CHAPTER 11

ORCHARD FLOOR MANAGEMENT

Litchi is a slow growing plant. If the trees are planted at normal spacing there is considerable land remain vacant for several years. This space can be utilized for growing suitable inter-crops for economical return during non-bearing juvenile phase of the trees. Once an orchard is laid out and trees are established, it becomes imperative on the part of the orchardist to use the vacant space between the trees to ensure a quick return on investment. Management of ground space of orchard for additional benefits, however, should not be at the cost of main crop. It is also imperative for an orchardist to keep the orchard floor weed free. Therefore, it is desirable to grow some short-term crops in initial stage of orchard establishment and should continue till the litchi plants come in full bearing. Poor management of inter space in litchi orchard leads to deterioration of plant health and growth of weeds.

Intercropping with suitable and synergistic crop improves the fertility and protects the top soil of orchard and give additional income. The other method of orchard floor management would be growing cover crop or sod culturing which in due course protects top soil and supplements organic matter to the orchard soil.

Benefits of Proper Orchard Floor Management

1. Due to wide spacing and developing root patterns, the large unutilized interspaces can be exploited for growing inter and mixed crops successfully.
2. The soil fertility can be enhanced by careful selection of intercrops and adequate management of the orchard. Selection of intercrops depends on agro-climatic region, marketing facilities, levels of inputs and other local considerations.
3. Cover crops save the orchard soil from being eroded during the rainy season. When the cover crops are turned into the soil, the organic matter of the soil is increased.
4. Water-holding capacity of the soil is increased and the biological complex of the soil is also improved.
5. Cover crops prevent weed growth; protect the young plants from wind and even from cold injury.

6. Cover crops also a source of mulching after they have been harvested.
7. Constant use of intercrop may reduce the soils' phosphorus and potassium content while increasing their nitrogen content. Because of this, small quantities of P and K should be incorporated to offset these losses.

Selection of Crop

Though there is difference of opinion among scientists with regards to whether to crop or not in litchi orchard the general opinion favours it. Carefully controlled intercropping with primary attention paid to permanent trees would, prove beneficial to them.

Feasibility of inter-planted crop is determined by many factors, like, valuation of land, fertility of the soil, and level of intensification of cropping by orchardist. Where the investment is large and expenses are high, intercrop would do much help or produce profit during first few years. However, intercropping is labour intensive and is not practicable under the condition where the land values are low and labour cost is high.

Orchardists are advised to grow shade loving plants in grown up litchi orchards and leguminous crop, vegetables, etc in young orchards.

Factors Determining Choice of Intercrops

1. Orchards which are nearer to cities or towns, better to grow vegetables as intercrops as it is more paying. For distance orchards crops like onion and potato can be grown during young stage.
2. Select the crops which are well adapted to the climatic and soil conditions of the area. Legumes are better choice for soils poor in nitrogen.
3. Water requirements of the intercrops should as far as possible coincides with the requirement of litchi plants. Such intercrops should be selected that do not exhaust the nutrients and moisture from the soil which are essential for the growth of litchi plants.
4. For young orchards, vegetables which require abundant sun-light can be selected. For old orchards shade loving crops are preferred. It may be kept in mind that the intercrop should not affect the management of the main crop or interfere with the cultural practices. It is not desirable ordinarily to grow grain or other exhaustive crops like sugarcane, because of the exhaustion of nutrients and moisture.
5. Crops like wheat, oat, grain, oilseeds and radish (for seed) may not be grown as intercrops in grownup litchi orchard. This is mainly because the period of seed production and subsequent development of seed in the intercrop generally coincides with the period of active fruit development and during the period the intercrop extracts maximum amount of moisture and nutrients from the soil.
6. Perennial or exhaustive crops should be discouraged as an intercrop in the orchard. This may have devitalizing effect on the growing trees. For example, sugarcane, pigeonpea,

maize, *jowar* should invariably be excluded from an intercropping programme in the litchi orchard.

