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Handbook for Agrotextiles

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MESSAGE

Agriculture forms the backbone of the Indian economy and one cannot disregard the significant role that agriculture plays in the Indian economy and in the daily lives of its citizens. Yet, food security continues to be a pressing issue in India. In light of this major challenge, Agrotextiles utilization has helped the agriculture community in attaining increased yield and enhanced quality in agricultural produce. Thus, to further promote the usage of Agrotextiles in India, I am pleased to release the report on **Study on Developing Measures to Promote the Use of Agrotextiles in India** conducted by the Ministry of Textiles as part of the Technology Mission on Technical Textiles.

Agrotextiles constitute an important and impactful sector that is very closely aligned with the needs of the agriculture community. Amongst its various benefits, Agrotextiles protect produce from harmful external elements and assist in better soil management. These benefits provide farmers with enhanced productivity and increased yields resulting in further socio-economic development of the stakeholders within the agriculture community. This report focuses on laying the foundation and setting the roadmap to accrue the economic and social benefits from the usage of Agrotextiles.

I am proud that the joint and tireless efforts of the stakeholders are being realized and hope that this study will provide the necessary information on the current usage of Agrotextiles along with detailed data on the key interventions required to increase the economic and environment benefits for the nation. I sincerely hope that this report leads to increased interactions in the entire Agrotextiles value chain and result in stronger partnerships amongst the various stakeholders.

I eagerly hope that this study proves beneficial to the industry & farmers for a better understanding of the Agrotextiles industry in India and its potential uses.

(K.S. RAO)

श्रीमती पनबाका लक्ष्मी
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Message

The growth of the Indian economy is significantly reliant on the success of the agriculture community. Traditional methods are limited in their ability to increase yields with the current constraints of restricted space and water supply. In this context, Agrotextiles have proved to be an effective alternative that delivers strong results despite the constraints. In our endeavour to increase the utilization and application of Agrotextiles in India, I am happy that the report on Study on Developing Measures to Promote the Use of Agrotextiles in India is being released.

The study ensures that the Indian Agrotextiles sector has been exhaustively analysed and appropriately benchmarked against the most relevant and widely recognized best practices from across the globe. Along with a comparative analysis of the Agrotextiles industry in India and abroad, the study also provides valuable insights into the various Agrotextiles products, theirs uses & applications as well as the associated socio-economic and environmental benefits. Further, the recommendations provide a well-defined direction for promoting the development of the Indian Agrotextiles industry.

The assessment of the Agrotextiles industry in India involved the support of various Government organizations, project teams and individuals associated in the ecosystem. I am proud of our efforts and hope that various stakeholders shall utilize this report and partner with us in our pursuit of accelerating the development of this significant sector.

(Panabaaka Lakshmi)

New Delhi
January 11, 2014

Zohra Chatterji
Secretary

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MESSAGE

Despite significant economic growth and improved living standards, the surge in population has continued to increase the demand for various agriculture products considerably. The decrease in cultivable land, unpredictability of the monsoons and imbalanced distribution of irrigation facilities necessitates improvement of India's agricultural yield to sustain its growing population and Agrotextiles is a sector that has exhibited successful outcomes across the globe in increasing the yield and quality of agriculture and horticulture produce.

Further progress in this field is possible with the application of new technologies, processes and products. The Ministry of Textiles has got a detailed study done to further the understanding of the Agrotextiles industry, its benefits & scope for application in India and to chart a strategic plan to accelerate the development of this sector. I take great pleasure in releasing the report of the **Study on Developing Measures to Promote the Use of Agrotextiles in India**.

The utilization of agrotextiles is a technique which has shown significant improvements in agricultural productivity; even in unfavourable conditions. Some of the benefits of the usage of agrotextiles are enhancing freshness in fruits and vegetables, prevent soil from drying, protection from harmful pesticides, yield increase etc. However, there are challenges such as lack of awareness of agrotextiles, cultivation complexities, affordability and high investment costs which act as deterrents for potential agrotextile entrepreneurs. This report points towards developing solutions to address these challenges and suggest the necessary steps required to overcome the identified impediments. I am sure it will prove to be a critical initial step towards obtaining a better comprehension of the agrotextiles sector and will contribute towards attaining further cooperation with all stakeholders in ensuring that efforts and objectives are jointly realized for achievement of the common goal of increased productivity in agriculture.

I congratulate the Joint Secretary, Shri Sujit Gulati and the team of officers which have taken this sector forward with great interest & devotion.

(Zohra Chatterji)

This report is a compilation of literature/data/photographs from various sources (including public sources including internet, manufacturers and sources cited in the annexures) as suggested by key stakeholders during the course of the assignment. This objective of the handbook is to promote the usage of agrotextiles in the country and should be used only for the promotion of this sector.

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Introduction

Technical textiles are defined as 'textile materials and products manufactured primarily for their technical and performance properties rather than their aesthetic or decorative characteristics'. Technical textiles are reported to be the fastest growing sector of the textile industrial sector and account for almost 19% (10 million tonnes) of the total world fibre consumption for all textile uses. Agrotextiles is one of the forerunners in this growth within technical textiles.

Agrotextiles are textiles used for their functional benefits in the agricultural field. With the continuous increase in population worldwide stress on agricultural crop production has increased. Hence it is necessary to increase the yield and quality of agro-products within the space and water constraints we are faced with today. But it is not possible to meet this increased demand completely with traditional methods such as use of pesticides and herbicides. The agriculture and horticulture industries have realized the need to pursue various technologies to get higher overall yield and better quality agro-products. The essential properties required in agro textiles are strength, elongation, stiffness, resistance to sunlight and resistance to toxic environments. All these properties help with the growth and harvesting of crops and other foodstuffs. With growing diseases due to various chemicals in and pollution, due emphasis is laid on organic foods and vegetables today. These are best done with controlled use of water, sunlight and composts duly achieved by use of agrotextiles.

Fibres Used for Agrotextiles

Synthetic as well as natural fibres are used in agro textiles. Fibres used in agro textiles are as follows:

a) Polyethylene
b) Polypropylene
c) Jute
d) Wool

Among all these fibres the polypropylene and polyethylene is extensively used whereas among natural fibres jute is used as it not only serves the functional purpose but is also bio-degrade and acts as a natural fertilizer at that point.

The key functional properties that are required of agrotextile products keeping in mind their applications are as follows:

- *Weather resistance* – They must work effectively in various climatic conditions involving wide ranging temperatures, precipitation, etc.
    - *Resistance to micro-organisms* – They must be resistant to microorganisms to protect the produce and prevent diseases

- *Stable construction* – The construction must be such that they can undergo a fair amount of wear and tear
- *Light Weight* - The weight of the fabric should be such that it can be borne by the plant
- *Resistance to solar radiation*. – They protect the plant from solar radiations
- *Resistance to ultraviolet radiation* – They must protect the plant/living being from ultra violet radiations
- *Long service life* – They ideally should have long life span
- *Biodegradability* – Agro textile products should be biodegradable after their life so that they do not pollute the soil and environment.
- *Water conservation* – They must have high potential to retain water and reduce evaporation

Overview of Key Products

Agrotextiles have vast areas of application and accordingly their classification also varies. Agro textiles can be classified on following basis:

Classification of Agrotextiles on the basis of fabrics production technique:

a) Woven
b) Non-woven
c) Knitted

Classification of Agrotextiles on the basis of areas of application:

a) Agrotextiles for crop production (agriculture)
b) Agrotextiles for horticulture (garden cultivation), floriculture and forestry.
c) Agrotextiles for animal husbandry and aqua culture.
d) Agrotextiles for agro packaging related applications.

The various types of Agrotextile products are:

1. Shade Nets
2. Windshield Nets
3. Bird Protection Nets
4. Crop Covers
5. Plant Nets
6. Root Ball Net
7. Anti-Insect Nets
8. Harvesting Nets
9. Mulch Mats/Ground Covers
10. Anti-Hail Nets
11. Fishing Nets
12. Turf Reinforcement/Protection Net
13. Pallet Net Covers
14. Woven Sacks/Bags
15. Leno Bags

Shade Nets

Shade Nets are nets made of Polyethylene or Polypropylene thread with specialized UV treatment having different shade percentages. These nets provide a partially controlled environment by primarily reducing light intensity and effective heat during day time to crops grown under it. This enables lengthening of the cultivation seasons and well as off-season cultivation depending on the conditions and type of crop. Shade nets are typically used in structures known as shade net houses which are frame structures made of materials such as GI pipes, angle iron, wood or bamboo which are then covered with shade nets to provide the benefits listed above.

Each plant has its individual and unique requirements for sunlight and shade under which it flourishes at its best. To create optimum climatic conditions, selection of the correct percentage of shade factor plays an important role to enhance plant's productivity to its optimum.

Figure 1: Shade nets

Shade nets are available in different shade percentages or shade factor i.e. 15%, 35%, 40%, 50% 75% and 90%. For example 40% shade factor means - the net will cut 40% of light intensity and would allow only 60% of light intensity to pass through the net. Typically the 35%, 50% and 75% shade factors are most common.

The principal environmental parameters that affect the rate of photosynthesis are

- Carbon dioxide
- Water supply
- Mineral or nutrients in the soil

Apart from being affected by availability of water, availability of nutrients, Carbon dioxide; Photosynthesis plays a vital role and hence plantation growth and yield is significantly affected by the following factors

- Intensity of light
- Colours of Visible Spectrum (spectral colours)
- Temperature

- U.V. Radiation
- Wind
- Rain
- Hail

If the conditions (factors) that the plant needs are improved, the rate of photosynthesis will increase. The maximum rate of photosynthesis will be constrained by a limiting factor. This factor will prevent the rate of photosynthesis from rising above a certain level even if conditions needed for photosynthesis are improved. If factors such as intensity of light, temperature etc are increased beyond limiting factor then it will have an adverse effect on growth and yield.

Thus, using suitable shade net will enable to modify or create an optimum protected environmental condition, which will result in enhanced quality and quantity of yield:

a) Help in cultivation of flower plants, foliage plants, medicinal and aromatic plants, vegetables & spices.
b) Used for raising nurseries of fruits and vegetable
c) Helps to enhance yield during summer season
d) Protection against pest attack
e) Protects crops from natural weather disturbances such as wind, rain, hail, frost, snow, bird and insects
f) Used in production of graft saplings and reducing its mortality during hot summer days
g) Used for hardening tissue culture plants
h) Helps in quality drying of various agro products
i) Helps in creating favourable micro environment for production of vermi-compost

How to Install Shade Nets?

Shade nets are typically used in Shade Net Houses. Depending upon the costs involved in the construction, these shade net houses are of three types – low cost, medium cost and high cost.

- The ***low-cost shade net house*** is made of a supporting structure of Bamboo and UV stabilized shade net covering. It doesn't have any climate control system. Costing for low cost shade net house including all the components is around Rs 150 per square metre.
- The ***medium-cost shade net house*** is made of G.I pipes, profile springs and wires, and a UV stabilized shade net which has a high HDPE granule content percentage (up to 4-5 %) which in turn increases the life of the net house. Costing for medium cost shade net house including all the components is around Rs 180-250 per square metre.

- The ***high-cost shade net house*** is made of steel tubes and has many facilities like auto control mechanism, heating, cooling and humidification system, drip irrigation system, etc. These have the life span of around 8-10 years. Costing for high cost shade net house including all the components is around Rs 300 per square metre

Shade Factor	End Uses
35 %	Roses, Strawberry, Gooseberry, Tomatoes, Cucumber and fruit bearing plants
50 %	For plants that grow under partial light like general Pot and foliage plants and Cut greens, Orchids, Anthuriums, Ginger
75 %	For plants that grow under extreme low light like Indoor plants, certain Orchids, plantation crops, Tea, Coffee and useful in summer to reduce the light level
90 %	Usage in Cattle sheds, Poultry houses, Construction Scaffolding and vehicular shades.

