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The fruit industry in other lands. 1. The United Kingdom

Frank Melville

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The following report deals with the many aspects of fruit growing both technical and commercial covered during a tour of three overseas countries undertaken on behalf of the Department of Agriculture and the fruitgrowers of Western Australia. In the course of the three and a half months spent on this work, 13 research establishments were visited and contacts were made with research personnel both within these organisations and elsewhere. Visits to commercial fruit growing areas were made with extension officers and these included brief visits to packing houses. Altogether I had discussions with 127 research and extension personnel and industry representatives.

It was not possible in the time available to cover all aspects of fruit-growing nor the vast field of horticultural research. It was necessary to confine my attention to matters directly related to fruit-growing problems at home and, in many instances, visits had to be limited to discussions with research workers as time and distance did not permit inspection of trials in the field.

In reading this report it should be borne in mind that the observations are made in relation to the limited areas visited and on this account may carry a certain amount of bias.

The subject matter is dealt with under the three countries concerned and the American section is further subdivided into kinds of fruit. The detail is dealt with under subject headings covering the various aspects of fruit culture.

FRUIT-GROWING IN BRITAIN

THREE weeks were spent visiting research institutions and commercial fruit areas in the United Kingdom. Places visited included the East Malling Research Station, the Long Ashton Research Station, the National Agricultural Advisory Service (N.A.A.S.) Experiment Station, Luddington, the National Institute of Agricultural Engineering at Silsoe, Bedfordshire and commercial orchards in Gloucestershire, Worcestershire and Kent.

COMMERCIAL GROWING
The largest property visited, the "Man of Ross" orchards at Ross on Wye, covers 700 acres including cider apples and is equipped with a large packing shed and cool stores. Other orchards varied in size from 500 acres down to 30 acres. Among the dessert apple varieties being grown were Cox's Orange Pippin, Worcester, Bramley, Crimson Cox (red sport of Cox) Laxton Superb, Fortune, Tydemans Late, Grenadier and Beauty of Bath. Pears included Conference, Comice and Williams (Bartlett). Most orchards are laid down to permanent sod which is mown continuously during the year. Several systems
of pruning have been developed experimentally but the commercial grower is mainly using the Delayed Open Centre system with a trend towards the pendulous habit of the Regulated systems. Pruning is generally light and together with picking and packing is often carried out by women. The fruit is picked into lug-boxes and at present there is no development of bulk handling in the orchard. Growers are very conscious of the need to prevent bruising, and mechanical sizing and handling in the packing shed are reduced to a minimum on this account.

A large proportion of the fruit is marketed in returnable wooden boxes. These are either packed (for top grades) or loose filled (inferior grades) and covered with a sheet of paper stapled on the top carrying the grower's brand or name. Wrapping of fancy grade fruit is becoming more common to compete with imported fruit and some growers are using cardboard cartons. Boxes contain, 20, 30 or 40 lb. of apples.

The fruit is not marketed in accordance with specific grading regulations hence there is a wide variation in quality and presentation. One of the problems hampering the introduction of grading regulations is the large areas of farm orchards where apples are being grown under very poor conditions with practically no attempt at disease or pest control, or proper grading or packing. The apples, mostly Bramley, are often shed-stored during the winter and bring very low prices. The Government is encouraging the removal of these orchards which are not economical and are adversely affecting the fruit industry.

APPLE ROOTSTOCKS

Apple rootstock trials have been in progress in various centres for many years and a considerable amount of information is available on performance. Of the original Mailing series, selected from existing clonal material in the early 1920's, MII is the stock which has emerged as the principal commercial choice and is expected to remain popular for some years yet. It is the basis of comparison in all recent experiments. MIX the most dwarfing stock available is still frequently seen in commercial orchards mainly as fillers but new plantings on this stock are limited. MVII and MIV are also restricted as far as new plantings are concerned. A number of trials also include the more recent Malling Merton series—crosses mainly between Northern Spy and MII and MIV—which are woolly aphid resistant. Of these MM 104 has consistently proved superior in cropping to all other stocks. It forms a moderate-sized tree, is quite well anchored and seems certain to become the most popular commercial stock of the future in England. In a trial at East Malling the production of Cox up to the age of 14 years has been 50 per cent.
greater on MM 104 than on MII. In a younger planting at Luddington it also appears to be forging ahead. It is easily propagated and trees crop early. MMIII is also showing great promise, particularly as regards drought-resistance. In tree growth it is similar to MII, but in cropping is much better and is generally felt to be a good replacement for MII. MM 109 is doing quite well in trials but has no apparent advantage over MM 104 under English conditions and has the disadvantage of producing a larger tree and having poorer anchorage.

