CHAPTER 5

ESTABLISHING THE ORCHARD

The success of a litchi orchard depends largely on the initial establishment of plants. A well established orchard itself avoids many problems related to plant growth and performance. Therefore, one can prevent many risks through appropriate orchard establishment practices. This includes:

Land Preparation

Poor land preparation and inappropriate layout posses recurring problem. Therefore, selected fields should be deeply ploughed and then harrowed to root out the perennial weeds, roots of perennial bushes and heavy clods. If the litchi plantation has to be under taken on bushy / minor land, clearing of bushes and forest stuff is essential before deep ploughing. Under hillocks and steep sloppy land (30-40% slope), contour trenching instead of deep ploughing should be done. This operation provides congenial tilth to young roots for their healthy development. After harrowing, proper leveling of land is done and a gentle slope is provided in one direction to facilitate irrigation as well as drainage of excess water during rains. The soils which have drainage problems should be provided with adequate trenching from the very beginning to avoid serious damage to young plants due to water stagnation.

On sloping land with a gradient up to 10 per cent, it is advisable to plant the trees on mounds or in trenches. This facilitates management operations and improves drainage. Where the land is more steeply sloping, terraces should be established, although this makes ploughing considerably more difficult. It is also advisable to have grass or stone-lined irrigation ditches to prevent soil erosion.

Deep ploughing of the land in dry weather prior to planting will ensure uniform growth and is essential in previously cultivated soils where a compact layer has usually been formed. It is desirable, but not essential to use cover crops prior to planting and continuing the same for the first 3 or 4 years. They will prevent weed growth, act as a windbreak for the young trees and provide a source of "*in situ*" mulching.

Soil Reclamation

In normal as well as alkali soil, plants do not require liming however, if the soil analysis show the lower pH than required (5.6-6.0), lime should be applied and if there is magnesium deficiency, dolomite, should be used to improve the soil pH. If the soil is very acidic, heavy lime applications may be necessary. Two-third of the recommended quantity of lime must be scattered over the planting area, mixed with the top soil and then ploughed as deep as possible, at least 9 to 12 months before planting. Calcium (lime) moves very slowly downwards into the soil and must therefore be applied into the depth of the root zone. If a lighter lime application (2-4 t/ha) is required, the lime can be applied into the soil at least three months before planting. The lime should only be applied when the pH is lower than the target soil (water) pH. In alkaline soils with a pH of 7-8, repeated applications of sulphur may be made at the rate of 500 kg/ha, until pH falls to 5.6. Litchi can be grown in alkaline soils provided the soil reclamation practices are adopted and micronutrients added to the soil in sufficient quantity.

Layout

Proper layout of a litchi orchard is necessary. The system of layout and distance of planting is decided according to needs. Laying out an orchard on level land is a simple matter of establishing a straight baseline, usually next to a fence or roadway. Then, lines at right angles to the baseline are established at both ends of the plot and one or two places in the middle. An easy way to establish these angles is to use three ropes whose lengths are in 3:4:5 proportions. Put the 4 m rope along the baseline, then place the 3 m rope at approximately a right angle, and finally, close the triangle with the 5 m rope (Fig. 5.1). Adjust the 3 m segment in either direction so that it just touches the end of the 5 m piece. Ensure that the 3 m section is at a right angle to the baseline. Next, place stakes along the baseline and the right angle line for sighting to extend these lines. From this point on, any desired row and tree spacing can be established using a tape measure or knotted rope to measure at the proper intervals.

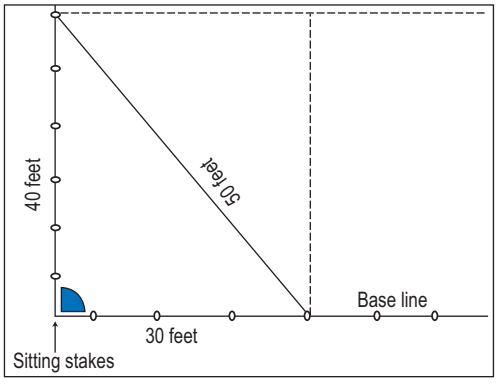

Fig. 5.1: Orchard layout based on a triangle

When boundary lines are drawn, it becomes easy to divide the whole orchard area into squares or rectangles with their sides equal to the planting distance. For planting under the hexagonal pattern, two chains equal in length to the planting distance are used. These chains are joined together by a ring. Two rings are also attached to the other two ends. Thus the connected chain is equal in length to double the planting distance with one ring at centre and two rings at either end. First of all pegs or stakes are placed on the base line at appropriate

distance. Then, the two rings at the ends are fixed in the two adjacent pegs on the base line and the chain is pulled tight holding the centre ring in hand. This tightened position is held and a stake or peg is fixed in the centre ring. This way another row of trees will be marked out and this can be used as base line for marking out a third row. For triangular planting, the markings are set as in the square or rectangular systems, except that those in the even numbered rows are mid-way between, instead of opposition in old pattern.