Components of Shade Net Houses

- Depending on choice of shade net house, GI pipes, bamboo or steel for the structure along with nuts and bolts to hold structure in place at the joints
- Special aluminium locking profile to fix covering materials with structure
- Bears, hanging load 15- 25 Kg per Sq. Mt.
- UV stabilized covering materials like Insect Net or Shade Net
- Trellising system for vegetable
- If high cost shade net house is being installed, then Control System - Manual/Semi-Automatic/Automatic
- Planting material - soil less media like coco peat.

Shade Net Installation

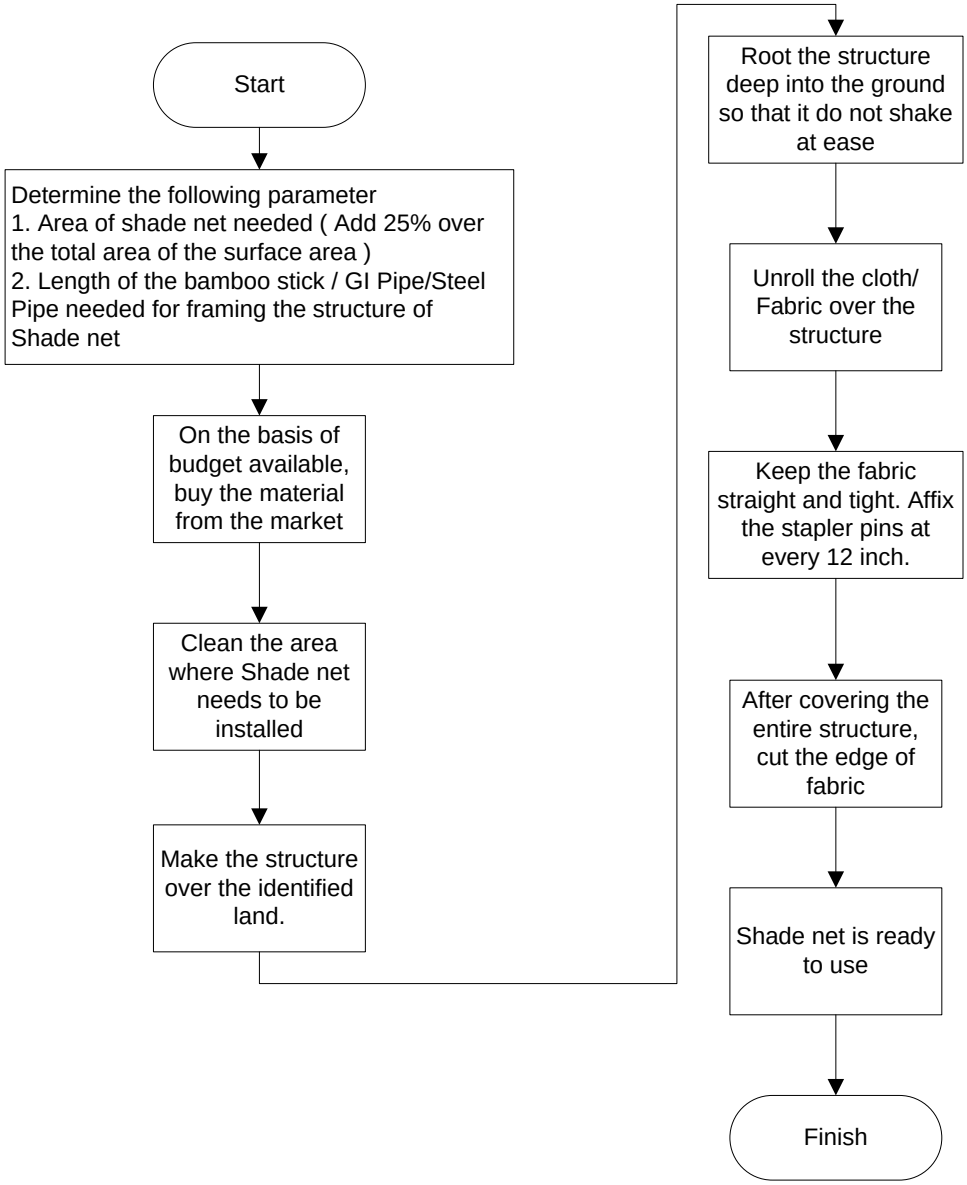
- Measure out about 25 per cent more shade cloth than you will need to cover the entire structure. Unroll the shade cloth across the structure, leaving at least one foot of cloth overhanging on all sides. Pull the cloth into position, straightening as needed.
- Start with the longest side you will be covering and affix the cloth with staples every 12 inches across the structure. Staple near the inner side of the board so they will not interfere when you later go to cut the edges off the fabric. Keep the fabric taut and the lines on the knitting straight as you work across the length of the structure.
- Begin stapling on the closest short side, keeping the shade cloth evenly lined up as you head in the direction away from the home. Always continue in the same clockwise or counter clockwise motion you began in when attaching the cloth; never start stapling from an unattached side.

- When you finish the last edge, try to avoid any overlap in the fabric. Affix the cloth to rafters and centre supports of the structure as needed.
- Specification of shade nets as per established BIS (Bureau of Indian Standards) that should be adhered to while selected shade net is as follows:

Sr. No	Characteristic(s)	Requirements			Test Method
		Type 1 50% shading	**Type 2 75% shading**	**Type 3 90% shading**	
1	Weight/square meter (g/sqm)	Min. 100	Min. 120	Min. 140	IS 1964, ISO 7211/6
2	Avg breaking strength (raveled strip method, 325mm x 70mm[#], (N):				IS 1969 (part 1), ISO 13934
	a) Warp way	Min. 200	Min. 250	Min. 290	
	b) Weft way	Min. 200	Min. 250	Min. 290	
3	Retention of breaking strength after UV exposure, N	Min. 85 percent of original actual value (fabric)			Annex B and IS 1969 (part 1)
4	Bursting pressure, (kg/cm^2)	Min. 5	Min. 6.0	Min. 9.0	IS 1966 - 1975
5	Haze %	Min. 15%	Min. 18%	Min. 22%	Annex C
6	Colour fastness to artificial light[##]	Min. 4	Min. 4	Min. 4	IS 2454 – 2008
[#]	*Width after ravelling = 50 mm, Gauge length = 200 mm*				
[##]	*Applicable for coloured shade nets only.*				

Figure 2: Installation of Shade net

Flow Chart


Start
Determine the following parameter
1. Area of shade net needed (Add 25% over the total area of the surface area)
2. Length of the bamboo stick / GI Pipe/Steel Pipe needed for framing the structure of Shade net
On the basis of budget available, buy the material from the market
Clean the area where Shade net needs to be installed
Make the structure over the identified land.
Root the structure deep into the ground so that it do not shake at ease
Unroll the cloth/ Fabric over the structure
Keep the fabric straight and tight. Affix the stapler pins at every 12 inch.
After covering the entire structure, cut the edge of fabric
Shade net is ready to use
Finish

Windshield Nets

Wind Shield Nets are designed for the protection of crops, small trees and plants from strong winds. They are UV stabilized in order to ensure durability and they are easy to install. There is loop line provision so that a beanpole can be used to hold the net towards the wind.

Figure 3: Wind shield Nets

Each type of cultivation has different wind standing properties at different wind speed. If the speed of wind increases beyond the tolerable speed of plant, there is a risk of fall (plant or fruit or flowers) which will defeat the objective of cultivation. To create optimum climatic conditions, selection of the wind shield with appropriate height plays an important role to enhance plant's productivity to its optimum.

Thus, Wind Shield enhances the overall productivity by following factors:

- Wind control fabrics can improve fruit quality by minimizing brushing, shoot tip scorching.
    - Trees that are protected from wind are generally healthier, reach full growth more rapidly, and have higher yield.
    - Wind break fabrics protect crops from wind and, in some cases, orchard temperatures can be increased by reducing wind speed.
    - Wind Break fabrics start blocking wind immediately, don't harbour insects, require little maintenance, and will not compete with crops for water and nutrients.
    - U.V. stabilized fabrics provide years of wind protection for crops. These fabrics are also made up of UV stabilized polyethylene mono filaments both woven and knitted form.

Advantages of using Windshield Nets are as follows:

i. Prominent wind breaker
ii. Nursery propagation, floriculture, indoor plants, vegetables, tea, coffee, spices.
iii. Drying of various agro products

How to Install Windshield Nets?

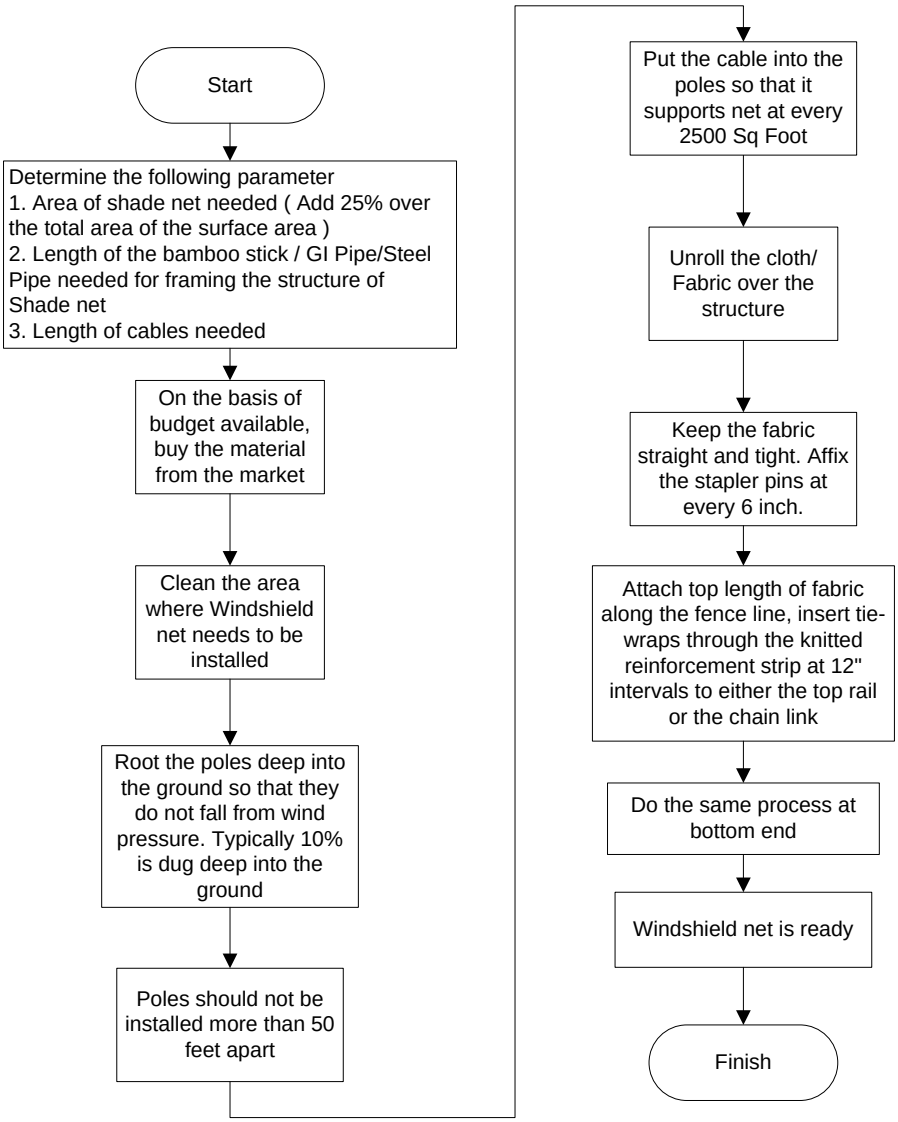
a) Unroll the fabric along the fence line. Double fold the vertical edge of the fabric to create a 2" hem. Position fabric at desired height, aligning edge over the tension bar.
b) Starting at the top corner, secure the fabric along the vertical edge with the tie-wraps at 6" intervals. Insert the tie-wraps through the hem (approximately 1" from the edge) and around the tension bar.

c) Attach the top length of the fabric along the fence line, inserting tie-wraps through the knitted reinforcement strip at 12" intervals to either the top rail or the chain link.
d) Pull the fabric tight and attach along the bottom using the same procedure in step 3.
e) Complete the installation by trimming the fabric and attaching the remaining end to the tension bar following instructions in step 2.

