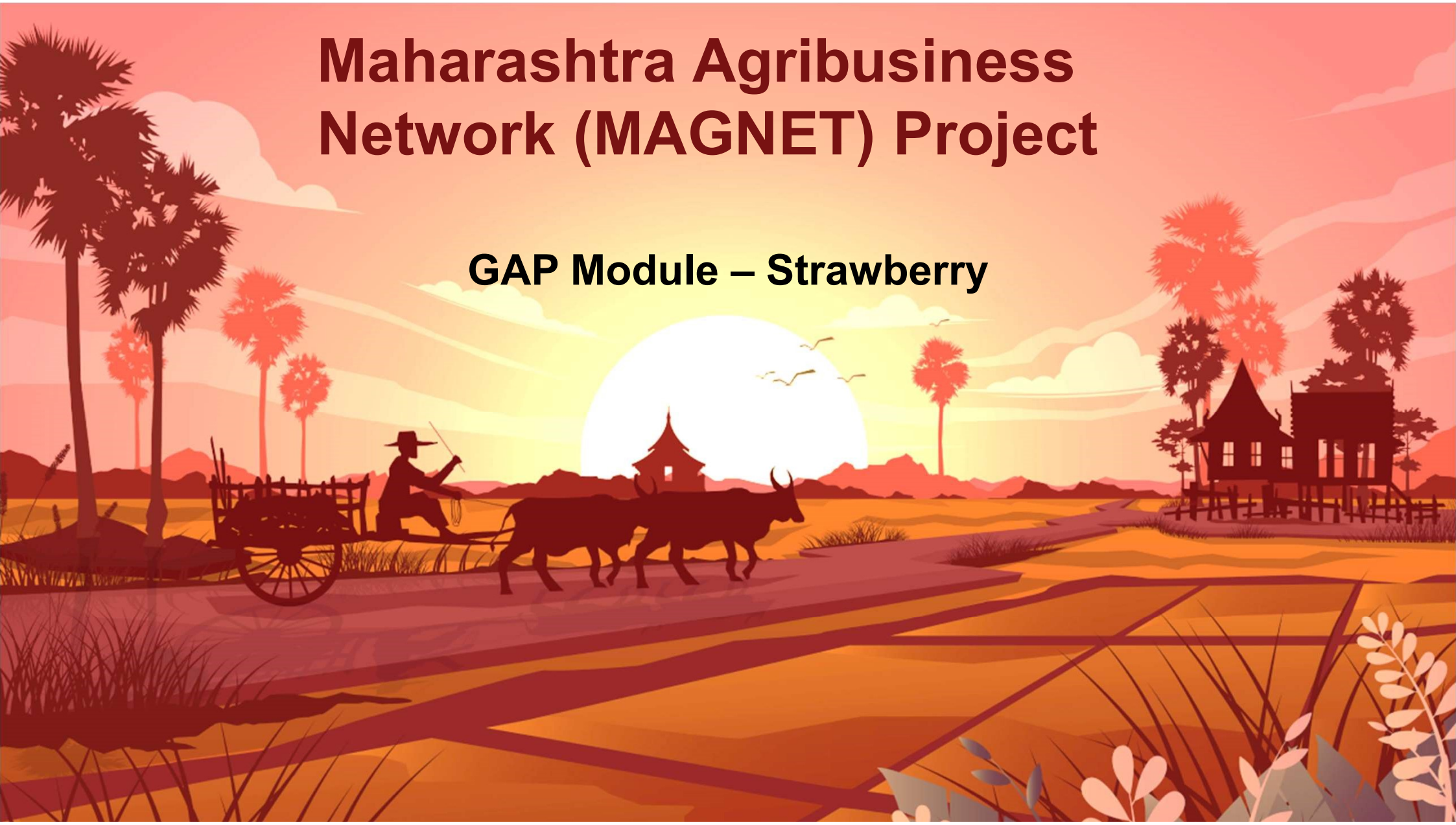
Maharashtra Agribusiness Network (MAGNET) Project

