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Best Practices for APPLE Production and Marketing in Afghanistan

Aimed at farmers, extension workers, exporters and members of the business community, the guide offers tips on cultivation, harvesting and marketing techniques to improve sales of Afghan produce on international export markets.

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www.CHAMP.af



Ministry of Agriculture,
Irrigation and Livestock

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Apples

While Afghanistan's commercial apple production began with varieties imported only during the past 25 years, Afghan apples are among the crunchiest, sweetest, and largest in the region. Grown mainly in central Afghanistan, these apples are distinctive for their size, deep-red color, high brix content (very sweet) and flavor. Afghan apples maintain their flavor and freshness for up to seven months in cold storage.

Regions and Varieties

Commercial varieties of Apples are produced in the colder areas of Afghanistan, such as Wardak, Logar, Kabul, Parwan, Ghazni, Paktya, Paktika, Badakhshan and Bamiyan provinces. Apples flower in early spring, with fruit ripening in August to October depending on varieties and locations. Apples are mostly cross-pollinated, requiring growers to plant two or three different varieties in the same orchard. Many varieties of apples are grown in Afghanistan, with the most popular commercial varieties being Red Chief, Royal Gala, Double Red Delicious, Blushing Golden, Fuji, Galaxy 7243 and Saturn 7235.

Producing for Export

Cultivation

- Plant only improved varieties that are commercially sought, high quality and disease-free.
- Plant new orchards with a planting density of 4m x 4m or 4m x 5m and a north/south orientation of the rows.
- Add a 3- to 4-inch layer of mulch around the tree to keep the ground free of vegetation that would compete with the tree for nutrients. Keep the mulch several inches from the tree trunk to prevent rot.
- Prune to create central leader system. Remove excess branches and buds to maximize plant energy reaching the fruit. Thin out less-developed or diseased fruit to improve the quality and avoid fruit dropping.
- Fruit thinning is recommended for optimal yields and quality as it reduces the burden on the tree from underdeveloped or damaged fruit. It also ensures a crop the following year; the tree is accustomed to having fruit removed during the growth cycle and will therefore set better.
- Insect pest management and appropriate fertilization are critical to good orchard management.
- Irrigation management is vital for plant health and to prevent fruit cracking. Ideally trees should receive moisture every 4-7 days to prevent water stress.
- Adjust the soil pH to 6.5 - 7 for topsoil and 6 - 6.5 for subsoil.

Harvesting

- Fruit should be thinned throughout the growing season to allow only the best quality to reach market and to increase the potential yield.
- Fruit should be picked by hand, keeping the stem and using harvest bags.
- Harvesting should take place at the coldest part of the day to reduce energy expenditure in precooling for storage or shipping.
- The product must be kept cool and reach the packing center as soon as possible.

Post-harvest Handling

- Apples need to be sanitized with chlorinated water at 100ppm using cold water to further lower temperature.
- Waxing of apples is recommended where mechanization is available. This will add to the shelf life and aesthetics of the fruit.
- When packing, use molded foam separators to prevent movement and impact injuries.
- Do not mix grades or pack poor quality fruit. Not only can it create spoilage in the shipment, but it will also lead to a loss of confidence by the buyer in future transactions.

Packaging and Shipping Requirements

Labeling

Identity: Commodity, variety, size (grade description)
Responsibility: Exporter, packer, province, country
Quantity: Weight, number of packages if not bulk-packed.

Cold Storage

- Optimum Temperature 0° C. Optimum Relative Humidity 90 - 95%.
- Ethylene can cause accelerated senescence. The use of 1-methylcyclopropene fumigation or ethylene scavengers is recommended.

Ground + Sea Freight

- Apples need to be transported in refrigerated containers with ample air movement to prevent heat build-up and ethylene concentrations in areas where airflow cannot reach.
- Do not block pack or palletize.

Air Freight

- Airfreight is available on a daily basis to all target markets with at least 2 MT reserve. Bi-weekly freightliners out of Kabul can accommodate 20 MT.
- Freight needs to be kept at the target temperature or protected by thermal blankets.

Target Markets

India

- Strong market for well-graded, waxed fruit packed in 18kg layered boxes.
- Market advantage from no import duty.
- Demand and price increases to a peak in February-August.
- Opportunity for extended supply window from October to March.

Pakistan

- Similar to domestic market: low input, low return.
- Mainly supplied in bulk 20kg packaging.

Central Asia

- High demand especially in early season, with preference for 18kg packs.

UAE

- Good demand for consistent lines of Red Delicious supplied over an extended period.
- Pre-packed into international standard 18kg export pack.
- With strong competition from international suppliers, pricing depends on packing and physical appearance of fruit.

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Part I

Cultivation

Introduction

While Afghanistan's commercial apple production began with varieties imported only during the past 25 years, Afghan apples are among the crunchiest, sweetest, and largest in the region. Grown mainly in Central Afghanistan, these apples are distinctive for their size, deep red color, high brix content (very sweet) and flavor. Afghan apples maintain their flavor and freshness up to seven months in cold storage.

Climatic Requirements

Apple trees are temperate zone fruits that require 400-1,100 chilling hours (temperature below 45F⁰) during winter as a dormant period. Apples trees can grow in a wide range of soils from medium textured clay to sandy soils. However, the best soil for cultivation of apple is fertile and well-drained loams soil. The required range of pH is between 5.8 - 7 (acidic to neutral soil).

Botanical Characteristics

The apple is a deciduous tree. The size, shape and branch density is determined by the rootstock selection and how it is trained. Generally apple trees can grow from 1.8 to 4.6 meters tall. The leaves have serrated margins and a soft underside. The trees are primarily propagated by grafting.

Blossoms are produced in spring with the budding of the leaves. Flowers are white with a pink tinge. Most apple cultivars are cross-pollinated, which necessitates the planting of at least two varieties in the same orchard.

Fruit bearing depends on factors such as the variety of tree, location and how the trees are tended. An average apple tree can bear fruit after 3-4 years of planting but needs 6-7 years for fruiting at the commercial level.

Regions and Varieties

Commercial varieties of Apples are produced in the colder areas of Afghanistan, such as Wardak, Logar, Kabul, Parwan, Ghazni, Paktya, Paktika, Badakhshan and Bamiyan provinces. Apples flower in early spring with fruit ripening in August to October, depending on varieties and locations. Apples are mostly cross-pollinated, requiring growers to plant two or three different varieties in the same orchard.

Many varieties of apples are grown in Afghanistan, with the most popular commercial varieties being Red Chief 101, Blushing Gold 102, Royal Gala 110, Double Red Delicious 109, Michgla Modal Gala 7209, Fuji 7237, Galaxy 7243 and Saturn 7235. Common root stocks of apples available in Afghanistan are B9, M7, M9, M26, MM106 and MM111 (for more information, refer to ANNGO – Catalogue 2012 -2013).

Red Chief originated in the U.S. The fruit has an intense red color and an elongated shape with marked lobes. Fruit is medium size, juicy and has a crispy texture. It flowers in mid-May

and ripens in early October.

Blushing Gold has a yellow-red color and is round in shape. Fruit is medium to large in size, creamy, juicy and has a crispy texture. It flowers in mid-May and ripens in mid-October.

Royal Gala has a round, dense, sweet, aromatic and juicy flesh. The color varies from yellow to almost orange with deep orange stripes. It flowers in mid-April and ripens in early August.

Double Red Delicious has red skin with dark red streaks and a round shape. The fruit is medium in size with a sweet, aromatic flesh and a slightly crunchy texture. It flowers in mid-April and ripens in mid-September.

Michgla Mondial Gala has a mid-red color with stripes, a round shape, medium size and sweet juicy flesh. It flowers in mid-May and ripens in mid-August.

Fuji has a brown-red skin, round conical shape, medium to large in size, with a sweet and juicy taste. It is moderately resistant to powdery mildew and blight but susceptible to scab and spider mites. It flowers in mid-April and ripens in mid-September.

Galaxy has a dark red, almost purple color and a round conical shape. The fruit is medium to large, juicy and moderately firm. It flowers in mid-May and ripens in early September.