MXXV and MM 115 show some merit in the very vigorous group, but are not being used to any extent commercially. MXXV although raised with the Malling Merton series was placed in the Malling group owing to its susceptibility to woolly aphis. MM 106, which produces a tree approximately equivalent to MVII, is also not being planted very much. A more recent selection M 26 (previously known as 3436) is expected to be a suitable substitute for MIX although it is rather more vigorous.

The United Kingdom was subjected to an extended dry spell in June, and many apple trees showed leaf yellowing and some defoliation. At Luddington Experimental Station the apple rootstock trial is planted on light soil and is in the first year of grassing down, therefore, drought symptoms were more severe. Observations made early in July on Cox showed that, in terms of foliage symptoms, MMIII produced the most drought-resistant tree with little to choose between 109, 104 and 106 in the next group. MII was most seriously affected and a considerable proportion of the leaves had yellowed and dropped.

East Malling is producing quantities of the new stocks from stool beds for distribution to nurserymen and growers. Commercial plantings on the new stocks are being made, but growers still hesitate to embark on large scale usage. Some growers are making close planting of two or three stocks planted in such a way that eventually one or two stocks can be removed leaving the stock which is found to be the best.

Mr. Preston of East Malling made a number of suggestions regarding stocks
worth trying in Western Australia and these will be taken into consideration in planning rootstock trials.

All recent rootstock trials in England have been very lightly pruned and this has encouraged the expression of early cropping tendencies even to some extent on the more vigorous stocks.

Open-pollinated seedlings are considered too variable in nature, particularly as regards effect on production, to be satisfactory as apple rootstocks. An interesting exception is being demonstrated at Long Ashton. Certain apple species have been found which produce apomictic seedlings, i.e., from nucellar seeds produced without the stimulation of pollination. The resulting seedlings are therefore true to the maternal parent and uniform genetically. Two such species are known viz., *Malus sikkimensis* and *Malus torimoides* and seedling stocks from both these are under test. A few fertile seeds are produced but the resultant seedlings can be easily recognised and culled out.

PROPAGATION OF APPLE ROOTSTOCKS

Apple rootstocks are normally propagated in layer or stool beds but this is costly and takes up valuable space. The raising of clonal rootstocks from cuttings has therefore engaged the attention of research workers periodically for a number of years. Recently Garner and Hatcher at East Malling demonstrated the importance of environment in obtaining a satisfactory strike and the effect it has on the type of cutting used. As a result of this work practical methods of propagation cutting have been developed.

The main factors involved are:

1.—Source of Cuttings.

Stoolbeds have generally provided cuttings with the highest percentage “strike.” Practically, however, hedgerows developed from clonal stocks are a better source of material and with suitable growing conditions will give good results. Cuttings from nursery rows as a rule give a much lower strike.

2.—Time of Taking Cuttings.

Both softwood and hardwood cuttings have been successfully used, the softwood cutting being rooted under intermittent mist. May and June cuttings proved the best and under partial shade and mist up to 100 per cent. strike was obtained. Cuttings taken at this stage have a high capacity to form roots but are very liable
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to fail unless growing conditions are ideal. Those taken later in the summer have a lower rooting potential but a higher survival rate under slightly adverse conditions.

Hardwood cuttings may also be struck by taking them in autumn and holding them over the winter under controlled temperature conditions.

The method is to partially bury the cuttings in a well-drained mixture of sand and peat, the temperature of which is maintained above 40° F. by means of bottom heat. The soil is in a bin with sides and tops insulated with baled straw.

