FRUITGROWING UNDER IRRIGATION

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UNDER THE CLIMATIC AND GEOGRAPHICAL CONDITIONS PERTAINING TO THE MURRAY VALLEY

BY

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Gift of Prof E. J. Wickson
to

PREFACE

The absence of any Australian work of a general nature dealing with the subject of fruitgrowing under irrigation is the author's apology for placing this work before the public.

Much of the subject matter of some of the chapters herein dealt with appeared in the form of articles written by the author during the past four years, which were printed in the pages of the *Murray Pioneer*.

It is the author's hope that the following pages may be of some service as a guide to prospective irrigationists or to settlers new to irrigation enterprise, in helping them to acquire the chief principles of Australian irrigation practice, and thus to enable them to avoid the mistakes made by many of the older irrigationists, who, for want of information upon this subject, had often to acquire their irrigation knowledge as the result of painful and costly experience.

F. R. ARNDT.

Berri, River Murray,
South Australia,
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CHAPTER I

THE CLIMATIC AND GEOGRAPHICAL CONDITIONS OF THE MURRAY VALLEY

THE MURRAY.

The Murray, the largest river in Australia, has its source in the Snowy Mountains, near Mt. Kosciusko. With the help of its chief tributaries, the Darling, the Murrumbidgee, Goulburn, Mitta, Ovens, Campaspe, and Lodden, the Murray attains a river of large dimensions in its lower course, being at high river navigable for river boats for a distance of about one thousand miles from its mouth. With the completion of the inter-State locking scheme, the Murray will be rendered permanently navigable for the greater portion of its length. Along its banks are situated the two most successful irrigation colonies in Australia—Mildura and Renmark; while the newer irrigation settlements of Merebein, Berri, and Waikerie, are showing every indication of a successful future.

NATURE OF MURRAY LANDS.

The land suitable for fruit growing along the Murray consists of two distinct sections: the river flats and the high lands.

The river flats consist of alluvial soil deposited by the river in the course of ages. These flats are, on the whole, fairly level, but usually contain numerous small local irregularities, which have to be graded off before the land can be planted. The soil usually consists of a variety of clays and loams of a fairly heavy nature, which are often overlaid with a layer of sand.

The high lands generally consist of loose, sandy rises, which in their native state are often thickly timbered with pine, mallee, and other bushes. The soil is generally a red, sandy loam. The depth of soil varies from about 2 feet to 5 feet, and is usually underlaid with a loose, light-brownish marl. Land of this nature exists by the thousands of acres along the Murray Valley.

WATER SUPPLY.

The prosperity of an irrigation settlement necessarily depends upon an assured water supply. With the exception of two abnormal years, the water supply from the Murray has been both pure and plentiful for the irrigation requirements of the river settlements. But during the droughts of 1902 and 1914 the Murray flow practically ceased, and the water turned saline. The irrigation colonies situated along its banks were thereby faced with a situation of extreme danger, and such was the salinity of the water that many plantations were seriously injured by its application. To prevent the recurrence of such a state of affairs in future dry seasons it is necessary for the States of New South Wales, Victoria, and South Australia (as is provided for in the Murray Waters Agreement) to immediately enter upon a joint scheme of **Water Storage** by the construction of weirs at Lake Victoria and at other places, whereby some of the surplus water that flows in such enormous volumes into the sea in normal years would be impounded, and liberated for the use of the irrigation settlements in years of drought.

CLIMATE.

The climate of the Murray Valley is hot and dry. The rainfall, which averages about ten inches per annum, is insufficient for fruit culture without the aid of irrigation. The months of November, December, January, February, and March are usually hot, the temperature often exceeding 100 degrees Fahr., and sometimes reaching 110 degrees during severe heat waves. Hot, northerly winds often accompany these heat waves. The nights during the summer months are usually cool.

The climate during the autumn, winter, and early spring is mild. The days are usually fine and sunny. The night temperature sometimes sinks a few degrees below freezing point, but any considerable damage to plant life from frost is rare.

During September and October the equinoxial gales often blow with considerable force and persistence, making it necessary to take precautions against the drifting of the surface soil of the looser sandy slopes.

FAVOURABLE CONDITIONS FOR FRUIT CULTURE.

The conditions favourable for fruit culture consist of:

Fertile Soil. Soil of the highest fertility, both alluvial and high land, exists along the Murray Valley by the thousands of acres. The sites of the various irrigation settlements have naturally been chosen where fertile land and a plentiful water supply exist in close proximity. This, however, owing to the impossibility of large tracts of land all being of a uniform nature, does not prevent there being patches of hard-pan or shallow soil scattered among the more fertile land.

One of the chief factors making for soil fertility is due to the dryness of the climate, as owing to the absence of heavy rains the various plant foods of a readily soluble form have not been leeched out of the ground on the virgin lands.

Water Supply. Water is applied on most of the Murray irrigation settlements in four or five irrigations, ranging from August to March. Owing to the chief waterings taking place during the period of greatest plant activity, trees and vines grow with a rapidity and vigour unknown to most horticultural districts of Australia, where they have to depend upon the natural rainfall. For the same reason once the fruit has set a crop is practically assured, absence of rain making no difference to the crop when water is artificially applied at the right time.

Heavy Average Yields. Owing to the favourable conditions of water, soil, and climate, it is safe to say that trees and vines reach maturity two years earlier than they do in the temperate regions of Australia where they are dependent upon the natural rainfall. As the summer irrigations can be arranged at the right periods to fill out the fruit, heavy average yields are the rule. The average yield of grape fruits in about one ton to twenty-five cwt. of dried fruit to the acre, and of stone fruits about ten to fifteen cwt. dried to the acre, which are equivalent to about four tons of fresh fruits of these kinds.

MARKETS.

Dried Fruits. Owing to the difficulties of transportation in the past, most of the fruit grown in the Murray Valley has been dried, in which state it could be kept until conditions of navigation were favourable for shipment.

The fruits, which in the dried state have proved a commercial success, are apricots, peaches, nectarines, pears, currants, sultanas, and gordos (raisins). The Australian markets for dried stone fruits are at present fair, while conditions seem favourable for the opening up of a good export trade with Great Britain in dried apricots.

The supply of locally-grown currants has for some time been in excess of Commonwealth demands, and owing to the tremendous output of cheap currants from Greece there is at present no prospect of being able to compete with the product of that country on a footing of equality in the markets of the world. Gordos (pudding raisins) have also long passed the Commonwealth consumption.

The sultana has been the most extensively planted of all the different varieties of vine along the Murray. Its product has also passed Australian requirements; but there appears more probability that high-class fruit will be able to compete with Mediterranean sultanas on the European markets with a greater degree of success than would be the case with currants or gordos.

Canned Fruits. Very little fruit is at present canned at the various irrigation settlements. Where railway facilities are available a considerable amount of fresh fruit from the river has during the past few years found its way to the Melbourne and Adelaide canneries. Owing to the large quantity of high-class fruit that can be grown on the irrigation settlements it seems probable that the canning industry will, in the future, become an established fact at most of the irrigation centres along the river.

Fresh Fruits. Apricots, peaches, and pears are at present being sent away from the irrigation areas in some quantities for consumption fresh to the chief centres of population; but to do this successfully railway facilities must exist. The most important of all the fruits sent away from the Murray Valley in the fresh state is the Washington Navel orange, which thrives here better than anywhere else in the Commonwealth. Very heavy plantings of this variety have been made on the Murray irrigation settlements during recent years, which, as the new groves come into bearing, must have a steadying influence on its price in the Commonwealth markets. As, however, there appear good prospects for the sale of this fruit on the markets of the world, the overseas demand should prevent the Australian market from becoming glutted.

FUTURE PROSPECTS.

The fruit-growing industry of the Murray Valley is at present in a sound condition. For it to remain so it is necessary for the growers to retain control of the marketing of their fruit. As the Commonwealth's demand has been reached in most lines, a great boom in fruit-growing, resulting in very heavy plantings, is to be deprecated, as tending to result in over-production, and ultimate loss to the growers. There is enough good land in the Murray Valley and enough water available when the river is locked and weired, which would, were it all planted in fruit, be sufficient to supply the present needs of the Commonwealth more than ten times over. But with a steadily increasing population, and with an expanding overseas market there is room for a rational expansion of the area under the majority of fruits grown on the Murray irrigation settlements.

CHAPTER II

SELECTING THE LAND

Although on the whole the great proportion of the land on the various irrigation settlements is of first-class quality, there are still patches of second-class soil scattered about among the better land, as nature seems to have ordained that no large tract of land shall be of an absolutely uniform character. Prospective fruit-growers would therefore be well advised, before taking up a piece of land from the perusal of a plan, to take a trip up the river and view the land for themselves. There is nothing like seeing the country to judge the possibilities of it, which no mere looking at plans can give.

Should the would-be settler not be able to inspect the land at the time, the next best thing for him to do is to get an experienced irrigationist—one with local experience for preference—to examine the land for him, and follow his advice. By this means, should the prospective settler be destitute of irrigation experience, it is possible for him to make a better choice of a piece of land than if left to his own judgment. The best plan, however, would be for him to view the land in company with an experienced local irrigationist, who could point out to him the merits or defects of any blocks, and he could then make his choice.

CHOICE OF SITE.

As one of the greatest drawbacks on an irrigation area is the menace of seepage, land that is full of hollows, or that has a heavy sub-soil, should not be chosen. Seepage is brought about by the irrigation water running along the sub-soil and coming to the surface where this sub-soil is shallow or where it meets the surface of the ground. Blocks situated on sandy rises which peter out on to clay flats are liable to develop seepage, which will show itself along the line just above where the clay and sand meet. Land that contains hollow, basin-shaped, depressions should also be avoided, for unless the sub-soil of such depressions consists of deep sand, the water from the surrounding higher lands will soak into the hollows and kill the plants it contains. A block of land having deep soil of a uniform nature, with a not too tenacious sub-soil, and having an even slope, is about as good a proposition as can be obtained.

SIZE OF BLOCK.

Another thing the prospective settler must consider, before finally making his choice, is the size of the block. Providing he wishes to work his land by his own labour, this will greatly depend on what he intends to grow. For fruit-growing, a block from 10 to 15 acres is quite large enough for one man to manage successfully. New-comers selecting land for fruit-growing almost invariably make the mistake of choosing too large holdings. It is a big proposition for one man to successfully look after more than 15 acres of fruit trees and vines on an irrigation area, especially as the trees attain age. Good livings have been made at fruit-growing on 10 to 12 acres of land, and for the man of limited capital a block of such an area will be found most convenient.

Given efficient management, more can be accomplished on a large holding, for the labour applied to it, than on a smaller one. On a large plantation, labour-saving implements, such as multiple ploughs, larger cultivators, tramlines on drying grounds, can be profitably employed, which would not be the case on a small plantation, as there would not be sufficient work for such implements, which would therefore be mostly standing idle and thereby earning but little on their purchase price. Also on the laying-out of a plantation considerable economy in fencing and channelling can often be effected in a larger holding as compared with a smaller one.

However, as long as our present system of small individual holdings obtains, and growers make but little effort to co-operate with each other in their work, it will not be possible for any rural community to obtain as much of the benefit of their efforts as more united action would bring.

CHAPTER III

GETTING THE LAND READY FOR PLANTING

CLEARING, FENCING, PLOUGHING.

The expenses of clearing will, of course, vary according to the nature and density of the natural vegetation. Blue-bush land is easily cleared, and will cost about £1 per acre to clear. Box lands, as well as pine and mallee country, are considerably more expensive to grub, varying from about £2 to £6 per acre, according to the size and density of the natural growth. For the grubbing of the more heavily timbered lands grubbing machines and tree-pullers are usually used, and on some of the Government irrigation areas steam traction engines are employed in pulling out the trees and stumps.

To protect the orchard from the ravages of rabbits and stock it is necessary to enclose the plantation with a good substantial wire fence, with 3 feet wire netting. At normal prices for material, a 4 ft. high fence, posts 12 ft. apart, four wires, and wire-netted, will cost about £60 per mile. After the land has been cleared it should be deeply ploughed to loosen the soil and to get rid of the roots of the native tree which occupied the land. The cost of a first deep ploughing will be about £1 per acre.

GRADING.

As it is essential for the success of an irrigated orchard that there should be an uninterrupted flow of the irrigation water, all irregularities of the surface of the ground which would interfere with the water flow should be graded off.

Lands having any considerable fall, such as the greater portion of the high lands, require but little grading, which will be mostly restricted to the removing of small bumps or rises. On no consideration should more soil be removed than is absolutely necessary, as experience has shown that where from six inches to one foot of the surface soil has been graded off and trees planted on the exposed subsoil, that their growth has been slow and unsatisfactory for years. On the blue-bush and box flats and on other lands where there is but little fall, the grading has to be more thorough, as the slightest rise will stop the flow of the irrigation water.

Lucerne and fodder plots are usually graded quite level, and are surrounded by an earth check-bank to keep enclosed the irrigation water.

INITIAL COST.

The cost of preparing the land for planting will, of course, vary with the nature of the land. On the State irrigation areas of South Australia, the Government make advances to settlers for grubbing, fencing, grading, and channelling up to £15 per acre. Not every block, however, will cost as much as this to prepare for planting, and £12 per acre may be taken as a rough average.

CHAPTER IV

LAYING OUT THE LAND FOR WATERING DIFFERENT SYSTEMS OF IRRIGATION

Irrigation methods naturally vary according to the country, climate, and nature of the land. Broadly speaking, there are three distinct systems of watering: the overhead or sprinkler system, the "check" or flooding system, and the furrow system.

For irrigation on a large scale the overhead or sprinkler system is yet largely in the experimental stage. Theoretically, this method of watering is the most perfect of the various systems, as it approaches most nearly to nature's method of watering—rain, and gives a far more even distribution of water than is possible on the furrow system. Land watered on this system would not require nearly as much grading as would be the case if the flooding or furrow systems were used; and as the water would be applied evenly on the surface of the ground, water-logging of the sub-soil, with the danger of seepage resulting therefrom, would be reduced to a minimum if the water were at all intelligently applied.

To water by sprinkler it is necessary that the water should be conveyed, by means of cement or iron pipes, to the place where it is required. By burying the pipes in the ground, over which ploughing and cultivation could take place, more land could be utilized for planting purposes than where open channels intersected the land.

The sprinkler method of watering has so many advantages in its favour that it seems reasonable to suppose that irrigation experience will, at a no distant future, devise an inexpensive and efficient system of overhead watering that will to a great extent supersede our present methods of orchard irrigation.

On the "check system" a piece of land is graded perfectly level and is then surrounded by a check bank. Water is let in at one end and the whole piece flooded, the check bank confining the water to the enclosed piece of land. Owing to the cost of grading, the check system of irrigation is chiefly confined to fairly level country; but where this method of watering is used on sloping ground, the land is graded into terraces, each with an encircling check bank. Watering by flooding the land with an even sheet of water was the favourite method of irrigation practised by the ancients, and is also the system adopted on a great many of the modern irrigation areas.

For the growing of cereals, such as rice, barley, wheat, as well as for such classes of fodder as lucerne and clovers, flooding is the best method of watering. Theoretically, the check system of watering is a good system of irrigation, as all the land obtains the same amount of water. In practical application, however, the flooding of land has its drawbacks, as it consolidates the surface of the ground. Where this system of irrigation is practised in orchards, the land has to be thoroughly cultivated after each irrigation to prevent it from setting into a hard mass.

The "furrow" system of irrigation is the one usually practised in orchards, and often also for the more vigorous growing varieties of fodders, such as sorghum or maize. A furrow is ploughed along each side of the rows of the plants to be watered, and the water is allowed to run along them until the end plants have had sufficient. The great advantage of this method of watering is that it can be used upon land that is too steep to grade into level checks, except at enormous expense, and that the water, being confined to the furrows, does not flow over the land and consolidate the surface. The disadvantage of this system is that the first plant of a row must necessarily get more water than the last one, and for that reason the rows should be so laid out that the water does not take too long to reach the end.

LAYING OUT THE LAND FOR WATERING.

For the best results to be obtained from the irrigation of a piece of land it is necessary that the land should be correctly laid out for watering from the start. This will greatly depend upon the nature and contour of the land and the kind of crop it is intended to grow.

IRRIGATION CHANNELS.

Let us first consider the watering of fruit trees, which are usually watered by the furrow system. After the land has been cleared and graded it is necessary that the irrigation channels are put down, from which the land is to be watered. Where the soil is of a loose, sandy nature, the irrigation channels are usually made of lime concrete; but where the land is hard and level, earth ditches are often successfully used.

CEMENT PIPING.

Irrigation by means of reinforced cement piping instead of the usual open lime concrete channels is one of the latest products of irrigation development. The chief advantages claimed for cement piping are their great strength and durability, their great resistance, as compared with the lime concrete channeling, to the attacks of such alkalies as are often dissolved by irrigation water; and to the fact that if buried in the ground so that cultivation may take place over them, less land is wasted for headlands than is the case with open channels.

During the last few years some hundreds of chains of reinforced cement piping have been put down at Berri for irrigation purposes, and where these have been well laid the results have been very satisfactory.

POSITION OF CHANNELS.

The greatest care should be exercised as to where the channels are put down. Upon the position of the channels depends the length of the rows of trees and vines to be watered. Experience has shown that in loose, sandy loam, rows five chains long are enough, and that on no consideration should rows over six chains long be watered in one section. On hard flat land it is possible to water with longer rows than on sandy rises, but even here it is not wise to have rows over 10 chains long.

As by the furrow system of irrigation the water is flowing for a considerable time past the first trees of a row before it reaches the last one, therefore, the longer the rows, the longer will the water take to reach the end. On very long rows the first tree will have had too much water before the last tree has had enough, and the top of the land will in time become water-logged, to the injury of the trees. In any case, the surplus water will soak down the slopes along the sub-soil, and should this in any case come close to the surface of the ground, the water will come up there in the form of seepage, bringing the alkalies contained in the soil with it, and killing the plants in its vicinity. Having short rows means, of course, much channeling, which greatly adds to the first cost of the place, but it will pay in the long run in the ease with which the land can be watered, and in the satisfactory growth of the trees.