Contour layout for sloppy land requires the use of a surveyor's level and rod. The first row is at the highest elevation, and is staked out on the level (i.e. all points on the line are at the same elevation). Next, the steepest slope along the first row is found and the distance that has been selected as the minimum distance between rows is measured down the slope. From that point the next row is laid out on a level line as before. Moving away from this steepest slope to less-steep slopes, the rows will be wider apart. Wherever, the distance between two adjacent rows becomes twice the minimum distance, short contour row is laid out between them that point to the end of the plot. While planting litchi on contour, staggered method of planting is preferred between the two contours which utilizes the additional natural resources for production.

Planting Methods

Among the prevalent systems of layout, Square, Rectangular, Quincunx, Hexagonal and Contour are practiced. However, for high density planting single hedge row system (Rectangular method) or double hedge row system can be adopted. For normal orcharding square system is very much common.

(i) Square Planting

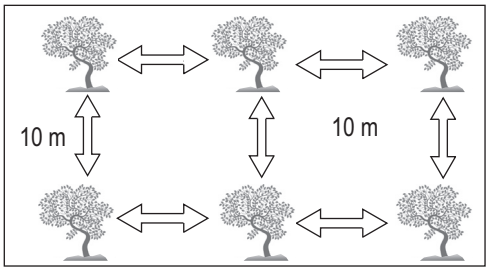

Fig. 5.2: Square planting

In this method, the orchard space is divided into squares and the trees are planted at the four corners of the square, in straight rows running at right angles. It is easy to layout (Fig. 5.2). All cultural operations in the orchard can be carried out in either direction.

(ii) Rectangular Planting

In this case, planting trees are set out in straight rows that line up at right angles to one another with spacing between them in a row somewhat less than that between rows forming a rectangle (plant row). Like square planting, this is easy to layout and manage with respect to cultural and harvesting operations. This layout is often adopted for high density planting system in single or double hedge row methods. The advantage of a rectangular pattern over a square pattern is that, by removing alternate trees in every row, additional width is obtained in the drive row when fillers are removed. This can

only be accomplished, when the in-row spacing is greater than half the between-row-spacing. Such a plan allows for more space for the trees as they mature and also adequate space for power driven equipment (tractor / harvester).

(iii) Quincunx (Five Spot)

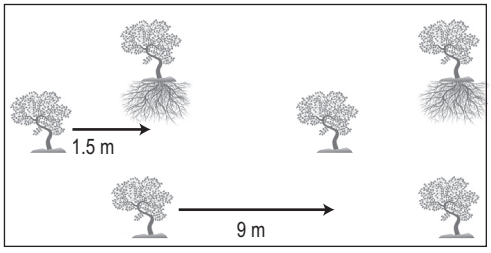

Fig. 5.3: Quincunx planting

In this, planting is done in the same way as in the square or rectangular pattern except that a fifth tree is set in the centre of the square or rectangle (Fig. 5.3). The central tree is usually the filler which is kept for a short period or till the main trees develop to full canopy size. Alternatively, this space can be utilized for growing perennial short statured plants. If the main trees become crowded, the middle tree can be headed back after few years and finally removed. This arrangement permits more plants than the main square or rectangular pattern.

(iv) Hexagonal

A pattern in which plants in alternate rows are spaced in the form of an equilateral triangle. The distance between the rows is equal to (3/2)2 x a where 'a' is the length of one side of the triangle (Fig. 5.4). Thus, though the trees are equidistant from each other, the row to row distance is less than plant to plant distance. This allows maximum use of the land with about 15% more plants per unit area, compared with a square pattern of the same dimensions. This is widely used where the land is expensive and fertile.

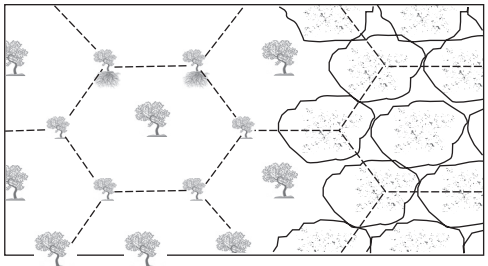

Fig. 5.4: Hexagonal planting

(v) Triangular Planting

A pattern in which plants in alternate rows offset half the space between plants in a row (Fig. 5.5). The distance between the rows is the same or more than that in a row. Thus a series of iso-scales triangles (two sides equal, instead of three as in an equilateral triangle) are formed. This is easier to layout than the hexagonal pattern but results in 9% fewer plants than the equivalent square or rectangle.