Early in the spring the beds are gradually uncovered to harden off the cuttings before planting out. The object is to get good callous formation during the winter without root growth.

3.—Types of Cuttings.

The basal portion of the shoot provides the best striking material in the case of hardwood cuttings. Root development decreases progressively from the base to the tip of the shoot. For softwood cuttings however the tip growth roots more readily but only when growing conditions are ideal such as shaded mist propagation.

4.—Treatment of Cuttings.

Effective root promotion has been obtained by a quick dip of the cuttings in a solution of indole-3-butyric acid (½ mg per ml. of 50 per cent. alcohol) before planting.

PLANTING SYSTEMS

Production per acre and tree size in relation to management costs are basic considerations in the economics of fruit production. This aspect of fruit-growing has been given considerable attention both by research stations and commercial growers. Trials were seen at Long Ashton and at the N.A.A.S. Experimental Station at Luddington comparing production and production costs with varying numbers of trees per acre planted and trained to different systems. Any considerable increase in the number of trees per acre is only possible by the use of temporary
fillers, dwarfing rootstocks or close planting methods using dwarf pyramids or cordons.

At Long Ashton an 11-year-old trial with Cox comparing four systems of planting was seen. Details of the treatments together with costs of planting and production figures are as follows:

<table>
<thead>
<tr>
<th>Planting System</th>
<th>Stock</th>
<th>No. of trees/acre</th>
<th>Planting costs/acre</th>
<th>Total Production per acre for 1st 10 years</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. 24 ft. x 24 ft. sq.</td>
<td>Mix</td>
<td>75</td>
<td>£ 37</td>
<td>706</td>
</tr>
<tr>
<td>2. 24 ft. x 24 ft. sq.</td>
<td>Mix</td>
<td>75</td>
<td>37</td>
<td>706</td>
</tr>
<tr>
<td>3. 12 ft. x 12 ft. Inter</td>
<td>Mix</td>
<td>227</td>
<td>116</td>
<td>716</td>
</tr>
<tr>
<td>4. 8 ft. x 4 ft. dwarf Pyramids</td>
<td>Mix</td>
<td>1,361</td>
<td>696</td>
<td>1,737</td>
</tr>
<tr>
<td>5. 8 ft. x 4 ft. dwarf Pyramids</td>
<td>MIX</td>
<td>302</td>
<td>2,307</td>
<td></td>
</tr>
</tbody>
</table>

The permanent trees with or without fillers in Treatments 1 and 2 respectively have yielded about the same, indicating that under these conditions competition between trees was not a factor in production. With the addition of fillers on NIX at 12 ft. spacings in both directions production per acre was increased 2½ times in the first 10 years. At this stage crowding became such a problem that two thirds of the fillers had to be removed to provide access for machinery. Dwarf pyramids at 1,361 trees per acre have given by far the greatest production (3.3 times the orthodox 24 ft. planting) although establishment costs are high. Cordons are not considered economical. Both pyramids and cordons require a great deal of detailed training and tying down, particularly during the summer, and this greatly increases the labour cost.

In commercial orchards, a number of instances of close planting were seen mainly using MIX fillers in a permanent Mix planting. Generally, by this means, production per acre could be at least doubled in the early years but the need for access for spraying and harvesting usually necessitated the removal of at least some of the trees after about ten years. There was feeling among growers and field officers that close planting with a single stock may be preferable to using two stocks of different vigour. A few growers are successfully growing close planted dwarf pyramids but this is more of a novelty than a practical method. The main aim of most growers visited seemed to be to get greater production per acre even at the expense of some inconvenience in working. Plantings of 17 and 18 ft. square with fillers in the middle of the squares were seen. Tree yields under English conditions are not high and, even with interplants, production on several orchards visited was only 450-500 bushels per acre.

**SOIL MANAGEMENT**

Permanent grassing of orchards is now accepted as an ideal method of soil management and is widely practised in commercial plantings. Its value in facilitating spraying and other orchard activities is immediately apparent on walking through the orchards.