Another matter in which care has to be exercised is to see that the channels are so situated that the grade of watering is not too steep or too level. On sandy rises a fall of one foot to the chain is sufficient, while anything under four inches to the chain is too little. It is a mistake to water straight down steep slopes, as the force of the water washes deep gutters in the land at the top. The washed-out soil carried down by the water silts up the furrows further down the slope, causing the water to spread over the land at that place, so that very little water reaches the end of the rows.

Where the land is hard, as on most of the flats, the grade along which to irrigate may be considerably less than upon sandy rises, as the soil absorbs the water far more slowly than is the case with the looser land. The danger of watering along an almost level grade on loose, sandy land is that, through the porous nature of the soil, the water sinks in so rapidly that the top ends of the rows get too much water before the bottom ends have had sufficient. Unless the drainage of the land is excellent, such a system of watering will, sooner or later, cause seepage to appear lower down the slopes. Thus it is not safe to water with a fall of less than four inches to the chain on sandy rises, from six inches to nine inches being the most convenient grades, while on hard flats a considerably smaller grade, of even an inch to the chain, may be used with safety.

Where the contour of the ground is such that the only way to water is to irrigate down a steep slope, then the rows should be very short. Rows that have a grade of one in thirty or less, should not be longer than three to four chains, the principle to follow being: the steeper the grade the shorter the rows. By this means the land can be watered by a small stream running down the rows, which, while strong enough to reach the end, is still not too strong to cause much washing of soil from on top. Long rows require a strong stream to flow along them to reach the end, and this, on the steep slope, washes deep gutters into the top portion of the land.

Where earth irrigation ditches are used it is advisable that these should be on the lower part of the holding. A certain amount of water, depending on the nature of the soil, soaking out of an earth channel on top of a rise, may, in time, cause seepage to appear lower down the slopes. Hence an earth channel should be situated on the lower portion of the slope, and, to prevent washing out, should be run along a level contour.

CHAPTER V

WHAT TO PLANT

DRYING VARIETIES.

The chief fruits usually grown on the irrigation areas along the Murray are currants, sultanas, apricots, peaches, nectarines, pears, and oranges.

The Vine. Of all the varieties of fruits grown along the Murray Valley the vine is the most important, both in acreage planted and in the annual value of its crop. Soil, climate, and water have made the Murray Valley an ideal home for the vine. Nowhere else in Australia does the vine come so early into profitable bearing, and nowhere does it bear such consistently heavy crops.

For this reason every fruitgrower who desires an early return should plant some considerable portion of his land to vines. Vines that have been well cared for should yield about one ton of dried fruit to the acre in their fourth year, and thereby come into full bearing about three years before any other class of fruit. Regarding currants, as there is already an over-production of the local grown product it is not advisable to plant much land to this class of fruit until the local demand has again caught up to the supply.

As previously stated, the sultana, which is the most extensively grown of all the varieties of vine along the Murray, has also passed the limits of the Commonwealth's consumption, but as there appears a possibility of the Australian article being able to compete with the Mediterranean product on the

English markets, a moderate planting of this variety should prove a safe investment. The gordo blanco (pudding raisin) has also been extensively planted on the river irrigation areas, and the Malaga raisin to a lesser extent. The supply of "gordos" has long passed the Australian consumption, the surplus being used for distillation purposes.

As there has been for some time a good demand for spirits, a number of the riverside growers are planting some of their land to doradillos. These are very heavy croppers, crops of ten tons of fresh fruit to the acre being not unknown.

The Apricot. After having been condemned for some years, the apricot seems once more to be coming into favour. This is largely due to the fact that local prices have been good, and that a good demand is arising for Australian dried apricots in England. It is not advisable, however, for the average grower to plant many acres of apricots, as this fruit ripens during the hottest part of the year, often so rapidly that, unless many hands are employed in harvesting, a great portion of the crop is lost. As it is not always possible to procure the necessary labour at the right time, the average grower should not plant more land to apricots than he and his family, with perhaps an occasional hand or two, could manage to harvest; say, from two to three acres. The Moorpark variety is the best drying kind to plant.

The Royal is also planted to some extent and, although hanging better, is not of such good quality as the Moorpark.

The Peach. Peaches and nectarines are grown to a considerable extent on the irrigation settlements. Up to the present the Australian markets for these have been fair. But there does not appear to be room for great expansion with these fruits, as Californian dried peaches are at present sold on the

European markets at prices with which the Australian grower could not successfully compete.

The best drying peach is undoubtedly the Elberta, its great size entailing less labour in cutting than smaller varieties of peaches, and it has the additional advantage—as peaches are classed according to size—of obtaining the best prices when dried. The Elberta, which is an early and heavy cropper, is also in good demand for canning. Other varieties used for drying are: Foster, Muir, Lady Palmerston (late), and Salway (late).

The varieties of nectarines usually dried are Goldmine and Stanwick. Owing to its smaller size the nectarine curtails more labour in harvesting, and up to the present has not proved as profitable to grow as the peach.

The Pear. The pear also does well along the Murray. The Bartlett (Bon Chretien or Williams') has been the chief variety grown so far, and is equally well suited for drying or canning. As this variety has been very extensively planted at the various irrigation settlements, probably more than its present market prospects warrant, it is hardly advisable at present to plant this kind to any considerable extent.

As late export pears have for some time realized good prices in the overseas markets, it is probable that this class of fruit has a good future before it.

Some good export varieties which have proved good croppers and keepers along the Murray are: Glou Morceau, Josephine De Malines, and L'Inconnue.

Another variety, which is a very good keeper, but is not of such good quality as the kinds above mentioned, which would perhaps do well in land too heavily water-logged for other classes of fruits, is the Vicar of Winkfield. The writer has known this variety to bear good average crops in very wet land in the Adelaide hills.

The Prune. Another variety of fruit not so extensively tried as the foregoing varieties, but which may yet prove to be a profitable kind, is the prune. As most of the prunes at present consumed in Australia are imported, there is a profitable local market for this class of fruit, providing that a satisfactory sample can be produced. After being neglected for some time, the prune is now being planted to some extent at Mildura, Yanco, and Berri.

Some of the best varieties are Fellemberg, Prune d' Agen, Robe de Sargent, Splendour, and Tragedy. Experience has taught that a single variety of prunes does not fruit well if planted by itself, as most of the varieties are self-sterile. Two or three kinds should therefore be planted together. After the first two or three years the trees should be pruned but little, as it has been proved that along the river the prune will not bear satisfactory crops if cut back to any considerable extent.

CANNING VARIETIES.

Although very little fruit canning is yet done at the various irrigation settlements, there is every reason to suppose that in the course of time this will yet become an important industry, as the size and quality of the river-grown fruit is superior to that produced on most of the other Australian fruit-growing areas. Where railway facilities are available a considerable quantity of river-grown fruit is annually sent away to city canneries, but where neither railways nor canning works exist heavy plantings of canning varieties should not be made unless there is an early promise of a local canning factory being erected.

The following are good canning varieties:

Apricots. Moorpark and Mansfield Seedling (end December and early January).

Peaches. Elberta (end January), Foster (middle January), Muir (February), Lovell (February), Lady Palmerston (end February), Salway (March), Pullar's Cling (February)—a great canning favourite at present.

Pears. Bartlett, or Williams' Bon Chretien (February).

Fruitgrowers intending to plant for canning purposes should aim at a succession of varieties ripening at different periods so as to avoid a rush of harvesting work at a particular time, and also to prevent a glut occurring at the canneries from the over-supply of any variety.

The Orange. Of all fruits, the orange has, perhaps, been the most extensively planted along the Murray Valley during the last few years. The Washington Navel is the variety usually chosen, but Thompson's Improved Navel, Valencia Late, and Mandarins have also been tried. Orange trees should be planted on the best land of the holding, where there is good drainage. As it takes about seven years from the time of planting for the orange tree to produce profitable crops, the grower would do well, unless supplied with sufficient capital, not to plant too large a portion of his holding with this fruit. Through the enormous plantings that have taken place, navel oranges must certainly come down in price in a few years, but if a big export trade can be worked up with Europe, there is every reason to think that this branch of the industry has a good future.

OTHER VARIETIES.

Should the fruitgrower wish to go in for a few side lines, apples and almonds may be tried. The climatic conditions of the Murray Valley, which agree so well with the pear, do not appear to be suitable to most varieties of apples. The whole subject of apple culture along the Murray is still in its experimental stage. The Jonathan and Cleopatra have not proved a success, being deficient in flavour, but Dutch Mignon and Gravenstein are varieties that are of more promise.

The almost has proved a fairly hardy doer under irrigation, but likes a fairly loose and dry soil, and should not be over-watered. Almonds are usually planted as breakwinds along the fences, and with reasonable care and attention yield a profitable return. As almonds are benefited by cross pollination, different kinds which flower at the same time should be planted together. Ne Plus Ultra and I.X.L. fulfil this condition, as do Nonpareil and Peerless. The variety Brandis, although making a beautiful breakwind, is through its shy bearing habit not a profitable variety to plant.

ADVANTAGES OF VARIETY.

Although a fruitgrower well supplied with capital often does best by specializing in one line of produce, chiefly by being able to do everything on a comprehensive scale, nevertheless the average settler would be wise not to put all his eggs in one basket by planting all his land to one kind of fruit. By having a block of mixed fruits, the grower will not be rushed by having everything ripening at the same time. The harvesting apparatus (drying racks, trays, cases, etc.), need not be so extensive as if only one class of fruit were grown, as the same material may be used over again for each different kind of fruit.

The grower who cannot plant all his land in the first year would do well, unless he has a liberal supply of capital, to plant those varieties which come into bearing soonest—such as vines, apricots, and peaches—the first planting season, leaving the slower bearing varieties—oranges, pears, and prunes—for the second year. By this means his land will yield him some return while the other trees are coming into bearing.

LUCERNE.

As it is necessary to keep the orchard well worked and cultivated, the fruitgrower must be supplied with sufficient horse-power to do this work satisfactorily, and the problem of feed, therefore, is an important one. As lucerne has proved itself to be the best of all fodders grown under irrigation, the fruitgrower should, right from the beginning, set apart as a lucerne patch at least one acre for each horse he intends to keep, which should not be under two.

For the successful growing of this fodder the land should be graded into level checks, so that it can be flooded with an even sheet of water. The best place for a lucerne patch is on the lowest part of the holding, where it can catch all the overflow water from the rest of the land. Owing to the great amount of water that is required for their successful culture, vegetables can also with advantage be grown in level plots graded even, like a lucerne bed, so that plenty of water can be poured into the land; and to avoid danger from seepage, these plots, like those for lucerne, are best situated on the lowest part of the holding. With two acres of lucerne, and with a little hay that can be grown on his dry land, the fruitgrower should have sufficient feed to keep a couple of horses.

CHAPTER VI

WHERE TO PLANT

Owing to their various habits all classes of fruit do not do equally well in every kind of soil or situation, and as the lands of the Murray Valley consist of many different classes of soil, it is necessary to the success of an orchard that every kind of fruit should be planted in land best suited to its requirements.

The whole subject of the adaptability of plants to soils is a difficult one, and a lot more of experience will have to be gathered and experiment made before any degree of finality is reached. Still, the experience of the Murray irrigation areas seems to have demonstrated one or two facts which should be of use to the new fruitgrower.

In the first place it should be laid down as a principle that **the nature of a piece of land should determine the class of fruit that is planted upon it.** Self-evident as such a course may appear, nevertheless it is not always acted upon. Many settlers in starting a new orchard have made up their minds from the beginning what they intend to plant, and so the land is set out irrespective of the suitability of the soil to the varieties planted.

Even on a ten-acre block there are often two or three different types of soil, so that in all probability no one class of fruit would succeed equally well on every part of it. Newcomers wishing to plant any particular variety should first find out the soil requirements necessary for its best development, and then choose a piece of land having as nearly as possible the required characteristics.

Those new fruitgrowers who, in their anxiety to make a financial success of their undertaking, only wish to plant those varieties which they think will "pay" them the best, have to remember that no kind of fruits will "pay" unless they bear good average crops, and that these can only be produced if the trees are planted in soils and situations best suited to their requirements.

The chief types of soil used for fruitgrowing along the Murray Valley, and their suitability to various fruit varieties, as far as present experience seems to indicate, are as follows:

Box and Blue Bush River Flats. This class of land, which evidently consists of ancient river deposits, is mostly made up of a variety of loamy clays, often with a layer of sand on top. On the whole the soil is heavy, sets hard with irrigation, but is made much looser and friable by the application of gypsum. As drift-sand is usually found within twelve feet from the surface of the ground, the under-drainage is good, and no danger from seepage exists. This land requires much cultivation, with the systematic use of gypsum to make it loose for the root requirements of the trees.

All varieties of vines do well on this class of land and yield heavy crops, but their growth is not so rapid during the first three or four years, as is the case on the high lands.

Pears, which bear best on heavy soil, also do well; and the prune, although not yet much grown along the Murray, does best on a clay soil elsewhere.

The apricot also thrives well on a fairly heavy soil, but must have good under-drainage, and should therefore be planted where the drift-sand is fairly close to the surface.

Peaches and oranges, which naturally prefer a loose loamy soil, will, however, also do well on the best river flat land, provided that the under-drainage is perfect, and that no irrigation water stagnates around the roots.

On the whole the good lands of the river flats are a safe proposition for most varieties of fruits, although their initial growth is not so rapid as it is on the higher lands.

River Flat Hardpan. Running through great portions of the better class of river flat lands are patches of hardpan, or claypan, originally without vegetation, and on which it is only with the greatest difficulty anything is induced to grow. With much cultivation and heavy dressings of gypsum, pears and vines may be made to grow on this land, but can hardly be said to thrive.

Pine and Needlebush Rises. Of all the Murray uplands these usually contain the deepest soil. The first two feet to four feet consist of a red, sandy loam, and below this is generally a loose, greyish-brown, calcareous marl. Where such soil exists on even, sloping ground, ensuring good drainage, it may be considered as first-class orange land. The orange thrives best in a fairly rich and loose soil, and the conditions favourable to its growth on the deeper class of soils of the Murray uplands may be said to be practically ideal.

The peach, which of all the fruits grown along the Murray appears to be the most delicate, withstanding less salt and moisture than any other class of fruit, seems to do better on this soil than it does on any other class of land of the uplands.

Almonds, apricots, and all classes of vines grow luxuriantly on this type of land, and come into bearing earlier than when planted on the river flats. The pine rises may be said to be the "safest" of all the river highlands, being practically free from salt.

Deep Mallee Soils. The mallee lands of the Murray may be conveniently grouped into two classes—deep and shallow. The deep soils are often indicated by trees of the largest size having big individual stumps. The land varies from about 18 inches to 3 feet in depth, is generally well supplied with vegetable mould from decayed and semi-decayed mallee leaves and stumps, and is usually underlaid with a loose, greyish-brown calcareous marl, as are the pine lands.

The currant, sultana, malaga, doradillo, and practically all varieties of vines luxuriate in this class of land, bear early, and carry heavy crops. Provided the land has an even slope for under-drainage, the orange also does well, and, if anything, grows even faster here than it does on the pine lands.

Owing to this land having probably more salt in its composition than the pine and needlebush rises, it is "safer" not to plant it with peaches, nectarines, or apricots.

In the writer's opinion stone fruits have been greatly over-planted in the newly-settled irrigation areas, and to make matters worse a large proportion of the plantings appear to have been made on unsuitable land. The writer's own experience has been that it is useless to attempt to grow stone fruits on mallee soils that are under two feet in depth before the sub-soil is reached, or in situations where the drainage is not perfect. On such lands or position the trees grow well for some years, but are generally overtaken by salt or seepage before they are in full bearing. It is therefore advisable that for the planting of stone fruits mallee soils should be avoided unless the surface soil is of exceptional depth, say, four feet, and is situated on steep, sloping land so as to ensure good drainage.

Shallow Mallee Soils. These vary from about nine to eighteen inches in depth. The sub-soil is either the usual light-brownish marl, a whitish calcareous clay, or limestone rubble underlaid with marl. The natural vegetation is often dense, with medium to small individual trees. This is the most difficult of all the upland soils to deal with. Where the sub-soil is the usual loose brownish marl, which allows the irrigation water to pass through it fairly rapidly, the trouble is not so great. Where, however, the sub-soil is greatly impervious to water, as is generally the case with the whitish calcareous marl (which when irrigated gets into a tenacious putty-like mass), then injury from salt may be expected.

Therefore on soil of this nature it is not advisable to plant peaches, nectarines, apricots, almonds, or oranges. Of all classes of trees the pear is the hardiest in its resistance to both salt and seepage; but most varieties of vines are even hardier. The sultana, currant, and doradillo have been found to be able to withstand salt and seepage better than other varieties of fruits, and are the "safest" proposition to plant in this kind of soil.

Level and Gently Undulating Mallee Lands. These lands are of various depths, but having little or no fall have practically no get-away for the irrigation water excepting straight downwards. As the sub-soil of the mallee lands is often impervious to water, water-logging may result. Salt also often makes its appearance on this kind of land, and is probably due to the natural salinity of the soil, aided by defective drainage.

Neither citrus nor stone fruits should be planted on this type of land, the vine being the only safe proposition.

Other Classes of Land. Other kinds of highlands used for fruitgrowing include: **Sandalwood rises**—soil loose, medium depth, good for vines, fair for citrus. **Hop Bush Flats:** The firmest of all the upland soils; good for apricots, prunes, pears; also peaches, oranges and vines. **Porcupine rises:** Loose surface soil, generally firm sub-soil; vines, pears, apples, prunes.

SUMMARY.

Apricots like fairly firm soil with good drainage.

Peaches, Nectarines, Almonds prefer loose, deep soil; must have good drainage.

Prunes like fairly firm soil; will stand more moisture than most varieties.

Pears prefer firm soil; hardy almost anywhere; will withstand more salt and moisture than other trees.

Citrus like loose, deep soil; must have good drainage.

Vines will grow practically anywhere, but do best on good soil.

