The price they are prepared to pay decides the fate of apple growers.

Presently 44% of apples are sold on markets and 42% in shops. Turkish consumers prefer firm and juicy fruits; and when put in the freezer they want them to stay fresh for a week. For this quality consumers are prepared to pay more than TL 5,00, even in the spring and summer. Proof of this is retail prices in the USA, the EU and even in China. In those markets, the out-of-season prices easily rise above 2 dollars.

So much is obvious, with the solution of the variety and storage problems in Turkey, exports will pick up.

Modern Apple Orchard
in Karaman in Turkey 5700 da

The 1st National Apple Summit organised by the Ministry of Food, Agriculture and Livestock in 2012 was the first platform on which growers could discuss their problems with the public authorities. The National Strategic Apple Plan, formulated at the summit, bears witness to the state of the apple in Turkey.

At first sight Turkish apple orchards give the following impression: old, little variety, and outdated cultivation practices. Cut into ever smaller plots through inheritance, investment and operational costs constantly rise. The use of fertilisers is twice as high as in Europe. Cheap and low-quality pesticides only further aggravate the problem. The use of tall and widely-spaced trees cannot possibly bring high per sqm-yields. They are also open to the forces of nature. High hanging fruits are often left on the branch, will others are damaged during picking, adding to the overall loss.

Growers must be made aware of the fact that dwarf and semi-dwarf trees and more variety will solve their problems because it increases yields per dönüm while reducing labour, electrical power and fuel costs. Drip irrigation will save the water problem and facilitate fertiliser and pesticide application. Covering nets will protect plants and fruits against the sun and meteorological events. The use of wind fans will prevent freezing.

The next improvement step is post-harvest storage. The storage life of apples under the classical system – normal atmosphere cold storage – is known. However, operational mistakes, but more often not well-enough thought through practices, cause quality losses.

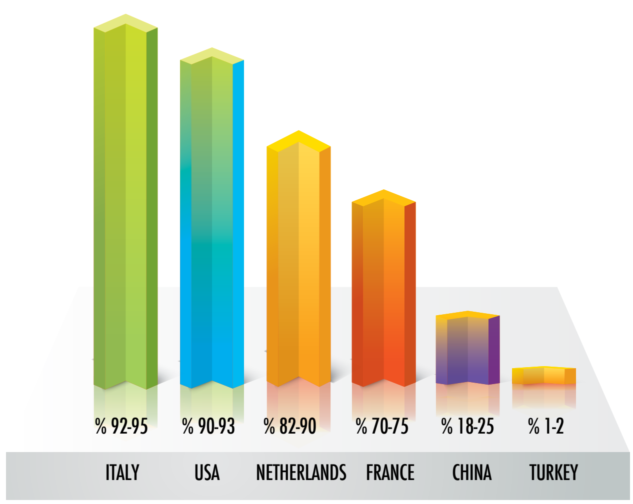
The secret of year-long storage is controlled atmosphere. The storage methods of old must be left behind and modern technology be embraced if we want to double the added value of apples in Turkey and expand our exports to the desired level. Some growers try to make do with 1-MCP as has been explained above. While the method yields positive results under normal atmosphere conditions, it will only ever reach its full potential when applied in combination with controlled atmosphere which has been used successfully for years in industrialised countries. While trying to bring a few more fruits to market, we are missing the big picture: international markets and exports.

"There is a fallacy in Turkey that prevent the spread of controlled atmosphere storages.

The practice of supplying fruits, as per demand, in small quantities to markets has led to the habit of frequent storage openings which is counterproductive for CA storage.

It is as if this situation has led storage owners to subconsciously oppose the new methods. As a result of the current demand structure, they prefer not to invest in CA."

Percentage of Controlled Atmosphere System in The World



IT'S NOT JUST ABOUT GROWING APPLES

The economic loss of 15 million ton wasted apples is $ 30 billion

Worldwide one in five apples goes to waste.Total loss amounts to 15 million tons. They are enough to fill 600,000 trucks.