Grassing-down almost invariably imposes a check for a year or two on the trees' vigour. This check is most severe with strong grasses such as rye and least with clovers. The effect is worst on very young trees and also when grassing-down coincides with a dry summer. Trees on light soils may also receive a greater setback. To minimise the effect it is usual either to delay grassing down for four to five years, at which stage the trees should be well established, or else to provide a 6 ft. square of straw mulch around young trees for at least the first two years of grassing-down to enable the trees to adjust themselves gradually to the new environment. The more competitive award species such as ryegrass, while producing maximum setback of the trees, will also give the greatest improvement in fruit colour and may be used to advantage on good deep soils. S50 Timothy, the generally-recommended species, or natural tumble-down will check the trees less and are more suitable under average conditions. Clovers, while causing a briefer check to the trees, tend to die out owing to the heavy nitrogen dressings (5 cwt. per acre) which the trees must receive to counteract the induced deficiency. Once the trees overcome, the initial setback of grassing-down they rapidly improve.

Growers tend to choose the weaker grass species which are easier to cut and often rely on natural tumbledown. Mowing is a continuous operation during the summer and weekly cutting is sometimes necessary. Gang mowers are commonly used and also some rotary types.
It is very difficult to maintain the sward species in anything like a pure stand and the final result is usually a mixture of grasses with a high proportion of natural species.

In a trial at East Malling comparing permanent grass, straw mulch and clean cultivation at 14 years, trees grown with a straw mulch have produced the largest trees and greatest yields. The fruit however, has proved inferior in colour and storage quality to other treatments. Under clean cultivation the trees are the smallest, and are now showing stoppage of leaders and general lack of vigour.

**NUTRITION**

Long term experimentation with major elements on apple trees under clean cultivation conditions has shown a response, mainly to potassium, which is often nitrogen-induced. At East Malling, mature apple trees receiving no fertiliser over a period of nearly 20 years were at least equal in performance to those receiving various major element combinations. As soon as the orchard is grassed-down, however, nitrogen becomes limiting. It is usual to apply 5 cwts. of sulphate of ammonia and 1 to 2 cwts. of potash per acre.

Storage trials carried out at the Ditton Laboratories with Cox from the soil management trials at East Malling showed the best storage quality fruit comes from grassed plots and appears to be related to low nitrogen and high phosphate in the fruit. High K and low N gave no improvement in quality while high N under clean cultivation or straw mulch gave the poorest quality in terms of rots and breakdown.

**Magnesium.**

A very decided increase in yield (up to 100 per cent.) was obtained with close planted apple pyramids by the application of several foliage sprays of 2 per cent. magnesium sulphate during the early growing period.

**Trace Elements.**

Although copper and zinc are not seriously deficient as a rule in English orchards, experience at Long Ashton has
shown that a greater response is obtained with a 0.1 per cent. spring spray of zinc sulphate without lime than a 4 per cent. dormant spray. Similarly 0.05 per cent. straight bluestone as a foliage spray is preferred to a stronger Bordeaux mixture. At Long Ashton it has been demonstrated that molybdenum deficiency inhibits the nitrifying process of bacteria in legumes. This is of interest in connection with the relationship of molybdenum to nodulation.

**IRRIGATION**

Considerable interest is being shown at present in the effects of irrigation on apples, and numbers of growers have installed irrigation plants particularly in the western fruit areas.

Trials being carried out at East Malling have clearly demonstrated the benefits of maintaining adequate summer soil moisture on tree growth, yield and fruit size, although the trees normally show no severe stress. Water was applied to maintain soil moisture at specific tensions viz., 10, 20 and 50 cms. of mercury during the summer months. Tensiometers were located under each tree.

Applications at 10 cms. tension gave improved tree growth and considerable increase in yields due to increased fruit numbers and improved size. Irrigation at 20 cms. produced less effect on tree growth and yield. At 50 cms. the effect was mainly on fruit size resulting in slightly better yields than no irrigation.