Mounting of Windshield Net

a) Poles: Poles should be no greater than fifty feet apart. The depth of the poles in the ground varies with conditions from region to region depending on such factors as soil density, water to soil ratio, type of pole used, etc. Typical pole depth is 10% of the pole's overall height, plus 3 feet buried.
b) Cables: The netting should be supported every 2500 square feet. A cable is required along the top and bottom. The upper support cable should be a minimum of 7,000 lbs. bursting strength. Bottom cable's strength is 3,800 lbs.
c) Mounting the Cables: If wood poles are used, eye bolts should be mounted through the pole facing the inside of the range. Steel poles require a bracket to be welded perpendicular to the fence line facing inside of the range. The cable should not be allowed to move through the mounting hardware. The cable can be secured by placing a cable clamp through the eye bolt head to trap the cable.
d) Mounting the Net:
    i. With Hog Rings: As the material is unrolled on the ground, it will appear substantially narrower and longer than the actual dimension ordered. Pull the material out to its intended width before installing. As this is done, the length of the material will decrease. The netting can then be hog ringed directly to the cable working the top and bottom simultaneously. The top should be hog ringed at every opening and the bottom every other opening. It is important that the netting not be allowed to rub against the surface of the wood poles. This may be prevented by placing a 9 gauge wire over the top of the netting and fastening to the pole with staples, or capping the net between the pole and a 2 x 4.
    ii. With Caribbean Clips: The netting will require the installation of a rope border. An additional cable must be run down the length of the pole. Clips are attached to the cable every twelve inches.
b) The Windshield Net should adhere to the following characteristics:
    - Filament used: Poly Propylene Monofilament / Tape Yarns
    - Weight g/sq. metre: 40-90
    - Mesh size: As per the required wind blocking
    - Technology used: Warp knitting

Flowchart



Bird Protection Nets

Enormous fatalities are caused by birds in most of the crops. The crops like grapes, guava, and pomegranate are harshly infected by parrots. From time to time the parrots can wipe out the

Figure 4: Bird Nets

whole crop within hours. To keep away from such huge losses, bird protection nets are used.

Bird protection nets are produced from Polypropylene or High Density Polyethylene (HDPE) mono filament yarn. These yarns are ultra violet (UV) stabilized and knitted into a durable mesh fabric.

Bird protection net protects the crops through following ways:

- Bird protection net is a mesh product designed to prohibit the birds and prevent the costly losses they can impose on the harvest
- Bird protection nets are placed over trees and fields to protect the fruit from being eaten by birds
- With a most favourable mesh size, it is big enough to permit movement of bees and keeps shadow to a least amount.
- It does not stop light from reaching the plants below and so flourish.
- Bird netting permits free movement of air means that harmful fungus does not grow on the crop.

How to Install Bird Protection Nets?

a) Check your plants to make sure there are no broken branches or overgrown vines. If there are damaged limbs, prune these back with a good set of pruning shears before installing the netting.

b) Determine how much netting you will need. If you have only a couple of small bushes, you could purchase netting that is sized specifically for an average bush, or use a pest control bag. If you have several bushes, or even small trees, then you may want to purchase this netting by the roll because it will be more economical.

c) Purchase the netting from your local nursery, taking care to ensure that you have the proper type of material for the job. Bird netting is specifically designed to keep birds from getting into your crop. It is also just thick enough that birds cannot destroy it easily with their beaks, yet lightweight enough not to crush the plants. It also allows air, water, and sunlight to easily get to the plants so they may continue to grow normally.

d) Place the bird netting on your plants. Starting at the top of your plant, simply drape the netting over your bush, taking care not to break off any branches. Leave a little extra netting at the bottom to allow for your plant's growth. If you are using netting from a roll, you may now trim the excess netting with a good pair of scissors.

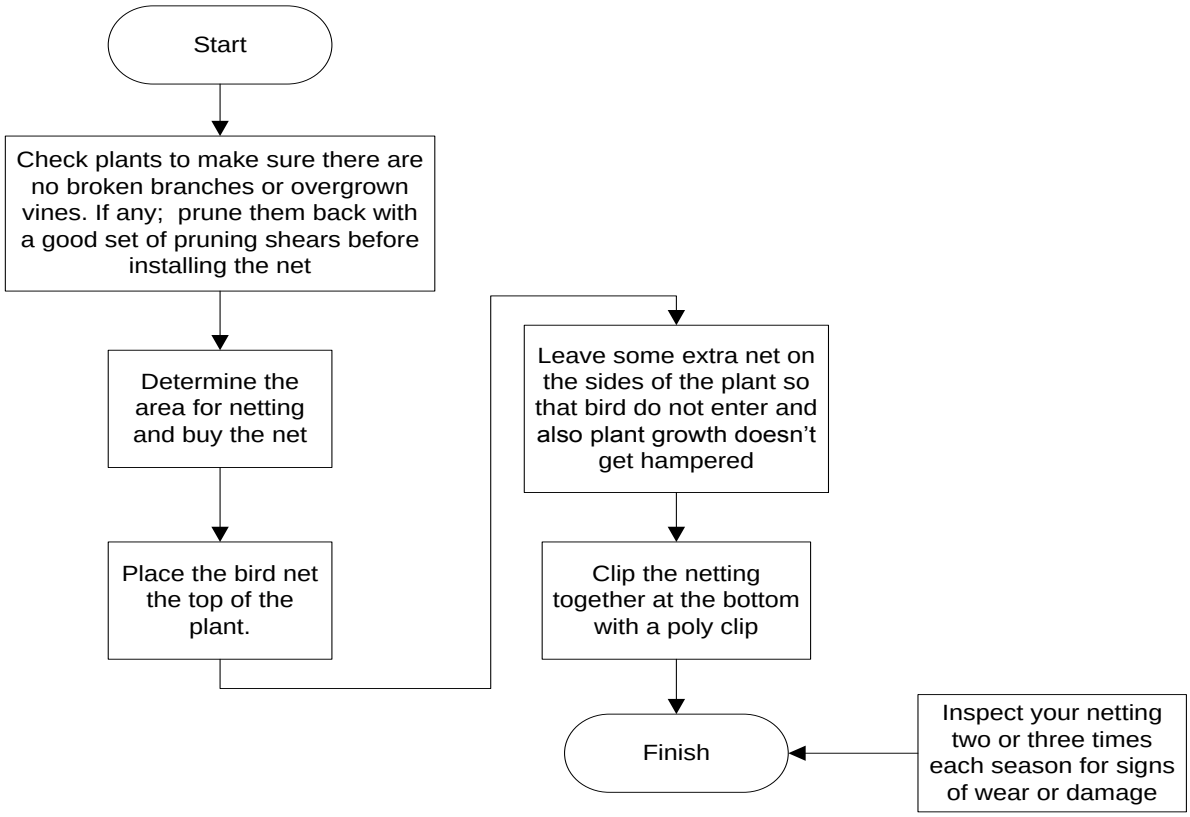
e) Clip the netting together at the bottom with a poly clip. This is because other small animals, such as rabbits, could get underneath the netting, or birds may try to fly under it and get trapped. The idea of the netting is to keep both crops and wildlife safe.

f) Inspect your netting two or three times each season for signs of wear or damage. You will likely not incur any, as this netting is extremely durable and should last for many years.

g) While installing the net adhere to the following specifications/characteristics:

- Bird protection nets are in general ultra-light fabrics & around 25 to 40 GSM in weight.
- These nets are tough, durable, tear resistant and light weight.
- The regular sizes of nets available are 1, 2, 3 & 6 meters in width and 10, 20, 50 and 100 meters in length.
- These nets are generally Green, Blue or White in colour.
- The shade percentage, which indicates the degree of shade provided by the nets, is around 20%.

Flow Chart



Crop Covers/Anti-Frost Covers

Crop-covers generate an outstanding micro atmosphere for seed germination and seedling growth. A crop-cover is positioned over a huge area (a number of rows) of a harvest. In cooler atmosphere, crop-covers are often positioned over direct seeded rows or newly removed crops to create a warmer, more humid micro environment to assist quick plant establishment of warm season crops. These are called "*Floating Row Covers*". Rope covers also offer crop shelter from pesticide.

Figure 5: Crop Covers

Following are the major applications of crop cover nets:

a) Protecting crops from cold by increasing the temperature under cover
b) Protecting crops against Hail and Rain
c) Protecting crops against insects which can cause damage to the crops

Figure 6: Crop Covers – Row Covers

As mentioned earlier that crop covers are used to protect the crops major in cold atmosphere. The crop covers net protects the crops through following mechanism:

- The cover reduces the occurrences of aphids, root maggots and flea beetles
- It maintains higher soil and air temperatures compared to those in the open field which leads to early harvest
- It helps in deterring birds and other animals from decimating crops through camouflage and helping to extend the growing season into late fall
- It also protects crops from rain, hail, snow and wind
- It helps in development in seed bed conditions
- It is used to detach varieties to maintain line cleanliness by excluding bugs and thus put a stop to cross pollination
- It increases yields and enhanced harvest quality

How to Install Crop Covers (Floating Row Covers)?

Step 1: Select a row cover of at least medium weight (0.50–0.55 oz/sq yd) in order to provide a durable cover for several years.

Step 2: Determine what length and width of row cover you will need. Remember, you will need enough row cover to:

- *Completely cover your crop on all sides*
- *Leave some extra room for crop growth*
- *Have enough material so that the row cover edges can be secured with soil, rocks, or other heavy objects*

For example, a 6-foot-wide roll can cover a 3-foot-wide plant bed, while providing enough room for seedlings to grow upright.

Step 3: Cut steel hoops such as from tension wire for chain link fences (or plastic tube hoops can also be used) and insert hoops along the crop row.

Figure 7: Installation of Hoops

Step 4: Lay the row cover loosely over the plants, keeping in mind that the edges must be secured. Tractor equipment similar to that used to lay plastic mulch or a fumigation tarp can also be used to lay row covers over large areas. Trim the row cover to fit the area being covered, or fold the row cover sides under.

Figure 8: Placement of row crop cover over hoops

Step 5: Secure the row cover edges with soil, rocks, or other heavy objects. Deposit a shovel full of soil or a rock every 3 feet or so along each side of the row cover to exclude insect pests and to keep the wind from pulling up the cover. Metal staples are available to help secure row covers along the edges; however, they have the potential to rip the row cover.