Saturn fruit is greenish yellow flushed with red and has a conical shape. The fruit is large, sweet, juicy, and crisp. It is resistant to scab and powdery mildew, flowers in early May and ripens in early October.

Orchard Establishment

Variety Selection

Plant only improved varieties that are high quality and disease-free. Varieties of new plantings should be chosen based on:

- Suitability for growing zone
- Even ripening
- Good color
- Suitable size of fruit
- Predictable market demand and market performance
- Resistant to diseases and pests

Always procure certified saplings from a reliable nursery (such as members of the Afghan National Nursery Growers' Organization). This will ensure that saplings are true to type and high in quality.

Site Selection and Preparation of Land

Site selection is very important in new orchard establishment. The climate and soil of the area should be suitable for growing apples. Choose an area that has been well established for growing apples in order to profit from the experience of area farmers. Apple trees can tolerate about minus 30 C⁰ during winter

The land should have year-round access to quality water (not contaminated or salty water) either through rain or irrigation. Also the site should be near a road with access to transportation.

After selecting the site, the ground should be thoroughly ploughed, levelled and enriched with well-decomposed farmyard manure. If the soil is poor, plough in 10-12 inches of green manure into the soil to improve its physical and chemical condition before planting. Deep ploughing is recommended for highly compacted ground.

Levelling is important for efficient irrigation and to prevent soil erosion. In hilly areas, the land should be divided into level terraces oriented to the topography of the area to protect the soil from erosion and provide enough water.

Propagation and Planting

Most fruit trees (including apple) are propagated through asexual methods (i.e. grafting, budding and layering). Grafting involves joining two pieces of genetically different apple trees together so that they grow together as one plant. The lower part of this compound plant is known as the rootstock and the upper part (which produces the shoot system of the plant) is referred to as the scion.

Grafting is usually done during the dormant season using tongue and whip grafts. In this method, a cut 25-60 mm in length is made on the rootstock and then a scion section having 2-3 buds is inserted into the cut. The cut should then be sealed with wax and tied with rubber strips or grating tape.

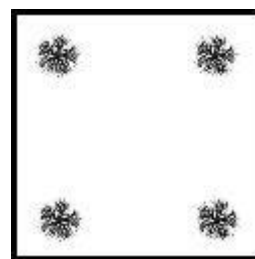
Budding is a form of grafting in which only a bud from the scion and a small piece of bark from the rootstock is used. T-budding and chip-budding are the most common types of budding used in apple propagation. T-budding is usually done on rootstocks of 6-25 mm in diameter. The first cut is a vertical cut about 10-25 cm above the soil level and then a horizontal cut is made just above the vertical cut to form a T. The bud from the desired plant is then inserted into the cut and tied with plastic strips. Chip budding is done on rootstocks of 13-25 mm in diameter. For this type of budding, a small chip of bark is cut out from the rootstock and an identical chip from the scion is put back in its place.

Some farmers use mound layering to propagate apples. In this method, soil is mounded around the shoots that have been cut back, thereby stimulating roots to grow at the base of shoots.

Any orchard layout should aim at providing the optimum number of trees per hectare, with adequate space for proper development of the trees and plenty of space for implementing orchard management practices. In commercial orchards, the saplings should be planted 4 meters apart and the rows situated 5-6 meters apart, depending on rootstocks, farm machinery and availability of land, although some dwarf varieties can be planted at a distance of 2m x 2m. A total of 65-100 saplings are required for one jerib (2,000 square meters) of land. When the saplings are planted, use a wooden stake to keep the saplings straight.

Apple orchards in Afghanistan are generally laid out along two patterns:

Square system: This is the most common system used in Afghanistan. Trees are planted on each corner of a square, regardless of planting distance. The central area between the four trees may be used to raise fodder crops or vegetables, such as clover or mong bean. This system permits intercropping and cultivation in two directions. (Avoid planting cereal crops in the central area, as they compete for nutrients and leave the trees weak.)



Rectangular system: In this system, trees are planted on each corner of a rectangle. As the distance between any two rows is more than the distance between any two trees in a row, there is no equal distribution of space per tree. The wider alley space available between rows of trees permits easy orchard management operations and the use of mechanical aids, such as tractor sprayers.



After the orchard is laid out, dig a hole of 1m x 1m x 1m, depending on the soil type and hardpan. Put the upper half of the soil to one side and use it at the bottom of the hole when the saplings are planted (the topsoil is more fertile than the soil below).

Pruning

Pruning is the selective removal of branches and shoots. Pruning helps form a better canopy to protect the fruit from excess sunlight. Pruning also eliminates unproductive, dead, broken or damaged/diseased branches and creates space for light penetration and air circulation. It makes trees easier to spray and harvest, increases the output and quality of the fruit and enhances flowering and fruiting.

Apple trees are pruned mostly during the winter dormant period (February and March) depending on location and climate of the area. Apple trees should be pruned along a central leader system (a single trunk extending to the top of the tree with smaller horizontal branches). Light pruning can be performed throughout the growing season to remove broken and diseased braches, water sprouts and root suckers. During the first two years the tree should be pruned with only three to five branches remaining on the trunk so that the tree develops a strong limb framework. Apply Bordeaux or fungicide paste on the cut portion of branches and limbs to speed healing of the wounds.



Apple pruning in Ghazni Province.

Thinning

Most healthy apple trees grown under favorable conditions set more fruit than they are capable of carrying to maturity. Therefore it is important to remove excess fruit to ensure a harvest of plump, healthy apples. Optimum fruit size and quality requires about 30 leaves per fruit. Fruit thinning improves the size and color of the fruit, reduces limb breakage and promotes regular flower production.

Fruit can be thinned two ways: size thinning (selective removal of small and weak fruits) and space thinning (selective removal of dense fruits to distribute fruits uniformly along the branches).

Trees should be thinned within 40 days after full bloom or when the fruit is about the size of a grape. Trees that are thinned too late have a reduced chance of increasing the fruit size, so fruits should be thinned at a proper time, keeping in mind the June drop.

Fruit can be thinned by a variety of methods, depending on size of orchard and availability of labours and tools: hand thinning, pole thinning, mechanical thinning and chemical thinning.

Irrigation

Water is an essential component of plant tissue, influencing and controlling the growth and development of apple trees. Water is absorbed by the roots from the soil, and nutrients dissolved in water are taken up to all parts of the plant through the process of translocation. Plants utilize water in a variety of processes such as transpiration, cell division and photosynthesis. An adequate water supply during the growth stage has a direct bearing on fruit quality and yield.

With water in short supply in the summer months, efficient irrigation and water management is essential for a productive apple crop. Irrigation scheduling should be based on knowing the moisture content of the soil, the growth stage of the plant, air temperature, wind speed, rainfall and the appearance of the leaves. Soil moisture can be measured by a number of methods such as tensiometers, neutron moisture probes, gypsum blocks or a soil probe. To test the moisture of the soil by hand, take a handful of soil 30cm below the surface and clench it in your fist (fig. a). If the soil holds its shape when the hand is unclenched (fig. b), the soil is sufficiently moist. If the soil crumbles (fig. c), the soil is too dry.



Tensiometers are useful for measuring soil moisture



A.

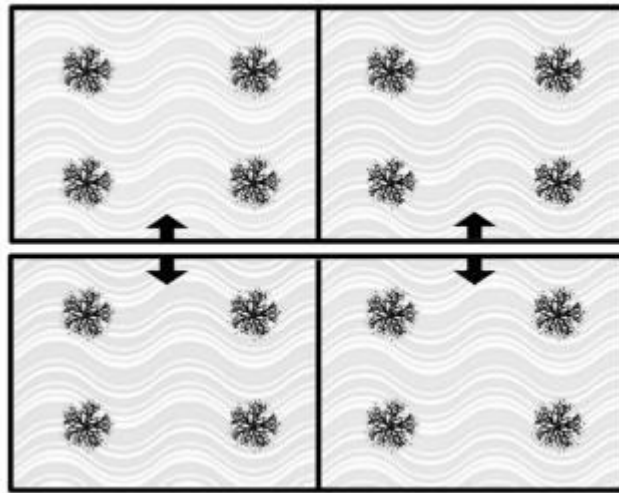
B.