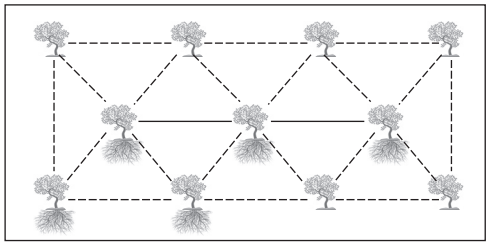

Fig. 5.5: Triangular planting

(vi) Single Hedge Row Planting

In this system the litchi plants are spaced closely in rows. The distance between trees in a row is usually

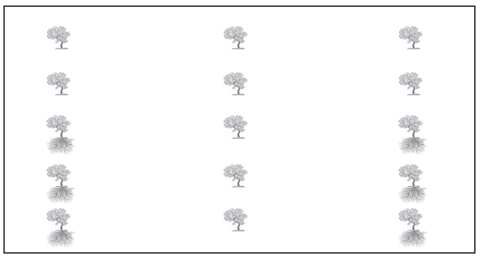

Fig. 5.6: Single hedge row planting

one half one-third the distance between rows (Fig. 5.6). This is practiced only for high density plantings of litchi. Such plantings are still at experimental stage. The yield potential and longevity of the orchards under hedge row system are yet to be ascertained. Initial results have shown that such plantings are more remunerative during early fruiting years.

(vii) Double Hedge Row System

This refers to the practice of spacing litchi trees in a row at about half the usual distance or adding additional rows to a conventional square or rectangular system. This arrangement is used for better use of the land during the early years of tree growth but does necessitate removal of the extra plants to keep them in bounds when they begin to crowd. After removal of the trees, the planting will become a square or rectangular one with original spacing. In double hedge row system, the additional row of the same crop and variety is permitted whereas; in hexagonal or triangular system other plants can be adjusted. The pattern in this system is consists of two closely spaced rows with a wide middle between the rows.

(viii) Contour Planting

The contour planting is used on rolling slopes or hillsides where some terracing may be needed. This planting arrangement permits production from sloppy waste land that otherwise could not be utilized. Considerable care must be taken to stop erosion by heavy rains or by irrigation by diverting the water to run among the tree rows rather than straight down slope. Any of the regular patterns described above can be used for planting trees on the sloping terrain. If the gradient of the slope is high, terraces are constructed following the natural contour as much as possible. The edges of the terraces are slightly higher than the side against the hill so that the irrigation water remains in the terraces. Drip irrigation and sod culture greatly minimize the problem of soil erosion. While planting the trees, marking for the tree points is from lowest level to the top is needed. Rows or group of rows are laid out along the contour.

Digging Pits

Once the planting geometry is decided and the land prepared, the pits are dug for transplanting the saplings. This should be done one or two months prior to planting. The main purpose of digging and filling the pit is to provide congenial conditions for plant growth and development, especially during the establishment phase. The pits should be invariably opened during summer to expose the dug soil to heat and sunlight. Pits should be filled before the rainy season for proper settling of the loose soil. To prepare the pit certain steps need to be followed.

In light soils 60 x 60 x 60 cm planting pits are sufficient for litchi while in heavy soils 90 x 90 x 90 cm pits should be prepared. In *murrum* (gritty) soil, pit size may be increased up

to 150 x 150 x 100 cm and 60-75 % of the dug soil is replaced with good soil and compost mixture. In locations, where the soil is loamy and deep, pits of 50 x 50 x 50 cm may be dug at desired distances. At hill slopes, the pits should be of 1 x 1 x 1 m size along the contour. At sloppy places, the pits are prepared in form of trench by cutting the upper side of slope and leveling the lower side of the slope. In this way a levelled platform is developed near the pit. Pit should be made in proper alignment so that saplings can be planted in the centre of the pit.

When the soil is taken out of the pit, the upper half soil is kept on one side and the lower half on other, under normal soil conditions; however, in murram (gritty soil) the whole soil of pit is kept aside and top soil is filled. Dug out soil and open pit are left as such to weather for 2-4 weeks during summer months to destroy any type of infection under sunlight and heat. In stony soils, it is better to separate all the stones from the excavated materials and left over soils should be mixed with manure and scrapped soil available in the field. Using a JCB machine for pit digging specially in hard and murrum soil is advisable because the pressure exerted by bucket of JCB cracks the hard pan which allows the litchi roots to penetrate.