7. The crops that may grow tall and have a tendency towards excessive growth should be discouraged. Trailing vegetables or vine crops are not desired as intercrops. Growth habit must be such that it does not affect the growth of litchi crop directly.
8. Certain pest and disease problems are enhanced by growing two or more crops together. It is also noted that intercrops favour some pests and pathogens since they serve as alternative hosts for them. Such crops may not be allowed to grow together.
9. Vegetables that have their roots within 25 cm depth of the soil are considered good for intercropping. (tomato, onion, cauliflower, beans, radish, *palak,* etc.)
10. It is preferable to take leguminous crops for cover cropping so that nitrogen fixation in the orchard soil is facilitated. Another advantage of cover crops is that they will prevent the growth of weeds. During rainy season *(kharif)* greengram, blackgram, cowpea and *guar* are preferable. During winter season *(rabi)* it is desirable to take chick pea, pea, lentil, mustard, tomato, potato, taba bean, etc.
11. Some crops like sunhemp in light soils and *Dhaincha* in heavy soils may also be grown to protect the orchard soil from erosion and also for enriching the soil fertility. These crops are sown in beginning before rainy season and ploughed back after 45-50days before or just before flowering.
12. Colocasia, ginger, turmeric and Zimikand are basically heavy feeders and therefore should be grown with supplemental does of nutrient. In addition to field crops, some short duration, less exhaustive and dwarf type inter-fillers like papaya, banana and guava can also be grown till these do not interfere with the main litchi crop.
13. Leguminous crops of like green gram, black gram, gram; etc., cereals like wheat; oilseeds like mustard, sesame and groundnut and vegetables crops such as cabbage, cauliflower, tomato, potato, brinjal, cucumber, pumpkin, bitter gourd, tinda, lady's finger, etc. and spices like chillies can be successfully grown as intercrops in young litchi orchard.

Crop Combination

To intensify the orchard operation, a lot of work has been done on intercropping in orchard crops during initial years. Although it is the choice of farmer to select a crop however field crops like gram, mung, pea, potato, sweet potato, maize and vegetables like cauliflower, cabbage, spinach, okra, carrot, chillies, radish, onion, etc. can be grown successfully in the litchi orchard (Fig. 11.1). Various other crops which can yield better under partial shade are elephant foot yam, sweet potato, ginger and turmeric. A combination of crops for inter spaces of litchi plants have been suggested below.

- Cabbage (Oct-Feb.) – Cowpea (March-June)-Methi (July-Sept.).
- Okra (Sept.-Dec.)-French bean (Jan-March)-Tomato (April-July).

- Potato (Nov-Feb)-Amaranth (March-May)-Cowpea (June-Aug.)-Radish (Sept.-Oct.).
- Cauliflower (Aug.-Nov.)-Potato (Dec.-March)-Dolicos (April-July).
- Cabbage (Sept.-Dec.)-Brinjal (Jan.-May)-Cucumber (June-Aug.).
- Palak (Nov.-Jan.)-Cluster bean (Feb.-May)-Brinjal (June-Oct.).
- Cow pea- potato/ Green gram-Niger/ Black gram-Mustard/ Green gram-gram/ Black gram-gram/ Cowpea-Mustard/ Cow pea-gram

Fig. 11.1: Inter cropping model for newly planted litchi orchard

Filler Fruit Crop based Multi-tier System

To maximize the per unit area output from litchi orchards growers prefer some quick growing and early bearing fruit trees. In some areas in a properly spaced litchi orchard there is scope for guava trees which begin to bear in second year and produce a good yield up to 8-10 years other smaller trees, may be papaya, citrus or phalsa which have been found suitable as filler plant in litchi (Fig. 11.2). In no case the roots of the filler trees occupy the soil where the roots of the permanent trees are concentrated.

Fig.:11.2: Litchi+ Guava+ Cowpea system in litchi

Method of Growing

The method of growing intercrop in an orchard is different in the young and the bearing orchards. In many plant almost, the entire land is utilized, leaving only the basin portion of the tree. The plant is located in the middle of the bed in which the crop is grown. As the trees grow in age, the size of the basin increases and the area for intercrops gets reduced gradually. When the plants attain good bearing age, the intercrop is grown in between the tree rows in one direction, i.e. on two opposite sides of the trees, leaving the other two sides of the tree without intercrop to facilitate orchard operations. The tree rows are enclosed by a strong bund on two sides running from one end of the orchard to the other. This facilitates irrigation of trees within the bunded space independently of the intercrop. It also provides space for movement during plant protection and other operations in the orchard.