Figure 9: Secure crop cover by shovelling soil or placing rocks or metal staples every 3-5 feet along the sides

Generally, the crop covers are ultra-violet treated fabrics of polypropylene manufactured using the spun bond technique. They are light in weight (generally 17-21 grams per square meter) so that the plants are not crushed under their weight and are available in widths of

up to 3.2 metres (generally 3.0 metres) with length varying between 400-500 metres. Specifications for Crop Covers/Anti-Frost Covers are as follows:

Sr. No	Characteristic(s)	Requirements			Test Method
		17 gsm	18 gsm	19 gsm	
1	Weight/square meter (gsm)	17	18	19	ERT 40.3-90 (DIN 53854)
2	Thickness (DTEX)	3.0	3.0	3.0	ERT 20.2-89 (DIN 53857)
3	Tensile Strength – MD (N/5cm)	28	30	32	ERT 20.2-89 (DIN 53857)
4	Tensile Strength – CD (N/5cm)	18	20	22	ERT 27.2-89 (DIN 53857)
5	UV Resistance %	< 2 %	< 2 %	< 2 %	UV-A tester (CEN method)
6	Elongation – MD/CD (%)	65-100	65-100	65-100	ERT 27.2-89 (DIN 53857)
7	Air Permeability ($m^3/m^2/min$)	350-375	350-375	350-375	ERT 140.1-81 (DIN 53857)

Root Ball Nets

A root ball plant is prepared for planting with soil adhering to their roots. The soil and root forms compact mass, larger then bare roots. Root ball plants can be planted throughout the year, except when the ground is frozen, flooded or in periods of drought or high heat.

Figure 10: Root Ball Net

Root ball net can be used to bind the mass of soil and roots of plants together as shown in the figure. The Root ball net supports the plants in following manner:

- Being made up of polymer fibers, this is flexible and shape can be changed accordingly.
- The elasticity of the ball net makes the adherence of soil with the roots of the plant
- The gap between the net allows the water to pass
- When the plant flourishes, the roots come out of the net. This shows the sign to change the net to a bigger size

The advantages of root ball nets are as follows:

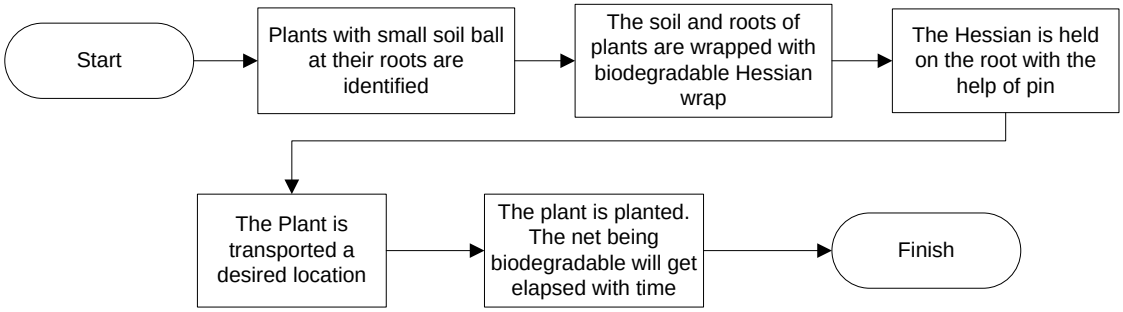
a) Protect root balls from damage during transportation and storage;
b) Biodegradable;
c) Keep soil sticking to roots;
d) Increase packing speed of root balls compared to covering with burlap and tying with twine;

e) Ensure nice and aesthetic appearance of root balls.

How to Install Root Ball Nets?

a) Root ball nets are used to plant plants with a ball of soil around the roots.
b) The soil and roots are wrapped with biodegradable Hessian wrap which will decompose with time.
c) The Hessian is held on the root ball with twine or is pinned in place with nails.

Flow Chart



Harvesting Nets

Harvesting nets are used to collect the fruits falling from a tree. This helps to keep the cost of cultivation low by eliminating additional labor associated with harvesting. Harvesting nets are predominantly grip structures which can be developed using warp knitting technology. The primary application of harvesting net is in apple orchids, mango farms, pomegranate clusters and in other similar type of fruits harvesting.

The advantages of Harvesting Nets are:

- It provides 100% protection to the harvested fruits and do not allow them to perish due to low impact provided by its flexible characteristics
- The finishing with reinforced seams on the sides and to the middle of the net
- They can be made of any size as individual nets can be sewed together from sides to create larger sizes

Figure 11: Harvesting Nets

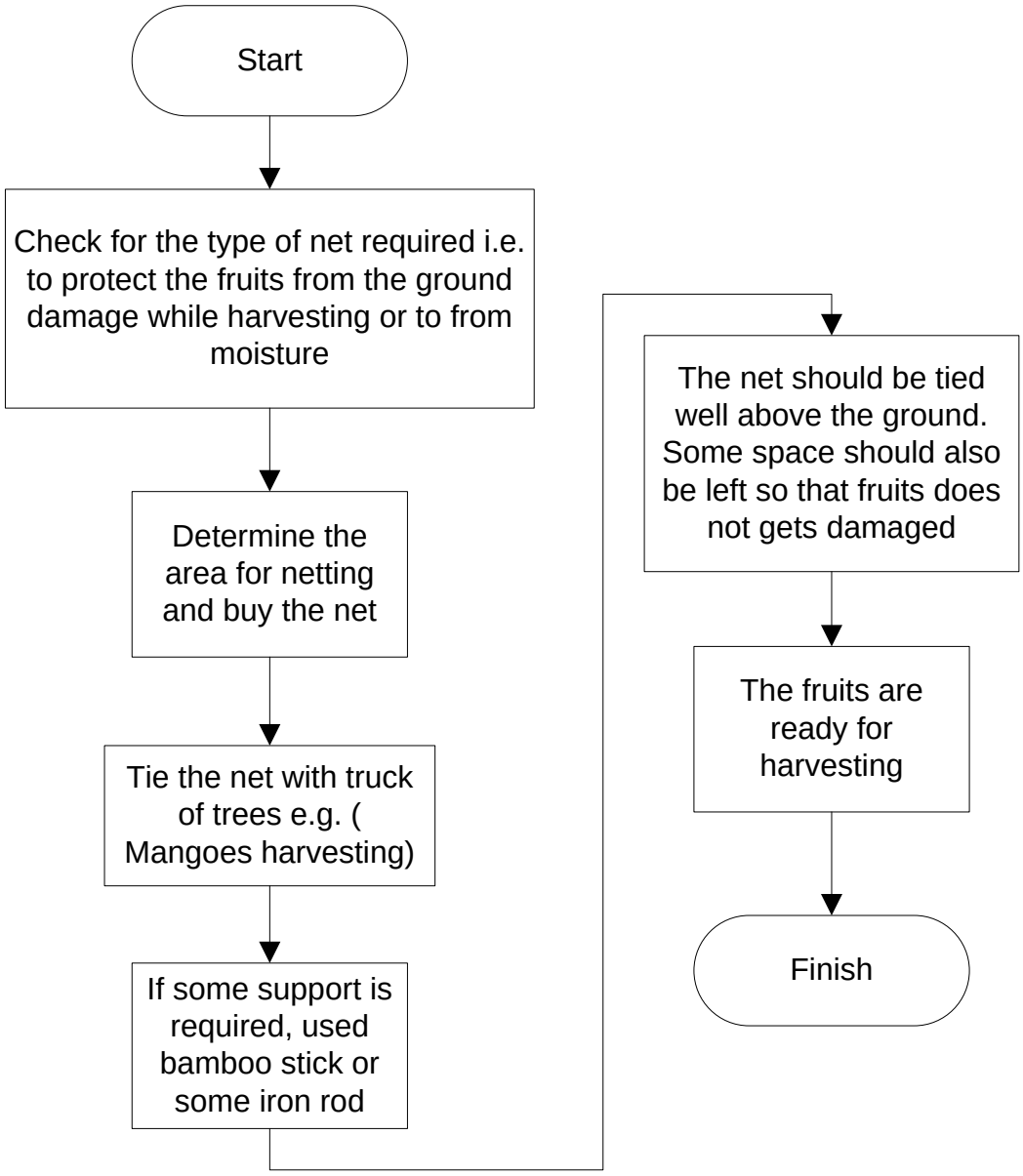
- They are made of eco-friendly, tear resistant material
- They are weather, water and acid proof
- They are temperature-resistant from -30°C to +70°C
- They are UV-stabilized
- They allow reduction in harvesting cost due to cut in labor requirements

How to Install Harvesting Nets?

The harvesting nets basic objective is to have fruits collection. It works by following ways:

a) The net is tied to the truck of trees and with some other poles made up of bamboo stick or iron rod.
b) The netting structure provides the flexibility of the falling impact of the fruit
c) The fruits are cut from the branches and they fall over the net
d) After harvesting of fruits is complete, fruits are collected over the net
e) The specifications/characteristics to be adhered to are as follows:
    i. Raw material used for the harvesting nets are polypropylene monofilament / Polyethylene Tape yarns
    ii. Harvesting nets are Warp knitted
    iii. Flat nets of square or triangular construction, of mesh size 8 – 12 mm
    iv. Weight is generally 40 – 90 g/sq.m.
    v. Woven structures of lighter weight are also used.

Flow Chart


Start
Check for the type of net required i.e. to protect the fruits from the ground damage while harvesting or to from moisture
Determine the area for netting and buy the net
Tie the net with truck of trees e.g. (Mangoes harvesting)
If some support is required, used bamboo stick or some iron rod
The net should be tied well above the ground. Some space should also be left so that fruits does not gets damaged
The fruits are ready for harvesting
Finish

Mulch Mats/Ground Covers

Mulching is defined as covering up of soil around plants to preserve soil moisture, reduce nutrient loss by leaching and in weed control instead of traditional chemical fertilizers.Mulching is also used to modify soil temperature. Mats used for mulchingare commonly known as Mulch Mats or Ground Covers (Figure 14). Mulch mats can be classified as Woven and Non-Woven. They are used for the following purposes:

Figure 12: Sheets of woven polypropylene have a long lifespan & are very effective on very weedy sites

- Mulch mats prepared by eco-friendly material are incorporated into the soil as fertilizer for the next crop.
- Woven polypropylene mulch mats are water permeable and stronger than the spun-bonded mulch mats. Ideal for weed suppression round bases of tree and shrubs.
- Wool mulch mats permit water to enter in to the soil and act as a blockade to put a stop to too much soil desiccation throughout dry period. It also offer better insulation and prevents damage from ground coolness.

Figure 13: Individual mats suppress weeds very successfully round the base of trees and give a neat appearance to the site

Following are the major advantages of Mulch mats:

a) Mulching reduces overflow, increase penetration of rainwater, controls erosion, and corrects the chemical stability of the soil and decrease damage done by pests and bug.
b) There are some secondary special effects, mulching produces, apart from the above major results; such as upgrading of soil structure, boost in micro-activity, earthworm populations.
c) Currently, mulch mats are being used largely in vegetable (which are small duration harvest) and few fruit crops.
d) As an additional benefit mulch mats help to keep ripening fruits off the soil. This reduces fruit deterioration while keeping fruits and vegetables clean, which is advantageous for the cultivation of fruits such as strawberries.