**SPRAYING**

Low-volume spraying is widely practised with air blast equipment and increased concentration. Dr. Morgan at Long Ashton is carrying out work on droplet size and distribution and is of the opinion that it is not necessary to use concentrate sprays with low-volume application provided the spray is efficiently distributed over the plant parts to be protected. This is considered to be a function of droplet size which in turn is related to air speed and design of discharge nozzle. He felt that any increased effect with higher concentrations was probably due to the increased concentration of wetting agent. Two

![Fig. 6—Dwarf pyramid apple trees on Malling IX stock planted 4 ft. apart in rows 8 ft. apart, Long Ashton Research Station](image-url)
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machines are under investigation. One uses air at 20,000 cu. ft. per minute (cf turbomist at 4,000 cu. ft. per minute) and a hydraulic pressure at the nozzle of 75 lb. per sq. inch. The other works with an airstream at approximately 200 m.p.h. the spray being picked up from a special arrangement of spiral rotating vanes. Dr. Morgan’s views on spraying were not generally held at other centres.

At the National Institute of Agricultural Engineering at Silsoe a low-volume spray machine has been developed to operate as a power-take-off unit attached to a light tractor. It incorporates a special non-blocking nozzle arrangement and swivel V-belt drive to facilitate short turns. Concentrate sprays successfully used in the machine include wettable sulphur at 14 lb. per 10 gallons, arsenate of lead, captan, DDT and BHC.

Dr. Martin at Long Ashton has demonstrated the translocation of mercury from sprayed foliage to shoots developed subsequent to spraying.

VIRUS

The main recognised viruses of apples in the U.K. are mosaic, rubberywood, chat fruit and stem pitting.

Mosaic does not produce serious leaf symptoms in England but is considered to reduce yields. Its method of transmission is unknown, the only vector considered at all likely being the nematode. There is no direct evidence of nematode transmission but tests are in progress. Transmission of the fan leaf virus by *Xiphinema* spp. in grapevines has been demonstrated in California and it is understood that since leaving England virus transmission has been effected on peaches. The possibility of jassids being involved was thought to be unlikely.

Rubberywood is no longer a serious problem, as only certain varieties show the symptoms and selections of virus-free stocks and scions are available for propagation.

The stem-pitting virus with associated symptoms of bark-splitting and bark necrosis shows up seriously on Virginia Crab and also *Malus platycarpa*. By using the later as an indicator the virus has been located in other apple material but its significance is now known.

The chat fruit virus is not a problem as far as could be determined. A line pattern developed in *Malus platycarpa* is thought to be a manifestation of this virus.

Some of the Malling series of apple rootstocks have been found to be virus-infected. As a result of intensive selection and indexing at East Malling virus-free clones are now available of most of this series. The Mallin-Merton series appears free. It is known that virus-infected clones show reduced vigour in the nursery and the production of off-shoots in layer or stool beds is affected. In many areas recent plantings on MII were thought to be making poorer trees than previously and this may be related to virus infection.

Virus Indexing.

Indexing is carried out usually by double budding. A seedling is budded with the test bud and the indicator bud inserted just above. The indicator bud is allowed to develop and, if virus freedom is indicated, the stock can be cut off above the test bud to allow it to form a tree.

Indicators normally used are:—

Lord Lambourne—for mosaic and rubberywood.

*Malus Platycarpa*—for stem pitting and also for chat fruit which is thought to show as a line pattern.

Heat Treatment for Virus Suppression.

Work is in progress to produce virus-free material of apple stocks and scions by use of a heat cabinet. The method depends on the fact that at high temperatures virus multiplication is suppressed whereas plant growth is accelerated. The temperature is fairly critical between 36 and 37°C. Above 37°C plant growth is suppressed. The material for treatment is grown in a special double glass-walled constant temperature cabinet for six weeks. After this time, the tip growth and first two or three buds are usually growing ahead of the virus and may be used for grafting on to an apple seedling to produce virus-free material. A cleft graft is used and the whole graft covered with a polythene bag until the union is complete. The resultant material is then reindexed.
NEMATODES AND THE REPLANT PROBLEM

A replant problem is recognised in the United Kingdom although it is not of any great commercial significance. An interesting effect was noted at East Malling in recent years. An old nursery site laid out previously with rows of apple and plum stool beds was allowed to revert to grass for five years and then used again for apple and plum stocks planted at right angles to the original rows. Where apple rows crossed original apple stool beds there was a suppression of growth and similarly with plums over plum stool beds.