CHAPTER VII

HOW TO PLANT

After the land has been grubbed, ploughed, graded, harrowed, channeled, and it has been decided what to plant, the ground is next set out for planting.

The length and grade of the rows of trees and vines necessary for their satisfactory irrigation has already been dealt with in Chapter IV. Where the land is hilly or undulating it is often impossible to water all the land of a holding with the same grade, therefore the orchard has often to be laid out in two or more sections, each section having a different grade along which to water. This somewhat spoils the appearance of uniformity of the plantation, but with our furrow system of watering this is often unavoidable, as the success of the orchard depends upon its efficient irrigation, so all other considerations must give place to this.

DISTANCES.

Trees are set out in orchard form in anything from 18 feet to 24 feet apart. Such varieties as pears, Rome Beauty apples, and some kinds of almonds, being of upright habit, do not take up as much room as the more spreading peaches, nectarines, and oranges. But for the practical working of the orchard, both in irrigation and cultivation, it is essential that the trees of the same irrigated section, and preferably of the whole orchard, should be the same distance apart.

The standard distance at which trees are planted in orchard form may be taken as 20 feet by 20 feet apart on the square. This gives, roughly, 100 trees to the acre, allowing for space for headlands, and this is generally found a convenient all-round distance. Some growers, however, prefer 22 feet by 22 feet, and even 24 feet by 24 feet, for peaches and oranges on deep rich land. A headland of 20 feet to 24 feet should be left along the channel and along the end of the rows to allow space for turning in horse cultivation.

Regarding vines, sultanas may be planted in rows 12 feet apart, with vines from 7 feet to 8 feet apart in the rows; currants and doradillos in rows 12 feet apart, with vines 10 to 12 feet apart in the rows, and gordos in rows 10 feet to 12 feet apart, with vines from 6 feet to 8 feet in the rows.

PEGGING OUT.

After the grade and length of the rows, as well as the distance at which it is intended to plant has been decided upon, the ground has next to be pegged out for planting. This is usually done by means of a wire planting line that has either metal or cloth tags inserted at regular intervals at the distance at which the trees or vines are to be planted. In using, the line is drawn tight and a peg is driven into the ground at every tag.

Where the land is fairly level or has but a gentle fall, the channel may be used as a base line and the rows go off at right angles from it; but where the rows, in order to have the correct grade, branch off from the channel at other than right angles, then the line drawn from the channel at the angle it is intended to water should serve as the base line, and all other measurements should be taken from this.

Owing to mistakes made in the laying out of a plantation remaining for the orchard's existence, those without previous experience should obtain the aid of an experienced man to help them with this work.

PLANTING DECIDUOUS TREES AND VINES.

As soon as the young trees have been received from the nursery they should be unpacked and "heeled in" in a trench. Water should be given immediately, and the ground kept damp until the trees are removed for planting. If the soil is damp, deciduous trees and vines may be planted with safety any time in August; should, however, the land be dry, it is best to plant with an irrigation, or at most a day before an irrigation.

In digging the holes for planting the trees, the pegs should not be removed, but the holes should be dug at the side of the pegs and quite close to them. By this means the pegs serve as a guide and show if the trees are being planted in line, but care must be exercised in digging the holes all on the same side of the pegs, or else the rows will not be straight. On the average sandy lands it is not necessary to dig large holes, which should be just wide and deep enough to receive the roots of the trees without cramping them, from 1 foot to 15 inches square, and from 9 inches to 1 foot deep will be found about the right size.

Before planting, all broken roots should be cut off and all other roots trimmed back. The average sized deciduous tree after being root-pruned should have a root-spread of 1 foot to 15 inches in a horizontal direction and be from 9 inches to 1 foot in depth. The top of the tree should be pruned back to 1 foot to 15 inches from the ground, either to a single stick or to three forks, according to the buds upon it.

In planting, spread out the roots evenly, giving them a slanting, downward direction, fill in carefully with earth, and press the ground firmly about the roots. When planted the trees should stand at the same depth as they stood in the nursery rows. If the trees are planted with an irrigation it will not be necessary to tread the ground around the roots, for if the water is led into the hole while the planting takes place it will firm the earth more thoroughly than by any other means.

In planting vines the tops are cut back to one spur carrying two or three buds, and the roots shortened back to two or three inches. The depth of planting is the same as when in the nursery, and the soil is firmed by water or treading as in the case of the trees.

PLANTING CITRUS.

Citrus trees are generally planted along the Murray Valley during the first two weeks of September. Planting during the month of May has something to recommend it, as it gives the trees ample time to make new roots before the hot weather sets in. Trees planted in May have to receive a planting irrigation, should be protected by hessian or other means from the winter frosts, and if the winter is dry, as is often the case, will have to receive a winter watering. As the pumping plants of most of the irrigation areas are not at work during the winter months, the difficulty of obtaining a late autumn or winter irrigation has militated against the autumn planting of citrus, and makes September planting the easiest and safest proposition.

Citrus trees are received from the nursery in boxes packed in earth or damp sawdust, with the tops covered with hessian. If it is intended to plant within a few days of their arrival, the trees, if they are in good condition, may be left in the boxes until planting time, care being taken to place the boxes in a cool and shady place, the tops kept covered up, and ample supplies of water given to the roots and tops. If it is not intended to plant for some time, or if the leaves of the trees are limp, the trees should be taken out of the cases and heeled in in a shady place. Plenty of water should be given to both the roots and foliage, and the tops left covered with hessian.

Before planting, the roots should be shortened back and all broken roots removed. In cutting back the tops it is not advisable to head the trees too low. Clean stems of about 18 inches are more desirable than shorter stems, on account of the limbs of low-headed trees, being nearer the ground, getting in the way of the cultivator. Besides this, the fruit of low-headed trees is apt to come in contact with the earth, and is therefore liable to be spoiled. Trees having long clean stems should have their stems protected by straw or hessian loosely tied around them for the first summer to prevent injury from sun scald, which covering may be removed in early autumn. Trees that have been headed low in the nursery should have all drooping growth removed, and pruned to **upward** growing branches, and under all circumstances all unripe shoots should be cut off.

Citrus are best planted with an irrigation, the water running along the furrows and being led into the holes while the trees are being planted. Care must be taken that the trees are not planted deeper than they stood in the nursery—if anything a little higher to allow for settling—as citrus do not do well if deeply planted.

When taking the trees out to be planted, the roots should be kept covered with a damp bag or piece of hessian, or carried with the roots in a tub of puddle until they are planted. Nothing is so injurious to young citrus than to have their roots exposed, even for a few minutes, to the influence of sun or wind.

If the trees are planted before an irrigation they must be each given a bucket of water immediately after planting, and the irrigation should follow in a couple of days. A good cultivation should follow, especially close to the trees, which should be done with a forked hoe or rake to avoid cutting the roots.

CHAPTER VIII

COVER CROPS

Crops of annual plants, such as cereals and legumes, are often grown in the orchard or vineyard, and are usually designated as cover crops. Cover crops are generally grown for shelter or for green manure, or for both. If situated on sandy land the soil of a newly planted or young orchard is liable to be blown about by the wind, especially after it has been freshly ploughed or cultivated, as the young plants have insufficient foliage to protect the ground from the full force of the wind. During a gale the sand is often blown with considerable force against the stems and foliage of the trees to their great injury.

Along the Murray Valley the weather is usually fairly calm during the summer and autumn months, but during September and October the equinoxial gales often blow with great force and persistence. During these storms, on newly-ploughed and freshly-planted orchards situated on sandy land, the damage done is sometimes severe—the drifting sand barking the trees, destroying their foliage, and even covering the irrigation channels with sand. To avoid losses from sand-drift in newly-planted orchards it is necessary that the soil should be held together by a mass of plant growth. This can be accomplished by sowing strips of cereals or legumes in the rows the way it is intended to water. If the trees are planted 20 feet apart a 9 feet strip will be sufficient for the first season, and a 6 feet strip for the second and third years. In every case the cover crops should be sown during the autumn or early winter months, so that the crop is of some considerable height by September, when the windy weather begins.

On newly-planted lands containing a fair supply of humus, such as on deep mallee soils, where it is not necessary to plough in green crops for manure for some years, the cover crops may consist of cereals, such as wheat, oats, or barley. Wheat has proved to be a very satisfactory cover crop for the first three years among young trees, if drilled in with manure in strips from 6 feet to 9 feet wide. Enough hay can in this way be grown to keep the grower's horses for some years, and provided the crop is manured on a liberal scale, no injury to the land or the trees should result. After the trees are three or four years old they should have developed sufficient growth to shelter the ground from the worst effects of the wind, and cover crops for shelter will no longer be required.

Trees or vines planted in land having a deficiency of humus will not make satisfactory growth, and that compound must be added to the soil if the orchard is to be a success. The cheapest way to get humus into the soil is by ploughing in green crops. The crops grown for this purpose are generally legumes, such as peas, clovers, vetches, which acquire, through the agency of the root-inhabiting bacteria, the necessary nitrogen for their growth out of the air, so that when they are ploughed in both humus and nitrogen are added to the soil. Like cereals, legumes are best sown or drilled in with a good dressing of phosphates, say, 2 cwts., in the autumn, so as to be well established before the cold weather sets in.

The best time to plough in is when the crop is in flower, and it should first be rolled down by short intervals abreast of the plough, so that the plough is able to turn the crop under.

As the clean system of summer cultivation that is necessary to practise under irrigation burns up the humus in the soil, it is advisable to plough in green crops in established orchards at regular intervals.

CHAPTER IX

IRRIGATION

As previously stated trees and vines are usually irrigated on the furrow system, that is, one or more furrows are ploughed on each side of the rows, and the water is allowed to run along them until the orchard has had sufficient. The check system—flooding the land with an even sheet of water—is sometimes practised on level land of a rather stiff nature; but owing to the heavy cost of grading where the land is at all hilly or undulating, this method is not practised to any considerable extent.

As it is necessary for the success of the orchard that every tree should have as nearly as possible the same amount of water, the watering should be so managed that the water does not take too long to reach the last trees of the row, nor should it be so rapid as to cause a washing away of the soil at the beginning of the row. As far as circumstances will permit, this end may be attained by the application of the following principles to the varying conditions of soil and grade.

Firstly: Fairly level land of a stiff nature. This class of land, whether watered by flooding or by furrow, may be irrigated with a large stream of water running into the checks or along the furrows, as the grade (if any) is insufficient to cause a washing away of soil, and the soil too tenacious to absorb the water quickly. On the river flat land it is, on the whole, not quite so essential to economize in the use of water as it is on the highlands, as the under-drainage is usually good; but heavy watering may result in water-logging the land for a time to the injury of the trees.

Secondly: Short steep rows on sandy land. These should be watered with a **small** stream running along the furrows for a comparatively long time. Watering with a large stream down steep slopes soon washes the top soil away, causing deep gutters to form, while the washed-out soil silts up the furrows further down the slope, so that the water spreads there, and very little reaches the end of the rows. A small stream will not cause this trouble, but as by this means the quantity of water going into the soil is not very great at any time; the time of watering must be extended to allow for this.

Thirdly: Rows of moderate length and grade on sandy slopes. Rows of 5 chains in length, with a grade of about 9 inches to the chain, give very satisfactory results in irrigating. These are best watered with a moderate to large stream along the furrows, and will give little or no trouble through silting. The size of the stream to use depends not only on the grade but also on the nature of the land. The sandier the land is, the more will it be absorbent of moisture, and the longer will the water take to get to the end of the rows. Therefore to get as nearly as possible an even distribution of water over the whole orchard it is necessary, other things being equal, to make it a rule in irrigating to follow the principle of the sandier the land the larger the stream.

Fourthly: Rows of moderate length with but little grade on sandy land. These should be watered with a **large** stream running along the furrows for a comparatively short time, for to water such rows with a moderate to small stream would cause the top trees of the row to receive too much water before the last ones have had sufficient.

As stated in previous chapters, nothing is so detrimental to the welfare of the orchard as to water along an almost level grade on sandy land; for the great quantity of water it is necessary to use before the end of the rows are watered may cause seepage to appear on the lower portion of the holding should the under-drainage of the land not be perfect. But seepage may also be brought about, even on land that has been well laid out, both as regards channeling and planting, if the watering is careless or excessive. One of the quickest ways to ruin a piece of land is to water along a gentle grade with a small stream, or along a fairly steep grade with a large stream. In both instances the upper portion of the rows gets too much water and the lower portion too little, with the likelihood of seepage appearing on the lower part of the holding at some time.

The chief work in connection with the irrigation of the orchard is to see that the furrows are kept running. Weeds and leaves will occasionally block the outlet pipes, and these must be removed. Furrows that are silting up must be cleared, and those that have burst must be repaired. Where the land has been well laid out for watering not much work is experienced in its irrigation; still it is necessary for a man to be in attendance for the greater portion of the time to see that all goes well.

AMOUNT OF WATER TO USE.

The art of irrigation may be said to consist of securing the maximum of crop from the minimum of water. The advantages of not using more water than is absolutely necessary is apparent for three reasons: firstly, that irrigation, which is at best a mussy occupation, should not be unduly prolonged, as this results in a waste of time and labour; secondly, that the economical use of water lessens the danger from seepage; and thirdly, that excessive watering leaches out the most expensive plant foods such as nitrates, contained in the soil, and carries them down deep into the sub-soil out of the reach of the roots of the plants.

Provided that the land is kept well cultivated, newly-planted trees and vines do not require more than from 15 inches to 20 inches of irrigation water the first season. When once established and before they come into bearing, fruit trees and vines planted on sandy land can be kept in vigorous health on 15 inches and under of irrigation water per annum. One of the greatest mistakes often made by new-comers on irrigation areas is in watering too heavily. On most of the irrigation settlements the regulations formulated by the governing authorities permit the individual irrigationist to use up to 24 inches of water per acre; but these regulations are not always enforced, with the result that inexperienced irrigationists often put far more water on to their land than is good for it. Seepage, the greatest foe the irrigationist has to fear, is more often brought about by excessive or careless watering than by any other means. Experience has shown that 24 acre inches per annum is amply sufficient for vines and trees in full bearing, and that with good cultivation it is possible to obtain the heaviest crops with considerably less water than this.

SOME EXPERIMENTS IN IRRIGATION.

To give practical illustrations of the results that may be obtained by an economical use of water combined with thorough cultivation, the writer hopes that he may be pardoned by here introducing the results of a few experiments made at his orchard, which is situated on the uplands of Berri.

Young Deciduous Trees. These, consisting of peaches, nectarines and pears, did not have their meter readings kept until their third year. Considering the irrigation season as commencing on July 1 and extending until the end of the following June 30, the irrigation records consist of:

1913-14 season: 12 inches of irrigation water per acre; rainfall during same period, 8½ inches; total water received per acre, 20½ inches.

1914-15 season: 11½ inches of irrigation water per acre; rainfall during same period, 5.3 inches; total water received per acre, 16.8 inches.

1915-16 season: 15 inches of irrigation water per acre; rainfall during same period, 7.73 inches; total water received per acre, 22.73 inches.

The growth of the trees during these three years was good, but as the land later on developed alkali trouble in places, the trees were removed and the land planted with vines.

Young Citrus. Owing to their evergreen nature, citrus trees require more water than most varieties of deciduous trees. For irrigation purposes the citrus plantation was divided into three different sections, each section receiving different amounts of water. Meter readings were not kept until the trees were in their third year. Naming the three sections as A, B, and C, the irrigation records are as follows:

SECTION A (Five Acres).

Six years old 1918.

Season	Acre inches of Irrigation water used	Rainfall 1st July to 30th June	Total Water received, in acre inches
1914-15........	17	5.3	22.3
1915-16........	18	7.73	25.73
1916-17........	10	16.64	26.64
1917-18........	13	13.93	26.93

SECTION B (Five Acres).
Six years old 1918.

Season	Acre inches of Irrigation water used	Rainfall 1st July to 30th June	Total Water received, in acre inches
1914-15........	20	5.3	25.3
1915-16........	24	7.73	31.73
1916-17........	15	16.64	31.64
1917-18........	21	13.93	34.93

SECTION C (Five Acres).
Seven years old 1918.

Season	Acre inches of Irrigation water used	Rainfall 1st July to 30th June	Total Water received, in acre inches
1914-15........	15	5.3	20.3
1915-16........	18	7.73	25.73
1916-17........	11	16.64	27.64
1917-18........	14	13.93	27.93

Although during these four years Section B received 80 acre inches of irrigation water as against 58 acre inches received by Section A, yet the growth and general health of the trees on both sections, which are situated on similar soil, was, as far as all appearances went, identical. However, during the 1917-18 season, as shown by the occasional wilting of some of the trees, it was evident that Section A, with 13 inches of irrigation water, had received the minimum amount, lower than which it was not safe to go if the crop was not to be lost. Nevertheless, on Section C, during the 1917-18 season, the application of 14 inches of irrigation water proved sufficient to mature an average crop of four cases of fruit per tree from a section of mandarins situated on land of a similar nature to Sections A and B.

The argument is sometimes advanced by fruit-growers that although it is possible for young trees and vines to make satisfactory growth on small quantities of water, yet when these have reached maturity and are carrying heavy crops it is necessary to water very heavily to ensure the filling out of the fruit and to make good fruit-wood for the next season.

To test this point experiments were carried out with bearing currant and sultana vines. The currants were situated on the highest part of the holding on a sandy rise with no irrigable land above them, and could therefore receive no water by seepage from other portions of the orchard. The irrigation results were as follows:

CURRANTS.

Season	Crop Dried Fruit per acre	Acre inches of Irrigation water used	Rainfall 1st July to 30th June	Total Water received, in acre inches
1913-14	16 cwt.	15	8.5	23.5
1914-15	1 ton	14	5.3	19.3
1915-16	2¼ tons	18	7.73	25.73
1916-17	2½ tons	9	16.64	25.64
1917-18	2¼ tons	14	13.93	27.93

Sultanas situated just below the currant plantation received the same amount of water, and during the four years of 1915 to 1918 (inclusive) gave a yield of 1 ton, 1½ tons, 1¾ tons, and 1½ tons of dried fruit per acre respectively.