GAP Module – Strawberry



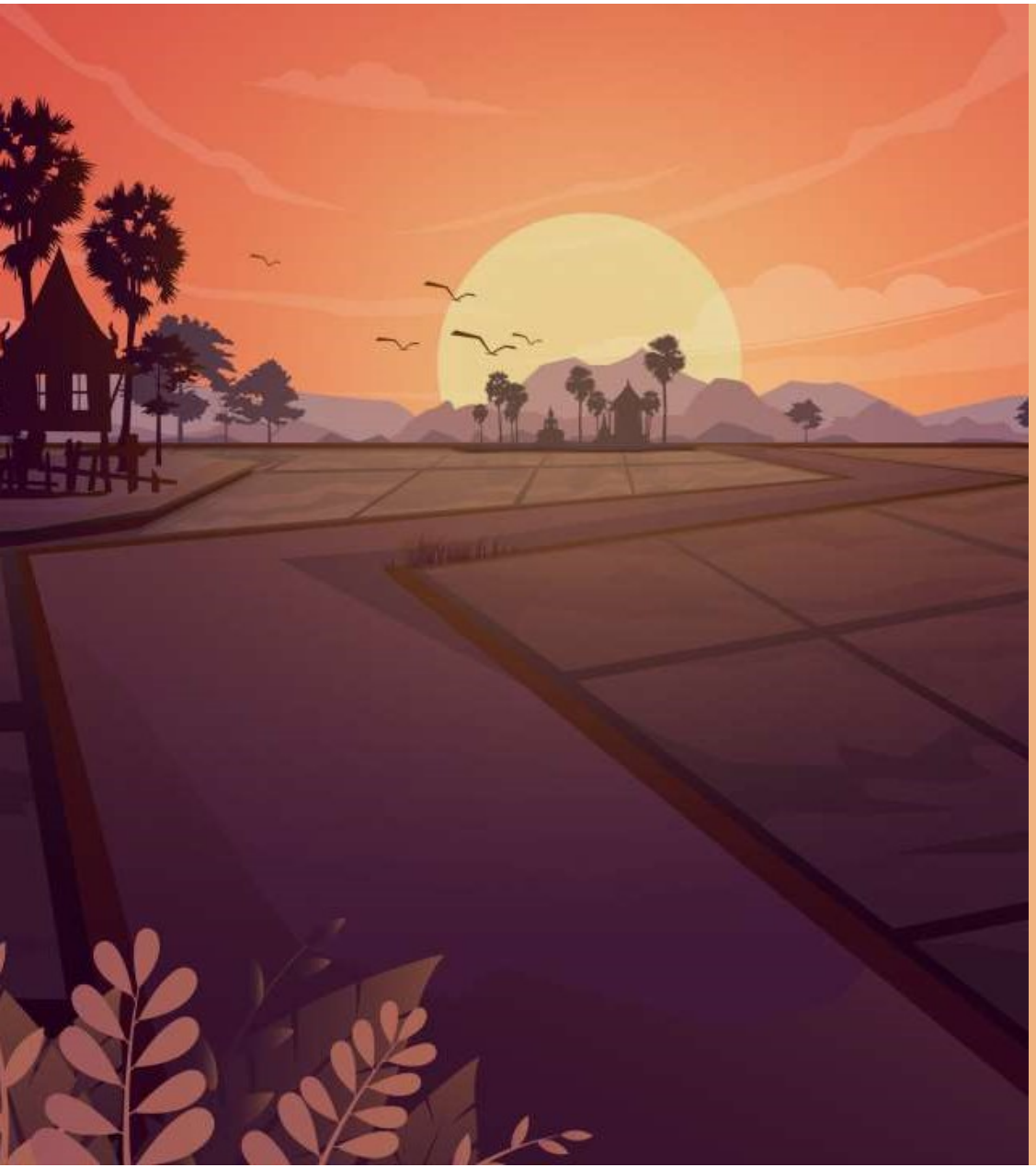


Table of Content

About Strawberry

- Over 100 varieties in the World.
- India has about 30, the largest number of varieties.
- According to the Germplasm Resources Information Network (part of the United States Department of Agriculture), there are 103 distinct species and subspecies of strawberry plants.

Family: Solanaceae

Genus: Capsicum.

Species: annuum (most common), frutescens (Eg.Tabasco), chinense (Eg. Habanero), baccatum

Strawberry Benefits

Boost Brain Function:

Strawberries are rich in iodine, vitamin C and phytochemicals, which help maintain the proper functioning of the nervous system

Aid in Skin Care:

Strawberries can protect your skin from pollutants and UV damage

Boost Immunity:

Vitamin C, present in strawberries and many other types of fruits, helps boost the immune system and helps in curing common cough and cold

Help in Preventing Birth Defects:

Folic acid is a necessary nutrient, especially during pregnancy, as it helps in preventing birth defects.

Help Prevent Constipation:

Due to their fiber content, strawberries help boost digestion and prevent constipation They can be particularly good for children.

Managing Diabetes:

Eating strawberries may lower the risk of developing type 2 diabetes as strawberries have a low glycemic index

Varieties

Varieties of Strawberry

Pajaro

Large-sized fruits with red-colored, firm skin and flesh.
They are susceptible to damage caused by rain but are tolerant to viral attacks

Sweet Charlie

The variety is an excellent choice for home gardens, thanks to its quality fruits and compact plant size, making the harvest easier.
The sweet strawberries are a good choice for fresh eating. They have relatively low levels of acid and bear fruits during June.

Several varieties of strawberries are available that are pest and disease resistant, which can be adapted easily to different climatic conditions, and importantly have a higher yielding capacity and good runner producing capacity.

Varieties of Strawberry

Chandler

- Large-sized fruits with firm skin and flesh.
- A single strawberry weighs around 18 grams.
- Owing to the outstanding color and flavor, the berries are popular for desserts.
- They are tolerant towards viral attacks and resistant to physical damages caused by rain.

Tioga

- Large-sized fruits with firm skin and flesh.
- A single berry weighs 9 grams approximately.
- An early maturing variety.
- They are tolerant to viral attacks.

Torrey

- Large-sized fruits with skin and flesh of medium firmness.
- They produce numerous runners.
- Each berry weighs about 6 grams.
- The dessert quality is excellent and so is the processing quality.
- Tolerant towards viral attacks.

Varieties of Strawberry

Selva

- Being day-neutral variety, it produces off-season fruits.
- Large-sized, conical to block-shaped fruits with a firm flesh and skin.
- Individual berry weighs upto 18 grams.
- Has excellent dessert quality.
- They can be shipped and handled during transportation.

Belrubi

- Large, conical fruits with bright red skin and flesh.
- Tastes sweetly acidic.
- Individual berry weight is around 15 grams.
- Plants produce runners

Fern

- This variety is early ripening and day neutral.
- It is of overbearing type cultivar.
- Fruit-size varies from medium to large with firm, red-colored skin and flesh.
- Produce excellent flavour.
- Well-suited for the fresh market.
- Fruit taste varies between sweet to slightly acidic.
- Individual berry weighs between 20-25 grams

Cultural Practices

Climate

Strawberry grows well under temperature climate

Some cultivars can be grown in sub-tropical climate

It is a short day plant, which requires exposure to about 10 days of less than 8 hours sunshine for initiation of flowering.

Daylight period of 12 hr or less and moderate temperature are important for flower-bud formation.

Each cultivar has a different day length and temperature requirement.

Day light

- From the standpoint of response to length of the light period, strawberries are placed in two groups:
  - Varieties that develop flower buds during both long and short light periods, the overbearing varieties and
  - Varieties that develop flower buds during the short light periods only, most commercial varieties.
- In winter, the plants do not make any growth and remain dormant. The exposure to low temperature during this period helps in breaking dormancy of the plant.
- In spring when the days become longer and the temperature rises, the plants resume growth and begin flowering.
- The varieties grown in milder subtropical climate do not require chilling and continue to make some growth during winter.

Soil

Strawberry requires a well-drained medium loam soil, rich in organic matter.

The soil should be slightly acidic with pH from 5.7 to 6.5

Alkaline soils and soils infected with nematodes should be avoided. At higher pH root formation is poor

Alkaline soils and soils infected with nematodes should be avoided. At higher pH root formation is poor

It is preferable to plant it in green manured field.

Land Preparation

Strawberry should not be cultivated in the same land for a number of years

For cultivating strawberry, the land must be ploughed deeply and then harrowed.

Once the ploughing is complete the land is prepared for planting. Organic manure - like farm yard manure, neem cake, etc. is mixed with the soil before planting the runners.

Different systems of strawberry plantation are followed such as matted row, hill system, spaced row or plastic mulch

Propagation

Propagation is done by means of runners that are formed after the blooming season.

The plants may be allowed to set as many runners as possible but not allowed to set any fruits.

All the plants with good root system should be utilised to set a new plantation.

Given the best attention and care, a single plant usually produces 12 to 18 runners.

Sowing Strawberry Plant

At the time of plantation, they must be set in soil softly with the roots running straight downwards.

Then the soil must be packed in a compact manner around the roots to keep air out.

However, ensure that the growing point of the strawberry plant stays just above the soil surface.

They must be irrigated immediately after planting and must not be allowed to dry.

Plantation methods

Matted Row Method

- This is the most common system of plantation followed in India.
- It is the most economical and easiest method of cultivation. Runners are planted with spacing of 90 x 45 cm.
- The runners after the initial growth are allowed to cover the vacant space around the mother plant. This gives it a matted appearance. Heavy soils wherein weeds do not grow easily are used for strawberry plantation in this method. It must be taken care to prevent overcrowding in this method.