Dr. Pitcher felt that the replant problem is a complex one with nematodes only one factor. Experiments conducted with heat treatment of soil showed that heating soil from an old orchard to 60°C resulted in much improved growth of apple seedlings planted in it. However, a similar treatment of nematode-free virgin soil also gave improvement in growth. Nematodes are not causing concern in United Kingdom orchards although their presence is known. Counts made at East Malling have not shown any significant resistance for MM 104. Counts of 240 were obtained for MM 104 as against 300 or less for other stocks.

HERBICIDES

Dalapon is being successfully used as a suppressent for species of couch grass under apple trees at Luddington Experimental Station. The trial consists of controlling couch within the rows of apple cordons. An application of 10 lb. per acre was only slightly more effective than 5 lb. per acre but two applications of 5 lb. gave a much better kill. East Malling has recorded slight damage to apple trees from the use of dalapon.

2,4-D. ethylsulphate has proved satisfactory for the control of weeds in apple stool beds at Long Ashton. Applied at the rate of 10 lb. per acre to cultivated soil the treatment suppressed weed development for at least six weeks. Respraying was not very effective in the absence of further cultivation. Two applications proved adequate for the season. The material breaks down to 2,4-D. in the soil and as would be expected is not very effective against grasses.

DISEASES

At the present time, powdery mildew is the disease causing the apple-grower the most trouble. Lime sulphur was eliminated from the scab programme with the advent of captan some years ago and this
has allowed mildew to build up to serious proportions. The problem has become so acute in some orchards that growers are embarking on a severe pruning programme on Cox, the main variety affected, plus a reintroduction of lime sulphur in an endeavour to bring the disease under control. Karathane is being used on many orchards with success but five sprays of 1 lb. per 100 gallons at fortnightly intervals commencing at mouse ear stage are considered necessary. Trials at Luddington over a number of years have shown that Karathane produces bigger trees than lime sulphur but appears to depress yields possibly by an effect on the blossom and also encourages spider mites. Many growers still prefer lime sulphur particularly where infection is bad, and colloidal sulphur at 10 lb. per acre is still recommended. In pruning out infected wood the prunings are dropped on the ground as is not considered a source of infection.

Apple and pear scab is being controlled by captan and thiram and sometimes early copper sprays. Organic mercuries are not being used and the opinion was expressed that because of heavy bud infection and reinfection from outside were not likely to prove satisfactory.

PESTS

Mites present the greatest problem for apple-growers in that the pest has built up resistance to practically all insecticides so far tested. There was evidence during the 1959 growing season that resistance to metasystox was established and likely to render this material ineffective.

Normally there is only one brood of codling moth in England but with the early spring and warm summer many growers were caught when a second brood of codling moth appeared. Woolly aphid and scale insects are not problems.

LEAF PHYSIOLOGY

Dr. Martin at Long Ashton has developed a method of cuticle separation, which entails the removal of the wax with ether, and then steeping in ammonium oxalate to dissolve the pectin layer between the cuticle and the epidermis. The cuticle is then floated off and used for observation, thickness measurement, etc. A study of cuticle thickness has revealed that it varies with nutrition and growing conditions. Leaf absorption of spray materials may be related to cuticle thickness. Pores other than those known to exist in the leaf were found in the separated cuticle. Their function is unknown.

BUD INITIATION

A method of breaking the biennial bearing cycle of apple trees has been developed at East Malling by Dr. Fulford. It consists of spraying the trees three weeks after full bloom with a 1.5 per cent. copper sulphate solution with a wetting agent. This causes heavy leaf drop (up to 50 per cent.) and is immediately followed by regrowth. This treatment applied to trees in their “off year” reduces flower bud development for the subsequent “on year” and if the right balance is struck crops can be balanced up quite well. Under hot climatic conditions this type of treatment could result in serious sunscald of the bark.

(To be continued.)