Pest Management

If the cover crops or intercrops are taken regularly, the weeds will be automatically suppressed. A constant watch over the diseases and insect pests of litchi is necessary for ensuring quality crop from the trees. When the humidity builds up appreciably during the flowering time, incidence of insect/pest and fungal diseases are increased and sometimes this may result in to heavy loss in fruit set. Sometimes due to excessive use of pesticides, the build up of natural enemies in litchi orchard is threatened. Thus, intercropping/cover cropping in orchard may promote infestation of pests and diseases in greater intensity than under clean cultivation. This is due to increase in the humidity and vegetation around the trees due to intercrops. Hence, regular plant-protection measures against pests and diseases of the litchi crop are essential. However, no vegetable insect pests have been found to attack litchi crop and vice versa in intercropped litchi orchard. Skirting and centre opening like pruning process must be followed from time to time in litchi plant for successful intercropping.

Irrigation and Nutrition

While taking intercrop, people do mistake by no application of nutrients to main crop with a view that the plant will obtain nutrients from the same fertilizer dose applied to the intercrops. This is not a good practice. The intercrop and the fruit trees must receive their nutrition separately because of their independent requirements of fertilizer and irrigation. The nutrition and moisture to intercrops must be provided in additional amount. Proper irrigation of trees, particularly during summer, is very essential to get quality crop from the bearing trees and proper growth in young plants.

Trees must be regularly observed for any setback due to any cause and steps must be taken immediately for its remedy. Round the year cultural schedule must be drawn up and operations should be done as per schedule. This will ensure production of quality crop from healthy litchi trees and good yield from intercrop.

Long-term Productivity

It is generally believed that growing intercrops will adversely affect the long term productivity of the main crop. But the problem is with the level of management not with the crop. If both the main crop and the intercrop are managed well, inter-cropping is most paying exercise. This has been proved by several experiments that inter-cropping not only give additional income but also enriches the soil. On the other hand, if the additional crop is allowed to be a parasite, then the yields of both main crop and intercrop will be adversely affected.

It is true that productivity in mixed cropping mainly depends upon plant to plant interaction. Intercrop and main crop draw their nourishment from the same environmental resource pool. If selection of crop is not properly done then the extent of competition may be too high and can harm the productivity significantly. If selection is done carefully taking care of aerial growth and root distribution pattern, then considerable additional benefits can be achieved by intercropping. Plants may complement each other in sharing resource pool and thus achieve a complete utilization of the eco-climate.

Weed Management in Litchi

Weeds are a serious threat in the initial stage of nursery plant establishment where they compete for nutrients and act as shelter for pests and diseases, but in full grownup plants weed do not have that impact except that of unpleasant look and shelter for pests. In litchi orchards, however, owing to shallow root system, it is necessary to keep the weeds under check at least twice a year which otherwise may prove harmful to the growth and productivity of litchi trees. First 1-3 years after transplanting are crucial for the growth of litchi plants. Application of organic manure and inorganic fertilizers, irrigation at regular intervals and good sunshine results in the growth of a broad spectrum of grassy and broad leaf weeds in litchi orchards. These weeds should be removed to have better growth and performance, failing which the ultimate normal growth of litchi trees will be hampered.

Depending on the duration of growth, weeds may be classified into three groups as annual, biennial and perennial. Annual weeds multiply by seeds and complete their life cycle in one season. The competition offered by weeds is due to the combination of their prolific reproductive capacity and vigorous growth. Annual weeds produce large quantities of seeds. Prolific seed production ensures that many seedlings conditions are favourable. Perennial weeds usually last for two seasons. These weeds grow from seeds, rhizome, runners and bulbs, etc., and flower and fruit every year. If not suppressed, they continue to live for a number of years. They are very harmful to young trees. The common perennial weeds of the area: *Cynodon dactylon, Cyperus rotundus, doddar* or *swamalata* (*Cascuta reflexa*) causes considerable damage to trees. It is very difficult to eradicate this parasite, unless systematic hand picking is resorted to.