C.

The amount of water for irrigation depends on the water-holding capacity of the soil, the amount of rainfall and the rate of transpiration of the trees. Seven different irrigation methods are outlined below.

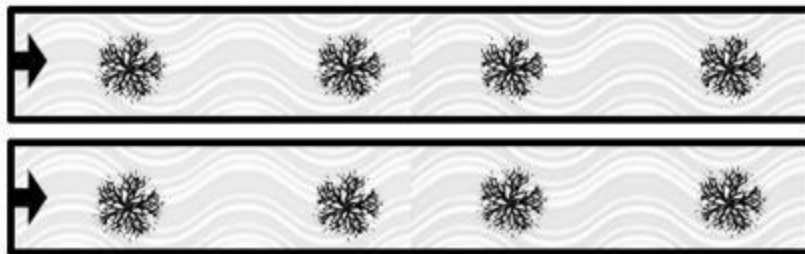
Flood Irrigation

This type of irrigation is used in areas where the surface is flat and local water sources are sufficient to irrigate the trees. Water enters a square enclosed area and irrigates a group of trees. While cheaper and easier than other methods of irrigation, flood irrigation results in high water loss through evaporation and leaching.



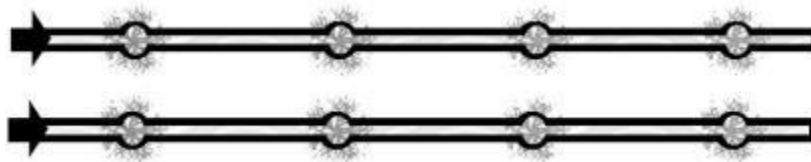
Furrow Irrigation (Channel System)

In this method, trees are planted in long parallel channels connected to a water source. The water flows from one end of the channel to the other. Several channels can get water simultaneously depending on the capacity of the water source.



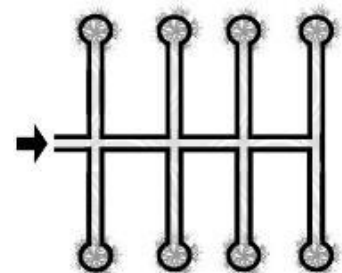
Basin Irrigation

Basin irrigation is similar to the channel system, except that the channel linking the trees is smaller, with rings circling each tree. Basins are made around each tree -- 50cm radius the first year, increasing to 1m or larger as the tree canopy grows and the tree's water needs increase. One disadvantage of this method is that manure and fertilizer tends to accumulate in the trees at the end of the line.



Modified Basin Irrigation

This is the most popular and efficient method of orchards on level ground. A central water channel feeds pairs of trees branching on either side. As above, small basins are prepared around each tree – 50cm radio the first year, increasing to 1m or larger as the tree's size and water needs increase. This system has many advantages. It uses less water and does not move nutrients from one tree to another. Weeds can be more easily controlled, as



water does not reach outlying areas beyond the channel. The disadvantage is the labor and costs involved in preparing each of the circular basins, extending them as the tree grows and cleaning debris from the central channels.

Spot Irrigation

Spot irrigation is one of the most economical methods of irrigating individual trees. Water is applied in a ring around the root zone through a flexible pipe, tanker or bucket, depending upon the distance of the water source. While a laborious method, spot irrigation is useful in places where water is scarce and land is uneven.



Weed Control

Weeds can greatly out-compete apple trees for nutrients, especially nitrogen. Fertilizer is drawn away from the tree and absorbed by the weeds. Weeds also divert much of the water that is crucial to the apple tree during the hot summer months. Weeds are also a potential host for pests. Weeds can be controlled by intercropping between rows, mowing or application of a weed-controlling chemical. Pre-emergent weed killers should be used only after germination. Glyphosate can be used throughout the growing season.

Winter Dormancy & Chilling Requirement

During the fall and winter, deciduous fruit plants enter a dormant period that is generally referred to as the plants “rest period”. Plants enter the rest period in the fall as air temperatures begin to drop below 50F⁰, leaf fall occurs, and visible growth ceases.

Apple trees requires 400 -1,100 chill hours (temperature below -4 C⁰) for bearing good fruits during winter.

Fertilization

Like all other living organisms, apple trees need nutrients to grow and thrive. They require sixteen essential elements for growth and normal functioning, which fall under macronutrients and micronutrients.

Macronutrients. These are the elements that plants require in relatively large amounts, such as nitrogen (promotes green leaves and foliage growth), phosphorus (stimulates healthy root growth and the formation of flowers, seeds and fruit), and potassium (required for proper development of flowers and fruit). Secondary macronutrients, which are needed in smaller amounts, include calcium, magnesium, and sulfur. (See Annex 2).

Micronutrients. These are the elements that plants need in relatively small amounts, such as boron, chlorine, copper, iron, manganese, molybdenum, zinc, and nickel. (See Annex 3).

When developing mineral nutrient management programs for tree fruits, it is important to consider the nutrient demand-supply relationship throughout the season. Early season canopy development and fruit growth require large amounts of nitrogen, while fruit quality development and adequate cold hardiness later in the season require only a minimum supply of nitrogen.

Like other crops, apple trees require some nutrients in the form of chemical fertilizer. Soil and leaves should be analyzed in order to determine the right quantity of fertilizer.

Agriculture experts in Afghanistan recommend 100g -1kg of urea fertilizer per tree, depending on the age and soil texture during the growth stage. In some apple orchards, iron deficiency is a problem that should be controlled through foliar spray of iron chelate or adding ferrous sulfate solution to the soil.

Fertilizer is applied by a variety of methods, such as broadcasting by hand, side dress (applying fertilizer below the canopy but away from the trunk), band placement (applying in bands down the row) and foliar spray. Well-decomposed manure or compost is also a good source of different minerals and nutrients. (Care should be taken not to apply fresh animal manure into the soil, as it will damage the trees.)

Maturity

The maturity of apples can be determined in a number of ways, such as color, firmness, brix (sugar level), and acid level. The firmness and brix is measured using a penetrometer and refractometer, respectively. The average sugar level for mature apples is between 11-14^o.

When using fruit color as a determinant of maturity, the farmer needs to be familiar with the developmental stages of their particular variety. Apples picked too soon may suffer from bitter pit and those harvested too late will not be appropriate for storage or long-distance transportation.

When using a penetrometer it is important that the readings are taken with identical methodology and a history is developed of tests to determine in future seasons what the firmness is for each particular variety.

When testing brix percentage using a refractometer, brix is measured in degrees, with 1 degree of brix equal to 1 gram of sucrose in a 100gm solution. The refractometer has to be calibrated with sterile water before use and cleaned after each use so as not to produce biased results. The temperature of the fruit should be around 20^o C. Newer, handheld refractometers have been developed which automatically adjust to the temperature of the sample.

Common Insect Pests

Apple trees pose a tempting target for a wide variety of pests. Pest management is thus a critical component of good orchard practice.

Codling Moth

The classic 'apple maggot' or worm can wipe out an entire orchard if not brought under control during early emergence. The adult is a dusty grey moth about 10 mm long that lays its eggs on apples by night, usually around the last week of June. It likes warm, dry nights without strong winds. The moths hatch out from overwintered larvae, which hide in cracks in the bark of large older trees. Adult emergence is dependent on weather conditions. Cool temperatures delay emergence by 10-12 days, while high temperatures cause early emergence in the spring and result in the deposition of more eggs. Late-emerging first generation adults may not appear in orchards until six or seven weeks after petal fall.



The larvae enter the fruit and bores down to the core, leaving a prominent entry hole. A smaller, unblocked exit hole can be seen on the fruit later, once the larva has left the apple. The wounds caused by codling moth larvae lead to fruit rot.