How to Install Mulch Mats?

a) The use of mulch mats along with the use of drip irrigation can lead to significant increase in productivity. But, the non-biodegradable mulches must be removed from the field and disposed off properly.

b) Specifications for Mulch Mat used should be as below:

- Nonwoven mulches use spun bond polypropylene nonwovens
- Multilayer construction of mulch mats consist of needle punched nonwoven, support scrim and mono porous laminate
- Specifications for 100 gsm Woven Ground Covers from Polypropylene/ Polyethylene:

Sr. No	Characteristic(s)	Requirements	Methods of Tests
1	Weight/square meter, g	100	IS 1964, ISO 7211/6
2	Thickness, mm	0.28	IS 7702, ISO 9863-1&2
3	Tensile Strength (Grab), Kgf Warp way Weft way	 65 35	ISO 13934, IS 1969
4	Tear strength woven, kgf Warp way Weft way	 30 20	IS 13937 – 1 & 2
5	Air Permeability, cft/ft^2/s	20	IS 11056, ISO 9237
6	Puncture Resistance, kgf Index	30	ISO 12236
7	UV Accelerated exposure testing, % strength retained	70	IS 1969
8	Water permeability lt/sq.m/sec	7	IS 14324, ISO/CD 10776, 11058
9	Water vapor permeability, g/m^2/day	730	ISO 11092

- Specifications for 50 gsm Nonwoven Ground Covers:

Sr. No	Fabric Quality	Unit	Test Results	Test Method
1	Basic Weight	GSM	50	ERT 40.3-90 (DIN 53854)
2	Thickness	DTEX	3.0	ERT
3	Tensile Strength - MD	N/5 CM	100	ERT 20.2-89 (DIN 53857)
4	Tensile Strength - CD	N/5 CM	70	ERT 20.2-89 (DIN 53857)
5	Elongation - MD/CD	%	65-100	ERT 27.2-89 (DIN 53857)
6	Air Permeability	CU M/SQR M/MIN	350-375	ERT 140.1-81 (DIN 53857)
7	UV (With % dosage for high tropical exposure	-	Compliant	UV - A tester (CEN method - European Committee for standardization)

conditions)

Step 1: Prepare the ground for Planting

Figure 14: Prepare ground for planting and to lay mulch mat

Step 2: Lay weed mat over the planting area.

Figure 15: Laying of Mulch Mats/ Weed mats

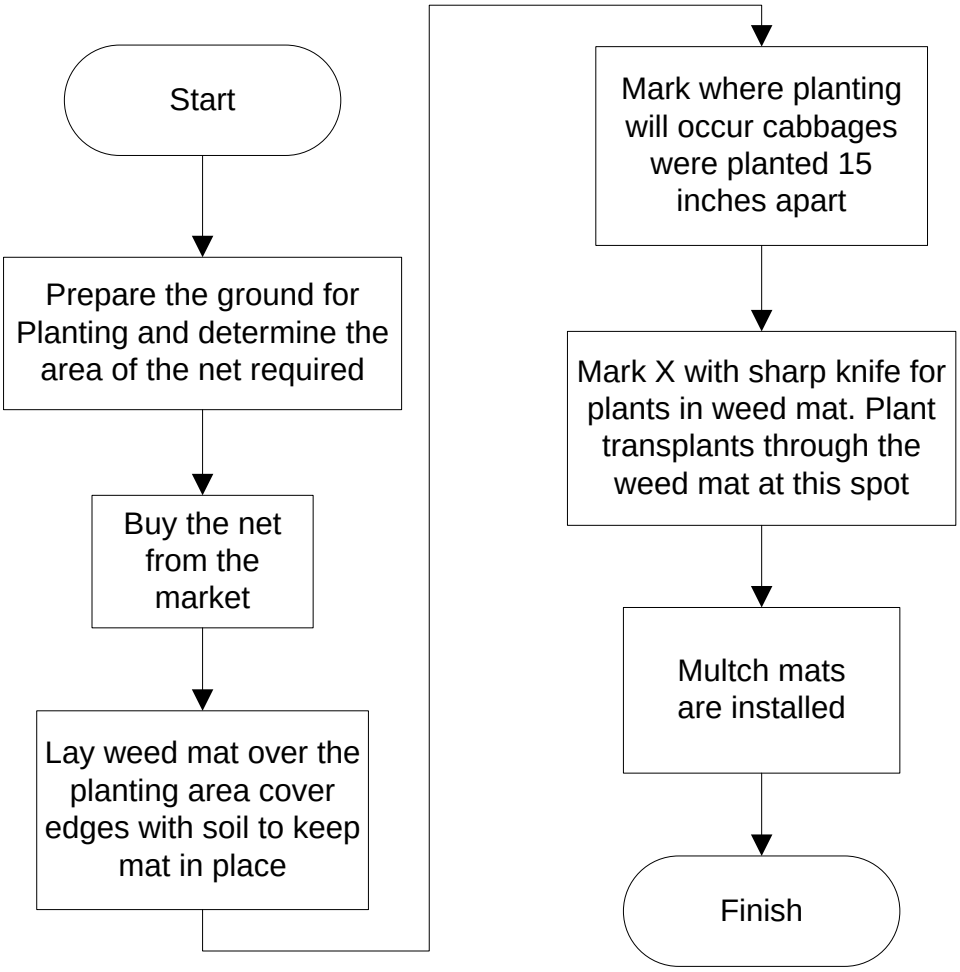
Step 3: Fasten edges with metal staples or soil or stones to keep mat in place.

Figure 16: Fastening of Mulch Mats/ Weed mats

Step 4: Mark X with sharp knife where planting will occur. Plant transplants through X

Flow Chart

Figure 17: Plant transplants through X slits



Anti-Hail Nets

Anti-hail nets are generally used to guard the crops like apple, litchi, etc. from hails in hail prone areas and high height areas like. Each individual tree needs the anti hail nets. These are woven from HDPE yarn or are combination of HDPE monofilament and tape in knitted form, stabilized against UV rays.

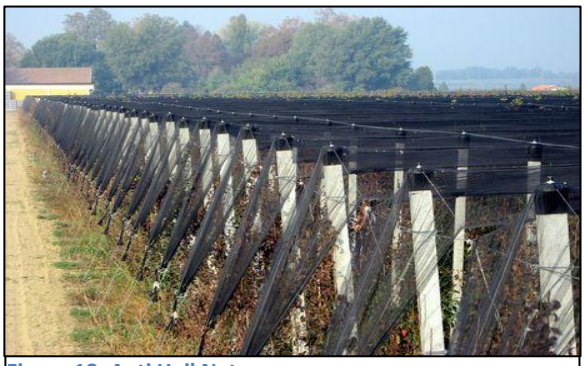


Figure 18: Anti Hail Nets

Generally these nets are transparent in colour with mesh size of 2*100 mm to allow the crops to receive a low level of shadow (13% to 30%).

The major advantages of Hail nets are:

a) These nets are flexible
b) They are low weight
c) They are strong
d) They are easy to spread
e) They can be placed on simple support structure

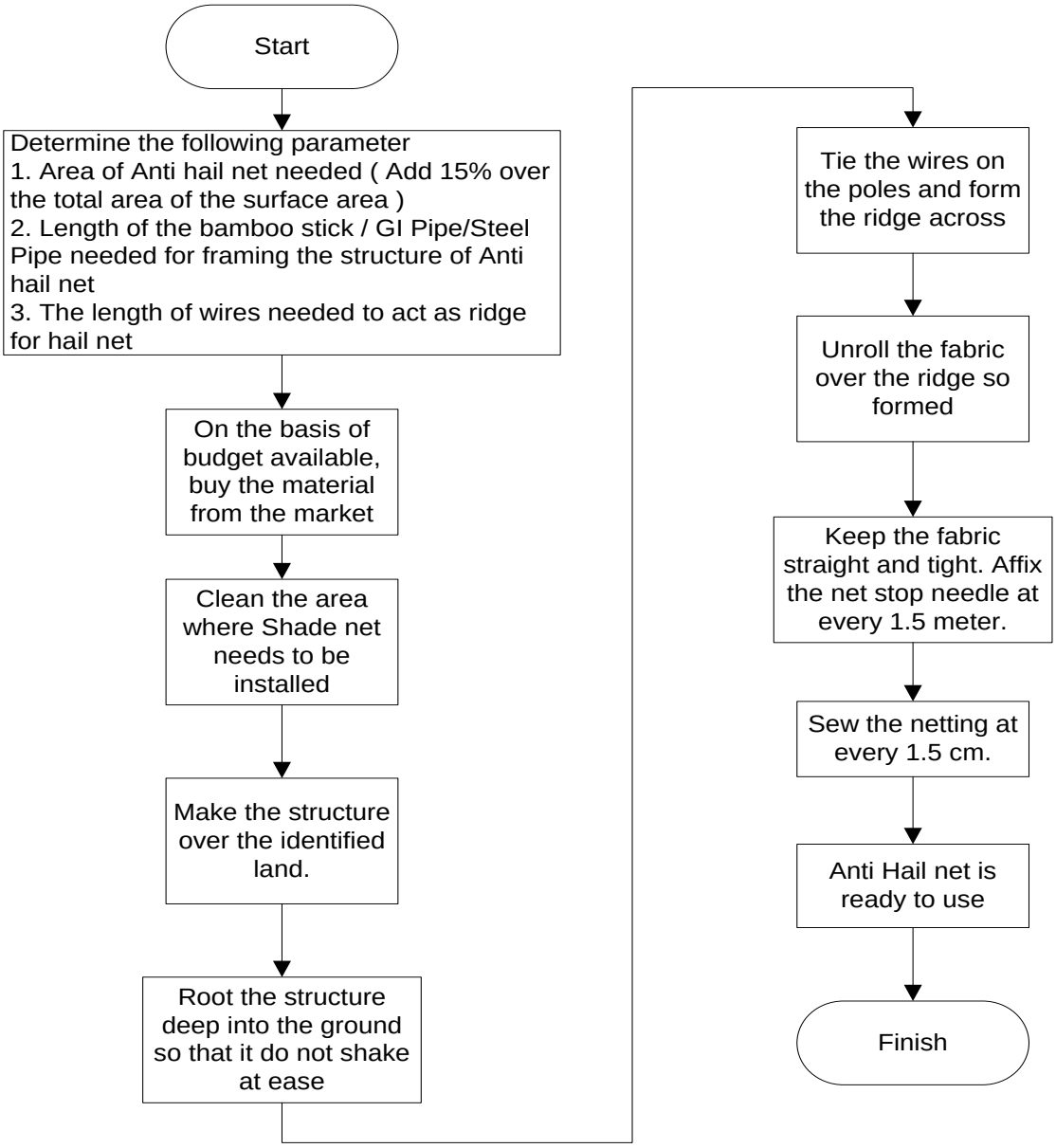
How are Anti-Hail Nets Installed?

- The hail netting of the inner tracks is, just as is the ridge wire, laid out or stretched in two lanes on the ground every second row. However, the work platform is used in those rows without any netting. Now, the net is put over the ridge wire on the left and on the right side and manually wired to each column with reasonably care.
- When installing the First fix device, ridge wire and the pre-stressed cross wire is fixed with screws.
- Net securing on the ridge:
    - Net stop needles: One net stop needle is placed at least every 1.5 m, piercing through both net halves closely beneath the ridge wire with these curved needles. The needles are shoved on about 3 cm, and turned.
    - Sew the netting on the ridge wire: By means of a sewing machine on wheels the left and the right half of the net are sewed up approx. 1.5 cm beneath the ridge wire.
- With this sewing machine netting panels can be sewed up at the end of the roll. What is more, net stripes can be sewed on in the plant on the side panels in the right size. The seam of both net halves is trailed in the middle of the track at a right angle to the ridge wire toward the front face rope, wrapped around this front face rope and secured with one needle each. Now a net connection is installed inside, about 30 cm away from the front face rope. Subsequently, the netting is rolled along the centre of the front side rope, beginning from the end of the panel and tied to the ridge wire

at right angles via a tube inserted on the front side rope. If both panels are tied, a second net connection is installed directly next to the top of the columns.