Pit Filling

Initial establishment and vigour of the litchi plant is governed by the available substrate in the pit. Therefore, the pits should be filled with good quality substrate. Substrates mainly include farm yard manures, cakes, vermi-compost, *Trichoderma* rich manures and bio-fertilizers along with soil from litchi root rizosphere and VAM culture. In rocky and murram soils, which are almost zero in their inherent nutrient capacity, the initial substrate supplied in the pit governs the performance of litchi plant. As a common dose, 30-40 kg *Trichoderma* enriched FYM, 2 kg neem/karanj cake, 250g SSP or bone meal is sufficient for one pit in normal soil. In problematic soil however, pit soil should also be replaced with good soil. In highly acidic situation, application of 1-2 kg slaked lime, 250 g each of Zinc and Boron (Agriculture grade) is helpful to restore initial vigour of plant. Where magnesium deficiency is thought to occur, 500 g of dolomite should also be incorporated in pit filling mixture. Where soils are very sandy or infertile, the super phosphate may be replaced by a 12-12-17 or similar type fertilizer mixture not less than two weeks prior to planting and, if possible, three to five months in advance. Fertilizers carefully mixed with topsoil should be placed at the bottom of the pit. If the soil is having infestation of white ants, fenvulrate dust is mixed with upper as well as lower soil of the pit. The upper soil of pit along with substrate is filled first followed by lower soil mixture. High quality soil mixture particularly the soil beneath the well grownup litchi tree with probable mychorrhiza culture improves initial establishment and growth of litchi saplings. The main purpose of filling rich mixture in the bottom of the pit is that the plant will first proliferate their roots in 2/3rd lower portion of the pit. The upper level of pit is kept 15 cm above from the field level. After filling, if rain is not there, the pits should be irrigated to settle down the soil.

Apply Mycorrhiza

Presence of *Mycorrhizae* in the rhizosphere of litchi tree shows symbiotic association of the fungus with the tree. This is characterized by bi-directional movement of nutrients, i.e. carbon flows to the fungus and inorganic nutrients move to the plant, thereby providing a critical linkage between the plant root and soil. In infertile soils, nutrients taken up by the mycorrhizal fungi can lead to improved plant growth and reproduction. As a result, mycorrhizal plants are often more competitive and tolerate environmental stresses better than non-mycorrhizal plants. Fungi make root tubercles in plant roots and play vital role in nutrient absorption. The mycorrhiza, *Rhizophagus litchi* belongs to the arbuscular group of phytomycetous endophytes popularly known as AM. This is endophyte and cannot be cultured on artificial media therefore, the presence of living roots are necessary for its survival.

Mycorrhiza is only found on short-lived sublateral roots. The fungi penetrate the roots through the epidermal cells into the cortex, whereas the root hairs, endodermis and vascular tissue are free of infection. Plants with the tubercles are larger and have more roots than plants without the fungi. Many workers have suggested that litchi requires mycorrhiza to grow satisfactorily, although healthy plants have been examined which were completely devoid of tubercles. Nevertheless, there are several reports that confirm the existence of the fungus in the litchi roots. The poor growth of litchi under alkaline pH has been attributed to micro-nutrient toxicity / deficiency or lack of mycorrhiza. It has been observed that the fungi grow better in acid compared to alkaline soils. In majority of the cases, improved phosphate uptake is the primary cause of growth and yield enhancement. Highly significant positive correlation between the incidence of mycorrhizal infection and phosphorus and potash contents of litchi leaves has been observed. It is also seen that infection with the VAM increases uptake of P and K into the shoot and increased root weight, trunk diameter and fruit yield of litchi. Therefore, it is suggested that new plants be grown in the pit having soli (5 - 7 kg) from the vicinity of old trees to introduce the mycorrhiza or a culture of the fungus is incorporated into the soil at planting time.

Quality of Nursery Stocks

The establishment of a litchi orchard is a long-term venture, so it must be undertaken with great care. True-to-type, healthy and vigorous planting materials have a direct effect on the success of the litchi orchard. Healthy planting material of genuine quality makes the base of orchard efficiency and profitability. The quality of trees grown in the nursery will determine their performance when planted in the field. Therefore, the orchard must be developed with a good quality, genuine planting material.

Planting materials should be purchased from a registered nursery to guarantee the authenticity of the variety and health of the plants. Plants can also be produced by the growers adopting the standard procedures well in advance so that planting materials attain appropriate stage by the time of planting in the orchard. While purchasing the planting materials, one

should examine the nursery stocks being sold carefully for their quality. Do not purchase over-aged saplings of more than two years. Saplings' height should range between 40 and 60 cm. A good plant should have sufficient number of leaves for photosynthesis. The glossy, dark green leaves give a clue for good plant health.

Presence of some new leaves having a coppery red colour should not be mistaken for a nutrient deficiency. If the leaves are deformed or discoloured then there is something wrong with the plant. Such plants may be stunted due to incorrect nursery practices or damaged by insects pests and diseases. Avoid saplings with compressed internodes and a rosette of leaves at the shoot apex. Such plants may be malnutritioned. Polythene bag/pots of at least 20 x 15 x 45 cm are recommended for use in litchi nurseries. Use only vigorous, hardened plants for field planting. Hardening is done by exposing nursery stocks to direct sunlight and with sufficient or little reduced water application. This improves of the success rate of field establishment.