Hill System Method

- This method of cultivation is followed when only a few runners must be developed. The runners must the mother plants are removed.
- Hence, the individual plants that grow are large in size and bear more fruits than those in matted rows.
- The inter-planting distance must be 25-30 cm. The distance between the twin rows must be 100 cm.
- A twin row system is followed here

Plantation methods

Spaced Row

- In case of cultivars producing average to weak runners, the daughter runners are kept at certain distance. Only some tips of runners are chosen which can develop into plants. Such tips are covered with soil.
- The practice is followed till each mother plant has the desired number of daughter plants.

Plastic mulch

- As the name suggests, a black, plastic film is used as mulch. The main idea is to control the weeds and preserve the moisture content.
- The plants bloom earlier than otherwise and they are less susceptible to damage by frost.

Plant Spacing

In Mahabaleshwar, the usual practice is to plant on raised beds 4 x 3 meters or 4 x 4 meters.

The planting distance should be 45 cm from plant to plant and 60 to 75 cm. from row to row.

Transplanting is done in March-April, September-October, in hills and in the plains, in the months of January-February.

At Mahabaleshwar normally strawberry is planted during November-December.

Mulching in Strawberry cultivation

- Soil is covered with mulch, protects the roots from cold injury in winter or cold climate. Straw mulch is used most commonly*.
- Black alkathine mulch is also used as it saves irrigation water, prevents the growth of weeds and keep the soil temperature high.
- The mulch also keeps the fruits free from soil, reduces decay of fruits, conserves soil moisture, lowers soil temperature in hot weather, protects flowers from frost in mild climates and protects plants from freezing injury in cold climates.

Fertilizer application

The land for strawberry planting should be thoroughly prepared by deep ploughing followed by harrowing.

Liberal quantities of organic manure should be incorporated in the soil before planting.

Application of manures and fertilizers as per soil test report.

Strawberry requires moderate amounts of nitrogen.

Organic matter in the form of 50 tons of Farm Yard manure per hectare is highly desirable - it improves the water holding capacity of the soil & also helps with better runner formation.

Fertilizer application

- Farm yard manure can be supplemented by chemical fertilizers to make up the total requirement:
    a) Nitrogen 84 to 112 kg/ha;
    b) Phosphorus 56 to 84 kg/ ha; and
    c) Potash 56 to 112 kg/ ha.
- The Phosphatic fertilizer should be incorporated into the soil before plantings.
- Nitrogenous fertilizer be applied in two doses
    - Three weeks after planting and
    - At the time of flowering
    - Potash at the time of flowering only.
- Adequate nitrogen gives higher yield of early berries

Irrigation

- Shallow-rooted Strawberry is susceptible to drought conditions
  - Planting early in autumn with frequent irrigation to newly planted runners allows the plants to make good vegetative growth before the onset of winter and reduces the otherwise high mortality of the plants.
  - During September and October, irrigation is given twice a week in case there is no rain, and reduced to weekly intervals during November.
  - In December and January, irrigation may be given once every fortnight.
  - When fruiting starts, the irrigation frequency may should again be increased. At this stage frequent irrigation gives larger fruits.

Area & Production

- Strawberry is cultivated in Himachal Pradesh, Uttar Pradesh, Maharashtra, West Bengal, Delhi, Haryana, Punjab and Rajasthan. Sub-tropical areas in Jammu have also the potential to grow the crop under irrigated condition.
- Satara district accounts for the country's 80% strawberry production - grown mainly in Mahabaleshwar, Wai and Panchagani areas.
- According to Agriculture ministry estimates, the production of the fruit in India has dropped by 40% from 8,000 metric tonnes in 2014-15 to around 5,000 metric tonnes in both 2015-16 and 2016-17.

Crop stage-wise IPM

Life span of strawberry plant

- A single strawberry plant begins to lose its vigour at about 3 years of age, in most cases, but few individual plants will make it to 6 years, but with decreased productivity.
- The plant can keep its ‘line’ going indefinitely through runner plants – an important method of propagation. Thus, with even a few plants, one can keep on growing strawberries forever, provided the plant doesn’t get diseased and is well cared for.

Crop Rotation in Strawberry Cultivation

- The strawberry plant starts bearing fruits from the second year onwards, and it demands a lot of nutrients from soil.
- Hence it must be rotated with leguminous crops like beans after harvest.
- Once harvested it is advisable to cultivate strawberry again after a break period of one year.

Pre-Planting cultural practices

- Timely planting
- Maintaining orchard sanitation and roguing (removing plants with less than desirable qualities)
- Elimination of alternate host plants and weeds
- Planting of the attractant, repellent, and trap crops around the periphery or bunds.
- Growing of trap crop like tomato or marigold to control leaf miner disease
- Planting of tall border crops like maize and sorghum to manage mites and thrips attacks.

Control of Weeds, Nematodes and Pests

- Weeds
  - The soil is ploughed during summer with a soil turning plough to control weeds
- Soil borne pathogens, nematodes, resting stages of insects

  They are controlled by following Biological control methods that include
  - Reducing nematodes and soil dwelling pests by application in soil (at the time of last ploughing) of
    - Neem cake/ Pongamia cake at 100 Kg per acre or
    - Press mud at 2 Tons per acre.

Planting

Planting

- The ideal time of planting Strawberries in India, in hilly areas and northern states is during September and October.
- Planting them too early may lead to low yield and less than optimum fruit quality.
- Because of tropical climate of India, many farmers/ gardeners prefer growing strawberries in the greenhouse, instead of growing outdoors for better production and fruit quality.

Nutrition

- Application of fertilizers based on the soil test report and expert recommendations for specific/ particular zone.
- Generally, for every acre 30-40 Kg N, 16-48 Kg P O and 16 - 32 Kg K O may be applied according to soil type and the variety planted.
- Full dose of phosphorus and half dose of potash is given at the time of planting by placing the fertilizer at a depth of 15 cm between the rows.

Management of Weeds and Soil borne pathogens, nematodes, resting stages of insects

Weed Control

- At the time of planting, the field is kept weed-free by physical methods like harrowing and ploughing. The intercultural practices are continued till the straw /plastic mulch is applied.

Soil borne pathogens, nematodes, resting stages of insects

- They are largely managed by cultural control measures such as:
  - Use of tolerant /resistant varieties
  - Avoiding the overlapping during planting
  - Using of drip irrigation/ judicious irrigation

Pests and Diseases

Nutrition

- Nitrogen is applied in two equal doses.
  - First dose is given one month after planting and
  - Second dose is given at the time of flowering.
- Potash is applied at the time of flowering
- Four Foliar applications of liquid fertilizers (containing 0.5% N, 0.2 % P O and 0.5 % K O) are recommended during August to February for all strawberry growing areas.