These figures seem to indicate that over a period of up to five years—the first three years of which were seasons of drought—that on sandy land, underlaid by the usual calcareous marl, it is possible to harvest the heaviest crops on less than 20 inches of irrigation water per annum.

IRRIGATION SEASON.

In practice the irrigation season extends from August until about May in normal years. If the spring is wet or cool the first two irrigations need only be light. The heaviest waterings should be made during the hottest months, when the evaporation both through the foliage of the plants and from out of the ground is at its greatest; but they should also vary according to the different classes of fruit. Thus, for the filling out of their fruit, apricots should receive their heaviest watering at the end of November; mid-season peaches in mid-December; currants and sultanas during December and January. Citrus should receive good waterings during the summer months, and are benefited by an April irrigation in the filling out of their fruit.

Perhaps some indication of how water may be applied with good results during a dry summer may be obtained from the perusal of the figures relating to the amount of water given to the vines before referred to during the 1915-16 season, which were: September, 3 inches; November, $3\frac{1}{2}$ inches; December, $6\frac{1}{2}$ inches; February, 5 inches; making a total of 18 inches for the season.

After the crop has been harvested, little, if any, water should be applied, as heavy waterings at this period force out late sappy growth which, being useless as fruit wood, has to be removed at the winter pruning. Apricots and mid-season peaches, which ripen their fruit during January, may receive a moderate watering after their fruit is off, as the time from January to the following August is too long a period to be without water during a dry summer.

CHAPTER X

CULTIVATION

So closely connected with irrigation as to be practically a part of it is the subject of cultivation. The irrigation of a piece of land is of little use unless it is followed by cultivation, as the water poured into the soil soon evaporates unless the surface of the ground is kept well stirred. Cultivation destroys the small capillary tubes along which the moisture passes through the soil into the atmosphere, and by thus forming a blanket of loose earth on top, through which evaporation can only imperfectly take place, the lower layers of the soil are kept moist.

Another result of cultivation is that by checking evaporation the formation of alkalis on the surface of the ground is prevented.

In arid regions, such as the greater portion of the Murray Valley consists of, the rainfall has never been sufficient to leach much of the natural salts out of the land and to carry them away in the river water. When this land is irrigated some of the salts are dissolved by the water. Capillary action draws the salt-impregnated water to the surface of the ground, where the water is evaporated and the salts left as a residue. As some of these salts are highly detrimental to plant life, being especially injurious when concentrated on or near the surface of the ground to the crown and surface roots of fruit trees, it is necessary, were it only for this reason alone, that the work of cultivation in the orchard should be of a thorough nature.

During the early part of the season, while the weather is still cool, the cultivation of the whole of the orchard is not quite so essential as it is during the summer months. If cover crops intended for hay, such as wheat or oats, are grown in between the rows of young trees, these should occupy strips of not more than 6 feet wide, so that a two-horse cultivator can be driven along each side of the rows of trees. After such cover crops are mown, which will be either in October or November, the whole orchard should be cultivated or disc-harrowed, and kept well-worked and free from weeds for the rest of the season.

Where the land cannot be stirred by horse-cultivation, such as near the stems of trees and vines, the land must be kept loose and the weeds destroyed with the hoe. Young trees should receive special cultivation close to the tree, as the roots are not far from the stem, and the forked hoe, which does not cut the roots, if by accident it is inserted too deeply into the soil, is a very useful implement for this work. To ensure satisfactory growth in a young orchard too much care cannot be exercised in this work of close cultivation, as every weed is a pump drawing the moisture into the air that the young tree requires for its needs.

One of the greatest mistakes often made by new-comers on irrigation settlements is in the lack of sufficient cultivation. How often are not newly-planted orchards met with with but a 2 feet to 3 feet strip of cultivated land along each side of the rows of trees, while the rest of the land is given over to the production of a crop of luxuriant weeds, which rapidly pump the moisture out of the land, and by creating a dry belt alongside the cultivated one, rob the latter of most of its moisture. Under such circumstances it is impossible for the trees to make satisfactory growth, and the development of the orchard is retarded.

The cultivation of a piece of land, by checking evaporation from out of the ground, causes most of the moisture to remain in the soil for the use of the plants occupying the land. Therefore the more thorough and more often the cultivation of the orchard takes place the less will be the evaporation, and consequently the smaller will be the quantity of water required to maintain the plants in good condition. The golden rule for the irrigationist to adopt is to apply **the minimum of irrigation with the maximum of cultivation** consistent with the satisfactory growth of his plants. To follow the opposite principle—to make up for lack of cultivation with excessive irrigation—is to court disaster, for such a policy, if persisted in, causes either the formation of surface alkalies or the water-logging of the sub-soil, or both, and ultimately results in the death of the plants and in the ruin of the land.

A cultivation of the orchard should follow every irrigation after the ground has been allowed to dry a little, so as not to puddle the soil, and also after every rain of any consequence. Where the ground is naturally hard or turns up in lumps, an additional cultivation in between each irrigation is desirable. During the late autumn and winter months, if no cover crops have been planted, weeds may be permitted to come up, but should be ploughed in green in the early spring. Cover crops intended for green manure should be rolled down and ploughed in when in flower, and the whole plantation should be ploughed up every season during the late winter or early spring months, after which no more weeds should be permitted to grow for the rest of the season.

TWO-HORSE IMPLEMENTS.

One of the reasons why settlers new to fruit-growing do not cultivate their land enough is that they often do not keep sufficient horses to do their work thoroughly. To do the work of cultivation well and expeditiously, two or three horse cultivators or disc harrows should be used. With the exception of the closing in of furrows, the one-horse cultivator, "scuffler," is of little use for orchard work. Not only do two-horse implements do the work in half the time that one-horse implements do, but they also do by far the better work. To cultivate all the land of even a ten-acre block with a one-horse cultivator is a slow and tedious task, and the result is only a mere scratching of the surface soil.

CHAPTER XI

TRELLISING THE VINE

Vine Trellis should consist of stout posts, split gum or box for preference. Mallee and sandalwood posts cannot be recommended, as the white ants usually destroy these in a few years, but they will not touch the river gum or box. The posts should be of 6 feet length, and inserted about 1 foot 10 inches into the ground, leaving them about 4 feet 2 inches above the ground.

It is not advisable for the posts of the trellis to be more than 24 feet apart, as if further apart than this the wires are apt to sag too near to the ground when under the strain of a heavy crop of fruit, and for some of the fruit to come in contact with the earth and be spoiled in consequence. Thus, if the vines are planted 8 feet apart the posts should be inserted midway between every third and fourth vine, thereby making the posts 24 feet apart and 4 feet from each of the vines between which they are inserted.

To further prevent undue sagging of the wires when carrying a heavy crop, the bottom wire of a trellis should not be closer than 2 feet 6 inches to the ground. If the trellis is to have three wires, then the second wire should be about 9 inches above the bottom wire, and the top wire about 9 inches above the middle one.

On a two-wire trellis the bottom wire could be raised to 2 feet 9 inches from the ground, and the top wire to about 4 feet. Three-wire trellises are certainly more convenient for pruning, but owing to the high cost of wire many growers are using but two wires to their trellis, and this class of trellis has, on the whole, proved fairly satisfactory.

THE SULTANA.

Grown on suitable land, the young sultana vine should have made sufficient growth to be in a fit state to trellis twelve months after planting.

The trellis should be put in during the winter or early spring, so that when the vine makes its second season's growth it may at once be trained along the wire and all its energy utilized to the best advantage.

A well-grown vine will generally have made numerous canes of varying length during its first season's growth. The best one of these should be taken up to the bottom wire, cut off above this height, the top bud of the cane thus treated blinded, and the cane from just beneath this blinded bud tied to the wire with stout string or binder twine. The other canes of the vine should be cut right off, as only one stem is wanted. When tying the cane selected for the stem on to the wire it should be pulled up tightly, even if the wire is bent down somewhat in consequence, so that the stem is quite straightened out, and in this taut condition tied to the wire.

Where none of the canes of a vine are long enough or of sufficient strength to be able to be treated in this manner, the vine may be reduced to its strongest cane as in the former case, but one of the canes that is not wanted should not be cut clean off but left with a stub of a few inches in length. On to this stub a piece of binder twine is tied, and the other end tied tightly on to the bottom wire of the trellis. The cane it is intended to use as the stem is then twisted around this piece of twine, which it uses as a support, and as the cane grows it is further twisted around the twine until it reaches the height of the trellis, when its top is pinched off.

Some growers favour cutting the young vines down to a few eyes on a single rod at the first winter's pruning, so as to make new vigorous canes that can be utilized as stems in the spring time. This method may be successfully used if calm weather prevails during the spring months; but as the equinoxial gales often blow with great force for days—and even weeks—at a time, the tender young shoots are apt to be broken off by the force of the wind, and the development of the vine retarded. Therefore, on the whole it is advisable to utilize for stems canes that have made good growth during the first season, and only to cut back for new rods where the growth has been unsatisfactory.

The sultana vine is trained on the T system, that is, with a straight stem and two short arms, one on each side of the stem running along the bottom wire.

After the stem of the young vine has been stopped at the bottom wire side shoots will grow out from the stem. Two of these, those nearest the wire, are laid or lightly twisted, or, better still, lightly tied on to the wire, one on each side of the vine. These rods form the permanent arms of the vine, and all other growth coming from the stem should be cut off.

The arms should be restricted to about 1 foot in length; but there is some difference of opinion among growers as to what should constitute the ideal length of arm. Some years ago it was the fashion to train sultanas with long arms, 2 feet in length or over; but now the pendulum has swung around to the opposite extreme, and in many instances vines are trained with exceedingly short arms of from four to six inches in length. Upon land where the growth of the vines is not vigorous, such as upon the harder class of river flat land, long arms are certainly not desirable, as the sap is not sufficient to form strong fruiting rods from the numerous buds on the arm, and so only numerous small, weakly shoots are often the result, whereas if the arm is kept short the sap, being distributed through fewer buds, forces out stronger canes. On very rich land again, such as on deep mallee soils, where the growth is exceedingly vigorous, if vines are trained with arms reduced to mere stubs of a few inches in length, the resultant canes often grow to the thickness of young bamboos, and as such are not suitable for fruiting wood. However, arms left to about one foot in length at the second winter's pruning should suit sultanas grown on fertile soil, but where the soil is inferior and the growth poor, it is advisable to reduce the arms to six inches in length.

THE CURRANT.

The Zante currant is trained either on the "cordon" or "espalier" system.

The cordon has one arm only trained on one side of the stem, while with the espalier there is at least one arm on each side of the stem.

The currant trellis is generally constructed with two wires, although as a support for the foliage a third wire is an advantage, but adds considerably to the cost of the trellis.

If the vines are to be trellised on the cordon system, the young vine is reduced to its best cane, as in the case of the sultana, and this cane is then twisted or tied on to the bottom (or middle) wire and trained along it. Sometimes the alternate vines of a row are trained along alternate wires; thus one vine will be trained along the bottom wire and the next vine along the middle wire, and so on alternately all along the row, and the cordon year by year extended until it reaches the cordon of the next vine trained upon the same wire. The advantages claimed for the cordon system is that as all the growth is upon one plane there will be a more even flow of sap, and consequently a more even growth, than is the case where vines are trellised with a multiplicity of arms one above the other.

On the South Australian irrigation areas currant vines are usually trellised on the espalier system, sometimes with two, but generally with four arms. A vine trained as a two-armed espalier has all its fruiting wood on one plane, as in the case of the cordon, and consequently obtains the advantages resulting from this method of growth.

A currant vine trained to four arms, one along each side of the stem following the bottom and second wires, will, when young, have more fruiting wood for the first two or three years of bearing than is the case if trained with fewer arms; and consequently heavier early crops can be expected. This is probably the reason why this method of trellising the currant is so popular; but the objection that is advanced against this system is that in later years the upper arms will gradually obtain most of the sap and develop at the expense of the lower ones. Where this is seen to take place it is necessary to cut off one of the pair of arms and turn the vine into a two-armed espalier; but while both sets of arms are making good growth and bearing well it is as well to leave well done alone.

To train a young currant vine on to the trellis, if it is intended to shape it into a two-armed espalier, it is treated in similar manner as a young sultana, only the arms are left longer for a start—up to 18 inches or 2 feet on a well-grown vine at the winter's pruning during the second season.

To form a four-armed espalier the stem should be trained up to the second wire straight away, and if not long enough to reach this for a start it should be trained along a piece of binder twine, one end of which is firmly tied to the second wire, and the other end to a stub of the vine and twisted once around the bottom wire; or if the vine is long enough to reach the bottom wire the twines need only connect the bottom and second wires.

At the second wire the top of the stem should be pinched off, and with the exception of the four shoots, two below each wire which are to form the arms of the vine, all other growth should be suppressed, and the arms lightly twisted or tied on to the wires.

OTHER VARIETIES.

Muscat Gordo Blanco. This variety is usually trained on the gooseberry-bush system, but many growers are now trellising these vines, as heavier crops are thereby generally secured, and the fruit is kept well off the ground.

Gordo trellis usually consist of posts about 2 feet out of the ground, having a single wire running through them near the top. The vine is trained like the sultana, with two short permanent arms of 6 inches to 1 foot in length, and spur-pruned like the currant.

White Malaga. This kind is usually treated like the sultana, with two short permanent arms trained along the bottom wire, and the fruiting rods twisted on to the wire above.

The Doradillo. The doradillo when trellised may be trained with two permanent arms along the bottom wire somewhat like the sultana, but with longer arms, about 3 feet in length, and spur-pruned. The second wire is there to support the dense foliage and keep it off the ground.

CHAPTER XII

PRUNING THE VINE

The pruning of vines is confined to two different systems, the rod-and-spur-pruned and the spur-pruned systems. The varieties that are rod-and-spur pruned have at their pruning their old rods—that is, their rods that have once fruited—as well as any canes of the new season's growth that are not wanted for fruiting, either removed or cut back to one bud; while the selected canes, all of which must be of the previous season's growth, are either tied or twisted on to the wires, and it is the young shoots that burst from these canes at the following spring that bear the next season's crop.

With the spur-pruned varieties the previous season's growth is usually cut back to two buds, and it is from the growth shooting out from these "spurs" that the following crop is borne.

As the sultana, currant, gordo, malaga, and doradillo are at present practically the only varieties of vine grown on a commercial scale on our irrigation areas, it is not necessary to touch upon the pruning of other varieties than these.

ROD-AND-SPUR PRUNED VARIETIES.

The Sultana. If the sultana has been trained on to the trellis during the second summer, and the arms pinched back to about a foot in length, rods will probably have grown out from some of the buds upon the arms; and upon a well-grown vine a few of these canes can be left for fruiting purposes at the second winter's pruning.

At the third winter's pruning the sultana vine should be fully formed. The arms should range from 6 inches to 1 foot in length, the most vigorous-growing vines having the longest arms.

The canes selected for fruiting wood should consist of fairly strong but not over rank rods, which, as a rule, should not be left longer than three feet, and if the canes have any lateral growth on them this should be removed. Six canes will generally be sufficient for vines of average strength, but vines that have grown very vigorously may be left with eight canes.

The canes are usually twisted on to the bottom and second wires, but some growers prefer to twist them all on to the bottom wire, thereby having all the fruiting wood on one plane. In putting on to the wires the canes should be vigorously twisted, so as to give them a decided kink near their junction to the main arm, and should then be strongly wound around the wires so as to practically fracture the cane—without breaking it—between each set of nodes.

This twisting and partial fracturing of the canes between the nodes is done for the purpose of checking the rush of sap in the spring time of mostly getting to the end of the rods, and thereby forcing out the buds nearer to the main arm.

To provide fruiting wood for the next season's crop, some of the canes that are not wanted for the present season's fruiting are cut back to one or two buds. As a rule it will not be found necessary to leave as many spurs as canes, as strong rods usually shoot out where the old cane has been strongly twisted, either near its base at the main arm or where it has been twisted on to the wire, and these canes can be utilized for fruiting wood. If suitable rods are found near the end of the main arms it is better to use these as fruiting wood and to spur the rods closer in to the middle of the vine. By this means the sap is prevented from all rushing to the end of the arms, forcing out vigorous growth there, and by starving the buds near the centre of the vine, tending to make that portion of the vine barren. For a similar reason the rods at the end of an arm should never be spurred, as the sap would be enticed to flow there; but if not wanted for fruiting the end rods should be cut right off.

White Malaga. The white malaga is usually pruned like the sultana, but with somewhat shorter rods of about 2 feet in length. Some growers have also achieved very satisfactory results by leaving numerous short rods, or rather long spurs of about four buds in length besides the usual single-bud spurs to supply fruiting wood for the following season.

SPUR-PRUNED VARIETIES.

The Currant. At the first winter's pruning after it has been put upon the trellis the arms of the young currant vine are cut back to one to two feet from the stem, according to the strength of the vine. If the young growth has been twisted on to the wire during the summer, it should now be untwisted and lightly tied to the wire with strong twine. **No growth of any vine should ever be left twisted around the wire for more than one season,** as the arm in thickening is prevented from expanding where it touches the wire, and is therefore indented at such places and greatly injured in consequence.

At each winter's pruning the arms of the vine are lengthened until they reach the arms of the vines next to it. It is usually not advisable to extend the length of the arms too rapidly, and a foot per year is generally found sufficient in most instances.

At the annual pruning the growth arising from the arms of the currant vine is cut back to form either single or double spurs. To form a single spur the previous season's growth is cut back to two buds. During the following spring and summer these buds will each produce a cane upon which the season's crop is borne. At the following winter's pruning the top bud with its growth is cut right off, and the cane growing from the bottom one is cut back to two buds. This treatment is repeated annually.