Planting Time

Litchi may be planted at any time of year, except in very hot, cold or windy weather. Planting is best done on cloudy, very humid days, which usually occur in spring, late summer, early monsoon and early autumn. Since litchi requires abundant water during its establishment phase, therefore if irrigation facilities are not available, the onset of monsoon is usually preferred. If the plantation is in an area which is prone to frosts, spring would be the best time for planting.

The best time for planting all over India is during the monsoon when there is sufficient moisture in the atmosphere. However, under North Indian conditions litchi planting should be done preferably during rainy season (July to August). Planting can also be done during spring season (February to March) where assured irrigation is available. The spring season is short and followed by a hot dry period of low humidity and hence, high percentage of mortality of young plants is observed in the field. The best time of planting litchi in the heavy rainfall zone is the end of the rainy season. In dry areas, the rainfall is less; the planting can be done in the early part of the monsoon for better establishment. If it is planted during bright sun shine hours of day which turns out to be unusually hot and dry, the plants may wither due to excessive loss of water. If the sky is cloudy or sun light is hazy, planting can be done during day time also. However, it is better to plant the saplings in evening hours when the high humidity prevails in the atmosphere.

Planting Distance

The optimum planting distance is required for the most efficient and profitable use of land. Its basic function is to confine the exploiting area of the plant with regard to light, water and nutrients so that the highest total yield potential can be reached in the smallest possible area. Distance of planting in litchi is need based and dependent on various factors like nature and

fertility level of soil, vigour of the cultivar, general growth conditions in the area and purpose of orchard establishment. In poor soils, litchi plants makes slow growth, so require less space while in heavy soils, plant grow vigourusly and therefore require more spacing. A 25 year old litchi tree may attain a canopy diameter of 12 m and will require adequate aeration and light around its entire circumference in order to produce a good yield. Traditionally, a spacing of 10-12 metres between two rows and the same between two plants in a row is adopted allowing a population of 70-100 trees/ha. Now the trend is towards closer planting. However, the distance may differ depending on the cultivar and system of cultivation. For slow-growing varieties, in cold locations or in poor soils, trees may be planted at 9 m x 9 m (123 plants/ha) or 6 m x 6 m (278 plants/ha). Since litchi is a relatively slow-growing species, it may be advisable to have a higher density plantation. The trees can be planted at a still closer spacing of 5 m x 5 m, accommodating about 400 plants/ha (Table-5.1). Such a planting requires intensive management involving severe pruning of limbs in order to keep trees' canopy restricted within the provided space. Climatic factors of a place, varieties, intensity of crop management practices, should be taken into account while deciding the distance and planting in litchi.

Table-5.1: Sapling requirement at different planting density

Sl. No.	Planting distance (m x m)	No. of plants /ha	No of saplings to be procured*
1	10.00 x 10.00	100	110
2	9.00 x 6.00	185	203
3	8.00 x 8.00	156	172
4	7.50 x 7.50	178	196
5	6.00 x 6.00	278	306
6	6.00 x 5.00	333	366
7	5.00 x 5.00	400	440

* 10 per cent more saplings are needed to meet out mortality

Planting Saplings

Under no circumstances the plants should be carried by the stem. Dig a slightly bigger hole than the size of earth ball at the already marked point to accommodate the root ball. Before taking out the polythene bags from root ball, it should be moist with water for 5 minutes which helps compact earth ball. Thereafter, cut around the bottom edge of the polythene to remove the bottom polythene. Put the plant with its intact ball of earth in the hole in such a manner that the plant remains straight and collar portion of plant is in the level or slightly higher than the ground level. Then remove the polyethylene bag with two longitudinal cuts from bottom up. After removing the polyethene cover and placing the plant in the hole, fill the planting hole with soil and slightly tighten the soil by pressing the moist soil of the pit all around the root ball so that the plant is set firmly in the field. These steps help reduce root damage due to breaking and splitting of potting media block. The right place of planting saplings in the pit can be done with the help of a planting board (Fig. 5.7).

While planting, one should be careful that the earth ball does not break during pressing the soil. A small basin is then made immediately after planting for irrigation. The frequency of irrigation in the first month depends on the weather. Planting should not be done so deep as