Weed Control

- The orchard is kept weed-free by weeding machine or weeding tool or by hoeing.
- To suppress the weeds between the rows, it is recommended to use straw or plastic mulch.

Red Spider Mite

Resort to the following methods:

- **Cultural control**
  - Scouting of field/ orchard regularly
  - Controlling of weeds in and around the orchard.
- **Biological control**
  - Conservation of natural enemies (predators) like
  - Ladybird beetle, green lace wings, phytoseiid mite, Syrphid and observe P.D. ratio*.
  - Release ladybird beetle, green lace wings at 2 per plant

*P.D. ratio refers to Pest: Defender ratio. The general rule to be adopted for management decisions relying on the P: D ratio is 2: 1. However, some of the parasitoids and predators will be able to control more than 2 pests.

Alternaria Leaf spot

Alternaria Leaf Spot disease is managed by cultural control measures as below:

- Cultural control measures:
  - Scouting of field/ orchard and
  - Regular vigilance

Powdery Mildew

Powdery Mildew is managed by

- Mechanical control methods like
  - Clipping off of infested foliage and plant materials
  - Destroying ghe clipped infested materials

Leaf spot

Leaf Spot is managed by

- Mechanical control methods like
  - Removing and burning trash from the previous crop cycle
  - Avoiding overhead irrigation or watering.

Red stele

- Red Stele problem is managed by following cultural control methods that include
  - Not planting Strawberries in fields where Red stele has previously occurred.
  - Using only certified and resistant plants and
  - Selecting well-drained sites

Black root rot

Black root rot disease is managed following

- Cultural control methods like:
  - Using only certified plants
  - Avoiding poorly drained plots or sites
  - Rotation of planting sites and
  -Fumigation methods

Wilt

The Wilt problem is managed by following common cultural, mechanical and biological practices.

The cultural control measures include

- Avoidance of plantation of tomato, potato, pepper, brinjal and raspberry

Anthracnose (black spot)

Anthracnose (black spot) is largely managed by following:

- Cultural control
  - By fumigation of soil and soil solarization
  - Following crop rotation with non-host crops
  - Prior to planting, wash away all soil from plant crowns
  - Carry out weeding around strawberry plants on a regular basis
  - Plant only selected, disease free transplants
  - Avoid using excessive amounts of nitrogen fertilizer

Angular leaf spot

The Angular leaf spot disease is managed largely by following

- Cultural control:
  - By using of only certified planting stock
  - Carrying out crop rotation and
  - Avoiding overhead irrigation

Leaf Roller

The management of Leaf Roller is largely achieved by following

- Cultural control
  - Hand clipping of rolled leaves in trails and destroying the same
  - Regular monitoring and vigilance

Root Louse

The Root Louse problem is managed by following cultural and biological control methods as below:

- Cultural control:
  - By going for crop rotation with cowpea and legumes
  - By securing plants free from infestation
  - Treatment or dip of the strawberry plants for some time in strong solution made by boiling stems or leaves of tobacco
- Biological control:
  - Application of neem cake

Aphids

The Aphid problem is managed by cultural and biological control measures as below:

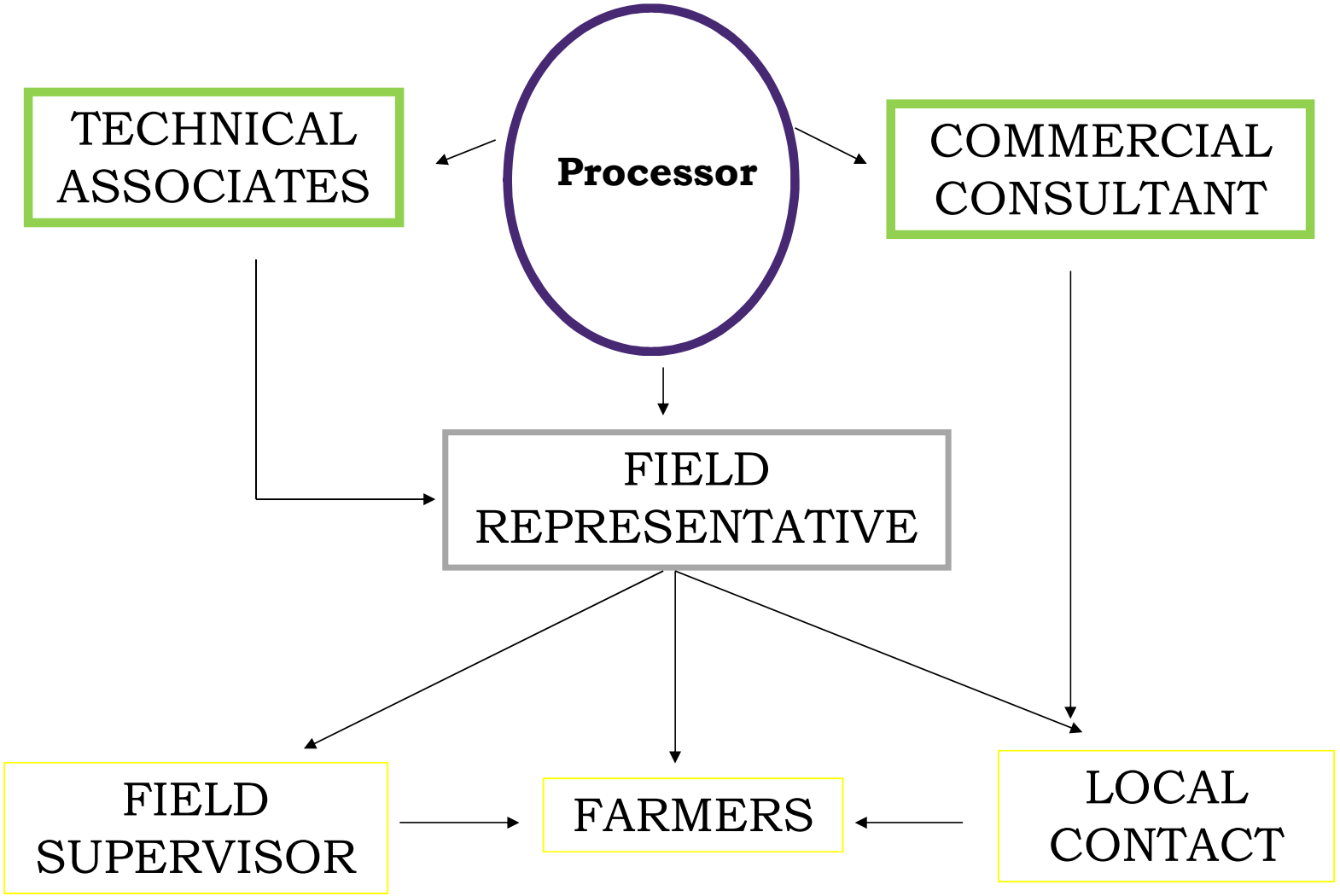
- Cultural control
  - Carried out by clipping off of the leaves infested with aphids
- Biological control
  - Conserving and augmenting predators like coccinellids, Syrphids, green lace bug and parasitoids

Cutworms

The cutworms problem is managed by following cultural and mechanical control measures:

- Cultural control
  - Weed control is a very important step in preventing a serious cutworm problem
  - Pruning reduces overwintering larvae
- Mechanical control:
  - Facilitated by installation of bird perches

Backward Integration



Qualified agriculturists along with local partners co-ordinate all field activities

Purpose of Contract Farming

- Controlled pesticide use.
- Controlled pesticide dosage.
- Controlled timing of pesticide application.
- Secure supply chain for protection from artificial colour/ dyes.