To form a double spur the rod is cut back to two buds the first season, as in the case of the single spur. During the next season's pruning of the two rods growing from these buds, the top rod is cut back to two buds and the base bud, while the lower rod is reduced to one bud and the base bud. At the following winter's pruning the upper spur with its growth is cut right off, and the two canes growing from the previous season's lower spur are cut back—the uppermost of these canes to two buds and base bud, and the lower one to one bud and base bud. This constitutes the annual winter's treatment for this system of pruning. As the leaving of numerous buds for fruiting wood is a great strain upon a vine, owing to the crop therefrom resulting, the double-spur system of pruning is best adapted for vines of very vigorous habits, while the single spur system will give satisfactory results with vines of medium growth.

In addition to the usual single or double spurs small rods or long spurs are sometimes left on vigorous vines. This system was first introduced into the South Australian portion of the Murray Valley by Mr. Beverley, of Pyap Estate, and called by him the **"drooping spur."** The "spurs," of from four to six buds, are usually left at the ends of the permanent arms, and removed at the following winter's pruning. After trying this system upon vigorously-growing vines for three consecutive seasons, the writer has found this method of pruning to yield very satisfactory results in the way of crop returns. For vines that are growing very strongly, especially if they have been planted somewhat closely to each other in the rows, the leaving of "drooping spurs" at the extremities of the permanent arms has a tendency of checking the vines from growing too strongly into each other, as the sap, which generally rushes to the end of the vine, is chiefly utilized in the formation of fruit, rather than in making useless, rampant growth.

Currant vines that have made very vigorous growth during the spring and summer, and that have their foliage trailing over the ground, thereby interfering with cultivation, have some of their growth removed by means of secateurs, a heavy knife, or even with a sharp sickle; but this pruning should not be so severe as to expose the fruit, especially in its early stages before the sugar has begun to form, to the direct rays of the sun.

To ensure the setting of their fruit, currant vines are **cinctured** in the spring when they are shedding their flowers. This is done by running a sharp knife around the stem. On weak vines the knife is just run once around the stem, but on the average strong growing vine two cinctures are made into the bark of the stem concentric to each other of about one-eighth of an inch apart, and the piece of bark in between these two incisions entirely removed.

The Gordo. When trellised the Muscat Gordo Blanco is spur-pruned in a similar manner to the currant vine. The permanent arms, however, are not extended for more than 15 inches on either side of the stem, and the spurs are generally not allowed to exceed six to eight in number upon each of the arms.

The Doradillo. This variety is spur-pruned in a similar manner to the currant when it is trellised. On very vigorous vines canes are sometimes used for fruiting wood in addition to the spurs, and removed at the following winter's pruning.

CHAPTER XIII

PRUNING OF DECIDUOUS TREES

To go into detail in regard to the whole theory and practice of pruning would require a volume to do full justice to this subject. All that can be attempted here is to give a brief outline of the practice adopted by riverside growers in dealing with the chief varieties of deciduous trees grown under irrigation.

Briefly stated, the main objects of pruning may be said to be:

(a) For young trees: to create strong, sturdy, well-balanced trees.

(b) For bearing trees: to obtain regular crops of good quality fruit for the term of the tree's existence.

For the stimulation of wood growth the practice of pruning has always been to cut back the top growth, as the sap of the tree, being distributed over fewer buds, will cause more vigorous growth to be made for each new shoot thrown out than would be the case if all the old wood had been left and more new shoots had grown.

The application of this principle of the weaker the growth the severer the pruning, and the stronger the growth the lesser the cutting back, has an important bearing upon the pruning of deciduous trees as practised upon the irrigation areas where the general growth of trees is generally more vigorous than in other districts.

THE APRICOT.

At the first winter's pruning the object of the pruner is to lay out the framework for a sturdy, well-balanced tree.

If when at planting the young tree had been cut back to a single stick, and has grown well during the spring and summer, numerous branches will have grown out of the old wood. Of these, provided they are well-grown and are favourably situated, only three will be required to form the main arms of the tree, and all other growth is cut right out.

The three branches that are selected to form the framework of the tree should be from shoots that have grown away from the centre of the tree, and should be as nearly as possible equidistant from each other, or that a hollow-centre, cone-shaped form may be attained. The height of these arms where they junction on to the stem should be from 9 inches to 15 inches from the ground, and it is advisable, owing to the liability of the branches to split where there are forks when carrying heavy crops, that the main arms are not selected from shoots issuing from the stem at the same place, but are situated on it some distance away from each other. The branches selected for the main arms should be cut back to about 6 to 9 inches in the case of an average well-grown tree, with the terminal bud pointing away from the middle of the tree, so that an open centre may be attained.

Where the young tree has made four healthy, well-spaced branches these may be utilized in forming the framework of the tree, but it is not advisable to leave more than four main arms to a tree at its first pruning.

If at planting trees have been felt with three short arms pruned back to a few buds, then at the first winter's pruning two short secondary arms should be left to each arm, pruned back, as in the case just mentioned, to about 6 inches to outward-pointing buds, and all other growth removed.

The chief object of the second winter's pruning is to further shape the permanent framework of the tree by the selection of wood to form the secondary arms, which in most instances will not have been accomplished at the first winter's pruning.

Trees that have grown well will generally have thrown two or more strong shoots from each of the arms left at the previous season's pruning. Two of these strong shoots, selected for their outward-growing habits, are left on each of the arms, and all other growth removed. Care must be taken that the selected branches are as nearly as possible equidistant from each other, so that the framework of the tree is well balanced. The branches left for secondary arms are cut back to 9 to 18 inches to outward-pointing buds, more wood being left upon the strong than upon weak trees. After the second winter's pruning the framework of the young tree should have the appearance, when viewed from above, of a hollow inverted cone, with all its branches equally spaced from each other.

At the third winter's pruning inside growth is again cut right out and the leaders growing from the secondary arms cut back. The more vigorous the tree the longer are the leaders left; but from 18 inches to 2 feet of new wood will about suit the average well-grown tree.

As an apricot tree produces its main crop from spurs growing out of the leaders, it is necessary to have sufficient of these to ensure good average crops, and from 10 to 12 leaders, situated as nearly as possible equidistant from each other, makes a good permanent framework of the tree.

After their third winter's pruning apricot trees are either cut back annually at their winter's pruning, according to time-honoured custom, or simply have their surplus growth cut clean away and the tops of the branches left entirely uncut, according to the newer pruning theory of the "Uncut Terminal." As this latter method of pruning the apricot and other deciduous trees is coming into favour in the irrigation areas, a separate section of this chapter is devoted to explaining its main principles.

THE PEACE AND NECTARINE.

For the first few years the peach and nectarine are pruned in a manner similar to that of the apricot. The young tree is trained with a hollow centre with main and secondary arms, having these as nearly as possible equidistant from each other, and pointing away from the centre of the tree.

As the peach is usually a stronger grower than the apricot, more wood may be allowed to remain at pruning time, and the stronger-growing trees being, of course, less severely cut back than the weaker ones.

After the third year the top of the tree is either annually cut back to a healthy leaf bud or the growth is turned to an outward-pointing lateral. All strong shoots arising in the middle of the tree are removed, although some of the weaker inside laterals may be left to shade the limbs of the tree and protect the bark from sun scald.

As the peach tree fruits from shoots made during the previous summer, it is necessary that a succession of such shoots should be maintained. These shoots usually take the form of laterals arising out of the larger limbs of the tree. Where the laterals are evenly supplied with good flower buds for their entire length they may be safely cut back to a healthy leaf bud. This, by decreasing the number of fruit buds on the lateral, will result in the formation of larger-sized fruits than if all the fruit buds had been left, and the cutting back to a leaf bud will probably force out new lateral growth at that place, which may be utilized as fruiting wood at the next winter's pruning.

Some varieties of peaches have the habit of having their flower buds at the end of the laterals. If these are all shortened back the succeeding crop will be lost. If they are all left long there will probably be a heavy crop of small-sized fruit, but owing to the sap flowing along the laterals being practically all taken up in crop production, there will probably be but a poor growth of fresh wood arising from the laterals for the formation of the following season's fruit. In such case, to obtain an average crop of good-sized fruit for a succession of years, it is necessary that a number of these laterals should be cut back to strong healthy leaf buds or to their base buds, so as to force out new shoots that may be utilized for the production of the following season's crop.

THE PEAR.

As with the apricot and the peach, the pear is usually trained as an inverted cone, having a fringe of outer limbs and a hollow centre.

For the first three years the object of pruning is to give the tree a broad base. This is done by cutting out all upright growth and pruning the lateral limbs to outward-pointing buds, leaving a piece of the old wood above the top bud, which is removed at the following winter's pruning.

At the first winter's pruning three to four short main arms should be left; at the second winter's pruning a well-grown tree should have from six to eight secondary arms, and at the third winter's pruning strong leading shoots arising from the secondary arms may be left, but pruned back to outward-pointing buds. A well-trained pear tree should have about a dozen leaders, spaced as nearly as possible equidistant from each other, and such a shape should be attained by the third, or at the latest, by the fourth winter's pruning.

At subsequent winter's pruning the tops of the leaders are either cut back, turned to a suitable outward-pointing lateral, or if pruned according to the system of the "uncut terminal," left entirely unpruned, the amount of cutting back depending upon the nature of the wood growth—the weaker the growth the severer the cutting back, and the stronger the growth the lighter the pruning.

The pear bears its fruit on permanent spurs arising either directly from the leaders or from laterals growing out from the leaders. Laterals of 1 foot to 18 inches in length growing out of the leaders in a horizontal direction should be left uncut at the winter's pruning until they are covered in fruit spurs, when they should be shortened back slightly each year until they have been reduced to sturdy, well-branched fruit spurs.

THE UNCUT TERMINAL.

As trees grown under Australian irrigation conditions receive their greatest supply of moisture when they are at their period of most active growth —that is, during the spring and summer months— it follows that the amount of wood growth made is much in excess of trees of like variety that are grown under conditions of normal rainfall, which chiefly falls in the winter months when the trees are dormant.

To deal with this rampant growth a new system of pruning has been evolved by irrigationists, which is usually known as the "Long Pruning System," but which may more correctly be described as the system of the "Uncut Terminal."

Briefly stated, the main points of this system may be summed up as follows: When the top of a strongly-grown branch is cut off, the sap of the tree will rush to the top buds left on the branch, and there again force out similar vigorous growth during the following year. This annual removal of large quantities of surplus wood wastes the vitality of the tree, which could be more profitably employed in the production of fruit. Moreover, the sap, in being drawn to the top of the tree, fails to a great extent to burst the buds lower down the limb, so that these in time become dormant, and the growth annually mounts higher up the tree, leaving the bottom branches comparatively bare of new wood.

To prevent this the main branches are left with their tops entirely uncut, or if cut back, the growth is turned to a suitable lateral, which is left uncut. This through the top-most buds of the tree being left uncut, there is no incentive for the sap to rush to the top of the tree, and is therefore more evenly distributed over all the buds of the tree, resulting by the bursting of many of these buds in the formation of a greater supply of moderately-grown fruiting laterals evenly situated all over the tree, than would be the case if the growth had been mostly forced to the top by the cutting back of the top growth.

Rationally applied, the system of pruning to an uncut terminal has much to commend it on vigorously-growing trees; but some growers, in their eagerness to quickly get large trees and harvest heavy crops, have, in adopting this method of pruning, left too much wood in their trees, chiefly in not sufficiently cutting back the fruiting laterals, and have therefore given their trees too much work to do, with the result that in a few years their growth becomes stunted through having too much old wood to support.

After having tried this system of pruning for some years, the writer has come to the conclusion that good results may be obtained from its application upon **vigorously-growing trees** if the following points are kept in view.

Firstly. For the first three years all classes of deciduous trees should be shaped and pruned back according to the usual system of pruning, the object being the formation of sturdy trees, with strong, well-balanced limbs.

Secondly. At the fourth winter's pruning strong-growing trees should have their main limbs turned to outward-pointing laterals, leaving their tips uncut, or if no such laterals are available the leaders may be left with their tops unshortened. All strongly-growing shoots not required as leaders should be cut clean out, and **a proportion of the laterals either shortened or cut back to base buds.** This latter operation is most important, especially with peach and nectarine trees, as it tends to keep the fruiting wood close to the main arms by their forcing out a succession of fruiting laterals which prevent the lower portions of the limbs from becoming bare.

The varieties of trees that respond the best to the system of "long pruning" are the almond, the prune, the pear, and the apricot; while the peach and nectarine will only give satisfactory results if the tops are turned, wherever possible, to suitable laterals, and have their fruiting laterals either cut back or thinned out.

Thirdly. After trees have been left with their terminals uncut for some years their vigour is sometimes so severely checked through the mass of wood they have to support and through the heavy crops they have borne that but little new growth is made. When this occurs the trees should be cut severely back to stimulate new growth, which at the following winter's pruning should be treated according to its vigour—if very strong again pruned to the uncut terminal, and if moderate to weak, shortened back.

By varying the pruning of each variety according to the vigour of the trees, pruning the weaker-growing trees more severely than the stronger-growing ones, balance is attained in both wood growth and in fruiting, and the trees are kept healthy and fruitful.

CHAPTER XIV

FERTILIZING THE ORCHARD

The substances that all plants need to carry on their existence are air, water, phosphoric acid, potash, nitrogen, lime, and to a small degree such minerals as magnesium and iron.

Air is, of course, plentiful and free to all, but it is the only requisite of plant life that is. Water is also a most important factor governing the development of the plant, as the greater portion of the living plant consists of water.

Water, moreover, by dissolving many of the plant foods contained in the soil, reduces these to a condition in which they can be easily assimilated by the roots of the plants. This action of water in making available large quantities of plant food is the reason for the increased fertility shown by all classes of land when irrigated; but if watered in excess of plant requirements, the available plant foods are apt to be washed too deeply into the sub-soil for the roots to reach, and so are lost to the plants. Water, therefore, although not a fertilizer in the ordinary sense of the word, is nevertheless, on account of its forming the greater portion of the substance of living plants, the first requisite that must be added to the soil to promote plant growth. Hence the first essential to successful crop production is an ample rainfall—or where this does not exist, then the land must be supplied with sufficient water by means of irrigation.

SOIL FERTILITY.

Soils having in the first place been formed out of various classes of rock, it is evident that all mineral salts necessary to sustain plant life must have been existing in the original rock, but were not available for plant food until the weathering influences of the sun, air, frost, and rain had reduced them to a form in which they could be absorbed by the roots of the plants.

A soil may be ever so rich in potash, phosphates, and other salts that are necessary to build up plant tissues, yet unless a proportion of these salts exists in a form that is soluble to the roots of the plants, vegetation will not thrive, and the soil will appear as unfertile. However, the action of sun, air, and water on the soil, being always in operation, has the effect of gradually changing most mineral salts into forms that are more soluble, and thereby more readily absorbed by plant roots. Therefore, left to purely natural agency, an unfertile soil may, in the course of time, be changed into a fertile one, and by the operation of familiar causes, especially by very heavy rains, the soluble salts may be mostly washed out of an erstwhile fertile soil and so rendered barren.

Soil experts are now generally agreed that the fertility of a soil does not depend upon the total amount of phosphates, potash, nitrogen, or lime it contains, but upon the amount of these ingredients that are existing in a form that the plants can assimilate. This theory would explain the reason why some of our light Australian soils, such as the Pinnaroo lands, which, when chemically analyzed by chemists were pronounced too poor for successful wheat culture, were nevertheless on trial found to produce good crops of wheat, as the small proportion of plant food contained in the soil was evidently existing in a form that was readily available to the roots of the plants.

Again, some soils such as heavy clays, appear to contain a considerable amount of potash, the greater portion of which is in a form that is not easily taken up by the plants, and so vegetation does not thrive. Experience has shown that soils such as these are rendered more fertile by applications of gypsum, which liberates a portion of this potash, and make it available for plant growth.

The more a soil comes under the direct influence of sun, air, frost, and rain the more will its ingredients be broken up, and be made more readily available to plant roots. Hence the value of ploughing and cultivating land lies not only in the general loosening effects resulting therefrom, but from the exposure of the soil to the elements, more of the plant food contained in the soil being available to the plants.

The beneficial effects often following a few seasons of bare fallow on wheat-sick lands appear to be greatly due to these causes, but other influences, such as the stimulation of the soil bacteria, have also to be taken into consideration. Therefore ploughing, or other methods of land cultivation, although not adding to the ingredients contained in the soil, have nevertheless, by making the substances already in the land more available to plants, become factors controlling soil fertility.

HUMUS.

Besides their mineral ingredients practically all soils contain an amount of decayed vegetable matter or humus. When in their natural state they are covered with forest, shrubs, or grasses, and all lands are continually receiving fresh deposits of humus, and where this has been going on for ages large deposits of decayed vegetable matter have accumulated. Humus, consisting of elements drawn from the air and soil, and having formed the substance of living plants must necessarily contain all the ingredients of plant life. A soil rich in humus must therefore be a fertile one, and few of the higher classes of plants will thrive if this is deficient in the soil.

As the fertility of a soil is determined by the availability of its ingredients to the action of plant roots, humus, as containing all plant requirements in a readily available form, must therefore be one of the chief factors controlling soil fertility.

SOIL BACTERIA.

In addition to its direct value as plant food, humus is the home of numerous small organisms called soil bacteria. These bacteria have the property of taking up the nitrogen from the air that penetrates the soil into their own bodies, and thereby increasing the nitrate contents of the soil.

These bacteria seem to be most numerous in the top layers of the soil, and are seldom found deeper than two feet from the surface of the ground. They also appear to like a considerable amount of heat, and are more active—that is, increase more quickly—during summer than winter, and in a hot climate than in a cold one. This is probably one of the reasons why the soils of hot, dry climates generally appear to be better supplied with nitrogen than the soils of wetter and colder countries.

Cultivation, by allowing the heat and air to freely enter the ground, has the effect of greatly stimulating the growth of these bacteria, and thereby increasing the nitrogen contents of the soil, provided always that the land is sufficiently supplied with humus for the satisfactory development of these organisms.

HUMUS AS A FERTILIZER.

Owing to the aid of the nitrifying bacteria humus contains all the ingredients necessary to promote plant life, and may be considered as the one substance having in itself all the necessities of plant life in a complete form. Therefore as long as humus is plentiful in the soil vegetation will thrive. On cultivated lands where quantities of plant food are removed from the soil by the crop, the land is apt to become poorer to the extent of the plant ingredients removed, unless these are in some form again restored to the soil.

