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A Survey of Fruit-growing Practices and Fruit Research Problems in India.

By

U. NARASINGA RAO,
Assistant Fruit Specialist, Coonoor.

Introduction: India is a vast country wherein diverse climates, ranging from the tropical to the temperate, are met with. As a consequence, the different regions, depending on their geographical situation, have come to be known for the particular fruit or fruits they grow; the apples of Kulu and Kashmir, the Malta oranges and grapefruits of the Punjab, the grapes of Quetta, the peaches of Peshawar, the litchi of Bihar, the mangoes and bananas of South India to name but a few are well known to the horticulturist in India. With the intensified culture of these fruits in the regions best suited for them, specialisation in fruit-growing practices has followed, leading towards an attempt to either evolve new practices or modify existing ones which would fulfil the needs of each individual fruit-crop in a rational manner. This trend towards specialisation embraces both the fruit-growing practices in the tract as a whole and also the fruit research upon which the workers there are engaged.

Both to the fruit-grower and the horticultural research worker in India, however, it is no easy task to gain an adequate knowledge of either the fruit-growing practices prevalent in regions other than his own or the features of the tracts associated with such practices. This is because horticultural publications are either scarce or are scattered in various journals, books and reports which are not readily available. This feature is of some consequence, particularly to the cause of fruit research as it often involves a certain amount of overlap in the work being done by different workers in different parts of the country and leads to an avoidable waste of efforts.

The author was deputed by the Government of Madras in 1946 for a survey of fruit-growing practices and fruit research problems in some of the more important fruit-growing provinces and States of India in order that a general knowledge on these aspects, which would be of help in shaping a research programme for Hill Fruits may become available. The survey lasted from March to May, 1946 over a period of three months, during which the author visited some of the representative tracts of fruit-growing in the Punjab including the whole of the Kulu Valley,

N. W. F. Province, Kashmir, Baluchistan, Kumaun Hills in the United Provinces, Sabour in Bihar, Calcutta and Nadia in Bengal and Hessarghatta in Mysore State. In all these places, numerous orchards, the various horticultural research institutions and the experimental fruit areas attached to them were visited. Centres of fruit-processing and preservation, of vegetable cultivation and seed production and of bee-keeping were also visited as subsidiary subjects of interest to the horticulturist.

It is felt that a popular account of the fruit-growing practices of the tracts visited, along with the problems confronting the growers and the methods adopted by the research workers would be of special interest to the fruit-grower in Madras. It is also hoped that such an account would evoke a better appreciation by all fruit workers, of the factors which go to promote horticultural practices and research in the right direction in any part of the country. An attempt has therefore been made, in what follows, to recount briefly the salient features of each tract, the existing fruit-growing practices and problems and the extent to which the last have been solved or are being worked upon.

The Punjab: The Punjab is reported to have nearly 1,04,000 acres under fruits, of which 55 per cent is under mangoes, 25 percent under citrus, 1 percent under grapes, and the remainder under miscellaneous fruits including the deciduous types.

The whole province is horticulturally classifiable into four zones according to their climatic features. First, there is the region of cool climate, where, between an elevation of 4,000 to to 7,500 feet, fruits like the apple, pear, cherry, walnut and the persimmon are grown. This includes the Simla and Murree Hills and the Kulu Valley. At lower elevations, between 1,500 and 4,000 feet in this tract, as in the Kangra Valley, the peach, plum, apricot and almond are cultivated. Mangoes are also grown here upto an altitude of 2,000 feet. The rainfall of this tract is about sixty inches and the average annual temperature varies from 27 degrees F to 50 degrees F. The second tract is the sub-montane area which includes the districts of Ambala, Gurdaspur, Hosiarpur, Sialkot, and part of Karnal etc. This region, with an annual rainfall of 20 to 35 inches and an average annual temperature range of 35 to 60 degrees F. is considered the best for mangoes. Thirdly, there are the Central districts

of Amritsar, Lahore, Guzranwala and part of Sheikapura with a rainfall of 15 to 20 inches and on average temperature of 40 to 70 degrees F. where mangoes are grown. The last zone comprises canal colonies and the southern dry tracts of Montgomery, Lyallpur, Sargodah, Multan, Muzaffargarh, Dera Ghazi Khan, etc. Here the rainfall ranges from 4 to 15 inches and the average temperature from 35 to 118 degrees F. Citrus thrives here, while mangoes can be grown with care.