Management of codling moth requires regular check-ups and examination of the fruit and trees, and pheromone trapping. Branches should be pruned and thinned. Alternate hosts should be removed from the orchard and dropped fruit or loose bark immediately removed. Trunks can be banded with corrugated paper or jute bags to prevent transit. Care should be taken not to kill the natural enemies of the codling moth during spraying, such as birds, spiders, ants, carabid and staphylinid beetles, which attack the pest at different stages of life.

Chemical control is ineffective unless carefully timed; when the larvae enter the fruitlets they are almost impossible to control. Most insecticides are applied to control larvae at the time of egg hatching. Sticky traps, mass trapping and mating disruption are other techniques used in the control of codling moth.

Brown Scale

The adult brown scale is recognized by light yellowish to dark brown oval shells appearing on leaves, petals and other parts of the tree. Mature female Boisduval scales are rounded and light colored, while males have a cottony appearance that can cause them to be confused with mealy bugs. The crawlers are tiny and not easily seen without a magnifier.

The scales feed on the sap of host plant and compete for moisture. They can usually be found on the undersides of the leaves in early stages, and later on the stems and branches. Infestation results in spotting and premature shedding of leaves, wilting and dieback of stems.

Brown scale tends to thrive on stressed plants, so plants should be provided nutrients in appropriate manner to promote growth. Scale can be controlled by removing the infested parts of the trees and cleaning the bark.



Dormant oils are usually applied for control of the pest during February and March depending on the climate and location of the area. Highly refined summer oils can be used on many trees and shrubs during growing season. Insecticidal soaps can also be used to kill the insects through direct contact. Some common pesticides include Acephate, Azadiractin, Carbaryl, Cyfluthrin, Lambda-cyhalothrin, Dimethoate, Esfenvalerate, Malathion and Permethrin.

Aphids

Aphids are a common secondary pest of apples, but infestations resulting in economic loss are uncommon in Afghanistan, except for the woolly apple aphid and green apple aphids.

Aphids have many natural enemies such as lady beetles, lacewings, syrphid flies, predaceous midge larvae and predatory bugs, which can often keep aphid populations under control if they are not disturbed by broad-spectrum insecticide treatments.

The apple aphid overwinters in the egg stage on water sprouts and terminals. Eggs tend to be concentrated on a few trees in a planting. Hatching begins as apple buds open in spring. Aphids feed on flower parts and then move to growing shoots. Females produce many



generations during the summer and disperse throughout the orchard and to other orchards. Males appear in the fall and mate with the females that then lay overwintering eggs.

The symptoms of aphids are seen in leaves, fruits and shoots. Leaves are curled downward and sticky with honeydew secreted by the aphids. Honeydew may also drip onto the fruit causing russet spots and black sooty mold.

Apple growers should monitor their trees carefully for the earliest onset of aphids. A few colonies can rapidly infest the entire tree. Examine ten fruit clusters from the inner canopy of each ten trees. After petal fall, treat for rosy apple aphids if 5% of the terminals or fruit clusters have live colonies. Monitor the trees for green aphids from petal fall until new growth hardens off (usually by mid-July). Examine five terminals in each of the five trees. Treatment is suggested if 30% of the terminals are infested and natural enemies are not present.

Apple growers should plant aphid-resistant rootstocks, if available. For both green and rosy apple aphids, sticky bands may be placed around the trees to trap ants and increase the number of natural aphid predators. Avoiding excessive nitrogen application will limit aphid populations by reducing succulent growth that is attractive to aphids.

Natural predators (ladybird beetles, lacewings, syrphid flies and predatory midges) and parasitic wasps are usually capable of controlling apple aphids. Avoid using pesticides toxic to these beneficial insects once they appear on the trees.

An application of dormant oil will kill many overwintering aphid eggs and will not affect aphid predators. Apply Alias, Admire, Assail, Thiodan, Thionex or Malathion if few predators are present and fruit damage appears imminent. Sprays applied before this level of aphid infestation may destroy beneficial insects and result in the need for additional sprays.

Tent Caterpillars

The larvae of several moth and butterfly species are collectively referred to as tent caterpillars. They produce large unsightly webs or tents in the crotches of tree branches. These webs are used to protect the caterpillars from predators and harsh weather. Sometime they are seen on the roadside under trees.

Most species of tent caterpillars overwinter in the egg stage. Dark brown to gray egg masses containing 150 to 400 eggs are attached around the small twigs of trees and shrubs. Hatching takes place about the time that leaf buds begin to unfold, usually in early spring. Caterpillars are gregarious and soon construct silken tents that they use as a refuge during the early morning and evening hours, as well as during rainy spells. They leave their protective tent and feed only during the day, laying down a silk trail as they crawl to help them find their way back to the shelter. Approximately six weeks after hatching, the larvae have grown up to 4.5 cm long. Pupation occurs in silken cocoons that are found



on tree trunks, fences, or leaf litter.

Tent caterpillars can cause severe damage, often defoliating an entire tree. If damage is minor, the tree can bud again later in summer, but if severe enough, the tree may take up to two years to recover. Check for egg masses in the fall and early spring. Rings of eggs around the twigs are the first sign in autumn, followed by silken tents among defoliated stems in the spring. In most areas of Afghanistan, damage occurs early in the season when the tree's carbohydrate reserves are low.

Physical removal of egg masses and the caterpillars from the trees can reduce their numbers greatly. The egg masses are brown or gray frothy materials that have hardened to look rather like Styrofoam. Egg masses are best removed during the winter when they are easily spotted. The caterpillars are best removed while they are feeding in a group and utilizing the tent or pad.

Since they congregate in groups inside the tent at night, you can easily destroy them by tearing the nests out by hand or with a brush and pole, then crushing the insect. Once the caterpillars have hatched, the simplest way to control them is to remove and destroy the larvae and their nests by stripping them or pruning the branches where they reside.

Attract small insect-eating birds by providing safe nest sites and a constant supply of water. Insect predators include assassin bugs, tachinid flies, paper wasps, lacewings and ladybirds. Dormant oils can be applied to egg masses in early spring to kill the eggs before they hatch. There are many chemical insecticides registered for the control of tent caterpillars. However, use of chemicals is recommended only in high value trees with heavy infestation.

Spider Mites

Mites aren't insects but members of the arachnid class along with spiders and ticks. Spider mites (web-spinning mites) are the most common mite pests in orchards. Spider mites reproduce rapidly in hot weather and commonly become numerous in June through September. If the temperature and food supplies are favorable, a generation can be completed in less than a week. Spider mites prefer hot, dusty conditions and are usually found on trees or plants adjacent to dusty roadways or at margins of gardens. Plants under water stress also are highly susceptible.

Mites cause damage by sucking cell contents from leaves. A small number of mites are not cause for concern, but levels high enough to show visible damage to leaves can lead to serious damage. Mites are tiny and difficult to



detect. You'll usually notice plant damage such as stippled or yellow leaves before you spot the mites themselves. Check the undersides of leaves for mites, their eggs, and webbing. To observe mites more closely, shake a few off the leaf surface onto a white sheet of paper. Once disturbed, they will move around rapidly. Be sure mites are present before you treat for them. Sometimes the mites will be gone by the time you notice the damage; plants will often recover after mites have left.

Spider mites have many natural enemies that often limit populations. Adequate irrigation is

important, because water-stressed plants are most likely to be damaged. Broad-spectrum insecticide treatments for other pests frequently cause mite outbreaks, so avoid these pesticides when possible. Sprays of water, insecticidal oils, or soaps can be used for management. Always monitor mite levels before treatment.

In gardens and on small fruit trees, regular, forceful spraying of plants with water often will reduce spider mite numbers adequately. Be sure to get good coverage, especially on the undersides of leaves. If more control is required, use an insecticidal soap or oil in your spray, but test the product on one or two plants to be sure it isn't damaging to them. Dormant spray is also useful when applied during late winter or early spring

Common Diseases

Powdery Mildew

Powdery mildew is a fungal disease that weakens trees, inhibits bud production and damages fruit quality. The severity of the disease depends on weather conditions, cultivar susceptibility and tree vigor. The disease can cause extensive foliar infections in dry years, following a mild winter or on highly susceptible varieties of tree.