Humus may be added to the soil either by bringing vegetable matter on to the land or by means of cover crops.

The cover crops which are usually grown in orchards consist of various varieties of leguminous plants, such as peas, beans, vetches, lupins, etc. These plants have the property of taking up the nitrogen from the air with the aid of the nitrogen-fixing bacteria, and if they are again ploughed in this valuable plant food is added to the soil.

Peas are at present the favourite class of legumins grown for cover crops on the Murray irrigation settlements. They are usually drilled in with superphosphate between the rows in the early autumn after the land has been watered. Usually only alternate rows are sown each season, the unplanted rows being sown the previous years are kept bare, so as to allow for one set of rows being used for the removal of fruit or prunings.

Peas are usually ploughed in during late winter or early spring after having been allowed to flower.

The weight of humus that may be added to a soil by means of a cover crop will of course depend upon the nature of the crop. A ton of wheaten hay to the acre is considered an average crop on our Australian wheat fields, and it is unlikely that the amount of dry matter added to the land by an average cover crop of peas will exceed this weight, more especially as the whole of the land is not taken up by the crop, as strips near the trees and vines are usually unplanted. Where only alternate rows are sown, and these moreover in strips along the middle of the rows, the weight of humus added to the soil will probably not exceed half a ton in weight to the acre.

The amount of nitrogen that is added to the soil by the ploughing in of green crops varies of course with the kind of plants grown and the weight of the crop. Experiments made at various experimental stations in Australia, United States, and elsewhere seem to indicate that about half per cent. of the total green weight, or roughly three per cent. of the total dry weight of a leguminous crop consists of nitrogen. A leguminous crop which would increase the dry vegetable matter in the soil to the extent of a ton would therefore add to the soil about 66 lbs. of nitrogen, which would be equal to a nitrate value of 3 cwt. of sulphate of ammonia or 5 cwt. of blood manure.

Another way of adding to the humus contents of the soil is by bringing farmyard manure, dry vegetable matter, such as straw or grasses, or vegetable mould on to the land. Where this class of matter is available in sufficient quantities, this method of manuring has many advantages over the growing of cover crops in among trees, as in the first place it does not interfere with the cultivation of the orchard, does away with the need of an extra irrigation in a dry autumn, and allows for the heaviest dressings to be applied on the land that is most deficient in humus, whereas a cover crop will give the poorest return on the land that is most in need of an increased humus supply.

Stable Manure is one of the best of fertilizers to apply to the soil, having a fairly high nitrate content as well as being valuable for adding humus to the land. Four one-horse drays will hold about one ton of this matter in a dry state, which if spread over an acre of land will enrich the soil with humus to about the same extent as an average cover crop, although its nitrogen-enriching properties are considerably less. A ton of stable manure to the acre would be a very light dressing to give, so light, in fact, that it would be a somewhat difficult matter to spread it over the land thinly enough to go round. A dressing of four or five tons to the acre applied every third year would give satisfactory results, and keep up the humus content of the soil.

The writer has known as much as thirty tons of stable manure to have been applied to the acre at one dressing on portion of an orchard which was poor in humus. This added in one year as much humus to the soil as would probably have resulted from the growing of cover crops on it for thirty years, with the additional advantage that the trees received the benefit of it immediately instead of having to wait for it for thirty years.

The fertilizing elements in a ton of rotted stable manure have been variously computed to consist of from 6 to 7 lbs. phosphoric acid, 6 to 12 lbs. of potash, and from 8 to 15 lbs. of nitrogen. This would be equal to about 21 lbs. of superphosphates, 12 to 24 lbs. of sulphate of potash, and from 75 lbs. to 120 lbs. of blood manure. This is from manures in a partly rotted state, hence containing considerable quantities of water, but the quantities of these ingredients from a perfectly dry sample would probably exceed this amount to some extent.

Dry vegetable matter such as straw, grass, or dry lucerne will repay the trouble for bringing on to the land.

This is especially the case with lucerne, which is a legume and is rich in nitrogen. According to recent American advices, many Californian fruitgrowers are now beginning to give up the growing of cover crops among their trees, and are instead reserving portions of their land for lucerne paddocks. The lucerne is cut before it begins to seed, allowed to wilt or partly dry, and carted on to the orchard. It is then either spread into furrows and ploughed in or broad-casted, chaffed up with the disc harrow, and then ploughed in. By this method the drawbacks resulting from the growing of crops among trees are avoided, clean cultivation can, if need be, followed all the year through, and humus and nitrogen are added to the soil.

Vegetable Mould is also a most desirable ingredient to bring on the orchard. Although difficult to obtain in quantities in the old settled districts, it is fairly plentiful where trees and shrubs are still growing in their native state. Where horticultural districts are surrounded by great tracts of forest and scrub lands, such as is the case with the newly-settled irrigation districts of the Murray Valley, large desopits of vegetable mould may be found under box, gum, and pine trees, as well as surrounding large mallee clumps; and the writer has seen as many as two dray loads of humus removed from a single mallee clump.

The profitable utilization of these deposits of vegetable mould depends upon their distance from the orchard, as the chief cost of getting this matter on the land is the expense of cartage. Where the cartage is half a mile this substance can be delivered on the orchard for about ten shillings per ton.

Allowing for a dressing of four tons to the acre every second year, this makes an average cost of one pound per acre per annum, which is a very reasonable price to pay for keeping up the humus content of the soil.

CHEMICAL FERTILIZERS.

As in many instances it is not possible to obtain sufficient quantities of organic matter to bring on to the land to make up for all the nourishment removed from the soil by continuous cropping, chemical fertilizers have to be used to make up the deficiency. As Australian soils generally appear to be somewhat weak in phosphoric acid, phosphates are usually the first kind of manures used to maintain the crop returns from the land. Commercial varieties of phosphates are of two kinds, the organic classes, such as bone dust and bone superphosphate, and the inorganic forms made from various kinds of phosphatic rock. Of these bone dust is the slowest in its action. lasting about two seasons in the soil before being entirely dissolved. By not being so water soluble as other kinds of phosphates, the manurial properties of bone dust are not so readily leached out of the soil by heavy rains or irrigation, and therefore, although slower, lasts longer in the soil for the roots of plants to feed on. The mineral superphosphates are usually water soluble to a great extent, hence their action on plant growth is rapid, and for this reason their effect is not lasting, therefore must be applied annually to keep up growth and crop returns.

Potash as a fertilizer is also needed on most soils that are being continuously cropped. As has been previously mentioned, potash is usually contained in considerable quantities on many classes of clay lands, but it often needs applications of gypsum to make it available for plant growth.

Lime may also be applied on many soils with great benefit, especially on heavy clay lands which are rendered looser and generally more productive by the action of the lime in making more available many of the plant foods contained in the soil.

DEPLETION OF SOIL BY CROPPING.

The depletion of a soil by cropping depends, of course, upon the nature and extent of the crop. According to Hume, in his work on "Citrus Fruits," 800 lbs. of oranges will remove from the soil ½ lb. phosphoric acid, 2 lbs. potash, and 1 lb. nitrogen. A crop of 400 Australian cases, weighing about 20,000 lbs., would at this rate deplete the soil to the extent of 12½ lbs. phosphoric acid, 50 lbs. potash, and 25 lbs. nitrogen. In addition to this, allowance must be made for a quantity of plant food necessary to make good leaf, branch and root growth, and for the amount of these ingredients leached out of the soil by rain or irrigation. Assuming the total amount of plant food removed from the soil by these agencies to be three times that taken out by the fruit alone (Hume's estimate) then the quantity of these substances lost to the land would be: 37½ lbs. phosphoric acid, 150 lbs. potash, and 75 lbs. nitrogen. Allowing for an 18 per centage of phosphoric acid, a 50 percentage of potash, and a 20 percentage of nitrogen, this is equivalent to 2 cwt. of superphosphate, almost 3 cwt. of sulphate of potash, and 4 cwt. of sulphate of ammonia, or to a total of about 9 cwt. of chemical fertilizers.

Supposing such a crop of 400 cases of fruit were removed from one acre of ground, 9 cwt. of chemical manures would therefore be required to make good the deficiency in the soil caused by the production of this quantity of fruit.

QUANTITIES OF FERTILIZERS TO APPLY.

The amount of fertilizers to apply on any piece of land to give the best results is largely a matter of experience, owing to the variations that exist in the nature of the soils. Some soils are naturally rich in potash, others in nitrates, while others again may be somewhat weak in these ingredients. Therefore soils should be supplied with the fertilizing elements they are most lacking in, if manure is to be applied in the most satisfactory and economical manner. Again the quantity and the nature of the manure to apply will also depend upon the age of the trees. For instance, young trees generally require greater proportionate amounts of nitrogen than trees in full bearing, as they should be kept in vigorous growth, and nitrogen greatly promotes wood and leaf growth.

On the fertile virgin soils of the Murray Valley young trees or vines require little, if any, artificial fertilizer until they begin to bear crops. The only exception are citrus trees, which are benefited for the first few years by light dressings of nitrogen or superphosphate hoed into the ground in rings around the trees two or three feet away from the stems.

Vines in bearing, being very heavy croppers, need considerable quantities of fertilizers to assist balance the plant food removed by the crops. A mixture of 2 cwt. superphosphate, 1 cwt. potash and about ½ cwt. sulphate of ammonia to the acre should about make good the plant ingredients removed from the soil by a crop of one ton of dried fruit, but besides this the irrigation water will probably leach an additional amount of plant food down into the sub-soil out of the reach of the plants, so a rather heavier dressing than this should be applied if the fertility of the soil is to be maintained. Last season the writer applied 6 cwt. of vine manure to the acre on his vineyard, and the result, aided by a fertile soil and favourable season, was a two-ton crop of dried fruit to the acre. This season it is intended to use 8 cwt. to the acre, as it is doubtful if 6 cwt. of this vine manure contains sufficient ingredients to make up for a two-ton crop.

The argument is sometimes advanced that as fertilizers have the effect of increasing the size of the fruit, they should be sparingly applied, especially to such a fruit as currants where very large berries are not desirable. But surely it is a better proposition to manure heavily and harvest a two-ton crop, even if some of the berries are large, than to manure sparingly and obtain a one-ton crop of medium-sized fruit.

Deciduous Trees in Bearing. Grown on similar soils, deciduous trees require practically the same class of fertilizers as vines. As on the whole these are not nearly as heavy croppers as are vines—yielding on an average only about one-half the weight of dried fruit to the acre that vines do, considerably less manure need be applied to the acre. For general purposes, such varieties as apricots, peaches, and nectarines, yielding from 10 cwt. to 15 cwt. to the acre dried, would require, to keep up the fertility of the soil, about 1 cwt. mineral superphosphate, 1 cwt. bone dust, 1 cwt. potash, and ½ cwt. sulphate of ammonia.

Citrus Trees in Bearing. As has been previously pointed out, about 9 cwt. of fertilizers made up of 2 cwt. phosphates, 3 cwt. potash and 4 cwt. sulphate of ammonia would be sufficient to cover the food stuffs removed by a crop of 400 cases, allowing for ingredients removed by fruit, leaf growth, and for the leaching due to irrigation and rain. Citrus in their young state require a considerable amount of nitrogen, hence they are benefited by dressings of such nitrogenous manures as sulphate of ammonia, blood manure, nitrate of soda and stable manure; when they come into bearing greater applications of potash and phosphates are necessary. As citrus trees are evergreen a considerable amount of root activity is always going on, therefore there should always be sufficient available plant food in the soil for the roots to feed on. One of the best manures for this purpose is bone dust, which gives up its plant food slowly and will generally last for a year or longer, before all its manurial properties have been given off.

Theoretically, although citrus, as well as other classes of fruit do not remove a very large quantity of phosphoric acid from the soil. nevertheless in practice it is found one of the most beneficial manures to use, even in considerable quantities. This is probably partly due to the fact that many of our soils are comparatively poor in phosphates, and so need this substance to give good returns, and also partly to the fact that if one plant food is present in the soil in large quantities so as to be easily assimilated by the roots of the plants, the energy of the roots is thereby set free to gather in the other ingredients they require. And as phosphate is the cheapest of all our artificial fertilizers, the soil can be kept well supplied with this substance at comparatively little cost.

For this reason citrus plantations can with advantage be given a good dressing of phosphates, and an annual application of 3 cwt. bone dust, 2 cwt. superphosphate, with 2 cwt. potash would not be too much to give trees when in full bearing. In addition to this, nitrogen is required. If the soil is well supplied with humus, the nitrifying bacteria in the soil will supply a considerable amount of the nitrogen that is needed, and in that case the large amount of nitrogen that chemical analysis shows is necessary for the successful growth and fruiting of citrus, need not all be put back into the land in the form of artificial fertilizers. Still, it is doubtful if this sort of nitrogen supplies the trees with all the food of this class that they require; even on soils containing a fair humus supply, and a dressing of a couple of cwt. to the acre of nitrogenous manures every second year will probably be needed on most soils.

METHODS OF APPLICATION.

Different classes of fertilizers may be applied at various times of the year. Such slow-acting manures as vegetable mould or bone dust, which contain ingredients not easily leached out of the soil by rain or irrigation, may be applied during winter or early spring, as but little plant food would be lost before the root activity commences. On the other hand fertilizers containing highly soluble ingredients, such as most mineral superphosphates and the various classes of nitrates, are best applied during early spring or summer when the roots of plants are active. Generally speaking, phosphates should not be put into the ground later than October if the current crop is to receive their full benefit, but nitrates may often be advantageously applied, as in the case of citrus, during summer as well as springtime.

Manures may be put into the ground either by being drilled in, broadcasted and ploughed in, or by being scattered along the bottom of plough furrows and ploughed in. Drilling in manures with the wheat seed drill cannot be recommended, unless the land is ploughed deeply afterwards, as the drill only penetrates the soil for a few inches, and the manure is placed thereby too near the surface of the soil for the roots to obtain, especially where the furrow system of irrigation is practised and the water does not leach the manure down to the roots.

Broadcasting and Ploughing in the fertilizer is theoretically the best way to apply manures, as every portion of the orchard is then evenly supplied. In practice, however, unless the land is cleanly and deeply ploughed, all the fertilizer will not be turned into the bottom of the furrow, and, moreover, where the furrow system of watering is used, a great portion of the manure will not receive sufficient moisture to carry it down to the roots of the plants because it is not evenly distributed.

Manuring in Furrows, despite its disadvantages, is the best way to apply fertilizer where the furrow system of irrigation is used. One or more deep furrows should be ploughed along the rows of trees or vines, not closer than four feet to the stems of bearing trees, and the manure scattered in the bottom of the furrows—the furrows then ploughed in and the new furrow thus formed used to water the plantation at the next irrigation. By this method the fertilizer is put deeply into the soil, thereby tending to keep the roots down in their search for plant food. By being in close proximity to the irrigation water the fertilizer is easily dissolved for the use of the roots of the plants; but for this reason an extra heavy irrigation should not follow the application of manures, as some of its properties may be washed too deeply into the sub-soil for the plants to reach.

CHAPTER XV

FRUIT DRYING

With the exception of oranges the great bulk of the fruit grown on our irrigation areas is disposed of in the dried state. As the two main classes of fruit dried, stone and grape fruits, require totally different treatment, each section is here treated separately.

STONE FRUIT.

Stone fruits, such as apricots, nectarines, and peaches, are sun-dried, after having been placed on trays and treated with sulphur fumes in a sulphur house or box.

The trays used for drying stone fruits are made from various kinds of soft-wood timber, and vary in size from 3 feet x 2 feet to 3 feet x 4 feet, having a flange of timber 2 inches to 3 inches in width nailed to each end, whereby one tray may rest upon another without the remainder of the tray coming into contact with the one beneath it.

Fruit that is to be dried is harvested when it is perfectly ripe, the fruit is then cut in halves, the stone removed, and placed cup upwards upon the tray.

When sufficient fruit has been thusly prepared, the trays with their fruit are placed in a sulphur box or house. Sulphur boxes are usually constructed with a wooden framework covered with ruberoid, malthoid, or hessian that has been whitewashed, so as to be practically airtight. The trays with their fruit are stacked one on top of the other, and the sulphur box is placed over them, but so that the roof does not come in contact with the top tray.

A small cavity or pit is beforehand prepared at the side or just underneath the spot which the sulphur box is to occupy, and a piece of galvanized iron or other fireproof material placed on top of it, but with sufficient air space left to allow for the sulphur fumes to ascend to the trays above. The sulphur is placed in an iron vessel, and a piece of old dry bag or hessian is placed in the centre of the vessel to act as a wick and the sulphur placed all around it. The vessel containing the sulphur is then placed within the cavity, the sulphur lit, and sheets of iron or other fireproof material placed over it and sand put on top of it so as to prevent the escape of the sulphur fumes into the air. Sand is also placed all around the bottom of the sulphur box to further prevent the escape of the sulphur fumes; but as the burning sulphur must have sufficient oxygen to carry on its combustion, two small air-holes are left in the sulphur box for that purpose.

The amount of sulphur used varies from about 2 lbs. to 4 lbs. to one hundred 2 feet x 3 feet trays, not so much sulphur being required in hot as in cool weather. The fruit is left in the sulphur fumes until the cups are full of juice, which in hot weather will be about five hours; or if the fruit is put into the sulphur box late in the afternoon it should be left in all night, and removed early in the morning.

After being taken from the sulphur house the trays with their fruit are spread singly on an even piece of land that is free from dust, such as a newly-mown lucerne plot. There they are left until they are dry, which will vary with the various classes of fruit, and with the conditions of the weather. If the temperature rises above 95 to 100 degrees it is best to stock the trays until cooler, as excessive heat has a tendency to shrivel the fruit and to somewhat darken its colour.

THE PRUNE.

When thoroughly ripe the prune is either picked or shaken (as in California) from the tree. The chief work in preparing the prune for market lies in dipping and cracking the skin of the fruit and then drying it.