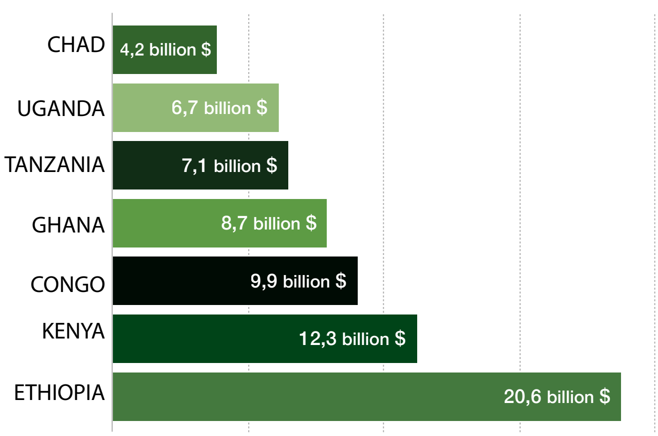
Turkish fairy tales invariably end with the phrase: "And three apples fell from the sky." Used as a metaphor the "three apples" that fall to earth every year amount to over 70 million tons grown on billions of trees worldwide. Apples are among the most beneficial fruits (exemplified in the English saying: "An apple a day keeps the doctor away."). The area under cultivation equals twice the surface area of the island of Cyprus, including mountains and plains and coastal areas. A rough calculation, excluding the land costs, puts the investment into apples until this day at over ğ 100 billion, and counting. Because operating expenses into major cost items such as fuel, pesticides and fertilizers add to the sum year after year. During harvest, millions of farm labourers are employed for months to collect the fruits and sort them by size. And I haven´t even mentioned water and electrical power yet…

All these costs and efforts to provide you with a tasty fruit "that fell from the sky". Enjoy your apples.

It is not our intention to spoil your appetite, but the food industries' activities are not without impact on the environment. During apple cultivation carbon fuels are burned which emits carbon dioxide and contributes to climate change. Then there are the pesticides and fertilisers and their harmful side effects. They enter the water cycle, penetrate into the ground water and cause problems for generations to come. This is true in particular for nitrates. Excessive ground water use, on the other hand, leads to desertification. Apple cultivation is part of this process and leaves its footprint on nature.

Other aggravating factors are lack of knowledge: small-scale growers who do not apply best practices, public authorities that do not provide sufficient guidance, lacklustre marketing strategies that do not attract interest, and lack of cold storage facilities that comply with international standards. They all contribute to apple wastage. Worldwide, this loss adds up to 15 m tons at a cost of USD 30 billion. In many African countries annual expenditure for food is less than that. Seen from this perspective the loss can only be qualified as catastrophic.

ANNUAL FOOD CONSUMPTION OF CERTAIN COUNTRIES



Source: World Bank

Next time you see a rotten apple think of the effort the grower has put into it, and the costs, because every rotten apple adds to the costs of production and finally to the price the consumer has to pay.

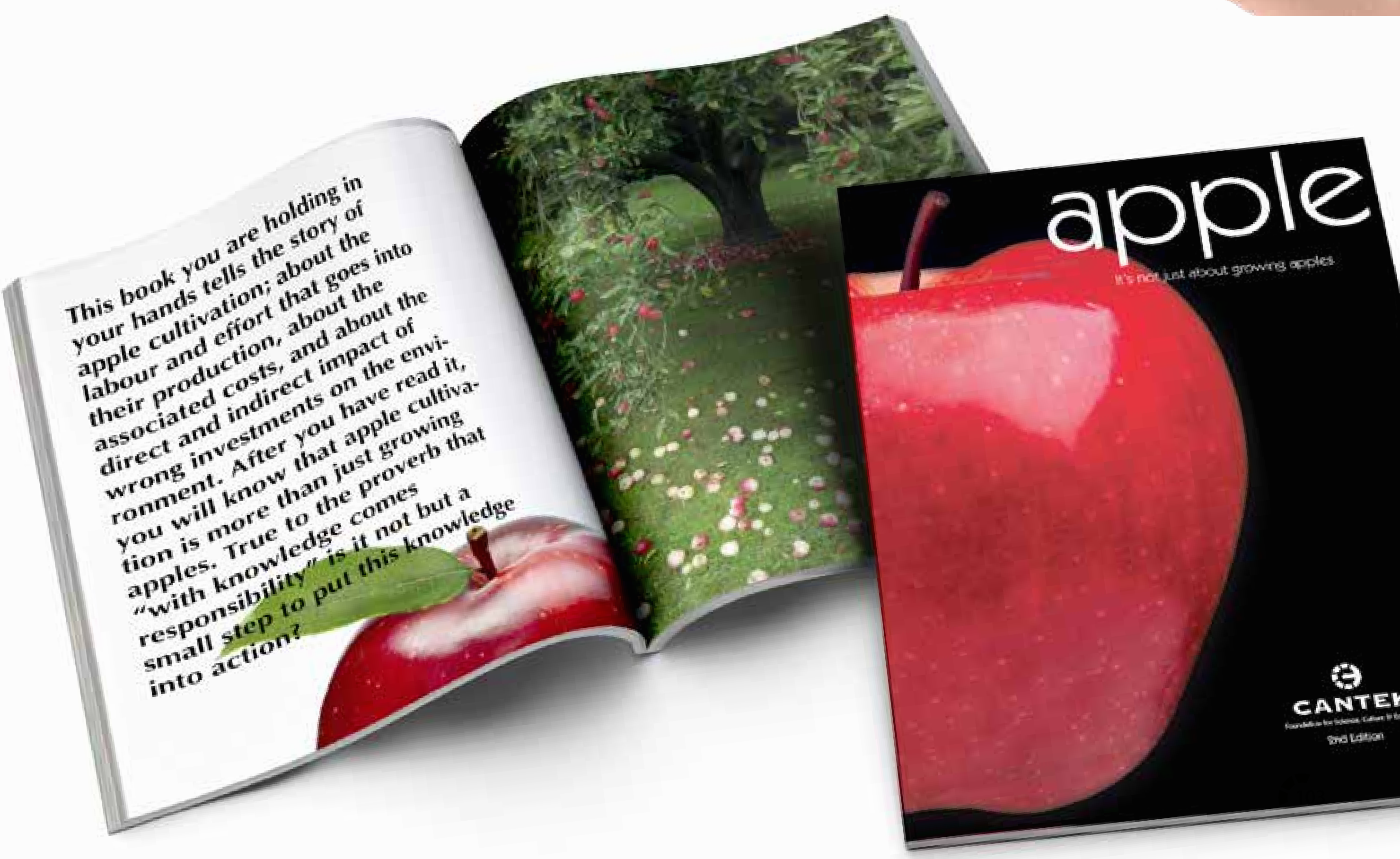
But money is not everything!