The mango is the most extensively grown fruit in the Punjab but the present trend is in favour of the citrus fruits, especially the Malta orange and grape-fruit, because of the relatively higher returns that can be secured from the latter. The *ber*, grape, *phalsa* and date are grown to some extent and attempts are under way to make their culture more profitable than what it is at present.

The establishment of mango orchards in this province seems to be beset with one primary difficulty and that is the reported intolerance of the mango seedling to transplantation from the nursery bed. Apart from this, the culture of the mango does not offer any exceptional features of interest. The favoured commercial variety is *Langra*. The only important investigation of economic significance with mangoes has been on the possibility of elimination of fatalities said to be caused in transplanting the young grafts. The workers in this region claim to have solved the problem by adoption of the method known as budding *in situ*. In this method, the seedling stock is raised in their permanent sites and when the plants have attained sufficient growth, buds of selected scions, suitably pre-cured, are inserted on them, producing thereby, grafts which can grow without any subsequent disturbance. The success achieved however appears to be low and further investigations in this respect are in progress. The procedure does not seem to differ materially from the Nakamura's method of side-grafting except that in the latter a graft stick is inserted into the stock instead of a bud. A comprehensive scheme of work on this fruit has yet to be planned in the Punjab.

The most important of the citrus fruits are several types of sweet oranges and the grapefruit. These are gaining in prominence and the special facilities afforded by Government such as extra supplies of canal water, and the increasing popularity of the fruits both in their fresh form as well as preserved, has stimulated all round interest in their culture.

Visits to large-scale orchards such as those of the Indian Mildura Fruit Farm at Renalakhurd and Dr. Cheema's Fruit Farm at Montgomery, reveal that the returns are quite handsome during the present boom period and the owners are alive to the possibilities of improvement of the existing orchards and of further extension. The common Malta, Malta Blood Red, Pineapple Orange, Valencia Late and Jaffa among sweet oranges, Marsh Seedless and Foster among grapefruits and Eureka, Villa Franca and European among lemons are the important commercial types. Improvement in several directions is being sought with some of these. A clonal progeny garden has been established at Riselawala near Lyallpur, where trees of different varieties have been raised from scion material collected of parents whose fruits have won exhibition prizes. The object is to confine the multiplication of citrus plants in the Province only from these selected promising parents. The trees in the progeny garden are being studied for performance and it is stated that only such of those that continue to be promising will be ultimately used for further propagation. Rootstock trials of citrus were commenced in 1937 at the Montgomery Research Sub-Station. Scions of Local Malta, Blood Malta, Sangtra Local and Marsh Seedless grapefruit are under test with two types of rootstock, viz., seedlings and rooted cuttings. The latter are of no commercial value and their inclusion is only of academic interest. With each of these groups, but with slight variations for the different scions, the following stocks have been included. *Jatti Khatti* (rough lemon), *Karna Khatta (Citrus Karna)*, sweet lime, citron, *Nasnaran (Citrus Japonica)*, *Jallandari Khatti* (smooth lemon), and *Chakotra (Citrus Maxima)*. Initially *Karna Khatta* was found best for all the scion varieties, both in the form of seedlings as well as cuttings. Subsequently this stock proved a failure for Blood Malta as growth came to a stand still. With the other scions, it continues to record the best performance. For Blood Malta, now, the rough lemon is adjudged to be the best stock. Sweet lime and citron proved a failure with all the scions. The results are of value in the extension of the area under citrus in this province. A manurial trial for the Malta orange is in its second year using different doses of N. P. and K. and their combinations, in the form of artificials and with cattle manure. The results are expected shortly. Though several varieties of Sangtra oranges are under trial, one important drawback is said to be the extensive fruit drop which makes their cultivation unprofitable. The drop is attributed to the high summer temperature prevalent at the time of fruit development.

The area under grape is small but the Punjab is keen on its extension. A study of varieties, both local and foreign, and hybridisation work to evolve types which would suit local conditions, are under way. An experiment laid out with three types of training the vines, viz., head, cane and cordon, has given results in favour of the last, which is now being generally adopted. Trials in ringing of vines and thinning and bagging of bunches did not yield striking results. But it is claimed that if grape bunches are bagged a few days prior to harvest, uniformity of ripening of berries is ensured, loss by damage due to wasps and bees is eliminated and indirectly, since the bunches are left on the vines until they are fully ripe, the sugar content increases from an average of 15·5 per cent in the case of unbagged bunches to 23·0 per cent of those bagged. Whether this will apply to inherently uneven ripening varieties is not clear.