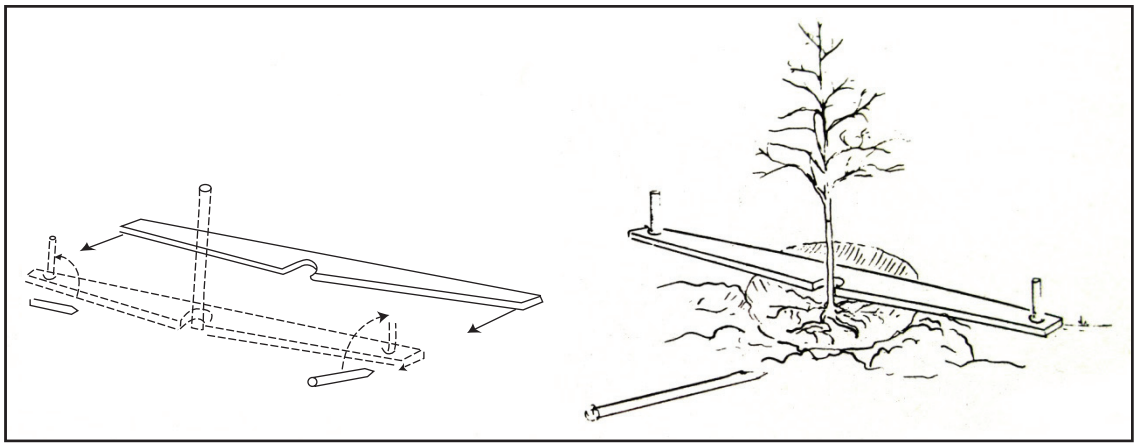

Fig.5.7: Planting board helps setting a plant at the right point during planting time

to bury the major portion in the soil or so high as to expose the upper roots. Allow the plant to grow directly up. Use a stick closer to the plant and tighten it into the stick carefully (Fig. 5.8a). Regular checking of plants is essential to detect the faults like sinking of soil, tilting of plant and cracking in basin of plant after planting the saplings. Sufficient moisture should be maintained till the plants do not set or start new growth in the field.

Irrigation

Water is a crucial input for establishment of litchi orchard. Assured availability of water and appropriate irrigation system is the most important aspect in a commercial litchi orchard. The type of irrigation system can be decided on the basis of water availability and available budget. Flood, basin, check basin and furrow system are the common methods; however drip sprinkler, microjet methods can also be used for litchi orchard establishment. Under tree, drip or micro sprinkler system is the best on account of water saving but the requirement of power, technical expertise and high initial cost makes the system most expensive as well. In the upland, with less irrigation facilities, litchi plants can be raised by providing life saving irrigation from natural water collected in plastic lined pots/Jal kundas/open ponds. Under these situations, practices of *in situ* water harvesting and moisture conservation near plant root zone should be practiced. Mulching helps reduce soil temperature in the root zone, controls weeds reduces drying of soil and soil erosion. Use mulch around the plant applying easily available mulching material such as dry grasses. Provide shade appropriately to protect plants from heavy sunlight.

Mulching

The last step in planting process, and also one of the most important, is to apply a mulch. It is strongly recommended to apply a mulch around young fruit trees. Any mulch material will do, since the main purpose is to suppress grass and weeds, which compete too much for

water and nutrients for a young fruit tree and stops it establishing properly. Try to mulch out from the trunk to a distance of about 1 m. Unless you are in an area prone to water-logging, it is a good idea to build the mulch up at the edges so that water naturally flows into the tree. Now water the tree with about 10-15 litres of water. Water it again after 4-5 days in summer or July–September, if there has been no rain.

Drainage

Drainage of excess water is a problem in litchi orchards which is accumulated in heavy soils or low lying flood prone areas. In these areas, poor provisions are reflected by the poor growth, sickly appearance or death of the young plants. Building up of a persistent water table may damage root growth and the functioning of roots is affected. High water tables and high soil moisture at critical stage of plant establishment and production cycle have been found harmful. Water logging affects growth of young plants and flowering in grown up trees and subsequent productivity of orchard. The main objectives of a proper drainage system is to remove the excess water from the active root zone during rainy months and as far as possible to keep the water table in the orchard below the active root zone, (1.80-2.40 m below the ground level). Soils with too much of slope are prone to erosion and too much of drainage in such soils also get moisture depletion quickly and require frequent irrigations.

Tree Guard and Staking

Newly planted litchi trees should have a tree guard of bamboo or wooden in a round or rectangle or square shape installed at the time of planting. It ensures protection from winds, bright sunlight and frost burn of main stem and branches. It also helps partially protection from small ruminants. The tree guard is placed in a perimeter about 50 cm from the tree to a height of about 1.5 m (Fig. 5.8b). However, within one year, this tree guard should be removed.