Powdery mildew attacks young shoots, leaves, blossoms and fruit, with symptoms most noticeable on the leaves and fruit. Commercial apple varieties differ in the degree of susceptibility to powdery mildew, though even less susceptible ones can be infected if weather conditions are favourable to them.

Growing resistant varieties is the most effective strategy for avoiding powdery mildew. Primary infections can be controlled by removal of the infected flower and shoot buds. Any whitened terminal shoots should be pruned during winter or early spring. Unfortunately, this is labor intensive and hard to accomplish effectively.

Secondary infections and fruit infections can be controlled by foliar fungicide applications. Fungicides are usually applied at 7- to 10-day intervals until about midsummer. This ensures that fungicide application coincides with rapid leaf development and the post-bloom period, and that the new growth does not remain unprotected for long.

A variety of compounds are registered in the U. S. for control of mildew including: inorganics (sulfur), sterol-inhibitors (such as fenbuconazole and myclobutanil), and strobilurins (such as trifloxystrobin and kresoxim-methyl). All of these can provide effective control, but growers should alternate different kinds of treatments. Control is more enhanced by shortening the spray interval than by increasing the fungicide rate.

Apple Scab

Apple scab occurs wherever apples are grown, but especially in areas with cool and moist climates. The fungus overwinters in leaf litter on the ground below trees. During spring rains, spores are released into the air and infect areas higher in the tree canopy. Leaves, petioles, twigs, and fruit may be infected. Leaves develop olive-green spots at the onset of infection; later spots appear dark green or black and velvety. Fruit spots become scab-like and fruit tissues may become misshapen.

Apple scab attacks leaves, petioles, blossom, sepals, fruits, pedicels and less frequently young shoots and bud scales. Severely infected leaves will drop. Infected flower stems cause flowers to wilt and fall. Fruit may grow unsightly scabby spots that turn black, brittle, cracked and sunken. Fruit may also drop before ripening.

Apple scab often attacks young and developing fruit. Therefore, orchards should be monitored for scab lesions starting at petal fall and continuing through first cover. Examine both surfaces of spur leaves and fruit. If scab is detected the safest recommendation is to apply insecticide at the full recommended rate plus a protectant through second cover to suppress further development of lesions and to protect susceptible fruit.



Apple scab can best be prevented by collecting and destroying dropped leaves in autumn, or by applying urea fertilizer on the trees just before leaf fall, or on the fallen leaves on the ground. Trees should be well pruned and enough space must be provided for sunlight and airflow.

The use of new high performance fungicides is an important part of the control strategy. Different kinds of fungicides must be applied during the growing season to avoid the development of scab resistance to chemical pesticides. Protectant fungicides must be applied at approximately 7-day intervals during primary scab season, as growing clusters and terminals are continually producing new tissues that need protection.

Crown Rot

Crown rot (sometimes called “collar rot”) is a serious pathogen that has been shown to infect up to 88% of grafted apple stocks and 97% of unbudded rootstocks in commercial Afghan



nurseries. It is often observed on trees that are between three and eight years of age. The pathogen is a type of water mold that requires high levels of moisture and cool temperatures for growth and reproduction. Some of these fungi are common inhabitants of soils, whereas others are present on planting stocks and contaminated water.

The first symptoms in the spring are delayed bud break, leaf discoloration and twig dieback. These symptoms indicate trunk girdling or root disorders, suggesting that crown infection is advanced. Typically the tree blooms heavily and fruits remain small and color prematurely.

The infected trees may survive the growing season but show symptoms of leaf and bark discoloration, and premature coloration and leaf drop in the fall. Infected trees usually decline progressively over several seasons.

Trees between 3 and 10 years of age grown on susceptible rootstocks should be observed for delayed bud break, leaf and bark discoloration. Orchard blocks with susceptible rootstocks should be observed for additional trees showing symptoms which may have developed after fruit set.

Successful control can be achieved by the careful selection of orchard sites and planting resistant rootstocks (such as M7, M9 and MM106) in areas with well-drained soils. Several fungicides are registered for control of crown rot. They are not a substitute, however, for good site preparation and the use of rootstocks adapted to the intended orchard site. Chemicals should be used more as preventive measures. It is difficult to eradicate the pathogen from the roots after infection is established.

Rodent Control

Short-tailed meadow mice can cause great damage to an orchard. During snowy winters, they sometimes chew the bark off of the lower portions of trunks, especially on younger trees. While growers try to save these damaged trees with approach grafts or bridge grafts, these methods are very slow and expensive, and do not always work well. There are no mouse poisons on the market that will economically control large populations of mice in the fall. Well-mown grass and a fairly clean weed strip is the most effective mouse management program.

Rodenticides are usually formulated as baits, which are designed to attract animals. Flavorings may include fish oil, molasses or peanut butter. Baits used in agriculture and natural areas may contain ground meat, vegetables, grains, or fruits. These may be attractive to children and pets, so they should never be used or stored within their reach.

Harvest

Fruit should be removed from the tree with the stem intact if the intention is to store or ship them long distances. Use of harvest bags can reduce the amount of impact and crushing, and also frees up both hands for handling.

If using plastic harvest crates for field harvesting, line them with plastic to protect the apples from being scratched by the rough surfaces of the crate. Any external scratch or impact on the apple allows an ingress point for pathogens and causes increased moisture loss. Avoid using wood, as it is difficult to clean and can harbour pathogens that will transfer from one load to the next.



Never leave poor quality fruit lying in the orchard. This can provide an opportunity for fungal infections and other pathogens to propagate over winter, causing new infections in the following season. Damaged fruit can be used for composting, juice processing or animal feed.

Harvest early in the morning so that the fruit is at its lowest core temperature. Fruit can then be packed and stored with minimal precooling. When packing in the field, dampen the area around the packing site to prevent dust from blowing onto the clean fruit. Where possible, lay a tarpaulin under a shaded area for packing and ensure that it is kept clean.

Where possible, use chlorinated water at 200ppm (20ml per litre) to wash the fruit.

Part 2

Post-Harvest Handling

Pre-cooling

Fruit should be pre-cooled before shipping the fruits in cold storage and placement in refrigerated containers; sudden changes in temperature will cause the fruit to be damaged.

Immersion Pre-cooling

Immersing newly harvested apples in cold water is the most effective method of pre-cooling as it can be combined with the cleaning process and use of shelf life-extension chemicals. The heat transfer from a solid to a liquid when immersed is even and because of the contact with water will not cause dehydration as may be the case with evaporative or mechanical cooling. It is up to 60% more effective than air-cooling as water draws off the heat faster than air due to direct contact.



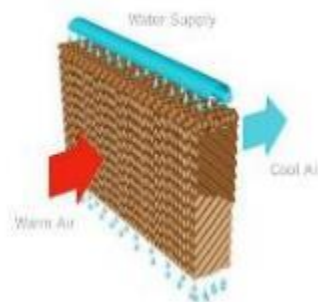
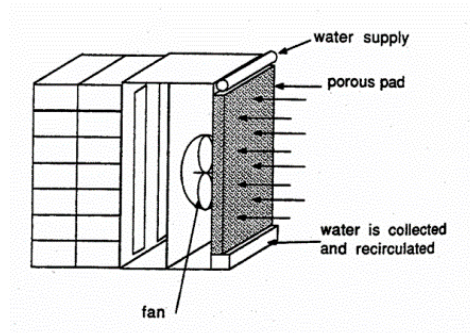
Use water that is cooled to your target temperature for storage of between 0.5^o and 2^o C to cool and clean the product. The water should be sanitary and not re-circulated, or it will need chlorine treatment. The apples should not spend an excessive amount of time in the water as they may absorb liquid leading to post-harvest disorders.

Evaporative Pre-Cooling

When air moves over a wet surface it causes evaporation of the water. During this process there is a transfer of heat from the surface to the passing air along with the moisture. The rate of evaporative cooling can be increased by using a fan to accelerate the air movement, causing more rapid cooling. This is additionally beneficial as it raises the relative humidity in the area being cooled, thus resulting in less moisture loss from the fruit.