The *phalsa* and the *ber* are considered to be the poor man's fruits and are receiving some amount of attention. Pruning trials with *phalsa* have shown that hard pruning down to the base (a severe form of dehorning) once in several years, when the tree shows declining yields, renovates the tree. This struck me as a close parallel to a similar system of pruning of tea adopted by planters on the Nilgiris with equally beneficial results. With the *ber* fruit it has been found possible to top-work the existing unthrifty trees with selected scions. The date is another fruit of the plains of some importance and investigations include varietal trials, the determination of the best season for planting, the optimum size of sucker to plant, and the curing of the astringent date fruit. In regard to the last, the passage on this subject in the Manual of Tropical and Sub-tropical Fruits by Popenoe should prove of use to the Punjab workers.

The temperate fruits are largely confined to the hilly tracts of the province, though there are small areas under some of them in a few localities such as Lyallpur, Renalakhurd, and around Amritsar. But broadly speaking, it may be said that they are of importance only on the hills at elevations of 4,000 feet and above. Among these fruits again, apart from the apple, stone fruits like the plum, peach, apricot, cherry and almond have been relegated to a secondary place. This is because the tracts suitable for their cultivation are inaccessible from the point of view of commercial transport and these fruits do not stand long distance transport. The pear, though well-suited to the tract, is in neglect due to the heavy damage caused to

ripening fruits by fruit flies which are said to take a heavy toll. The largest area under hill fruits is in the Kulu Valley but it is reported that Simla and Murree Hills and the Kangra Valley hold possibilities of extension. In the Kulu Valley, fruit cultivation is limited to a few large-scale orchards at Bajaura, Bundrole, Raison, Dobi, Naggar and Manali. These are fairly old and were almost all established by Englishmen within the last one hundred years. Fruit culture has not found much favour with the local cultivator mainly due to the difficulties met with in the transport of produce to consuming centres and the large financial outlay required for the purpose. There is now an attempt on the part of the Government to pool the produce of petty growers and to effect disposal through co-operative societies. Efforts are also being made to supply nursery material to cultivators who are desirous of laying out new orchards. As has been said before, large-scale cultivation is primarily confined to the apple because of its ability to withstand long-distance transport. Even so, there are several varieties of this which ripen in August when heavy rains are common, causing extensive breaches in the roads leading to the plains. This causes dislocation of transport and results in decay of the fruits harvested and stored in this period. It seems as though for a proper and all-round development of horticulture in this region, the only way is to provide canning and cold storage units. The first would absorb the easily perishable fruits and the second would lead to proper storage of apples during inclement periods. The favourable climatic features of the tract induce very prolific growth and bearing of most fruits without much effort on the part of the growers. Apple trees, thirty to forty feet high, each yielding yearly, ten to fifteen maunds (one maund is equal to 82 lbs.) of fruit are not uncommon. The orchard owners, it is observed, have deduced certain empirical methods for each of the fruits grown, from the experience of several decades. One reported difficulty of the nurseryman in this region is the inordinately long period of three years, taken by him to produce an apple graft by the existing methods. Seeds of the wild apple are sown in the first year, and these give seedlings of suitable size in the second year when they are budded to scion varieties and at the end of the third year, the grafts are ready to go in their permanent sites. Use of standardised stocks propagated in layering or stooling beds should solve this difficulty. Until then, however, the method of root-grafting which has recently been tried and found successful here, would materially reduce the period. It is said that the root pieces are collected from standing orchards by

giving a severe root pruning to the bearing trees. This procedure, if continued over some years, would eventually exhaust the trees and starve them out. It may be advisable, therefore, if a few unthrifty old trees are located in the orchards, which could be set apart for the sole purpose of collecting the root material from them. These trees could be manured heavily every year so as to stimulate fresh root output and in this condition can be maintained for several years solely for providing adequate rootstock material.

The woolly aphis pest on apple and San Jose scale pest on all fruit trees are common in this tract and routine control measures are being undertaken by the growers. But it was curious to note that even in neglected orchards the pests have not caused any appreciable damage to the trees. This must be due to the inherent vigour of the trees induced by the favourable climate.

The important commercial apple varieties of the tract are Red Delicious, Baldwin, Yellow Newtown, Black Ben Davis. Among pears, William, Easter Beurre and Marie Louise are favoured. Santa Rosa and Formosa are two popular varieties of the plum. White Heart and Black Heart cherries are the only two generally met with. The persimmon does well in this tract, the two varieties commonly grown being Hachiya and Karakume.