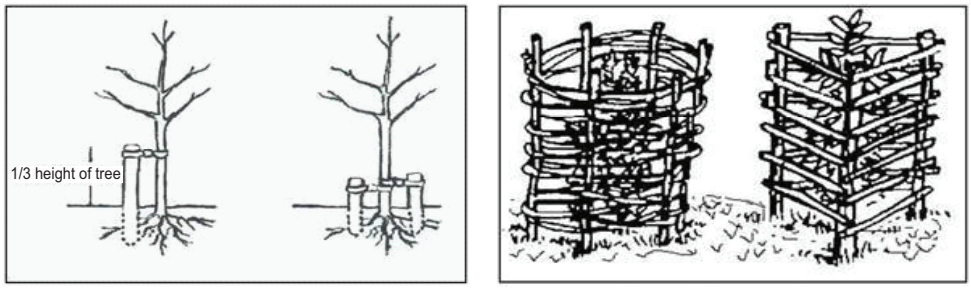

Fig. 5.8: Protecting plants (a) By staking them, and (b) From cattle grazing

Plants may be staked, at least for the first year until they are well established, to prevent damage by occasional winds. Stakes and ties add to the cost of the plant establishment and the maintenance requirement. Trees need to be staked against movement by the wind, but only a short stake should be used with a fairly loose tie (Fig. 5.8b). The reason is that the

flexing of the plant in the wind stimulates root growth to naturally brace the plant, and also stimulates growth in stem diameter at the base of the trunk. If the plant is so tightly staked that it cannot way, this natural bracing does not develop, and it is then very likely to snap or be blown over when the stake and tie are removed. Don't use a taller stakes. Stakes treated with preservative are not required, as the stake only has to last about two seasons.

Push the stake into the bottom of the pit on the windward side of the tree as close as possible to the root ball without damaging it. The stake should finish at a height not more than one third of the height of the tree. Loosely attach the tree to the stake, using a rope. Rope should form a figure of eight (8) or have a space between the plant and the stake to prevent chafing. In many cases, ropes need nailing to the stake to stop them slipping, unless they can be fitted just above a branch. Check the plant and stake frequently and remove the rope at the beginning of the second growing season, by which time the plant should be securely anchored by its roots. If it is not, then the plant is not growing sufficiently well and other steps will need to be taken to encourage the plant into growth. Double stakes can also be used as shown in the diagram (FCig. 5.8a). These are more reliable and less likely to cause chafing. They also act as protectors against careless mowing, which is a significant cause of damage to young trees. It could be done by planting four stakes one metre high in a square at one metre intervals and attaching some synthetic cloth of the same height to them of the same height as the plants and suitably intertwined around them.

Live Fences

Encroachment of trespassers, theft and animal grazing are the matter of common concern in litchi orchard. Fencing is done in two ways; fencing by using cement pole and wire or by erecting boundary wall and live fencing by growing of specific plants species. The first method of fencing is costly and can be afforded by rich farmers only. Live fencing is an age old and traditional practice. The fences act as wind break also if grown by using live plants particularly in the areas where cold and hot winds are the problem. The main purpose of fencing is to protect the plants from stray animals and harmful effects of cold and hot waves. Besides protection, the main function of live fences is to provide fuel wood, fodder and food, and enriches the soil. Therefore, fencing the orchard is an important aspect in litchi cultivation.

Traditional farmers have vast knowledge about the practice of live fencing and the species used. Planting live fence with tall growing trees as first row and small, bushy thorny plants in staggered manner as second row along the boundary of litchi orchard is very much important. In sloppy lands, windbreaks should be planted along with contour in ascending and descending order to protect the plants even at higher points. At such places, the live fencing can not be combined with wind break and must be planted along the boundary. Having a live fence around the farm has multiple benefits. It does however; take two to three years to develop. The species suitable for live fence should be thorny, inedible and non-grazable for cattle and goats, hardy and relatively maintenance free (other than pruning/

lopping), adaptable to the local conditions, fast-growing with ability to produce something that can generate some revenue. Live fences can be divided into two basic categories on the basis of their growth habit and use.

Fast growing hardy plants species can be grown as fence post at a spacing of 4-5m. These plants commonly grown by seeds or maintained from natural vegetations growing along the boundary to have strong root system. Farmers can also plant stakes of easy to root species such as Gliricidia sepium, Moringa, Flame tree etc. The live fence posts are more durable than traditional wooden poles as they are less prone to attack by termites and decay fungi. When grazing animals are part of the farming system, the only way to establish live fence posts and a living fence, is to start with a conventional wire fence supported by wooden pole and to gradually establish live fence plants to substitute for the decaying poles. Gliricidia live posts fence can be established by planting a few large (1.5-2.0 m) stakes in the existing conventional wire fence. These stakes normally take root within a month or so. After the first pruning, subsequent pruning can be carried out every 4 to 8 months. Shoot pruning at intervals of 6 to 8 months result in woody sprouts that are suitable for use as stakes. These pruned twigs can be used to multiply live stakes for fence posts within a year or two after establishing the first live fence posts. Palmyra palm, Babool, Simaruba, Jamun, Jangal jalebi, etc. can also be planted as fence posts.