If you are or dream of becoming an apple grower and read this book, then, by now, you will know how to go about and apply best practices. You will know how to select the land for your orchard and what steps to follow from choice of variety, to planting, to harvesting. You will know how much you have to invest and what the return on your investment will be. And you will also know about the effects of your actions on the environment.

If you are interested in cold storage, you now know how to establish a facility and equip it with modern technology. You will know how to reap a profit from your investment, and what you have to do, to leave a better world to the next generation.

We do not have the luxury to let a single apple rot, not even an apple that has fallen from the sky!

For this reason, it is not enough to just grow apples…



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CANTEK Foundation for Science, Culture and Education, carries on elaborating books and documentaries to inform the World about the most advanced **"Storage and Treatment Technologies"**

Who should read this book?

Apples Growers
This book informs about the origins of apples, including references to tales and myths that surround them, and it explains what products can be made from apples. It provides information about worldwide trends in apple cultivation and the most advanced methods of apply production. It also tells apple growers which apple varieties will earn them more money.

Apple Storage Operators and Traders
This book tells the story of apple storage from very humble beginnings to today's sophisticated storage systems. The cold storage sector is explained in comprehensive detail with all its various alternatives which ensure that this beneficial fruit achieves its full potential.

Public Authorities and Academia
In every country agriculture is a strategic sector. It affects growers, storage operators and consumers at the same time. The promotion of apple production in accordance with global market demand is a requirement of proper environmental management and essential for the profitable management of apple growers` investments. The inclusion of academicians with expert knowledge of apple storage methods ensures that apples attain their rightful place in the market.

Financiers
Banks provide financial resources for plantations, saplings, tractors and storage facilities as well as loans to traders. However, they usually do not have the necessary background knowledge about what they finance and how best to do it.
This book analyses the apple sector from every angle and highlights its feasibility. This valuable book has examined the data on the economics of apples in Turkey and worldwide and constitutes an intellectual reference source for financiers.

Cold Storage Builders
The most critical process connecting apple cultivation and apple consumption is cold storage. This book explains the design principles and methods of storage establishment, and highlights critical issues. The state of the art in apple storage is described in simple words and illustrated with the aid of colourful graphics and pictures. It will help cold storage builders to complement their knowledge and serve as a unique source of valuable information.

Apple Lovers and Consumers
Apples are the second most consumed fruit in the world. Apple cultivation is a global economy with a value exceeding USD 144 billion. The raw material is used to make apple juice, vinegar, whine, pectin, fruit pulp gum, beer, puree, chips, etc.
Because of the ubiquitous use of this highly beneficial fruit, apple losses translate into financial losses for the world economy in the order of USD 30 billion.
And the damage is not limited to that! Think of the fuel, pesticides, electrical power, water, etc. that were used in vein in their cultivation. If we add to this the damage to the environment, it becomes obvious that just growing apples is not enough.

With the best compliments to growers and their products – The Cantek family.

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