If weeds are not controlled, they interfere in the cultural operation like irrigation, spraying insecticides, fungicides or hormones, pruning and harvesting of fruits. There are many weed

control measures. These can be broadly classified into four groups, viz. cultural, biological, chemical and integrated weed management.

Cultural (Mechanical) Control

Cultural weed control involves practices to minimize weed competition with the main crop. The most effective way to control annual weeds is to prevent their flowering and seeds setting. For this, the collective efforts of all farmers of the area are necessary. Control practices are hand weeding, mechanical weeding (mowing), tillage, growing intercrops and mulching. These methods prevent weeds from becoming established.

Once established, destruction of weeds manually by cutting with sickle or turning into the soil with spade and cultivation of the land frequently and collection of the roots, rhizomes, runners, bulbs, etc. by hand are efficient and practical methods for small orchards, but it is economical only when sufficient and cheap labour is available. Also, the manual weeding has limited effectiveness against established perennial weeds. Mowing controls the weeds by preventing them from setting seeds. The advantage of the mowing is that the soil is never exposed to erosion. This is good for the orchards established on slopes or sandy soil.

Tilling the orchard soil regularly provides a weed free environment in the orchard. Traditional tillage with the spade or hoe involves shallow cultivation and partial burying of weeds. Use of animals for ploughing reduces the labour cost but some superficial tree roots get damaged in ploughing. The use of tractor-mounted tillage implements is an improvement over traditional holtilage and animal drawn plough. Tractor drawn tool can be used during initial years when the orchard trees are not fully grown. Branches hanging low, spreading in the inter-row spaces hinders the movements of the tractor even in widely spaced rows at maturity. Under such situations small power tillers can be used. Tillage controls weeds partly through burying weeds and partly through exposing underground parts of weeds to desiccation. The land around the trunk must be cleaned separately with the help of spade as it is difficult to operate a power implement in the vicinity of the trunk.

Under tropical and sub-tropical condition, sod or no-tillage in the orchard is harmful. It adversely affects the tree growth and development. In hilly areas or where the slop of the land is high, trees are often grown under sod to protect the soil from erosion. Grasses are planted or the natural grasses are allowed to grow on the vacant space and the soil is not disturbed. The grass is mowed time to time and preferably fell on the ground. For tropical fruit orchards existing on the fairly leveled plain land, this practice is not suitable. Under 'Clean Cultivation' the objective is to keep the floor (surface soil) clean as far as possible. This is done by tilling the soil when required. Tillage not only checks the weed but also protects the surface soil from becoming hard or excessively compact for penetration of moisture or nutrients. Compact soil surface interferes with the growth and functioning of the roots owing to lack of soil air. Clean cultivation or tillage may have other beneficial effects on productivity of the orchard. For example, it can increase microbial activity by increasing gas exchange (aeration) and water

penetration. Increased biological activity can promote the degradation of unwanted coarse organic material in the soil but it also can promote degradation of desirable organic matter causing decrease in the exchange capacity of the soil.

Intercropping/Cover Cropping for Weed Management

Cover cropping and intercropping are other practices followed in litchi orchards to suppress the growth of weeds, to bring additional income to the grower and to improve the health of trees until the trees begin to bear and can be continued even after that. Generally, cover crops are grown in space between the trees taking due care that no crop comes under the spread of the trees so that roots of the intercrops and the trees do not come into competition with each other for drawing nutrients from the soil.

Biological Weed Control

This type of weed control involves the use of natural enemies for the control of weeds. Grazing of animals like goats, cows, bovine can be allowed to suppress weeds in the established orchards but animals may graze the litchi plants as their height is quite low and within their reach in initial stage. Other aspects of biological control of weeds involve the use of mulch or low growing crops to smother weeds and manipulation of plant density and canopy. Theoretically, biological control is the best method for eliminating weeds, but it is difficult and tedious in practice to locate and develop agents for biological control of weeds.