- Placement of the net connections: The net connections are affixed at a distance of 1.5 – 2 m, bearing in mind that males and females must always be on the same side in the row. Furthermore, please note that from each side and inner column both on the left and on the right side, the net connections' distance is to be 60 cm minimum.
- These fabrics are made up of UV stabilized polyethylene monofilaments in both woven and knitted form. The GSM (gram per square meter) of these nets varies from 60 to 100.

Flow Chart



Fishing Nets

Fishnets are one of the technical textiles utilized in fishing industry. Fishing nets are knitted fabrics used for marine and inland fishing by fisherman, fishing trawlers and boats.

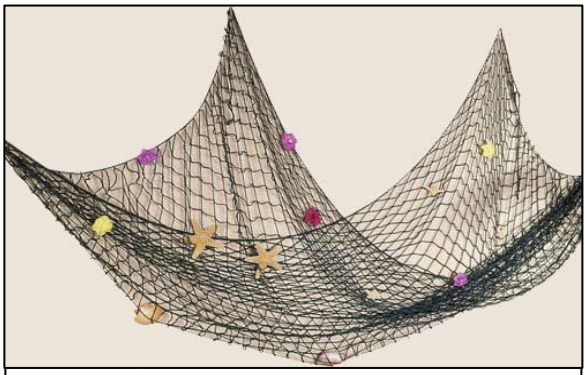


Figure 19: Fish net

The characteristics and specifications of fishnets vary on the basis of method adopted for fishing.

Fishnets are manufactured using nylon chips as well as HDPE. The average life of fishing nets is 2 – 3 years. Some fishermen use it after repair.

Following are the major advantages of Fishnets:

a) They have high tensile strength
b) They have high knot breaking strength
c) They have high abrasion resistance and Low drag resistance
d) They can be used for catching vast varieties of fish.

How to Install Fishing Nets?

- Locate an area with outgoing tide. Position your net so that water is flowing through the netting.
- Set the net in the water with anchors facing down and floats facing up. Anchors grip the sand, and must be strong enough to prevent larger catches from pulling your net away. Floats pull up the opposing end of the net, keeping it deployed.
- Spread out the net so it covers a wide patch in the water.
- Fishnets specifications/characteristics are as follows:
    - Fishnets are made from Nylon or HDPE twines which could be used in mono filament form or single twines twisted together for multi filament form.
    - The basic characteristics for fishnets are transparency and invisibility in water.
    - The variable mesh size from 10 mm to 2,000 mm makes it ideal for is use in different areas.
    - The fish net has various types of knots like single, double and U-knots.
    - In case of multifilament nets, the number plies in the yarn varies from 2 to 36.
    - The length and width size of the fishnets are primarily driven by customer terms & conditions. These types of nets are obtainable in 100 m, 250 m, 500 m, 600 m and 1000 m of spools.

Turf Reinforcement/Protection Nets

A Turf Reinforcement Net is an extruded plastic mesh designed to help grass seedlings germinate and grow in a uniformly strong structure. The roots intertwine with the durable mesh and prevent separation from the soil when rolled. This allows turf producers to harvest a crop in half the time, providing the opportunity for a second planting during their season. Such nets also provide soil stabilization to make green areas available for pedestrian and vehicular use.

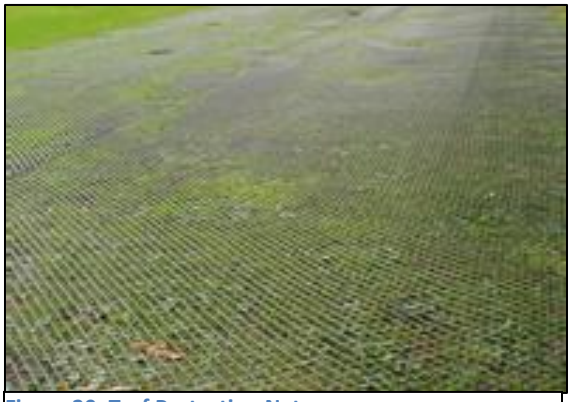


Figure 20: Turf Protection Net

Advantages of turf nets are:

a) The net is strong and have a long life
b) The net increase the grip of users
c) The net is not visible to the users once the grass is fully grown

How to install Turf Protection Net?

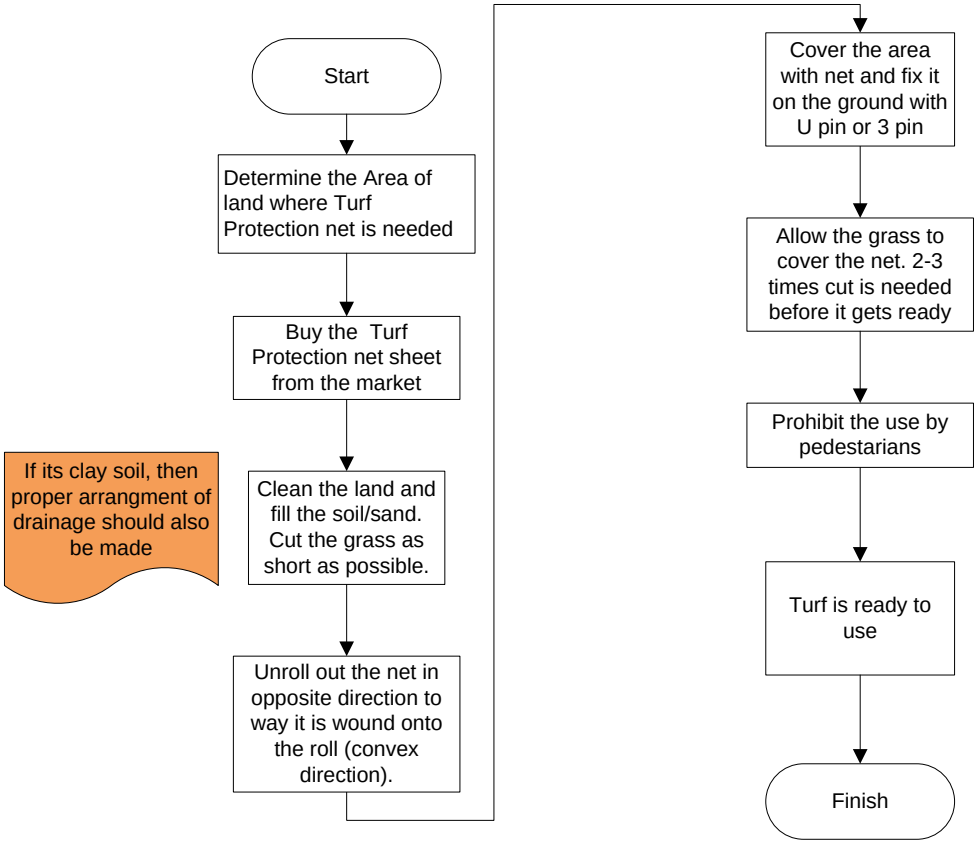
(A) Installation Procedures for Existing Grassed Areas:

1. Spring is the ideal time for laying Turf protect because the grass will grow quickly through the mesh and the root mass will interlock with the mesh filaments.
2. Prepare the area by filling any depressions with soil and sand and cut the grass as short as possible. If the mesh is being laid over clay soil, we recommend that a suitable drainage system be installed to allow drainage of excess surface water.
3. Lay reinforcement mesh flat over the grass and fix the ends taut with metal U-pins or 3-pins. For wider areas, rolls should overlap by 150mm and be secured with the metal pins. Make sure mesh is tensioned whilst unrolling it. It may help to roll out the mesh in the opposite direction to the way it is wound onto the roll (convex direction).
4. To promote root growth around the mesh and increase stability, cover the area lightly with good quality, sandy topsoil and, if necessary, cover any bare areas with grass seed.
5. Grass should be fully established before using and mower blades should, initially, be set high (for the first 2 to 3 cuts).
6. Traffic and pedestrians should be kept off the area until the grass has become fully established with the mesh.

(B) Installation Procedures for Newly Sown Areas

1. The ground surface should be reasonably level and cleared of debris and any local depressions should be in-filled with a mixture of sharp sand and topsoil.
2. Prepare the surface as a cultivated and well-firmed seedbed.

Flow Chart



Pallet Net Covers

For safe transportation of fruits and vegetables to the market individual boxes are collected into larger units and these boxes are covered with wide, large mesh nets on pallets to stop the boxes being turned upside down or squashing each other. This prevents damage to goods during transportation. Nets used for this purpose generally have high tensile strength and are made from high tenacity Polypropylene in a diamond mesh pattern and an elastic cord on the surrounding edges.

Figure 21: Pallet Net Covers

Following are the major advantages of pallet nets:

a) The high tensile strength helps in addressing the movement of high weight boxes
b) This prevents the damage of good during transportation
c) Perishable items can damage even by meshing with each other, thus this keeps a check and avoid early damage.

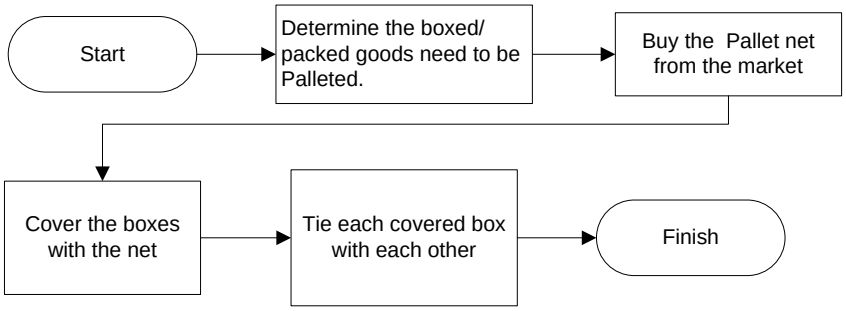
The pallet net covers are used in:

a) Transporting boxes of fruits and vegetables
b) Transporting other perishable items
c) Transporting other valuable items like electronics goods.
d) Transporting fragile materials

How to install Pallet Net Covers?

a) The pallet covering nets are put over the boxes / packets and tied with each other and also with the fixed angle in the container.
b) This keeps the check on the movement of the box when a lorry moves on road.

Flow Chart



Anti-Insect Nets

An Anti-Insect Net is a net that is placed over greenhouse openings to prevent flying insect and pests from entering growing areas. Various pests like Whitefly, scale insects attack some ornamental plants and vegetables frequently. The affected leaves of the plants of the plants give rise to the formation of black fungus because of the honey dew on the leaves left by the viruses. Insect Nets can also be placed over the openings of greenhouses to prevent pollinating insects, such as bumblebees, from escaping.

Figure 22-23: Anti-Insect Net

Advantages of Insect mesh/ Insect repellent fabric
Following are the major advantages:

a) They are environmental friendly as they don't emit smoke
b) They protect from last variety of insects and parasites
c) They do not harm plants or human
d) They keep the environment healthy

How to install Insect mesh/Insect repellent fabric?