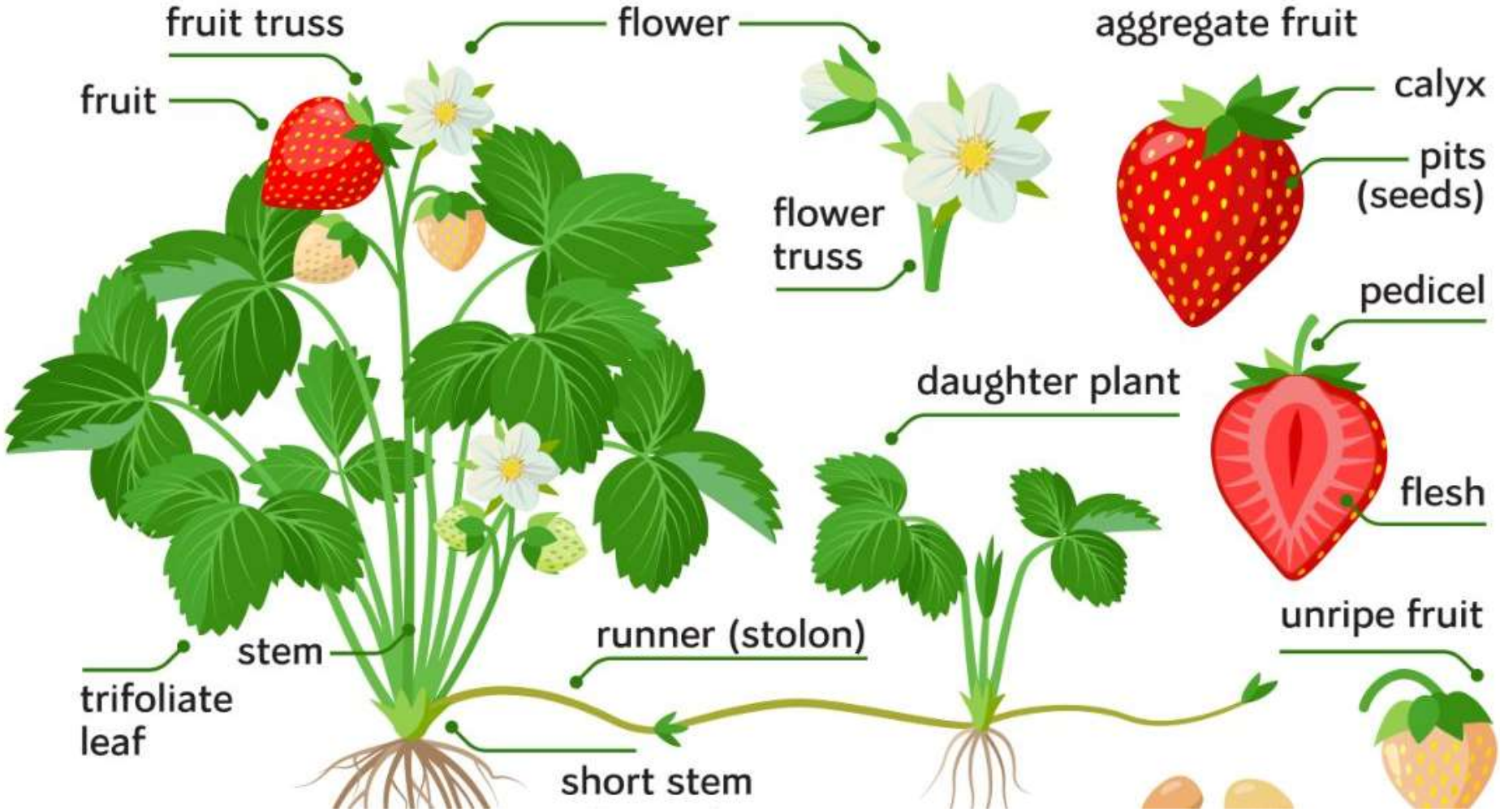
Integrated Pest Management

Pesticide Residue Control

1. Pesticide Residue is controlled by restricting application of pesticides in the field.
2. Pheromone traps and other observation methods help understand intensity of pest incidence and decide the right pesticide application.
3. When pesticides are to be applied, the right pesticide is chosen by our technical field staff based on the MRL's allowed under EU regulations.
4. Pesticides are rarely repeated.
5. 40 day pesticide holiday before harvesting is strictly observed.
6. Detailed logbook captures information regarding what, how much and when applied of the pesticide.
7. Lab gives feedback to field staff regarding residues found in the chilies cultivated by them. Helps to fine tune practices.

Crop

Strawberry Plant Parts



Source: Strawberry .org

Strawberry – pre & post harvest

- Strawberry - unharvested

- Harvested Strawberry

- Fresh cut Strawberry

- Frozen whole Strawberry

Source: Strawberry .org

Harvesting and Quality Management

Harvesting Strawberries

- The strawberries are harvested when fruits are firm and about three-fourth of the fruit has developed the colour.
- For local markets they are picked when fully ripe.
- Normally, harvesting is done on a daily basis.
- If the weather is dry then they must be harvested early in the morning.
- After harvesting they must be packed directly in flat, shallow containers.
- It is not advisable to wash them as washing causes them to get bruised and lose color.

Sorting, Grading and Packing

- In places like Mahabaleshwar, Nainital, Uttarakhand, and Kashmir harvesting starts from May to June, once the strawberries start ripening from late February till April.
- After plucking the strawberries are sorted, graded and packed into shallow trays, with one or two layers of fruits.
- The trays maybe of bamboo, cardboard or paper.

Low temperature storage and Transport

- Being perishable, Strawberries require a great deal of care in harvesting and handling as well as its marketing.
- Usually the fruit is picked in the early morning and sent to the market the same day in the afternoon or fruit is picked in the late afternoon, stored overnight in a cool place, and sent to market the following morning.
- The freshly harvest ripe fruits can stay good for upto 3 days at ambient conditions but the storage period can be extended to 8 to 10 days by storage at lower temperatures.
- It is transported in refrigerated vehicles.