The fruit is placed in perforated dipping tins and immersed in boiling lye of a strength of from one pound of caustic soda to 10 to 20 gallons of water, and kept immersed from 10 to 20 seconds, the length of immersion varying according to the strength of the dip—the stronger the dip the shorter the time of immersion, and vice versa, the object of such immersion being to crack the skin of the fruit.

After being immersed, the fruit is tipped out on to a draining board or tray for the water to drain off, after which it is usually passed on to a board having sharp-pointed needles about a quarter of an inch long, which further perforate the skin, so that the moisture may more readily escape whilst the fruit is drying. The fruit is sun-dried upon trays, and when finished is placed in sweat boxes for a few weeks to sweat and even up, after which it is sent to the packing shed.

THE PEAR.

The variety of pear that at present is by far the most popular drying kind is the Bartlett or Williams'.

The fruit is picked off the trees when still hard, usually some time in February, and placed in sweat boxes in the storage shed. When the fruit is ripening the sweat boxes are frequently examined, and the ripe fruit taken out and placed in separate boxes. The ripe fruit is cut in halves, from the stem to the calyx, placed on trays, and sulphured. After being taken from the sulphur house the trays are usually stacked, and when nearly dry are spread out in the sun for a few days to finish off, and then packed in sweat boxes before their delivery to the packing shed.

THE CURRANT.

Currants, like other fruit, should not be picked before they are thoroughly ripe; that is, when they are black and sweet, as otherwise there will be a loss in both weight and colour of the dried product.

Currants are shade dried, either on wooden or wire trays, or on wire-netting drying racks. The fruit is spread evenly on the trays or wire netting in a single layer; that is, not more than one bunch in depth, and it is then covered up to keep off the direct rays of the sun, either with empty trays where the fruit is on trays, or with hessian if on a rack.

When dry, clean hessian is placed underneath the wire trays or drying rack, the fruit is rubbed off on to the hessian, and then put in sweat boxes; but if on wooden trays the fruit is rubbed off into the sweat boxes direct.

THE SULTANA.

The sultana is generally dried on the rack or on wooden trays.

Drying racks may be constructed of various kinds, but the principle underlying all of them is the same. Stout posts are put into the ground in two parallel rows, the rows being usually from 4 feet to 6 feet apart, according to the width of the wire-netting used, and the posts from 8 feet to 10 feet apart in the rows. The height of the posts will vary according to the height it is intended to have the top tier of the rack, which for practical purposes should not be higher than the height of a man, or about 6 feet.

The bottom tier should be from 16 inches to 18 inches from the ground, and the various tiers the same distance from each other. A rack of four tiers would thus have its top tier from 5 feet 4 inches to 6 feet from the ground.

At the heights it is intended to have the various tiers, pieces of straight sawn timber are mortised into the posts opposite each other, being thus placed at right angles to the length of the row, and the tops of the posts have likewise pieces of timber mortised into them running parallel with the length of the rack, so that the posts may not shift when the rack is laden with fruit.

At the height of the tiers stout pieces of sawn hardwood, 3 inches x 3 inches to 4 inches x 4 inches in thickness, and stretching across the breadth of the rack, are lightly let into both outside sets of posts. Into these cross-pieces holes are bored, and wires stretched across to each other in such manner as to rest on top of the cross-pieces connecting each set of posts.

Wire-netting of 2 inch mesh is then stretched along each tier on top of the wires and fastened to them by means of tie-wire. Racks are usually supplied with covers, either of the movable type consisting of canvas, duck or hessian, or with a permanent roof made of galvanized iron.

Picking. The fruit should be quite ripe before it is picked, as otherwise there will be a big loss in weight of the dried product. From a labour-saving point of view it is the most economical to pick direct into perforated dipping tins, and to cut up the larger bunches as they are being picked. If picked into ordinary tins the fruit has to be transferred into the dipping tins before being dipped.

Dipping. Sultanas are dipped in a solution of lye consisting of hot or boiling water into which has been dissolved a quantity of caustic soda. The object of dipping is to slightly crack the skin of the fruit, so that the moisture can the more readily escape while the fruit is drying.

The strength of the dip used varies according to the nature of the fruit; fruit with hard, thick skin requiring a stronger dip than fruit having thinner skin. Sunburnt fruit, or fruit that has been much exposed to the direct rays of sun while ripening, is often dipped at a strength of 1 lb. of soda to 15 gallons of water; while thin-skinned fruit that has ripened in the shade requires a much lighter dip if the fruit is not to be too severely cracked in dipping, of a strength of from 1 lb. of soda to 25 to 30 gallons of water. However, for all-round general purposes a dip of about 1 lb. of soda to 20 gallons of water is usually found sufficient for the average class of fruit.

The temperature of the dip is usually varied according to the temperature of the day. Thus, in the morning, when the fruit is cold, the temperature is kept higher than in the afternoon when the fruit is warm. A temperature of 204 degrees in the morning, 200 degrees at midday, and 196 degrees in the afternoon is used by many growers in hot weather, and a good sample of fruit is usually obtained by this method of varying the temperature.

On immersing the fruit the nose of the dipping bucket is dipped in first and the lye thrown back over the grapes. The bucket should never be dipped straight down and up, as the grapes on the bottom of the tin will get more dip than is necessary, and will generally be badly split in consequence. The time of immersion should just be sufficient to cover the fruit with lye, after which the bucket should be quickly withdrawn.

Spreading. After being dipped the fruit is spread in a single layer upon the rack or drying trays. As much sun as possible is allowed to reach the fruit; so if spread upon trays these are placed in a single layer upon the drying green, or if spread upon a rack this is kept uncovered during fine weather.

The time of drying will vary according to the weather, which if hot will generally dry the fruit in a week or ten days' time on a rack, or a little less if upon wooden trays. When dry, clean hessian is placed underneath the rack, the fruit is rubbed off and falls upon the hessian, and is from there placed into sweat boxes. If dried upon wooden trays the fruit is rubbed off into the sweat boxes direct.

THE GORDO.

For drying purposes the gordo is treated in a somewhat similar manner to the sultana, the chief difference being in the strength of the dip, which, on account of the thick skin of the fruit, should consist of about 1 lb. of soda to 10 gallons of water. In drying, wooden trays are usually preferred, as the rack-drying of gordos, with the fruit being more or less in partial shade, is a rather slow process for such a large fruit as the gordo.

CHAPTER XVI

ALKALI AND SEEPAGE PROBLEMS

In previous pages passing reference has already been made to the alkali and seepage problems, which comprise two of the greatest difficulties that the irrigationist has to contend with. Seepage troubles are caused by the concentration of drainage waters in excess of plant requirements at places where there is defective under-drainage; while the alkali problem is due to the rising of alkalies or salts injurious to plant life to the surface layers of the soil.

SALTS INJURIOUS TO VEGETABLE LIFE.

Of the various chemical compounds contained in the soil, the salts of chlorine, sodium, and magnesium are usually the ones that cause injury to plant life if present in any quantity.

Of these, according to American experience, sodium carbonate is the most injurious to vegetation, and less than 0.1 per cent. in the soil is detrimental to plant life. Fortunately this compound has not, so far, been met with in excess on Australian irrigation areas, and the salts that have done the most damage are sodium chloride (common salt), sodium sulphate (Glauber's salt), and magnesium sulphate (Epsom salts).

ORIGIN OF SALTS IN SOIL.

It is a widely accepted theory of science that many—if not all—of the soluble salts found in soils, rivers, lakes, and in sea water have in the course of ages been gradually formed by the decay and weathering of the earth's surface rocks and soil particles, many of which contain traces of the elements of chlorine and magnesium. In regions where there is a heavy rainfall these salts are dissolved by the water in soaking through the soil, and are carried with them into streams and rivers, which in their turn deposit them into the sea.

In countries of low rainfall, however, the case is different, as the rain is very seldom sufficient to penetrate the soil to any great depth and to carry the soluble salts with it into streams that would ultimately discharge them into the sea. Consequently in arid regions, through the gradual weathering of the surface rocks and the chemical changes therefrom resulting, salts of various kinds tend slowly to increase in quantity; or where chemical activity has come to a standstill the salts that have been formed will remain in the soil.

Such rains as fall in arid regions, in penetrating the soil, dissolve some of these salts, and carry them downward. Through the influence of evaporation, however, caused by the intense heat usual to such regions—especially during the summer—the salt-impregnated water returns to the surface of the ground, where the water evaporates and the salts remain as a residue. Subsequent rains will again tend to wash these salts downwards, and evaporation again draw them upwards, there thus being a constant movement downwards and upwards of the soluble salts in the soil.

When irrigation is practised upon the soils of such regions, similar phenomena take place, with the exception of land resting upon an extensive bed of sand or gravel, which, having perfect underdrainage, allows for a considerable amount of the water and such salts as are dissolved in it to pass away from that particular locality. Such conditions of natural under-drainage are, however, rare. On the great majority of soils the irrigation water, acting in conjunction with the natural rainfall, naturally penetrates further into the soil than is the case with the rainfall alone, **and consequently more salts are dissolved.** Through the influence of heat a considerable portion of this salt-impregnated water is drawn to the surface of the ground, where through evaporation the salt is left deposited. The amount of salts thus brought to the surface of the ground through the influence of evaporation is therefore, under otherwise similar conditions, greater on irrigated than on non-irrigated land.

On irrigated land that has not perfect under-drainage there is, therefore, always a tendency for such soluble salts as are contained in the land to accumulate in the surface layers of the soil. Salts that are the most detrimental to plant life, such as salts of chlorine and magnesia, may not cause any damage to vegetation if they are fairly evenly distributed throughout five to six feet of soil; but when concentrated in the first foot of soil may be of such strength as to make plant life impossible.

Hence the object of good irrigation practice must be to prevent the accumulation of injurious salts in the top layers of the soil; or, where that has already taken place, to get rid of the salts there accumulated.

DRAINAGE.

As has previously been mentioned, accumulation of surface salts does not take place on irrigated land that has perfect under-drainage. Therefore where the natural drainage of a piece of land is not good, artificial drainage has to be reverted to if salt trouble is to be avoided, or where that has already taken place, to do away with the accumulation of salt already there.

The first essential for a successful drainage scheme is an assured get-away for the drainage waters. If near a river or lagoon, drainage can take place into these direct, or into a drainage system leading into these. To cope with the drainage problem on irrigation areas, shafts are often sunk until a layer of drift sand is struck, and the water led into these. The drawback to this method of drainage is that unless the layer of drift sand leads directly into the river bed, into a lake, or into the sea, the "sand pocket" must in time fill up with water, and consequently become useless for drainage purposes.

After having secured a get-away for the drainage waters by means of a well, dam, or drainage channel, trenches, being given an even fall are dug through the affected land leading into such drainage system, and earthenware pipes laid in the bottom of them. To ensure good drainage the pipes should be laid on top of the layer of water-impervious subsoil that prevents the water from passing downward, or as nearly as possible to it. Local practice has proved that pipes inserted at a depth from 4 ft. to 6 ft. give good results in most instances.

The trench is in the first place given an even fall into the well or main drainage system, the pipes are laid as evenly and as closely together as possible, and the joints are then covered with a small piece of oiled or tarred paper, which, while preventing the loose earth from getting into the pipes when the trench is being filled in, yet does not prevent the water from entering in at the joints.

To remove the salts from alkali-impregnated land, it is necessary, after the drainage pipes have been put in, to give the land a heavy flooding of water. As most of the salts in this class of land are contained in the top layers of the soil—often in the first six inches—the furrow system of watering is not of much use in leaching the salts into the drainage pipes, as by this method of watering the top of the soil only receives such moisture as soaks upward out of the furrows.

Where the sprinkler system of watering is installed the leaching of a piece of ground, whether of a level or of an undulating nature, is a comparatively simple matter, as the whole of the surface of the land can be heavily soaked with water. Where sprinkler irrigation is not available the land has to be graded into level checks and then given a heavy flooding of water. By this means a large proportion of the soluble salts will be leached into the drainage pipes.

CULTIVATION.

As has been previously pointed out in Chapter X, one of the most effective ways of preventing the rise of injurious salts to the surface of the ground is by means of deep ploughing and cultivation. Cultivation destroys the capillary tubes through which the salt-impregnated water finds its way to the top layers of the soil, where, through the evaporation of the water, the salt is deposited.

The deeper, then, that the land is cultivated the thicker is the blanket of loose, dry soil mulch shielding the moister soil beneath, and the farther from the surface of the ground is the salt kept from rising. Cultivation should be most frequent and thorough during the hottest months of the year, and to be effective should not be less than six inches in depth.

SEEPAGE.

Seepage has already been defined as the concentration of drainage waters at or near the surface of the soil at places where there is defective under-drainage, due to a subsoil that is more or less impervious to water. Seepage is often brought about by the excessive use of irrigation water, in saturating the subsoil with water at a quicker rate than it can drain away; therefore water should always be applied with moderation and should never be in excess of the requirements of the plants.

The remedy for seepage troubles is an effective system of under-drainage by means of earthenware pipes. These should be put down in a similar manner as described in the remarks made upon the drainage of alkaline lands; but in this case no leaching of the top soil is necessary, as there is already a surplus of water, and all that is wanted is an efficient drainage system to carry the water away.

CHAPTER XVII

FUNGOID AND INSECT PESTS

Owing to most varieties of fungi and many varieties of insects thriving better in a humid climate than in an atmosphere that is both hot and dry, the fruitgrowers of the Murray Valley have to contend with fewer orchard and vineyard pests than do the horticulturists of many other parts of the Commonwealth.

It is not necessary to touch upon the various classes of pests that are but seldom met with on the Murray irrigation settlements, and all that is needed here is to describe those varieties that are most prevalent on our irrigation areas, and the methods usually adopted in combating their ravages.

OIDIUM IN VINES.

This fungus, in the form of a mildew, attacks the leaves and fruit of the vine, and under conditions favourable to its growth spreads with great rapidity, and causes the destruction of both fruit and foliage. It increases most rapidly in a damp and muggy atmosphere, and thrives best in the shade where the foliage is dense. The currant is more susceptible to oidium than most other varieties of vine.

Treatment. The approved method of combating this pest is by dusting the vines with powdered sulphur. The sulphur is most economically applied by means of a "sulphur bellows," which appliance usually consists of a receptacle for the sulphur, a pump, and a piece of indiarubber hose. The machine is worked by one man (strapped to his back), while the pump is worked with one hand and the other hand guides the hose, through which the sulphur is ejected. All the foliage and fruit should receive a dusting with the sulphur, and where the foliage is densest the heaviest dressing should be given.

From 20 lbs. to 25 lbs. of sulphur per acre is usually considered an effective dressing, although on badly affected vines twice this quantity is often used. In treating vines that have been badly attacked, portion of the densest foliage should first of all be cut away, to allow the sun's rays to enter and destroy as much of the fungus as possible, and a dressing with sulphur should then take place.

A first dressing of sulphur, especially in places much given to oidium, is often applied just as the buds are bursting; a second dressing when the foliage is about six inches long—or when the vines are in flower; and a third dressing later on, if necessary. Each of these applications will, of course, take more sulphur than the preceding one, as there is more foliage to treat as the season advances. The number of applications depends upon the nature of the season, a wet and muggy spring being favourable to the spread of oidium, while in a spring that is both hot and dry little, if any, oidium will develop.

ANTHRACNOSE, OR BLACK SPOT, IN VINES.

This is another fungoid pest that attacks the vine and which has done great damage at various times. As water, either in the form of rain or dew, is absolutely essential to the germination of the spores, anthracnose is only prevalent in seasons having frequent rains during spring and early summer. The disease usually first makes it appearance in the spring on the leaves and young wood of the vine, where it is seen in the form of small dark or black spots. As the disease developes, the spots eat holes in the bark and leaves of the young wood, and if in an aggravated form cause the young growth to wilt and perish. The ravages of the fungus are not confined to the leaves or wood, but attack the young bunches as well, often causing these to perish before the fruit has set; while if the fruit is infested at a later stage, the berries become spotted and are either destroyed or badly injured in consequence.

Treatment. The only effective way that has up to the present been discovered to combat the attacks of black spots is by swabbing or spraying the vines in winter with a solution made from a mixture of sulphate of iron, sulphuric acid, and water. Mixtures of various strengths are in use, the proportion favoured by European growers being 35 lbs. sulphate of iron, 5 lbs. sulphuric acid, and 10 gallons of water, while the mixture most popular at Mildura is 10 lbs. sulphate of iron, 8 to 10 lbs. sulphuric acid, and 10 gallons of water.

In mixing, the sulphate of iron is put into a wooden or earthen vessel, the sulphuric acid is poured on and stirred with a stick. The boiling water is then added, and the mixture kept stirred until the iron is dissolved. When the iron is dissolved the solution is ready for use. Owing to the corrosive action of the acids upon iron, all vessels used for mixing or for conveying the solution through the vineyard should be made from wood, earthenware, or other non-corrosive material.

The solution is either applied by means of swabbing or spraying. In swabbing, a "swab" is made from a piece of cloth or canvas which is fastened to the end of a stick, the cloth is inserted into the solution, and the vine is then rubbed over with the swab until all the bark of the stem, arms, rods, and spurs is well wetted. As swabbing is a rather slow and expensive process, spraying against black spot is now generally taking its place, and spraying outfits made of more or less non-corrosive materials are being used for this purpose.

To prevent injury to the buds, the swabbing or spraying should take place before these start to swell, and in an average season should not be later than the middle of August. Badly affected vines should be given two sprayings, one in July and the other at the beginning of August.

Of the varieties of the vine the one most susceptible to the black spot is the sultana, while the Malaga, Gordo, and Dorodilla are also often badly attacked by this disease. The Zante currant, however, is very seldom severely affected.

CURL LEAF IN PEACHES.

This fungoid disease often attacks the leaves of the peach and nectarine tree, causing them to curl or "blister." When present in a severe form, the disease causes the first leaves of the season to become thickened and discoloured, and then to fall off, while the second set of leaves is often produced too late to fully mature the fruit.

Treatment. Spraying the trees with Bordeaux Mixture, just as the buds are opening.