"Standard Equipment "for Insect net

a) Bamboo/GI pipes according to structure requirement.
b) Insect Net - The effectiveness of insect nets is totally dependent upon net hole size. Below is a table to guide in select applications:

INSECT SIZING CHART		
INSECT PEST (common name)	**SIZE micrometers/inches Width of thorax**	**SIZE micrometers/inches Width of Abdomen**
Western Flower Thrips	215/0.0085	265/0.0104
Silverleaf Whitefly	239/0.0094	565/0.0222
Greenhouse Whitefly	288/0.0113	708/0.0279
Melon Aphid	355/0.0140	2394/0.0549

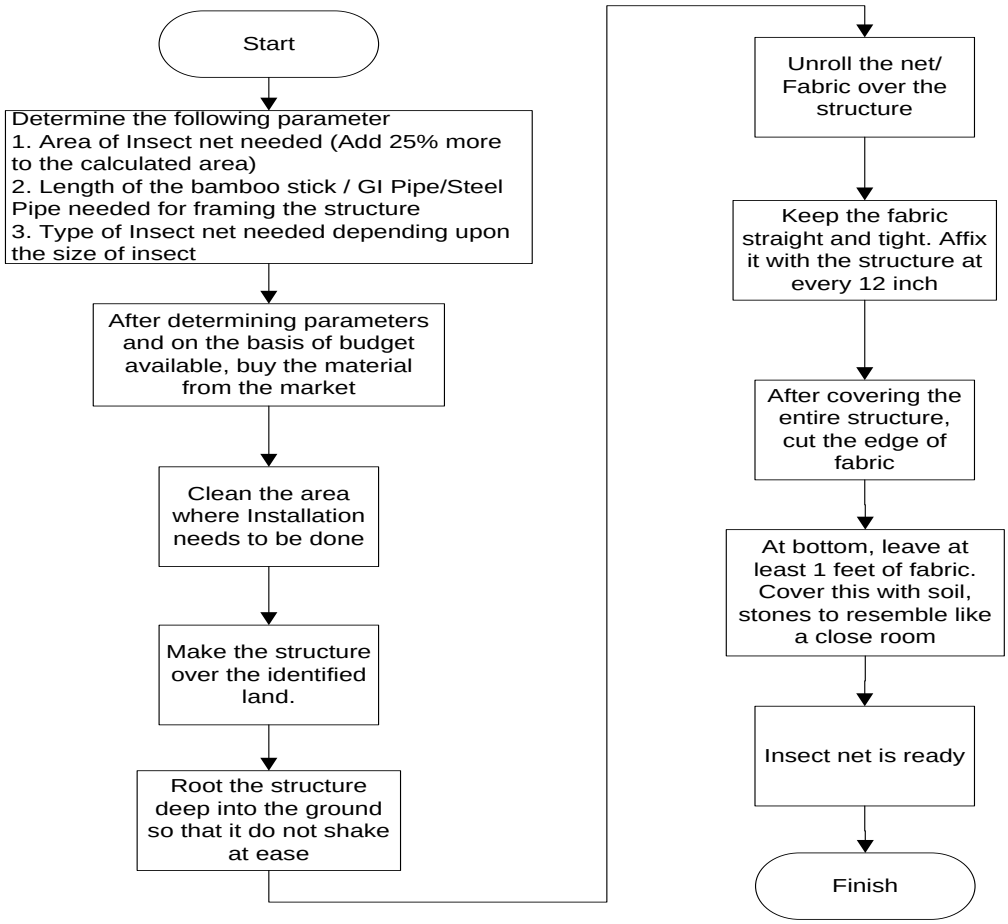
Green Peach Aphid	434/0.0171	2295/0.0904
Citrus Leafminer	435/0.0171	810/0.0319
Serpentine Leafminer	608/0.0239	850/0.0335

Major steps involved:

i. Prepare the structure by using bamboo/GI pipes as per the requirement.
ii. Measure out about 25 percent more insect mesh than you will need to cover the entire structure. Unroll the mesh cloth across the structure, leaving at least one foot of cloth overhanging on all sides. Pull the cloth into position, straightening as needed
iii. Cover edges with soil and rocks.

Figure 24: Anti-Insect Net

Flow Chart



Plant Nets

Plant Nets are the made from polyolefin type of fibre. It is mainly used for the tomato type of plant. The gsm of the nets are 30-40. Fruits, which grow close to the ground, can be kept away from the damp soil by allowing them to grow through vertical or tiered nets in order to keep the amount of decayed fruit to minimum.

Plant Nets are manufactured in high quality polypropylene, lightweight yet very robust, flexible and tear-resistant, UV stabilised and resistant to bacteria, chemical agents and mould.

How to Install Plant Nets?

When installed in layers, Plant Nets encourage air circulation, improve exposure to the sun and optimise the space available.

To install as layers for floriculture:

- Stretch the net as taut as possible and place over stakes at the ends of the bed with intermediates stakes positioned every 2-5 m.
- Subsequent layers of net can then be installed as required.
- For carnations and the transplantation of cuttings, it is recommended that Plant Nets with a mesh size of 100x80 mm is used for first layer.
- Then use Plant Net with a mesh size of 170x150 mm for subsequent layers.
- For the gladiolus it is suggested that Plant Net with mesh size 125x125 mm is used.

To install vertical support in horticulture:

- Plant Nets can be used as a vertical support for the cultivation of peas, beans, tomatoes, cucumbers and all other climbing plants and vegetables.

List of Manufacturers

Sr #	Company Name	Products	Address	Phone No.
1	Affy Weaver India Pvt. Ltd.	Nets, Shade Nets, Agriculture Net, Scaffolding Nettings, Silt Fence, Woven Fabric And Ground Covers.	Kottur (M), Mehboobnagar, Ghaziabad, Uttar Pradesh – 509 223, INDIA	
2	Agmore Industries	Fish Nets	493, Mahatma Gandhi Road, Indore	(91)(731)2706818, 4072893, (91)9826095896
3	Agrotech	Shade Nets	Phase-4 Shed No A1/D 1501/2 IDC Estate, Anand	(91)-(2692)-236275, (91)-9427610980/ 9825056637, 946002399
4	Shri Ambica Polymer Pvt. Ltd., (SAPPL)	Agro textiles – for farming, agriculture, horticulture & floriculture	A/3, 1st Floor, Safal Profitair, Near Auda Garden, Prahaladnagar, Ahmedabad – 380 051.	+91 9727749992/079 - 65453665
5	Arham Agro Textiles	Shade Nets, Agro Nets, Carpet, Flooring, Greenhouse Nets	202, Smit Complex, OPP. Ganesh Plaza, Navrangpura, Gujarat - 380009	91-79-26563052,9825955504
6	Arthi Enterprises	Shade Nets, Anti Insect Nets, Fishing Nets, Anti Bird Nets	501, 5th Floor, Lingapur House, Amrutha Estate, Himayath Nagar, Hyderabad - 500029, Andhra Pradesh, India	
7	As Wan Fish Net	Fish Nets	No.20/50, Kalaks Hethra Road, Thiruvaiyur	24419735
8	B &V Agro	Shade Nets	A-508, Mahape Village MIDC TTC Post Ghansoli	9820182270
9	Balaji Polynets	Shade Nets	Plot No. J-5103/4, 4th Phase, Gidc – 396195, Vapi, Gujarat	91-260-2432153, 919925547028
10	Betala Canvas Co.	Shade Nets, Tarpaulin	Mr. Vikas Betala (Proprietor) No. 17, Ramanan Road, Sowcarpet, Near Elephant Gate Police Station, Chennai - 600079, Tamil Nadu, India	(91)-(44)-25298961/ 42762961, (91)-9994335125, 09953353236
11	Bharat Tarpaulin Co.	Shade Nets, Tarpaulin	No. 80, J. C. Road, Opposite Auto Towers, Bengaluru - 560 002, Karnataka, India	919845310102, 9845024851, (91)-(80)-22128492

Sr #	Company Name	Products	Address	Phone No.
12	Bokaria Meshes and Wires	Plastic Shade Nets, Light Weight Nylon Shade Nets, Coloured Shade Nets, Window Screen Shade Nets And Nylon Shade Nets	12, Vepery High Road, Periamet, Chennai - 600 003, Tamil Nadu, India	91-44-25611151, 91 98400 84747
13	Br Agri Factors	Shade Nets, Monofilament Nets	No. 306, Sanskruti Co - Operative Housing Society Limited, Near Coast Guard Air Station, Kunta Road, Daman - 396210, India	(91)-9998156820/ 9724307325/ 9558811348/ 08377807853
14	Chidambaram Fishing Pvt. Ltd.	Fishing Nets, Nylon Twine	Rs No 42& 43 Puducherry Village, Puducherry Manimangalam Road, Kancheepuram	91 44 2246 2061 / 2246 2082 / 2246 2083 / 2246 0282 98400 73399
15	Chilka Fishnets (P) Ltd.	Fish Nets, Agricultural Nets, Fruit Nets, Safety Nets, Geo Nets	5-3/95, Mancheswar Industrial Estate,Bhubhneshwar	674-2580621
16	Consoli Dated Ancillaries	Fishing Nets	267, Sholinganallur Village Indian Bank Campus ,Chennai	4424501676
17	Creative Plastics	Shade Nets, Insect Nets, Bulb Sleeves	SHOP NO. 11, Gala Compound, Haji Bapu, Malad - East, Mumbai - 400097, Maharashtra, India	22-32542089/28779368, 919320637304
18	Creative Polymers	Shade Nets, Horti Pots	No. 2500/18, GIDC Industrial Estate, District Panchmahal Halol - 389350, Gujarat, India	(91)-(2676)-220207/ 221642/ 710256, (91)-9825031161
19	CTM Technical Textiles Limited	Agro Shading Nets	205, New Cloth Market, Ahmedabad-380 002, Gujarat	91-79-22165163, 09327988555
20	Dhanya Polymers	Agro Shade Nets	5/128, Thottiyapatti Road, Abinav Bhava, Rajapalayam - 626117, Tamil Nadu, India	919443132226
21	Essen Metals & Alloys	Shade Net, Shade Net Ropes, Insect Nets	H. No. 305/3, S. No.47, Bapdev Nagar, Kiwale, Dehu Road Pune - 411002, Maharashtra, India	(91)-(22)-27672368, 08447561278, 9850665030, 9923001412
22	Ever Green Industries	Anti-Bird Nets Agro Shade Nets	66-A Sengal Thottam Ramasamy Nagar Nallam Palayam, Coimbatore	91-422-3258162/2533119
23	Fiberweb India Ltd	Woven And Nonwoven Crop Covers	Airport Road, Kadaiya, Nani Daman, (U.T) 396210, India.	91(260)2220766 / 2220458 / 2221458 / 2221858