At the Palampur Fruit Station in the Kangra Valley the introduction of different fruits and their trial have been the main items of work up till now. Though it is admitted that the location of the farm is not ideal, several promising types have been isolated and their popularisation remains to be accomplished. Apricots, plums, peaches, almonds, persimmons, the purple-fruited passion fruit, and the black berry are among the most successful fruits at the station. Along with fruit varieties, introduction of stocks such as Pershore and Brompton for the plum, Malling and Merton types, *Malus crunifolia*, Doucin, Wybdon, and wild apple seedlings from Kashmir and California for the apple, Mahaleb and *Prunus serulata* for the cherry, *Pyrus ussuriensis*, *Pyrus serotina*, *Pyrus calleryana*, *Shegal* and *Shiara* and *Pyrus toringo* for the pear, *Diospyros lotus*, and 'amlok' for the persimmon have all been introduced to study their possibilities as rootstocks.

The All-India Fruit Preservation Institute which is located at Lyallpur deals with research in the methods of the preparation of different fruit products. At the Kissan Canning Factory at

Renalakhurd, some of these products are manufactured on a more extensive scale. A cold-storage unit of one and a half tons capacity has been located at the Agricultural College, Lyallpur. This is designed to maintain any desired temperature and the behaviour in cold storage of different varieties of Malta and Sangtra oranges, the grapefruit, pear, plum, Langra mango and the grape has been studied. The trend in cold-storage work appeared to me to be towards preserving the fruit at the consumer's end which would ultimately mean a higher profit range to the middle man under the existing methods of distribution. But the crying need is probably at the grower's end as for example, in the Kulu Valley, where much of the fruit is going to waste at present compelling the producer to sell the fruit at unprofitable prices.

At Lyallpur, there is a vegetable section which tests varieties and produces seed of promising types for distribution. The peas crops seen in the field appeared to be very prolific and early in bearing and a trial of the following in other tracts seems worthwhile.—Desi P. I. D., English peas No. 8, No. 44 and No. 35 and Sugar-coated peas No. P. 40 and P. 26, the pods of the last two being edible when tender. The cabbage does not set seed in the plains of the Punjab but this is not of much consequence, as the Kangra Valley is quite suitable for this purpose.

The All-India Bee-Keeping Station is also located at Lyallpur. It is learnt that attempts to introduce the hill bee to the plains has been accomplished by the simple device of providing a new queen to the imported hive every year during spring.

North-West Frontier Province : The North West Frontier Province possesses about 6,000 acres under fruits, largely comprising of the deciduous group. A small area exists under the sweet orange and grapefruit. Of the more important fruits, about 2,310 acres are under the pear, followed by 1,680 acres of peach, 1,350 acres of apricot, 18 acres of apple and about 10 acres under the strawberry. The important districts for fruit-growing are Peshawar, Murdan, Hazara and Kohat. The easy accessibility of the fruit-growing areas of the province by rail and road and the suitability of the tract to the cultivation of stone fruits are reflected in the relatively large areas under these. Signs of further extension are perceptible subsequent to the erection of a large canning factory which could take off the surplus fruit that is not consumed in its fresh state. Due to

the high summer temperature on the plains and absence of snowfall, the apple does not find a congenial place in most parts of this province and its cultivation is therefore confined to a small area around Abbotabad which is hilly. The annual rainfall in this province amounts to an average of about 12 inches received mostly in the winter. The maximum temperature in the year goes up to 117 degrees F. and the minimum slightly below 39 degrees F.

Though the pear occupies the largest area, the peach is considered to be the best fruit of the province in regard to quality and yield. The latter is claimed to reach almost perfection under the conditions in which it is grown here. The trees assume large proportions and bear abundantly, requiring annual thinning of the fruit, to ensure large size and prevent exhaustion of the trees caused by over-bearing. Research in several directions on the culture of this fruit was felt necessary and a scheme of work to determine the best varieties, irrigation and manurial requirements and the optimum pruning methods was financed by the Indian Council of Agricultural Research. Unfortunately, however, after five years of work had been done and certain results deduced, it was found that the experiments had been conducted on heterogenous material and the work had to be scrapped. The whole scheme, therefore, with an identical programme but on new plantations specially raised for the purpose, has been put under way. The important commercial varieties of the peach are No. 6-A (Early Crawford), Wiggins, Elberta, Leven Ceure, Triumph and Carmine.