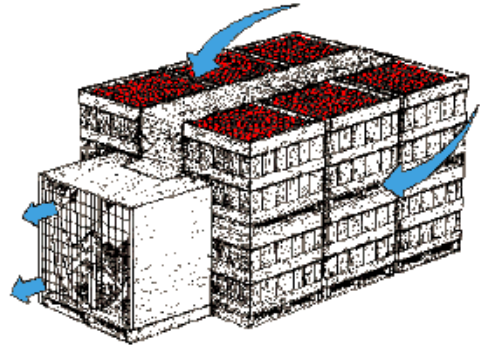
Mechanical Pre-Cooling

Mechanical pre-cooling uses high-speed cooled air to reduce the temperature of the product. This can be achieved utilizing specially-designed pre-coolers, refrigerated containers or creating forced air tunnels in cold rooms. When utilizing forced air/mechanical cooling it is important to maintain a high relative humidity (>90%), as the air will strip moisture from the product.



Reaching this core temperature in the shortest time possible is important to retaining quality and extending the shelf life of the fruit. (At 95% relative humidity, the fruit can be kept only 2 months at 41° F (5° C)).

If access to electricity and infrastructure are constraints, the use of a refrigerated shipping container powered by a generator is an affordable alternative. The cooling is not as rapid but will enable the temperature to be drawn down and maintained until transportation. The shipping container can also be used as a fumigation chamber for broad-spectrum fungicides and pesticides.



Post-harvest treatments

There are a number of ways of extending the shelf life of fresh apples by both preventing post-harvest disorders and retarding the factors that lead to premature aging.

Fungicides can be used either as a dip or through fumigation. The limitations of fungicides are that many export markets test for these chemicals and will reject shipments when residues exceed certain tolerances. The use of 1- methylcyclopropene (1- MCP) as either a fumigant or a dip halts the activity of ethylene receptors in the fruit, thus slowing down the ripening process and extending the shelf life of the product.

Sorting and grading

Proper sorting and grading is essential for reaching highest market prices. Below are some of the international export standards based on the United Nations Economic Commission for Europe (UNECE), complying with the Organization for Economic Cooperation and Development (OECD) requirements.

1. **Intact:** The apples should not be cracked or damaged by mechanical injuries.
2. **Sound:** Produce should not show signs of rot or deterioration such as to make it unfit for consumption.
3. **Clean:** Fruit is mostly free of any visible foreign matter.
4. **Pests:** Fruit is mostly free from pests.
5. **Damage from Pests:** Fruit is free from damage caused by pests affecting the flesh.
6. **Water core:** Fruit should be free of serious water core damage, with the exception of Fuji apples.
7. **Moisture:** Free of abnormal external moisture.
8. **Odors:** Free of any foreign smell and/or taste.

Part 3

Target Markets for Apple Export

Below are the specific market requirements for successfully importing apples into Pakistan, India, UAE and the Middle East, and other overseas markets (Europe, Central Asia, Canada and Australasia).

Pakistan

Pakistan offers opportunities for Afghan exporters looking for market opportunities within easy shipping distance from Afghanistan. Returns, however, are lower than other international markets. Pakistan imports Afghan apples both for home consumption and for resale to other overseas markets.

Regional Markets

Peshawar and Quetta

- These traditional markets have similar requirements to local markets.
- Supply is generally in bulk or 10-16kg boxes of mixed grade product shipped unrefrigerated.
- There is a low level of input, thus low returns to the exporter, with much of the product being transhipped or re-exported.
- Many Pakistani traders purchase entire apple orchards direct from the farmers leading to high yield losses.

Islamabad, Lahore and Karachi

- These markets offer opportunities for higher returns.
- They are run by wholesale commission agents who generally monopolize trade in certain products.
- The usual packaging is in 10-16kg cardboard packaging with mixed grades.

Supermarkets

- Supermarket sales opportunities include Metro Cash & Carry, Hyperstar (Carrefour), Al Fatah and Chase-up Shopping.
- Vendor registration and relationship management is required.
- There are good opportunities for well graded, staged supply. Packaging from 3.5 to 16kg is acceptable with negotiation.

India

The Indian market traditionally prefers red delicious varieties of apples. Afghan apples face high competition from apples imported from the U.S., China, Turkey and other locations, as a premium price is paid for size, color and quality. Afghan apple exporters have historically faced challenges in being able to provide the sorting and grading necessary to achieve highest returns.

Fees

There are no customs duties on fresh fruits. The following customs clearance fees are assessed at the Wagah border crossing (ground shipments) or at the airport:

Ground shipments:

- Fresh fruit: 5-8 Rs per kilo
- Dried fruit: 40-45 Rs per kilo

Air shipments:

- Fresh fruit: 30-35 Rs per kilo (incl. 11 Rs handling fee) for shipments up to 2 MT. For more than 2 MT, the fee is 20-22 Rs.
- Dried fruit: apx 100 Rs per kilo (incl. 11 Rs handling fee) up to 2 MT. For more than 2 MT, the fee is 80-85 Rs.

The boxes must be labeled with the following information:

- Product name
- Package weight (net and gross)
- Date packed
- Date of expiration ("Best before [date]")
- Importer and exporter name, address (in India and Afghanistan), phone number and/or point of dispatch

Documentation

A quality certificate is required for all products. This can be obtained from the Export Promotion Agency for Raisins, Fresh Fruit, Dry Fruit and Vegetables. A phytosanitary certificate for all products is required and for apples an additional declaration form must show that the produce has been tested and is free from contaminants. This can be obtained from the MAIL Quarantine Dept. In case of refrigerated apple shipments, the additional declaration form should state that these apples have been stored for 11 days at a temperature below 0.55 ° C. If additional tests are required, this will be mentioned on the import permit issued by the Indian government.

Other documents:

- South Asia Free Trade Agreement certificate of the origin country
- Invoice
- Waybill (if shipped by air)
- Product/packaging list
- Country of Origin
- Additional declaration form for shipments in refrigerated containers stating that the apples have been stored for 11 days at a temperature below 0.55 ° C.

All documents must be scanned and sent to the importer before dispatch of the consignment.

Wholesale markets

Delhi is home to India's largest wholesale market and has a large number of commission agents available. For a list of reputable agents, please contact the CHAMP New Delhi Trade Office, listed below.

There are many other large wholesale markets worth exploring in India, including Mumbai, Kolkata, Bangalore and Chennai. Commission Agents traditionally work on a 6-10% commission though there are often a number of handling fees that should be discussed in advance before consigning produce.

The wholesale markets will accept any form of graded and sorted apples, but a premium of up to 50% is paid for larger sizes of apples. Packaging can be in traditional 16kg cartons, though this can often result in compression damage. A well-graded, treated and cold-chain managed product in 16-18kg cardboard boxes with separators inside will attract premium prices later in the harvest season, when local supplies have diminished.

Facilitated Trade

CHAMP operates a New Delhi Trade Office through the Afghan Business Centre (ABC). The trade office can link Afghan exporters with Indian buyers, commission agents, supermarkets, and importers. It can coordinate the export of fruits with Afghan exporters, coach the traders in the requirements of Indian fruit markets and co-ordinate with Indian brokers in order to release the shipments from Indian customs authorities (air customs, border customs and inland customs).

The trade office will also provide transportation arrangements in order to deliver the cargo from customs to the importers' warehouses or cold storage facilities, while overseeing commission agents during sales. It will provide sales reports to the exporter, including shipment conditions after arriving at the market. It will also document the quality of the produce by taking pictures and providing recommendations to exporters for future shipments.

The trade office will coordinate with importers to release or transfer the pre-negotiated payments, providing specific transaction details. It can also coordinate lodging arrangements for Afghan exporters during their visits to India and assist them with language barriers.

This service, provided with a small service fee, assists in making the market transactions more transparent and reduces barriers to new entrants in the Indian market.

Channel Importers

There are a number of larger wholesale businesses, some with a national footprint. These businesses can offer a strong link to many of the major Indian customers, including supermarkets. These businesses are actively looking for consistent supplies of Afghan apples to complete the 12-month supply chain for their customers.