Cold Storage

- Once harvested the fruits should be cooled to 1 to 4 C and stored for up to 10 days at the same temperature.
- Fruits can be stored under cool conditions for up to 10 -12 days.
- If transported to distant places, the strawberries are pre-cooled to 4ºC within 2 hours of harvesting and then shipped in refrigerated vans.
- For still longer storage periods, fruits are quick frozen and stored at -18 C in frozen storage, with 90 to 95% humidity.

Damaged Strawberries

- Physiological defect

- Damaged due to Pest Attack

- Over ripe/ Soft fruits

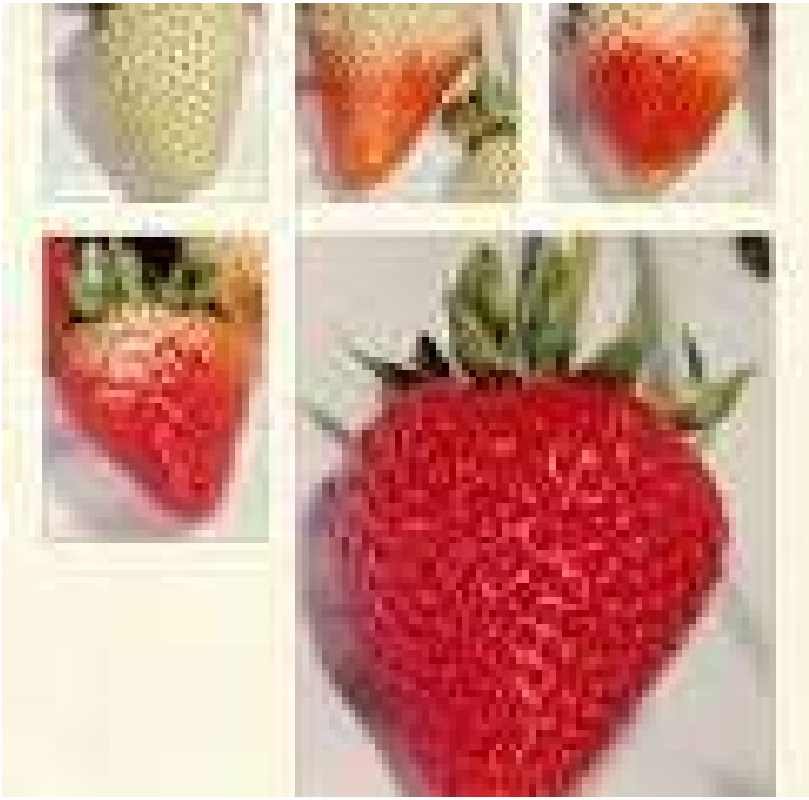
- Fungus-infested

Post Harvest Management

Maturity and fruit decay

- The maturation criteria are based on the colour of the surface of the berry.
- The TSS (total soluble solids) content of fruits is highest in fully matured berries and the lowest in less matured fruits (1/3rd)., in fresh form and the TSS increases during the storage period
- The level of anthocyanin content also increases as strawberry fruit ripens, which is accompanied by a decrease in firmness and chlorophyll content.
- The acidity of fruit decreases with increasing maturity.

- The more mature the fruit the decay in storage is more.
- The shelf life of fruit at the white tip stage (less matured) is higher than that of the red ripe stage (more matured).
- The increased ripeness leads to decreased firmness and enhanced fruit rotting.



Quality Indices

- The quality of strawberries are linked to their appearance: colour, type, shape, freeness from any defect and also to firmness, taste, scent and nutritional value.
- U.S. Grade A or U.S. Fancy:
  - It is the quality of frozen strawberries that possess similar varietal characteristics; that possess a good flavor; that possess a good color; that are practically free from defects; that possess a good character; that score not less than 90 points when scored in accordance with the scoring system.

Fungal decay is the major contributor to the loss of strawberry quality.

Optimum Temperature

- Should be cooled as soon as possible to reduce water loss.
- Storage at above 7.5°C cause water loss, shrivel, color change and decay.
- Storage at 7-10°C is considered the best for maximum shelf-life (3-5 weeks).
- Chiles can be stored at 5°C for at least 2 weeks without visible signs of chilling injury.
- Storage at 5°C reduces water loss and shrivel, but after 2-3 weeks, chilling injury is mostly detected as discoloration of the seeds.

Strawberry and value addition

- Fresh packed Strawberries

- Oven dried Strawberry

- Dried Strawberry

- Strawberry Preserve

Frozen Strawberry

Shape	oval
Taste	Sweet
Freezing Process	IQF
Glutinous	No
Shelf Life	1 Months
Type	Other, Fresh Strawberry
Size	3 inch
Weight (kg)	1 Kilogram (kg)
Colour	red
Cultivation Type	Organic
Part	Whole
Variety	Red Strawberry
Delivery Time	2 Days
Packaging Details	Plastic box