Chemical weed control

This refers to use of herbicides to suppress or kill weeds. A herbicide is a chemical that has phototoxic properties. It includes a wide variety of chemical compounds which are classified on the basis of certain characteristics which may include (i) chemical structure, (ii) selectively and (iii) where the herbicides act as a contact or translocated herbicides. Selective herbicides are those which kill certain kinds of plants (weeds) without significant injury to others. Selectivity depends on the reaction of both, the crop and associated weeds to the herbicide being applied. The most desirable condition exists when the crop is not injured by the herbicide but the weeds are killed.

Selectivity based on the nature of herbicides is often determined by whether it is active when applied to the foliage, to the roots or to both foliage and roots. To obtain maximum selectivity to the advantage of the crops and disadvantage of the weeds such factors as rate of application, soil type, irrigation practices and cultural practices must be considered. Selectivity may vary according to the weed species present, stage of growth and weather conditions. Consequently, selectivity is rarely perfect and depends upon the environment, the nature of the herbicides, application rate and method of application.

Non-selective herbicides will indiscriminately kill all plants when they come in contact. An example of non-selective herbicide is glyphosate. Paraquat is another example which destroys the green tissue of all plants when it comes in contact with but perennials are able to produce

new shoots from rhizomes or other such organs. Therefore, the action of paraquat is non-lasting for perennial weeds. But this is not the case with glyphosate. Its action is long lasting and thus, has been recommended widely for use in the orchards.

Some herbicides are systemic in their action. They are also referred to as translocated herbicides. They are readily absorbed by leaves, stems or roots of treated plants. Some herbicides move in the phloem of treated plants alongwith food materials. These herbicides tend to enter the plants through the leaves and stems (foliar applied). Some systemic herbicides move mainly in the xylem vessels along with water and minerals. These herbicides are generally taken up by the plant roots in the soil. Example of herbicides that move in the xylem vessels are atrazin, simazine, diuron, metachlor, alachlor and fluometuron.

Herbicides are generally safe to use if the information mentioned on the label is followed explicitly. A list of different herbicides used in fruit plantation has been furnished in Table-11.1. However, in using herbicides, the following guidelines must be strictly adhered to, otherwise crop injury or poor weed control can occur.

Table-11.1: Herbicides useful for weed control in litchi orchard

Name	Amount (a.i.) kg or l/ha	Remarks
(Paraqua)	0.6-1.2	Any time when weeds are young, 2-15cm high
Glyphosate	1.0-2.0	Use very carefully around trees; never use if any possibility exists for spray to touch young, green bark of tree trunk; can be used any time
Diuron	2.0-3.5	Lower rates in sandy soil
2,4-D	1.0-2.0	Any time, repeat as necessary
Dalapon	3.0-5.0	For grass control; repeat as necessary
Simazin	1.0-2.0	Good for annual weeds; can be damaging to young trees on sandy soil
Amitrol	0.6-1.8	Not recommended for trees less than 3 years old
Terbacil	1.8-3.6	Use in old orchards; use at lower rate in light sandy soils
Trifluralin	0.6-2.2	Mix with soil while tilling it

Cited from: K.S. Chauhan's Litchi: Botany, production and utilization, Kalyani Publishers New Delhi

- Rates other than those recommended never be used in the orchard.
- Sprayers must be properly calibrated and nozzles are directed towards weeds and not to the tree trunks or foliage.
- Young weeds are killed more easily than other older established ones.
- Fine textured soils (clay) require higher rates of herbicides than coarser (sandy) soils
- In old orchards, a relatively narrow band just covering the inter-row space is treated with the herbicides. Weeds near the trunk are controlled by tillage equipment.
- Application must not be made when weather condition are unfavourable (i.e. high velocity wind or rains or cloudy weather).
- Adjuvants or melting agents may be added to cause the spray solution to spread more uniformly in order to cover the foliage thoroughly.
- If leaves of the fruits trees are accidentally sprayed, the sprayed portion must be cut off immediately.

Integrated, weed control system suppresses weeds by combining two or more weed control methods. Environmental and socio-economic constraints make integrated weed management one of the best options for weed control measures in the tropics. Cultural weed control methods are often laborious, unattractive and ineffective. Integrated weed management has been demonstrated as the most effective in banana and other fruit tree plantations. Intercropping, tillage of the soil and use of herbicides are examples of integrated weed management followed in different fruit trees.