These channel importers are looking for higher quality and predictable supplies to integrate into their customers' supply chains. They may have a higher cost of doing business, but will

***For more information on
exporting to India, contact:***

**CHAMP New Delhi Trade Office
Attn: Nasrat Zaki
+91 (0) 8130 977 386
nasrat.zaki@abcpltd.in
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often return more consistent and higher prices. Contact the New Delhi Trade Office for more information.

Supermarkets

Apples are competitively sought by supermarkets in India, with many retail chains showing interest in Afghan apples. These supermarkets require not only a high standard of grading and packing, but also significantly higher levels of sophistication in building lasting relationships with exporters.

To deal directly with supermarkets, exporters must invest extensive effort into planning for the seasonal supply. The first step is gaining vendor registration through meetings and showing samples while communicating potential supply windows. If the quality, price and supply windows match up, then a relationship can be established.

Supermarket customers require a variety of sizes and grades of apple depending on their individual market dynamics and the volume of fruit that needs to be sold. With planned timing and good communication, volumes can grow to be very significant.

Supermarkets will embrace quality branded products and pay a premium, especially with the addition of promotional branding and point-of-sale material. Larger volumes of smaller sized apples can also be channelled into this market with good planning.

Packaging requirement must be negotiated with each supermarket. Premium fruit should be packed in four layers inside a cardboard box (16-18kg). Ideally, fruit should be in perfect condition, with waxing if possible, to assist in the extension of shelf life and aesthetics of the product.

UAE and Middle East

The Dubai market has a consistently strong demand for Afghan apples, but only when they have been properly processed, sorted, cleaned, graded and packaged according to the highest standards. Premium pricing is paid based on size, color and grading of the fruit. Consistent grading and sorting will deliver good returns, with A, B and C grade being in high demand in the market.

Fees

There are no customs duties on fresh or dried fruits. Each shipment will be assessed a municipality charge of 50 AED. Approximately one-third of shipments are inspected by customs agents. When a shipment is inspected, the shipment is assessed 150 AED.

Fresh and dried fruits must be packed in a completely white box labeled with the product name, weight, origin, shipper and destination. For fresh fruits, this box must be registered each year for a fee of 300 AED.

Wholesale markets

Dubai is the largest wholesale market in the region and has a large number of commission agents available. For a list of reputable agents, please contact the CHAMP Dubai Trade Office.

Commission Agents traditionally work on an 8-10% commission, though there may be a number of handling fees that can push the commission above 14%. These should be discussed in advance before consigning produce.

The wholesale markets will accept any form of graded and sorted apple, though a premium

of up to 50% is paid for larger sizes. Packaging can be in traditional 16kg cartons, though this can often result in compression damage. A well-graded, treated and cold-chain managed product in 16-18kg cardboard boxes with separators inside will attract premium prices later in the harvest season, when local supplies have diminished.

Facilitated Trade

In Dubai, CHAMP operates a trade office that facilitates sales of Afghan products, conducts promotion activities, arranges business-to-business meetings and facilitates proper documentation for the export of products from Afghanistan. The Dubai Trade Office also focuses on acting as an interface between Afghan traders and businesses in the Dubai market.

The trade office can coordinate the export of fruits with Afghan exporters and coach them in the requirements of UAE fruit markets. They can also coordinate with UAE brokers to release shipments from UAE customs authorities. The trade office will also provide transportation arrangements in order to deliver the cargo from customs to the importers' warehouses or cold storage facilities, while overseeing commission agents during sales. It will provide sales reports to the exporter, including shipment conditions after arriving at the market. It will also document the quality of the produce by taking pictures and providing their recommendations to exporters for future shipments.

The trade office can coordinate with importers to release or transfer payments by providing specific transaction details. It will also coordinate lodging accommodations with Afghan exporters during their visits to Dubai. This service, provided with a small service fee, assists in making the market transactions more transparent and reduces barriers to new entrants in the UAE market.

Supermarkets

Apples are sought by many supermarkets in the UAE, with many retail chains actively seeking Afghan apples for their customers. The supermarkets require not only a high standard of grading and packing, but also significantly higher levels of sophistication in building relationships with exporters.

To deal directly with supermarkets, exporters must invest extensive effort into planning for the seasonal supply. The first step is gaining vendor registration through meetings and showing samples while communicating potential supply windows. If the quality, price and supply windows match up, then a relationship can be established.

Supermarket customers require a variety of sizes and grades of apple depending on their individual market dynamics and the volume of fruit that needs to be sold. With planned timing and good communication, volumes can grow to be very significant.

Supermarkets will embrace quality branded products and pay a premium, especially with the addition of promotional branding and point-of-sale material. Larger volumes of smaller sized apples can also be channelled into this market with good planning.

Packaging requirements must be negotiated with each supermarket. Packaging can be in traditional 16kg cartons, though this can often result in compression damage. A well graded,

***For more information on
exporting to the UAE, contact:***

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treated and cold-chain managed product in 16-18kg cardboard boxes with separators inside will attract premium prices later in the harvest season, when local supplies have diminished.

Other Markets:

Europe, Central Asia, Canada and Australasia

Afghan apples have rarely had much success being exported beyond the immediate region (India, Pakistan and UAE), but have a strong potential if properly sorted, graded, cleaned and packaged. Premium prices are based on size, color and grading of the fruit. The largest and best graded apples will often attract a premium price that is required to make the extra effort worthwhile. There may also be secondary markets for fruit processed into juice.

Because of the extra distance and time to these markets, extra effort needs to be placed on post-harvest treatments, including waxing to reduce dehydration and cold chain maintenance. Because of the time, distance and cost to get to these markets, demand should be created in advance and a partnership developed with the channel importer to develop a transaction that is profitable for each party and which will mitigate the risks involved.

The ideal packaging for these markets is four-layer cardboard boxes with honeycomb separators. The use of the separators is internationally recognized and accepted and will reduce impact and compaction injuries in transit and allow for fruit to be shipped successfully at higher humidity with reduced dehydration.

Annex 1 – Apple Crop Calendar for Central Region of Afghanistan

Activities	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Dormant period												
Pre-bud swell												
Bud swell												
Bud burst												
Mouse ear												
Green Cluster												
Pink bud												
First flower												
Full bloom												
Late blossom												
End of blossom												
Pre-harvest												
Harvest												
Post-harvest												
Leaf fall												

Annex 2 – Disease Management Checklist

Crop Stage	Tasks to be done as Best Management Practices
Dormant Period	<ul style="list-style-type: none"> • Check for overwintering populations of rust mites behind growing shoots and buds, red spider mite winter eggs around spurs, aphids eggs on shoots, scale insects on bark and caterpillar larvae on apple twigs, branches and trunks. • Earmark orchards with populations of any of these pests for treatment at the appropriate time. • Apply winter oil for high populations of scale insects on bark while trees are fully dormant. • Remove badly-cankered branches, wood scab and mildew-infected (silvered) shoots and rootstock sucker growths during winter pruning. • Protect pruning wounds with suitable canker paint (Bordeaux paste and Bordeaux mixture application) or with wood glue. • Make compost pile for all leaf litter and pruned materials. • Check whether any leaf litter is left in the orchard by the end of February as this may be a source of scab inoculums. Plough thoroughly before bud-burst to aid biodegradation. • Fill gaps with saplings. • Form basin for irrigation. • Undertake nutrient management with irrigation management. • Stock pesticides.
Just before bud swell	<ul style="list-style-type: none"> • Consider a pre-bud burst spray of a copper fungicide, especially in areas where canker and scab were bad the previous season. This may give some control of overwintering scab and protect against canker.
Bud swell	<ul style="list-style-type: none"> • Assess weather conditions like humidity and rainfall. Forecast disease incidence from previous patterns.
Bud burst	<ul style="list-style-type: none"> • Monitor populations of apple pests at edges of orchards using the beating method if pest was present the previous season. • Spray for scab to maintain good protection at this sensitive stage.
Mouse ear	<ul style="list-style-type: none"> • Monitor numbers of rust mites on outer rosette leaves. If threshold (5 mites per outer leaf) is exceeded, apply acaricides or include sulfur at a reduced rate (25 – 33%) in the next 3-4 spray rounds.
Green cluster	<ul style="list-style-type: none"> • Conduct pre-blossom pest assessment for aphids, hairy and tent caterpillars, mites and other minor pests. Apply pre-blossom spray if necessary. • Start mildew spray program. Choice of horticultural product and dose volume and interval will depend on varietal susceptibility and mildew levels the previous year.
Pink bud	<ul style="list-style-type: none"> • Check truss leaves for scab until early June. Early detection of a potential problem is essential. Examine pink buds for tent/hair caterpillars, spray insecticide if larval population increases by 5%. • Assess powdery mildewed flower trusses. More than 2% indicates a problem, more than 10% a severe problem. Use eradicant mildew fungicide like baking soda.
First flower to full bloom	<ul style="list-style-type: none"> • Continue spray program for scab and mildew as necessary, but try to avoid spraying fungicide at this critical time. • Undertake irrigation management. • Undertake nutrient management.