Source: Ghadge Patil Strawberry Garden, Mahabaleshwar

Processing for Market

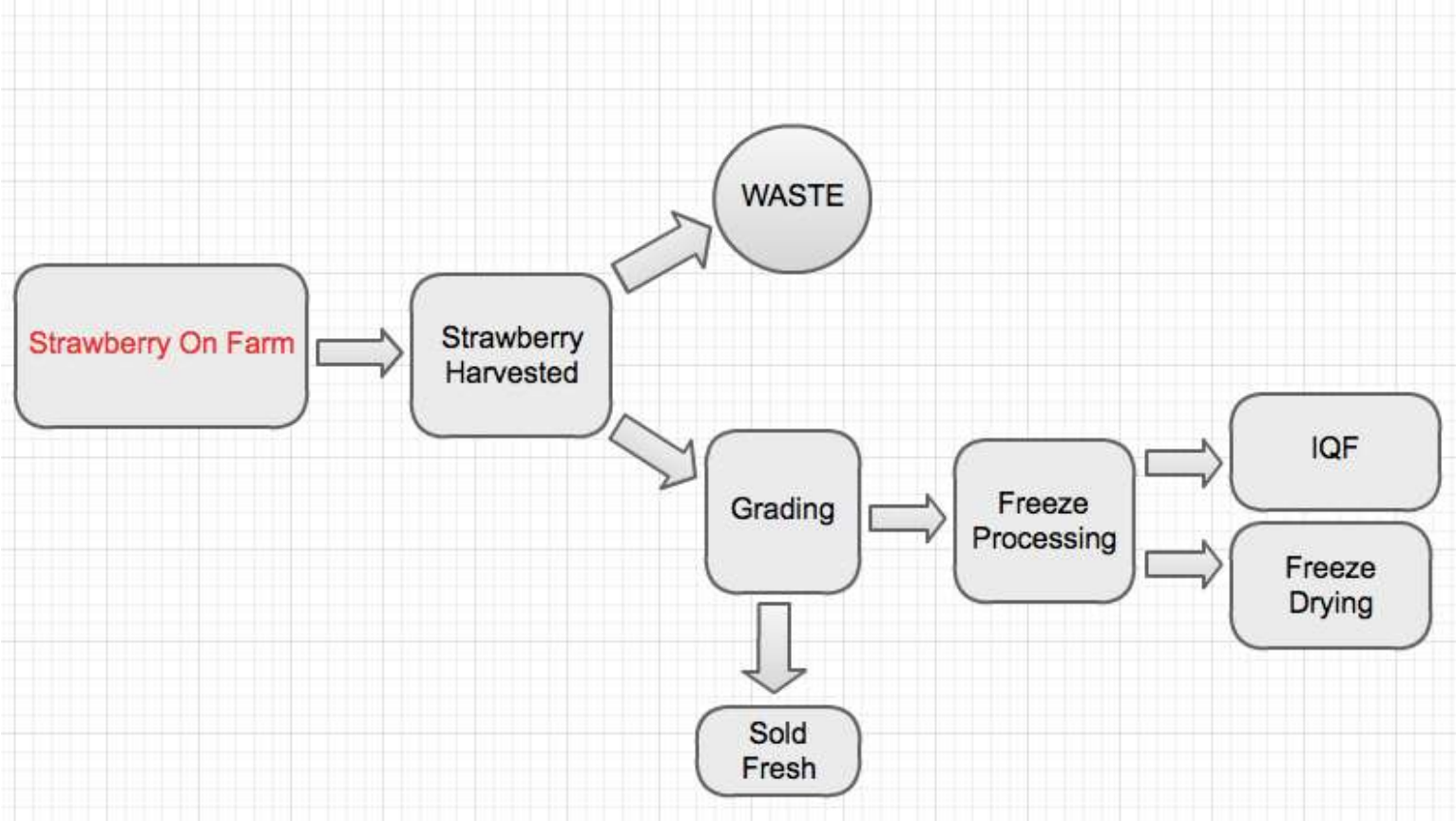
- Size Grading of fresh Strawberry

- Colour sorting Whole frozen Strawberries

- Strawberry packed in Punnets

- Quick Frozen Cut Strawberry

Flowchart of Strawberry processing



Source: University of British Columbia

Strawberry grade

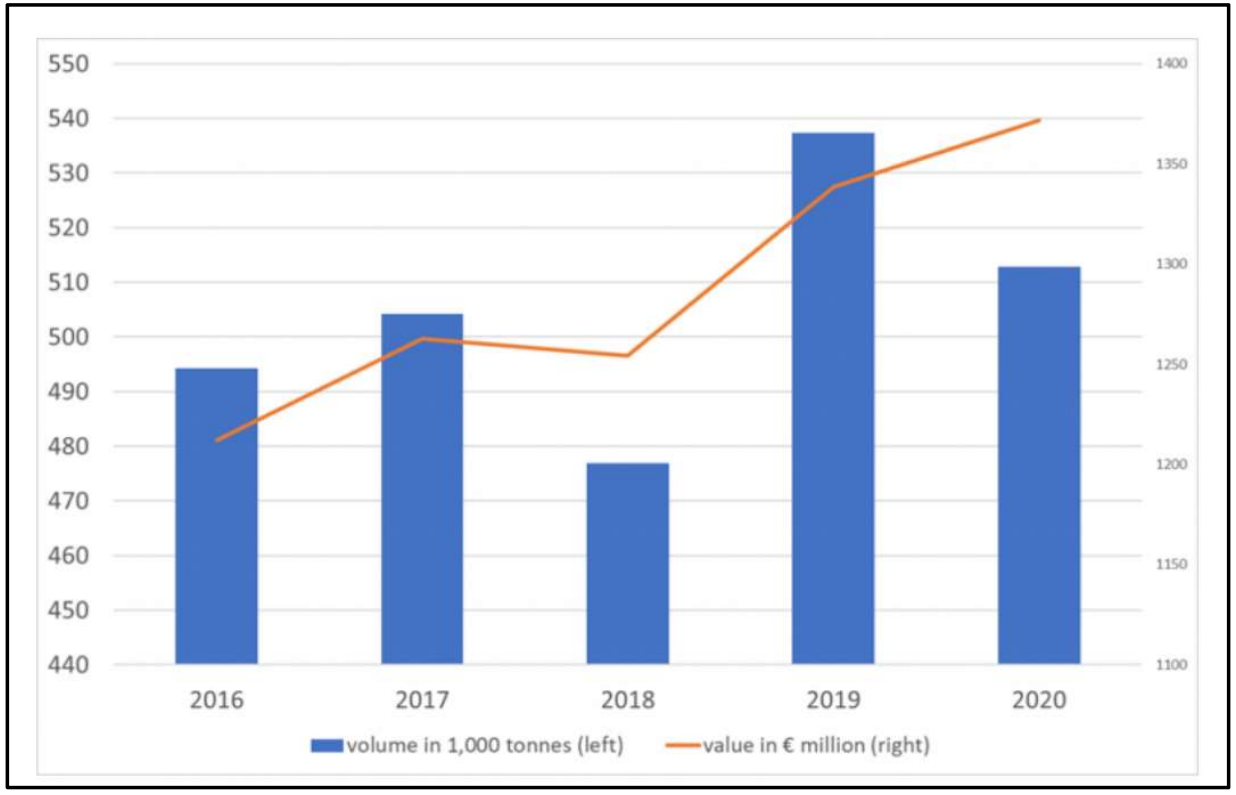
Grade	Value	Description
Undamaged	zero	– berries with no abrasions but may have up to two bruises less than 2 mm in diameter
Slightly damaged	1	– berries with no abrasions but may have up to four bruises less than 2 mm in diameter
Moderately damaged	2	– less than 25 % of the berry bruised or moderate abrasions covering less than 25 %
Severely damaged	3	– any berries with bruises or abrasions which penetrated the surface of the fruit
Very severely damaged	4	– entire fruit bruised, mould formation or pieces of fruit missing