Some hedge plants make a thicker and denser fence. Such plants include a number of species which do not require additional support of barbed wire. To minimize the initial cost of litchi orchard establishment, it is advisable to establish dense and thorny hedges to protect the orchard. Another alternative often used by farmers is the combination of easy to establish live fence plants that are poisonous and unpalatable species. If well established, these natural barriers can deter both animal and human trespassers from entering into the orchard. A live fence should ideally be planted just before the monsoons and watered regularly after the rainy season is over to ensure optimum growth. Agave, Sisal, Boradi, Karonda and Mehandi etc. are the promising plant species which can be planted as live hedge along the litchi orchard boundary.

Windbreak

Tall trees are planted on the border of the orchard to reduce the impact of wind on the fruiting of the litchi trees. Windbreak is commonly tall trees having dense foliage and keeps the surrounding atmosphere humid. These trees help in minimizing the wind velocity, impact of high temperatures which adversely affect the young plants and cause excessive fruit drop. Trees, which are generally used as windbreak, are seedling mango, jamun, mulberry, moringa, jackfruit, carambola, shisham, teak, gamhar and bamboo. These can also be used as live fencing posts. These trees are usually planted close to each other to provide an effective shield. Tall growing trees like shisham and jamun are planted 6m apart while low headed trees like mulberry and carambola are planted at 7m distance. Normally, plants grown as wind

break may extract nutrients from litchi plants. Therefore, a trench of one meter depth should be dug between litchi row and wind break.

Replanting

In spite of all possible care some litchi plants die during first two years of transplanting. The extent of such deaths does not exceed 5% or maximum to 10% of the total population if proper care is taken. These gaps are filled by replanting fresh saplings of the same cultivar. The replanting can be taken up during the planting season or off season except in severe winter or summer months. The most common faults observed in establishing the newly planted trees are improper irrigation and lack of weed control. These two faults cause more loss of plants than any other factor during the initial years. Proper attention must be paid to irrigation and mulching.

When an old litchi orchard is terminated, it is not replanted again. This is simply because, owing to long life of the orchard, the soil gets impoverished and the pests and diseases associated with the crop are fully established. Thus, if the same site is replanted, the success of the second establishment becomes doubtful.

Production Systems

The production of fruit crops involves a wide range of resource and input decisions. Changing circumstances, changing technology and science, and, finally, changing ideas mean that the decisions will also change with time. The long term view of past developments in litchi production shows changes in approach and decisions about how and what should be done to produce maximum yields of high quality fruits.

High Density Planting

One such change in orchard production has been the intensification of tree density together with a rationalization of tree shapes, with the aim of producing fruit-bearing canopies better suited to current management and harvesting practices. HDP, meaning high-density planting, has been used in litchi, with the intention of delivering early yields in the orchard life cycle and with improved efficiencies. The efficiencies relate to improving the relationships between capital investment and particular inputs with the production system outputs (which can be measured in terms of level of yield, fruit quality or financial return). For example, some orchards have sought efficient returns to labour by developing short stature trees with less need for pruning and training. The lower labour requirement for training, pruning and accessing the tree at harvesting time aids the competitiveness of the high density production system.

Organic Production

Fruit production systems have to be competitive but there is also a realization that fruit production systems should be sustainable. While the term 'sustainable' can be interpreted

in many ways, the overall direction for orcharding has been to minimize environmentally disruptive actions and to find inputs that are sustainable and, if possible, renewable. Some specific production systems are identifiable by the focus on the choice of production inputs. Some producers choose not to use manufactured fertilizers, crop protection compounds and other chemical inputs. Typically the alternative system inputs chosen by these producers are labelled 'organic', and these producers also follow particular practices, which are also labelled 'organic'. In many countries, government and/or non-governmental bodies have established certification schemes that permit growers to label their produce identifying the produce as 'organic'. The certification schemes set out the criteria (acceptable organic practices and inputs) that must be adhered to. An international organisation, IFOAM (International Federation of Organic Agriculture Movements) acts as an 'umbrella' movement and actively promotes the interests of the organic agricultural movement worldwide.

There is another movement that also promotes organic farming, with an emphasis on principles or method of production, termed 'biodynamic agriculture'. This emphasizes the interrelationship of soil, plants and animals as a unified system and in need of a holistic treatment. There are some methods of production and preparations that are unique to 'biodynamic' principles. Once again, certification of the use and adherence to the principles of biodynamic production is available, offered by approved bodies. Demeter International is the largest certification organization for biodynamic agriculture.

Integrated Fruit Production Systems

Buyers, consumers and even government' agencies have choices about what products are acceptable. Governments have responsibilities for national biosecurity and for the health of their citizens. Fruit consignments must meet set standards for the presence or absence of particular organisms and for the safety of the product, most of the attention is focused on the presence and/or level of particular chemicals deemed to be of concern. Producers have choices about the production methods and inputs they use, and clearly these choices need to be in alignment with the demands of buyers, consumers and governments. The trend towards minimizing pesticides and fungicides, with the benefit of less ecosystem disturbance and lower production costs, has resulted in new systems.