Late blossom	<ul style="list-style-type: none"> • Conduct late blossom pest assessment for rosy apple aphids and fruit tree spider mites.
End of blossom	<ul style="list-style-type: none"> • Continue spray program for scab and mildew as necessary • Assess primary mildew vegetative terminal buds. More than 2% indicate a problem, more than 10% a severe problem. Use good eradicant mildew fungicide, decrease spray interval and increase spray volume if a problem is indicated. • Check for signs of wilting, drying blossoms due to blossom wilt. Cut out affected trusses now while they can be seen before cankers form. • Check for early signs of collar rot in older orchards on susceptible rootstocks. Early detection can help save the tree. • Apply post-blossom insecticide spray if required for rosy apple aphids or other pests. • Apply acaricides spray for fruit tree red spider mites if necessary. • Set out pheromone traps for codling moth. Record the catch of moths at least weekly.
Fruit formation	<ul style="list-style-type: none"> • Check orchard thoroughly for signs of scab on leaves or fruitlets for wood scab. Continue sprays as necessary if scab is present, or if the weather is very wet or if scab problems occurred last year. • Monitor secondary mildew in shoots regularly, at least fortnightly, ideally before each spray round. • Conduct pest assessment for green apple aphids, woolly aphids, fruit tree red spider mites, rust mites, tent/hairy caterpillars and scale insects. • Continue weekly monitoring of pheromone traps for codling moths. If required, spray suitable insecticide for control of codling moths, then spray as soon as the threshold pheromone trap catch is exceeded.
Berry size fruit, fruit size enlargement, color change	<ul style="list-style-type: none"> • Continue monitoring secondary mildew in shoots regularly, at least every two weeks, ideally before each spray round. Continue mildew sprays until the mildew growth has ceased. • Look for signs of dieback caused by canker. Cut out and burn. • Conduct pest assessment for woolly aphids, green apple aphids, fruit tree red spider mites, rust mites and scale. • Install mating disruption pheromones for management of codling moths. • Continue weekly monitoring of pheromone traps for codling moths.
Fruit ripening	<ul style="list-style-type: none"> • Continue monitoring secondary mildew in shoots regularly, at least every two weeks, ideally before each spray round. • Continue sprays for scab if necessary • Conduct pest assessment for woolly aphids, green apple aphids, fruit tree red spider mites, and rust mites. Apply control treatments as necessary
Pre-harvest	<ul style="list-style-type: none"> • Assess rot risk in each orchard. Determine the best way of minimizing losses due to rots with minimal use of post-harvest fungicide treatment.
Harvest	<ul style="list-style-type: none"> • Train pickers to be vigilant for pest and disease blemishes to fruit and record the causes of significant losses in each orchard. • Drench fruit in fungicide only where a significant risk of rotting has been determined.
Post- harvest	<ul style="list-style-type: none"> • In orchards with a high level of scab or powdery mildew, apply a spray of 5% urea after picking and before leaf fall. This will aid microbial breakdown of the leaves bearing scab or powdery mildew and prevent overwintering from developing.
Leaf fall	<ul style="list-style-type: none"> • To protect leaf scars from canker infection, apply a copper spray at the start of leaf fall and again at 50% leaf fall.

Grading

- Train grading staff to be vigilant for pest and disease blemishes to fruit and fungal rots and record the causes and extent (% incidence) of losses due to each cause in each orchard.

Annex 3 – Macronutrient Deficiencies and Excess

Nutrient	Function	Symptoms of Deficiency	Symptoms of Excess
Nitrogen (N)	Important for many growth and development processes. A constituent of proteins, enzymes, and chlorophyll (needed for photosynthesis).	Slow growth, stunting, and yellow-green color; more pronounced in older tissue; tips and margins turn brown; premature death.	Excessive vegetative growth, dark green color, excessive transpiration, reduced yield; delayed maturity; few fruits.
Phosphorus (P)	Stimulates early growth and root formation; promotes seed, fruit, and flower formation	Slow growth, stunting, and purplish or dark green color on foliage; dying leaf tips; delayed maturity; poor fruit or seed development.	Excess can interfere with micronutrient absorption; may mimic Zinc (Zn) deficiency.
Potassium (K)	Proper growth of fruits and flowers, ensuring good size, color and quantity.	Slow growth; leaf tip and marginal burn (starts on more mature leaves); weak stalks; small fruit and shrivelled seeds.	Light green foliage; tendency for Calcium and Magnesium symptoms to appear.
Calcium (Ca)	Essential part of cell wall structure, must be present for formation of new cells. Adequate in most San Diego soils.	Reduced terminal growth of shoots (buds) and roots, resulting in plant death.	Interferes with micronutrient availability.
Magnesium (Mg)	Essential for photosynthesis	Leaves curl upward along margins; marginal yellowing with green “Christmas tree” pattern along mid-ribs of leaves.	Interferes with Calcium uptake.
Sulfur (S)	Responsible for characteristic odors of plants such as garlic and onion	Reduced growth, delayed maturity. Light green to yellowish foliage on leaves; small spindly plants.	Not known.

Annex 4 – Micronutrient Deficiencies and Excess

Nutrient	Function	Symptoms of Deficiency	Symptoms of Excess
Iron (Fe)	Required for formation of chlorophyll in plant cells.	Yellow-green color, but veins remain green; twig dieback; reduced growth, and death in severe cases.	Mimics phosphorus, manganese deficiency.
Manganese (Mn)	Assists iron in chlorophyll formation and serves as activator for enzymes in growth process.	Yellow-green color of young leaves, but no sharp distinction between veins and interveinal areas as with iron.	Mimics iron deficiency; loss of foliage color, bronzing of leaf margins, necrotic areas.
Zinc (Zn)	Important plant growth regulator; essential in root and plant growth.	Yellow-green color, but veins remain green; decrease in stem length; rosetting of terminal leaves; reduced fruit bud formation; twig dieback after first year.	Not known.
Boron	Regulates metabolism of carbohydrates in plants. Critical for new growth in plants, flower pollination, fertilization, fruit set.	Death of terminal growth; thickened, curled, wilted leaves; Reduced flowering.	Rare except in inland deserts with high boron-contaminated water.
Copper (Cu)	Activator of enzymes in plants.	Stunted growth; dieback of terminal shoots in trees; death of leaf tips.	Reduced growth.
Chlorine (Cl)	Required for photosynthesis and root growth.	Very rare; wilting followed by yellow-green color; leaf bronzing.	Poor growth; marginal leaf necrosis.
Molybdenum (Mo)	Required by plants for the utilization of nitrogen. Plants cannot transform nitrate nitrogen into amino acids without molybdenum.	Stunting; reduced yield; lack of vigor; marginal scorching; cupping, rolling of leaves.	Not known.
Nickel (Ni)	Needed to complete the life cycle of the plant and viable seed.	Leaf tip necrosis	Induces iron and zinc deficiency; interveinal yellowing.

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