Strawberry grading system with considered value for each damage level

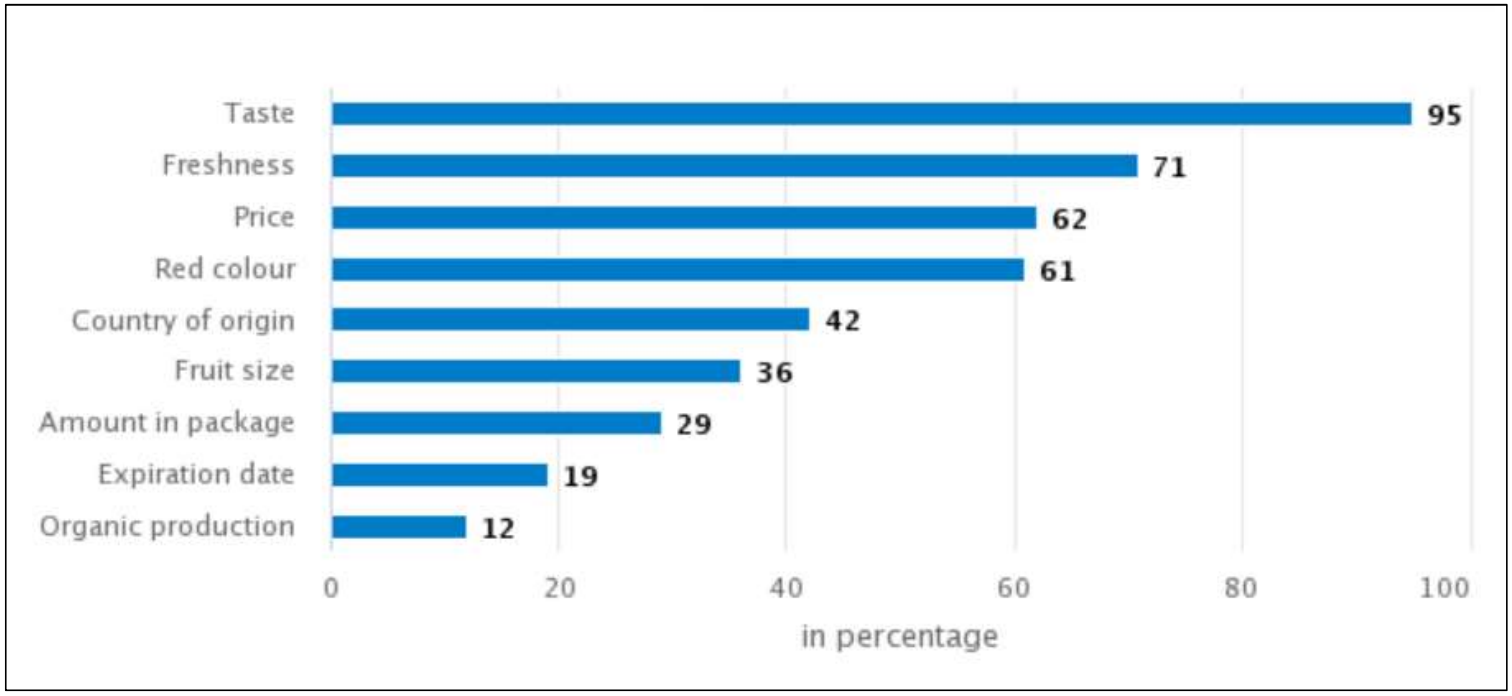
Source: Saeed, A, et al, 2015. Mechanical Damage of Strawberry During Harvest and Postharvest Operations. Research Gate Vol 18.

Processing and Exports

Total European Import and Internal Trade



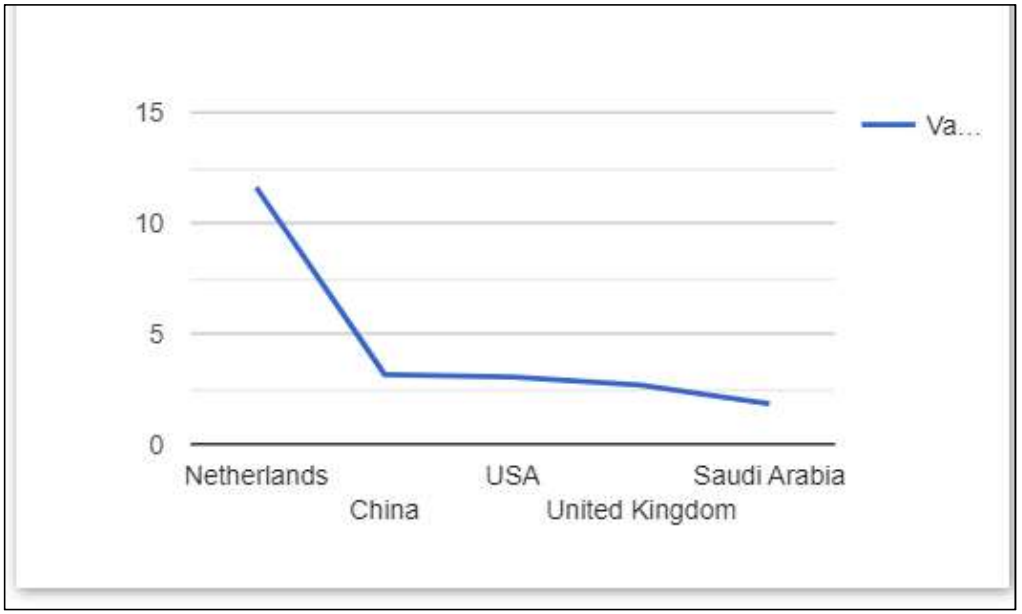
What do Europeans look for when purchasing Strawberries (2019) (Source: CBI)



Top Countries for Export of Strawberries from India

Country	Value (USD Million)
Netherlands	11.61
China	3.14
USA	3.04
United Kingdom	2.66
Saudi Arabia	1.83

Top Importing nations for Strawberry



Important Notice:

The information on performance of recommendations given in this handbook holds good only when used under optimum conditions. Their performance may either change in due course of time due to several factors or can vary under different systems of management. Mishandling/negligence of the user can also result in damage/loss/non reproducibility of results.
The user is advised to contact their nearest KVK and refer to the latest Ad-hoc list for information on banned chemicals and other nationally-issued directives.

महत्वाची सूचना:

या हँडबुकमध्ये दिलेल्या शिफारशींच्या कामगिरीची माहिती इष्टतम परिस्थितीत वापरली जाते तेव्हाच चांगली राहते. त्यांची कार्यक्षमता एकतर अनेक कारणांमुळे योग्य वेळी बदलू शकते किंवा व्यवस्थापनाच्या वेगवेगळ्या प्रणालींमध्ये बदलू शकते. वापरकर्त्याच्या चुकीच्या हाताळणी / निष्काळजीपणामुळे परिणामांचे नुकसान / पुनरुत्पादन न होणे देखील होऊ शकते. वापरकर्त्यास त्यांच्या जवळच्या केव्हीकेशी संपर्क साधण्याचा आणि प्रतिबंधित रसायने आणि इतर राष्ट्रीय-जारी निर्देशांच्या माहितीसाठी नवीनतम तदर्थ यादीचा संदर्भ घेण्याचा सल्ला देण्यात आला आहे.

Thank You

Contact Details

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