Sr #	Company Name	Products	Address	Phone No.
24	Fisheries (P) Ltd.	Fish Nets	Bardoli, Gujarat	91-262-22220636/676
25	Flora Agrotech	Shade Nets, Monofilament Nets	Plot No. 243, Phase 2nd, GIDC, Sardar Chowk Vapi - 396 195, Gujarat, India	(91)-(260)-2451580, (91)-9712998933, 08447558516, 9712958933, 9712968933
26	Fortune Agro Nets	Shade Nets, Poly Sacks	A/2/5002, 4th Phase, G.I.D.C., Vapi-396195, Gujarat.	094261 17099, 0260-2401062 / 6539389
27	Garware Marine Industries Ltd.	Fish Nets	Chandramukhi, Nariman Point, Mumbai 400021	91-22-2202 0745 91-22-22028398
28	Garware-Wall Ropes Ltd	Nets	D/66 Kirti Nagar, Delhi	91-20-30780000 91-20-30780195
29	Gayatri Plastic Corporation	Fishing Twine	Gadhechi Road , Kumbharwada	91-278-2438886/2438087/2211671 919824293105
30	Globe Cast	Fish Nets	Plot no. - 1304/1305, 3rd Phase, GIDC, Umbergaon, Gujarat - 396191	91-260-2563001/2563002/ 2563004/ 9824704628
31	Gulati Canvas	Shade Nets, Canvas	237-238, Azad Market Delhi - 110 006, India	(91)-(11)-23618922/ 23524301, (91)-8527612612/ 9891651651/ 08373905541
32	Hari Om Polysacks	Shade Nets, Polysacks	Plot No. 16, 17, 18/13/ A, Shed No. A/1/3/ A, G. I. D. C., 1st Phase, Vapi - 396195, Gujarat , India	(91)-(260)- 2400880/ 3207230, (91) 9429117406
33	Hind Fab	Shade Nets, Packing Sacks, Tarpaulins	1961, Nihal Building, 1st Floor, Above Royal Cycle, Panchkuva, Ahmedabad - 380002	(91)-(79)-22138646
34	India Plastic Associates	Garden Fencing & Shading Net	303, 3rd Floor, Elegance Complex, Nr. Urmi Cross Road, Productivity Road, Vadodara - 390 020, Gujarat (India)	(91)-(265)-2320571, (91)-9825082727, (91)-9978992706
35	Indian Fishnet Manufacturing Association (IFMA)	Fish Nets - Nylon	IFMA, Temple Rock, 105, New Avadi road, Kilpauk Chennai - 10	044-42857359
36	Indonet Plastic Industries	Shade Nets	C1-243/3 & 4, GIDC Industrial Estate Waghodia - 391 760, Dist : Vadodara, Gujarat (India)	9978992706, 91-2668-263133/210133

Sr #	Company Name	Products	Address	Phone No.
37	Jayshree Marine Nets	Fish Nets	723/5-B, SOMNATH ROAD, SOMNATH ROAD DAMAN - 396215	91-260-2255061/2242946
38	JC. Net Manufacturing Co.	Fish Nets	Xl/2716, Mossa Bazar, Jews Street Ernakulam, Cochin	2366090
39	K. G. Fishnet Manufacturing Co.	Fish Nets	NO. 4B/1104, Damodar Park, LBS Marg, Ghatkopar (W), Mumbai - 400086, Maharashtra, India	91-22-25002342/(260)2242357, 919869413993
40	Khetan Twist Net (P) Ltd.	Fish Nets, Fishing Twins	101/102 Surat Sadan, Near Masjid Station, Surat	022 - 28820441, 28820442 , 9892225681
41	KT Exports (I) Pvt. Ltd	Shade Nets, Windshield Nets, Bird Nets, Non-Woven Mulch Mats, Geolay & Frost Covers	148, Vyas Bhuvan, Hind Colony Road 6, Dadar E, Mumbai, Maharashtra - 400 014, India	(91)-(22)-24185107 , 24104500, (91)-9820322055
42	Kwality Nets Mfg. Co.	Bird Protection Nets, Fish Nets, Shade Nets	3, Prem Grih, Sir Vithaldas Nagar, Santacruz (W) Mumbai - 400 012, Maharashtra	022 26600356 / 26603019
43	Lepakshi Tarpaulin Industries	Shade Nets	5 - 5 - 65,1 St Floor, Shop No. F - 10, S. A. Trade Center, Ranigunj, Hyderabad - 500 003, Andhra Pradesh, India	91-40-27706071/ 66486071, 91 - 9959102999/ 08447577929
44	Makharia Netting	Fish Nets	Po Box 107 Makhria Complex Chakalia Road	912673264541, 9426394541
45	Malmo Exim	Shade Nets, Mulch Mats	Office - D-17, ACME Estate, Sewree E, Mumbai - 40015 Factory Address- Malmo Compound, H.No. 1074, Tulsi Nagar, Khoni Village, Khadipaar, Bhiwandi – 421 302 Maharashtra (India)	91-22-24131111, 9322831915 Factory No. - 02522–222992/ 257503/ 256882
46	Mangalam Fabricators	Fish Nets	Reekjawani Raarhat, Kolkata	22697036
47	Matsyafed Net Factory	Nylon Fish Nets	Erg Road, Cochin	4842394410
48	Mysore Nandi Tarpaulins Mfg. Co.	Shade Nets	No. 5-5-201/1, Lala Temple Road, Ranigunj, Secunderabad - 500003, Andhra Pradesh, India	(91)-(40)-27712404/ 40025394, (91)-9963066003/ 8121066003/ 08447499154

Sr #	Company Name	Products	Address	Phone No.
49	Nataraj Silk Mills Pvt.	Fish Net	P-4/8, Sunder Nagar S.V. Nagar, Mumbai	28725296
50	Neelgiri Tarpaulin Co.	Shade Nets, Tarpaulins, Poultry Shed	No. 106/50, Peramanur Main Road, Near Four Roads Salem - 636007, Tamil Nadu, India	(91)-(427)-2310996, (91)-9843249209/ 9786044999
51	Neo Corp International Ltd	HDPE/ PP Woven Sacks, Raschel Bags, Bags with Tie-String, Shade Nets & Other Allied Products	220 Mahavir Industrial Area Off. Mahakali Caves Road Andheri (E), Mumbai – 400 093 Maharashtra INDIA Factory - Plot # 62-63-64A Industrial Area, Sector 1 Pithampur – 454 775 Dist. Dhar Madhya Pradesh INDIA	22 2687 9510, 91 7292 410 400/ 7292 420 499
52	Netlon Ltd	Shade Fabrics	201/202, Regent Tower Race Conres Circle, Baroda	265332581
53	Panchanathan Sons	Fish Nets	18/51, Kalachthra Road, Thiruvamayur, Chennai	24911348
54	Phuar Agrotech	Shade Nets, Insect Nets & Irrigation Components	WZ-75 , Todapur, Delhi -110 012, India	(91)-(11)-25050168, +(91)-9312640985
55	Planet Plastics	Shade Nets & Anti-Bird Net	101, 33/A Pushkar Blossoms, Ram Mandir Road, Swawlambi Nagar, Nagpur - 440025, Maharashtra, India	(91)-9975720025/ 9370120028, 08447497366
56	Premier Tarpaulins	Tarpaulins, Shade Nets, Pond Liners, Chilli Drying Mats	No. 53, Nehru Stadium. Coimbatore - 641 018, Tamil Nadu , India	(91)-(422)-2380466/ 2380343
57	Priyafil Group	Shade Nets, Polymer Bags	16 Iv Main Industrial Town, West Of Chord Rajajinagar, Bangalore	(91)-(80)-22971480
58	R. R. Polynets	Shade Nets, Insect Nets, Bird Protection Nets, Pond Liners	Survey No. 391/25, Premraj Nagar, Near Rema Paper Mill, 4th Phase, G. I. D. C., Vapi - 396193, Gujarat , India	(91)9377015705, (260)-3256651
59	Rajdeep Agri Products ltd.	Shade Nets	No. 3279/1, Ranjit Nagar New Delhi - 110008, Delhi , India	9810630206, -(11)-25847771/ 25847772
60	Rajvi Plastotech Pvt. Ltd.	Shade Nets	Plot No. - 4305, 4th Phase, GIDC, Vapi - 396195	0260 - 2425449/ 6534432

Sr #	Company Name	Products	Address	Phone No.
61	Ratna Fiber Industries	Insect Nets, Window Mesh, "UV Stabilized" Agro Shade Nets, Anti-Virus Nets	No.252/254, Muddanna Est, Magadi Rd, Kamakshipalya, Bangalore - 560079	8023489271
62	Rays Fishnet Works Pvt. Ltd.	Nylon Fish Net	S.No.18 Koorambakkam Road, Kannigaipair Village Uthukottai T.K, Thiruvallore D.T.-601102	
63	Reach netting Solutions Pvt. Ltd.	Shade Nets, Bird Protection Nets, Monofilament Nets	No. 139, Mohamadpur, Bhikaiji Cama Palace, New Delhi - 110066, Delhi, India	(91)-(11)-46551541
64	Rishi Packer	Crop Protection Nets	612, Veena Killedar Industrial Estate, 10/14, Pais Street, Byculla (W), Mumbai - 400 011 **Factory -** Zari Causeway Road, Kachigam, Unioin Territory of Daman & Diu	022-23074897 / 23074585 / 23075677, 0260-2241936 / 2241949 / 3091221 / 3091291
65	Rishi Techtex Limited	Shade Nets, Woven Fabrics	612, Veena Killedar Industrial Estate, 10/14, Pais Street, Byculla (W), Mumbai - 400 011. **Factory -** Zari Causeway Road, Kachigam, Unioin Territory of Daman & Diu.	Office - 022-23074897 / 23074585 / 23075677 Factory - 0260-2241936 / 2241949 / 3091221 / 3091291
66	Ruparel Plastics	Fish Nets, Cargo Nets, Twine, Etc.	No. 43, Industrial Plot, P. B. No - 12, District Bhavnagar, Mahuva - 364290, Gujarat , India	(O)+91-2844-222625/222681/222334/ 9898908651
67	Shree Siddhivinayak Polyhouse	Fabricator Natural Ventilated Greenhouse, Poly House, Tunnel Type Shade Nets	At & Post Chimbli, Tal Khed District, Pune - 410501, Maharashtra, India	08447570211, 9960845301, 9730087983, 9730087984, 9730087985
68	Sree Durga Industries	Shade Nets	No. 14- A, Uzhaipalar Road, G. N. Mills Post, Coimbatore - 641 029, Tamil Nadu, India	(91)-(422)-2642985/ 2646592/2646335, 9842284298/ 9894312999
69	SRF Limited	Fish Net Twines, Coated & Laminated Fabrics	1. Malanpur Industrial Area, Bhind 477116, Madhya Pradesh, India. 2. Manali Industrial Area, Manali, Chennai - 600068, Tamil Nadu, India	M.P - Tel: +91-7539-283164 +91-7539-283164 Chennai - Tel: +91-44-25946000 +91-44-25946000
70	Sri Vijaylakshmi Polymers (P) Limited	Polypropylene Twines for Nets	51, Kalagaderi Road, Arasiyarpatti, Rajapalyam, India	04563-236202

Sr #	Company Name	Products	Address	Phone No.
71	Sunpak	Shade Net, Ground Cover, Vermin Bed, HDPE Rope, Planters Bag	P.O. Box No. : 147, 809, Sankaran Kovil Road, Rajapalayam – 626 117, Tamil Nadu, India	+91- 04563 – 231320 / 220735
72	Tuflex India	Shade Nets	702/704, GIDC, Palej, Bharuch, Gujarat - 392 220, India	91-9898058583 , +91 - 2642 - 277663
73	Unimin India Ltd.	Shade Net/Fabrics	Village Kadaiya, Daman Industrial Est, Bhimpore, Nani Daman - 396210.	0260-2221557 / 2221385
74	Venkatesh Agro Shade Nets	Shade Nets	Shed No. C/1/B, 2009, Gala No. 2, 4th Phase, GIDC, Vapi - 396195, Gujarat	91-260-6451371, 919825111061
75	Venus Industries	PP Twisted Fish Nets	7 Chapsi Bhimji Road, 1st Floor OPP New Po Anjeerwadi, Mumbai	022-23729315
76	Welpack Industries Pvt. Ltd.	Shade Nets, Tarpaulins	Plot No 87, Govt. Industrial Estate, Ganesh Nagar, Mr. Garuda Petrol Pump, Charkop, Kandivali (West), Mumbai- 400 067	022-28678111, Mob: 9824213929

Annexure I: Information Sources

Websites:

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