Mulching for Weed Management and Moisture Conservation

Fig. 11.3: Mulching in Litchi tree

The process of covering plant root zone or entire basin with protective coverings is called mulching. Mulching is beneficial to all litchi orchards (Fig. 11.3). It is very much useful in plants raised under rainfed conditions or in adverse soils. The covering materials may be organic or inorganic in nature. Using mulch can help a litchi orchard in many ways.

Mulches make unfavourable conditions for seed germination of weeds and provide a physical barrier for emerging weeds. A good mulch layer saves many hours of manual weeding. Thick layer of mulch material is very effective in preventing the number of annual weeds in the orchard, since they have difficulty to penetrate such a layer.

Mulches maintain uniform moisture conditions in the litchi orchard. Moisture loss through evaporation is reduced, and soil erosion is decreased in rainy season. Slow and steady water infiltration takes place in the soil and crusting is prevented. Mulches reduce the force of raindrops, thereby protecting the structure of the soil at the surface. Mulches may serve as vapour barriers, thus reducing evaporation of soil moisture. Water fall on bare soil surface causes splashing of soil onto the fruit. Mulches keep fruits cleaner and help in reducing the spread of disease.

Organic mulches add nutrients and humus to the soil as they decompose, improving its tilth and moisture-holding capacity. Some mulches are tilled into the soil before planting a new crop, and therefore may have an effect upon soil fertility and soil property. In the short term, mulches may decrease nitrogen available for a given crop. A material that has a high carbon content and is very low in nitrogen and other nutrients may actually "bind" or immobilize plant-available nitrogen temporarily. This occurs because soil microorganisms use available nitrogen to metabolize and decay the organic material. The immobilized organic nitrogen can be made available (mineralized) later as the organic matter continues to decompose.

The increased organic matter content due to mulches increases soil aggregation, infiltration, and water-holding capacity. In poor soils, addition of organic material improves water retention and reduces water losses through deep percolation.

Mulches shield the soil surface from solar radiation effects. Because of the increased moisture content and reduction of incoming solar radiation energy, a mulched litchi plant basin has lower difference between day and night temperatures. However inorganic mulches can act otherwise .For example, dark mulch can adsorb more solar radiation and may actually increase soil surface temperature; transparent plastic mulches may increase temperature through a "greenhouse effect"; and can prevent water from entering soil, thereby decreasing soil moisture and increasing water runoff.

Thus, mulches are very much useful for grownup as well as developing litchi plants. In bearing plant, it has direct impact on fruit drop, fruit cracking and quality development whereas in developing plants it helps in better survival, growth with less water. Natural as well as synthetic materials are used for mulching. Details of some of the mulch materials has been given as under.

Types of Mulches

To cover the soil surface in and around tree basins in litchi various kinds of organic (saw wood dust, crop residue farm waste, dry leaves,) and inorganic (polyethylene of different colours) can be used as per availability and scale of investment.

Method of Mulch Application

Most of the organic mulches should be applied after plants are well established. In developing litchi plants also, organic mulch can be applied but problem of termite should be taken care of. Remove all weeds before spreading the mulch. Apply mulches when there is reasonably good soil moisture and before the weather turns hot. Infiltration of rain water will be slowed somewhat by mulch, so it is best not to place the mulch on soil which is dry. Water thoroughly or wait for a good soaking rainfall before applying any mulch. Application of organic mulch in plant basin can delay the termite infestation to tree trunk for some days as termite feed on mulch material and do not move to tree. However, it aggravates the infestation in subsequent days when mulch is digested and no additional mulch is replaced. To keep these termites in check, tree trunk should be pasted with chlorpyriphos 0.02% + coal tar paste and mulch should be applied one foot apart from the tree trunk. This practice delays the termite infestation and restricts the soil mounding on tree trunk. Black polythene and similar materials should be spread on land that has been completely prepared for planting and has a high moisture level. Edge of the mulch should be buried with soil to prevent it from blowing away due to air.