Bordeaux Mixture consists of a mixture made up in the proportion of 6 lbs. bluestone (copper sulphate), 4 lbs. quicklime, and 50 gallons of water. In making, first dissolve the bluestone in a wooden vessel by suspending it in a piece of hessian. and allowing the water to just cover it. When the bluestone has all dissolved, which will take some hours, dilute the solution down to 25 gallons. The lime is dissolved in a separate vessel. The solution is then strained through a fine sieve or piece of hessian into a larger vessel or cask, and is diluted down to 25 gallons. The two solutions are then mixed together, being kept well stirred while the mixing takes place. Besides being used for destroying the the curl leaf fungus of the peach and nectarine, Bordeaux Mixture is also useful for suppressing the black spot of the apple and pear and the shot hole of the apricot, by spraying just as the flower buds are opening.

ORANGE SCALE.

Red Scale is a small circular insect of a reddish brown colour, which increases very rapidly under circumstances favouring its growth, which are moist and muggy atmospheric conditions. The only effective way of getting rid of it is by fumigating the trees with hydrocyanic acid gas, which is generated by treating potassium cyanide with a diluted solution of sulphuric acid. Fumigation is done in the night time, the gas being liberated under a tent, which covers the tree. For 100 to 150 cubic feet of tent space the amount of ingredients generally used is 1 oz. potassium cyanide, 1 oz. sulphuric acid, and 3 ozs. of water.

The red scale, which is the most harmful of all insect pests to the orange tree, has up to the present time not made its appearance among the orange groves of the South Australian portion of the Upper Murray Valley.

Brown Scale. This variety of the genus of Lecanium, or unarmoured scales, is fairly well known to the citrus growers of the Murray Valley. The full-grown insect is about one-eighth of an inch long, broadly oval, convex upon the disc, surrounded by a thin flat margin, and of a brownish colour. The scale thrives upon the bark and leaves of the branches of the tree by sucking out the sap, and is generally found in the greatest numbers in situations not directly exposed to the sun.

The usual methods used for combating this scale are by means of sprays made of oils of various kinds and of resin compounds.

Red Oil. Various brands of "red oil" mixture are upon the market. The usual methods of mixing are to take equal quantities of rainwater and red oil, place the oil in a bucket or spray pump, add the water slowly, stirring or churning vigorously the while. When the oil and water have thoroughly emulsified, add twenty times as much water as there is emulsion—that is, forty times the amount of oil used—and mix up well in the barrel of the spraying outfit. This mixture may be considered as full strength, and a stronger solution than this is not advisable. The chief thing to see to at mixing is that the oil and water emulsify thoroughly, which will not be the case if the water is at all hard, and should it be in this condition it should first be softened by dissolving a handful of washing soda in it before mixing it with the oil.

The usual time for using red oil spray is in the summer months, generally during the months of January and February, and to guard against sun-scald of the leaves and fruit is best applied during a cool spell during these months. Should the weather be warm to hot when the spraying is being done, a solution of one gallon of oil to 50 gallons of water will be found strong enough to kill the scale.

Kerosene Emulsion is preferred by some growers for spraying purposes. This is made up in the proportion of 2 gallons of kerosene, ½ lb. soap, 1 gallon water. The soap is dissolved by boiling in the gallon of water. The water is taken off the fire, and the kerosene added slowly, the mixture being churned with a spray pump for ten minutes or so, until a stable emulsion is formed. Another gallon of warm water is then added, bringing the solution up to 4 gallons.

Spraying is usually done in the summer months in between the growths, that is, when one growth has finished and before the next starts. For spraying at such times each gallon of the emulsion is diluted with ten gallons of water; but for trees that are in active growth fifteen gallons of water to one of the emulsion will be strong enough for the young foliage to withstand. For badly affected trees two sprayings about a fortnight apart may be necessary to eradicate the scale.

Resin Wash. Owing to the scalding effect upon the leaves and fruit that sometimes follow the use of the various oil sprays, some growers prefer spraying their citrus trees with a resin wash made up in the proportion of 1 lb. resin, 1 lb. washing soda, ½ lb. soap, to 5 gallons of water. This is applied in a similar manner as the oil sprays, and usually but little damage to the foliage of the trees is done.

No spraying of citrus trees should be attempted if the trees are in want of moisture, as when in this condition the leaves of the trees have often not sufficient vitality to withstand the suffocating effects of the spray, and so fall off; whereas if the spraying takes place when the leaves are full of moisture, such as after an irrigation, and other conditions are favourable, ill-effects seldom follow.

CHAPTER XVIII

COST OF BRINGING AN ORCHARD OR VINEYARD INTO BEARING ON STATE IRRIGATION AREAS OF SOUTH AUSTRALIA.

To estimate the amount of capital required to bring an orchard or vineyard into bearing is a somewhat difficult subject, as the price of material and of labour is a fluctuating quantity, and further, owing to the fact that the expenses per acre will vary with every holding, as no two pieces of land will cost the same to clear, grub, grade, and to maintain in good condition. However, a rough average, both on the capital outlay and upon the income per acre, can be struck, and the estimates here drawn up have been chiefly compiled from Berri data. **In the following calculations the cost of labour and material have been estimated at normal pre-war prices**, as the present abnormal prices—especially for material—cannot be taken as a standard upon which to base fair average costs.

As this chapter is chiefly written for new settlers on the State irrigation areas along the Murray Valley in South Australia, it has been taken for granted that the assistance of the Irrigation Department in fencing, grading, grubbing, and channeling has been availed of. Where this has not been done the initial outlay will probably be increased by £10 per acre.

The subject has been divided into three headings of vines, deciduous trees, and oranges, vines being dealt with first.

Vines (Sultana).

Capital Outlay on One Acre of Vines.

Initial Outlay.

	£	s.	d.
15 per cent. deposit to Irrigation Department for channeling, grubbing, etc., at £12 per acre	1	16	0
Ploughing	1	0	0
400 vines	2	0	0
Pegging out and planting	1	10	0
Total initial outlay	£6	6	0

Secondary Outlay.

	£	s.	d.
Trellis	12	10	0
Drying rack, 35 ft., 6 ft. wide, 4 tiers ..	10	0	0
12 sweat boxes	3	0	0
Dipping tank, picking and dipping tins	3	0	0
Total secondary outlay	£28	0	0

Upkeep.

	£	s.	d.
Cultivation for 3 years	15	0	0
Pruning and tying-up	3	0	0
Water rates and rent for 3 years ..	2	12	6
Total for upkeep	£20	12	6
Expenditure for three years ..	**£54**	**18**	**6**
Interest on initial outlay, trellis, and upkeep, at 5 per cent.	4	5	0
Total for three years	£59	3	6
Owing Irrigation Department after five years for channelling, grubbing, etc. .	10	0	0
Total capital outlay	£69	3	6

The initial outlay for planting, including clearing and preparing the acre of vines, is not great, and including clearing and preparing the land for irrigation, only amounts to £6 6s.

The chief expense with vines is generally considered the trellis. Vine trellises have been erected at Berri varying in cost from £10 to £15 an acre, according to the quality and distance apart of the posts. The average cost will be about £12 10s.

The annual cost of cultivation and irrigation has been estimated at £5 per acre, and tying and pruning for the first three years at £1 per acre per annum. This is as cheap as this work can be done, and if anything is below rather than above its actual value.

Before the first crop can be harvested a drying rack has to be erected. It will pay best to put down a good substantial rack from the start. A rack 35 ft. long, 6 ft. wide, with 4 tiers of netting, as above suggested, will cost about £10, and will hold a third of a ton of fruit at a time. Allowing for a ton of dried fruit to the acre, this rack would have to be filled up three times.

At first sight it may appear that interest on expenditure should not be charged on to the capital account. But it is readily seen that in the case of a settler who has received financial assistance, the total outlay will consist of the amount spent upon the holding, plus the interest on the capital borrowed. Also, in the case of a settler who has been his own financier it is clear that the money spent in channels, cultivation, trellis, etc., which for some years does not yield a return, would have been earning revenue had it been elsewhere invested at interest. On calculating interest in this and the following estimates, it has only been counted from the time when the money has been spent, and not indiscriminately for the whole period under consideration.

After five years those settlers who have availed themselves of the assistance of the Irrigation Department for clearing, fencing, grading, and channelling their blocks, will have to begin the repayment of their loans. The Irrigation Department advances up to £15 per acre for this kind of work, but allowing that the average cost is £12 per acre, about £2 of which has been paid away the first year as deposit, the £10 still owing to the Government will have to be added on to the £59 3s. 6d. already spent, making a total of £69 3s. 6d. all told.

Probable Income from One Acre of Vines.

Vines that have been planted in deep, rich soil, and have been carefully pruned, irrigated, and cultivated should yield a paying crop in their fourth year. The average annual yield of sultana vines in full bearing may be considered one ton of dried fruit per acre.

The probable income and expenses are estimated as follows:

Probable Income One Acre Sultanas.

	£	s.	d.
1 ton Sultanas at 4½d. per lb. net ..	42	0	0
1 ton Sultanas at 4d. per lb. net	37	6	8
1 ton Sultanas at 3¾d. per lb. net ..	35	0	0

Expenses.	£	s.	d.
Cultivation, ploughing, watering ..	7	0	0
Pruning	3	0	0
Manures	2	0	0
Water rates and rent	1	15	0
Harvesting expenses	7	0	0
Management and supervision expenses.	2	0	0
Annual expenses	£22	15	0

Depreciation.

	£	s.	d.
On drying plant	2	10	0
On channels and otherwise	1	3	0
On vineyard at 3 per cent. of capital outlay	2	2	0
Total depreciation	5	15	0
Total expenses	£28	10	0

	£	s.	d.
Net profit per acre at 4½d. per lb. net ..	13	10	0
Net profit per acre at 4d. per lb. net ..	8	16	8
Net profit per acre at 3¾d. per lb. net ..	6	10	0

The annual working and harvesting expenses are estimated at £22 15s. per acre for sultanas, including a charge of £2 per acre for management and supervision expenses.

Regarding depreciation, it is notorious that the depreciation on drying plant—hessian, sweat boxes, and dipping tins is great. Channels will also have to be looked after, and lime or cement washed occasionally. Holdings situated on the sandy slopes, of which the greater portion of the Murray lands consists, will probably require draining at some time or another, and a portion of the income from the land be used for that purpose.

In the irrigation colonies of America the profitable life of a vineyard is usually put down as a little over thirty years, after which period the vines start to go off, and are no longer a paying proposition. Allowing for a bearing life of thirty-three years, the depreciation on the vineyard amounts to 3 per cent. per year on the capital outlay.

Deciduous Trees.

Capital Outlay on One Acre Stone Fruits.

Initial Outlay.

	£	s.	d.
15 per cent. deposit to Irrigation Department for channeling, grubbing, at £12 per acre..	1	16	0
Ploughing	1	0	0
100 trees	4	0	0
Pegging out and planting	1	0	0
Total initial outlay	£7	16	0

Secondary Outlay.

	£	s.	d.
Drying plant	£15	0	0

Upkeep.

	£	s.	d.
Cultivation for 4 years	20	0	0
Pruning for 4 years	3	0	0
Water rates and rent, 4 years	4	2	6
Net expenses for fifth year after deducting net income	3	10	0
Total upkeep	£30	12	6
Interest on initial outlay and upkeep at 5 per cent.	£6	9	0
Owing Irrigation Department after 5 years for channeling, grubbing, etc...	10	0	0
Total capital outlay..	£69	17	6

The capital outlay on an acre of peaches, nectarines, or apricots is about that of an acre of vines. The actual cost of the trees is certainly greater than that of the vines. But there the monetary advantages of the initial costs of the vines end. Trees require no expensive trellis, and their cultivation and pruning for the first year is also somewhat easier than is the case with vines.

Deciduous trees, however, take a few years longer to come into profitable bearing than do vines; and seven years is generally considered the time before peaches and apricots are in full bearing, although some fruit is usually obtained in their fourth year.

If the trees have been well looked after they should yield 400 lb. dried per acre in their fifth year. At 7½d. per lb. net this shows an income of £12 10s. per acre. Allowing for harvesting expenses at £5 5s., and expenses for cultivation, ploughing, pruning, and water rates at £10 15s., this makes a total expenditure of £15, or a loss of £3 10s. per acre on the fifth year's crop, which has to be added to the capital account.

Probable Income One Acre Stone Fruits.

	£	s.	d.
13 cwt. dried fruit at 7½d. net per lb. ..	45	10	0
13 cwt. dried fruit at 7d. net per lb. ..	42	9	4

Annual Expenses.

	£	s.	d.
Cultivation, ploughing, watering ..	7	0	0
Pruning and spraying	3	15	0
Manures	2	0	0
Water rates and rent	1	15	0
Harvesting expenses	16	0	0
Management and supervision expenses	2	0	0
Total	£32	10	0

Depreciation.

	£	s.	d.
On channels, trays, provision for drainage	2	10	0

	£	s.	d.
On orchard, at 6 per cent. on capital outlay	4	4	0
Total depreciation	£6	14	0
Total annual expenses	£39	4	0

	£	s.	d.
Net profit per acre at 7½d. per lb. net ..	6	6	0
Net profit per acre at 7d. per lb. net ..	3	5	4

The harvesting expenses will vary with the class of fruit, peaches being more cheaply picked and pitted, on account of their larger size, than apricots and nectarines.

As regards depreciation, it is obvious that the going off in value of drying trays and sulphur boxes is fairly rapid. As such trees as peaches, nectarines, and apricots are usually not long-lived, the annual depreciation of an orchard of such trees is considerable, and allowing for a bearing life of 16 years this works out at about 6 per cent. per annum.

Oranges (Washington Navels).

Capital Outlay on One Acre.

Initial Outlay.	£	s.	d.
15 per cent. deposit Irrigation Department for channeling, grubbing, at £12 per acre	1	16	0
Ploughing	1	0	0
100 orange trees	10	0	0
Pegging out and planting	1	10	0
Total initial outlay	£14	6	0

Upkeep.	£	s.	d.
Cultivation for 5 years	25	0	0
Water rates and rent, 5 years	6	2	6

	£	s.	d.
Pruning and spraying, 5 years	5	0	0
Net expenses for sixth year, after deducting net income	3	0	0
Total upkeep..	£39	2	6

Harvesting Plant.

	£	s.	d.
Picking or sweat boxes	2	0	0
Proportionate expenditure on storing or curing shed	8	0	0
Total	£10	0	0

	£	s.	d.
Interest on initial outlay and upkeep for six years..	10	10	0
Owing Irrigation Department after five years	10	0	0
Total capital outlay..	£83	18	6

The initial outlay for planting an acre of oranges is greater than that of any other class of fruit, owing chiefly to the greater cost of the trees themselves. In planting, also, greater care than is necessary with other trees has to be taken, and if the season is dry a special irrigation will be needed at planting time.

On calculating the annual expenses of cultivation and irrigation at £5 per acre a low estimate has been taken. A glance at the young orange plantations at Berri at once reveals the blocks that have received the best cultivation. So readily do orange trees respond to good cultivation that a first class looked after orange grove will come into profitable bearing at least a year before a block that has received but average attention.

Orange trees ought to produce some fruit in their fifth and sixth years. Allowing for half a case per tree at six years, at the price of 5s. per case net (at which price I have based my calculations), this would still mean a net expense of £3 per acre, after deducting all working expenses for the year.

As well as other fruit, oranges require a harvesting plant. In addition to picking cases or sweat boxes, a storeroom or curing shed will have to be erected, as oranges, after being picked, are generally stored or "cured" on shelves or shallow boxes for a week or so, to allow the skin to shrink and become leathery before being sent on a long journey.

Through orange trees taking so long to come into bearing, the loss of interest on the capital invested is considerable, and after six years amounts to £10 10s., thereby adding that sum to the cost per acre.

A total capital outlay of almost £84 per acre for six years appears, no doubt, a large sum; but on careful consideration I cannot see how it can be reduced. In the above estimate no loss is allowed for trees dying in their first year before they are established, neither for special irrigations at planting or other times, or for carting water to young trees during dry spells in between irrigations. So, if anything, the total expenditure could easily be increased.

Probable Income from an Acre of Oranges.

Oranges planted in good, deep soil usually commence to bear in their fourth year. The crop, however, will be inconsiderable; and the fifth year's crop will also be small. At six years half a case to the tree may be expected, while at seven years the trees should be bearing a case or more to the tree, and should therefore be showing a profit on the money invested. A well-grown orange tree on reaching its tenth year should yield at least two cases, and from that time may be considered as in full bearing.

In the following estimate I have calculated the average crop at 200 cases per acre, commencing in the tenth year of the orchard's existence, and continuing at that rate for the following twenty years:

Probable Income One Acre Washington Navels.

	£	s.	d.
200 cases at 5/– per case net	50	0	0
200 cases at 4/6 per case net	45	0	0
200 cases at 4/– per case net	40	0	0
200 cases at 3/6 per case net	35	0	0

Annual Expenses.

	£	s.	d.
Cultivation, ploughing, irrigation ..	7	0	0
Pruning and spraying	4	0	0
Water rates and rent	1	15	0
Manures	4	0	0
Harvesting and curing expenses ..	8	0	0
Expenses of management and superintendence..	2	0	0
Total	£26	15	0

Depreciation.

	£	s.	d.
On harvesting plant, channels, provision for drainage	2	0	0
On orangery on 5 per cent. of capital outlay (just on)	4	5	0
Total depreciation	£6	5	0
Total annual expenses..	£33	0	0

	£	s.	d.
Net profit per acre at 5/– net per case ..	17	0	0
Net profit per acre at 4/6 net per case ..	12	0	0
Net profit per acre at 4/– net per acre ..	7	0	0
Net profit per acre at 3/6 net per case ..	2	0	0

According to the above figures, oranges will pay to grow if 200 cases of saleable fruit averaging 4s. per case net—or over—to the grower are harvested per acre. At less than this price, however, oranges cease to be profitable; and if only 3s. 6d. per case net is realized, showing a profit of £2 per acre per year on a capital outlay of £84, then less than 2½ per cent. interest per annum is secured, which is not a paying proposition.

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