The pear comes next in importance. The *Bhatang* which is claimed to be a local variety is popular due to the abundant fruiting and hardiness of the trees. The fruits are reported to be of desert quality when fully ripe. Other successful varieties are Le Conte, William and a variety from Kashmir. The Kieffer variety is also cultivated but its growth and bearing do not compare well with others. Generally speaking, except the *Bhatang*, all other varieties, though making good growth, develop only a scanty spur system. It is likely that a dwarfing stock such as the quince may assist the pear to a better cropping habit in this region.

Several varieties of the plum are being grown and these are mostly of the Japanese type. Plum No. 1 and No. 2, Rubio and Beauty are considered as promising. Some varieties of local origin viz., *Alucha, Desi Alucha, Dugdin* and *Jangli* are valued for their earliness of cropping in the season.

The apricot is relatively a fruit of minor importance and of the varieties grown one Afghanistan variety is considered the best, largely from the point of view of its canning ability.

There is a small area in Peshawar under Washington Navel, Valencia Late, Blood Red Malta oranges and the grapefruit. The growth of all these is impressively good and flowering is profuse. It is claimed that the Washington Navel of this place is a stable variety and is of superior quality.

There is no research programme for any other fruit than the peach except that several varieties of each have been introduced and are under trial.

Visits were made to the Fruit Preservation Laboratories at the Tarnab Farm as also to the Government Fruit Processing and Fruit Canning Factories. The latter two are of the largest capacity I have met during the course of my tour. It is reported that the Canning Factory works only during four months in the year during the fruit season, remaining idle at other times. It appears worthwhile encouraging cultivation of crops like peas and tomatoes during the off-period of the factory so that it may get material for canning over a longer period.

Jammu and Kashmir State: According to figures compiled several years ago, this state has nearly 20,000 acres under fruits which are all of the deciduous class but it is possible that the area is now considerably more. Kashmir is pre-eminently a tract for apples with nearly 10,000 acres under this fruit, followed by walnut, almond, pear, apricot, cherry and the plum in the order of their importance. A few acres of the nectarine and the quince also exist.

The annual average rainfall amounts to about 26 inches. The maximum temperature goes upto about 100 degrees F. and the minimum below 24 degrees F.

The soil and climatic features of Kashmir are well suited to the cultivation of deciduous fruits in general and the apple in particular. If the development of horticulture is given a proper orientation, this tract would continue to lead all others in India where such fruits are grown. Unlike the Kulu Valley, Kashmir is connected to the railhead by very fine roads, which would facilitate rapid transport of the fruits. There are also facilities for erecting more than one canning factory in Kashmir to

absorb all surplus produce. Walnuts and almonds of this region are already renowned and their further extension would cater to a wider market not only in India but also in neighbouring countries.

The apple in Kashmir holds the pride of place among all the fruits grown. Its cultivation has been known from the early Hindu period when it was called the *Palevat.* It continued to be popular during the later Moghul period. The local indigenous variety known as *Ambri* was grown during this period and it continues to be the most widely cultivated type to this day. With the advent of the British rule, European varieties were introduced and two foreigners, Mr. Banute and Mr. Peychaurd were responsible for bringing in several French varieties from abroad about 50 years ago. At present among these various types grown, the *Ambri* continues to be the predominant commercial variety. French Red and Russet rank next in importance, followed by *Saharapuri,* Cox's Orange Pippin, Golden Russet, Ezopus Spitzenburg, Northern Spy and a few others.

The cultivation of the apple in Kashmir presents some features of interest. The trees are raised generally as grafts on wild indigenous apple seedlings known as *'trels'*. While in all other parts of India the apple is generally grown as a bush tree, here the standard is universal in order to suit its exhuberant growth. Irrigation and manures are rarely applied throughout the orchard life of the trees, as these are considered to be superfluous and observations of apple orchards in different parts of the tract seem to bear this fact out. On the other hand, it is maintained that the secret of success lies in the meticulous hoeing and intercultivation of the soil which are done on an average four times in a year. Intercrops of beans, peas, vegetable seed crops, potatoes, etc., are freely raised even in bearing orchards without apparent harm to the trees. The trees are reported to come to bearing between the fifth and the eigth years. A figure of 100 to 150 pounds of fruit per tree is given as the average annual yield. This quantity is too low for a tree in full bearing and probably represents the average for the State on the basis of the total number of trees which would include young and non-bearing plants. The longevity of the tree is generally between 50 and 60 years though 80 year old trees are not uncommon. The apple has had a setback in recent years due to the damage caused by woolly aphis pest and the San Jose scale. It is maintained that the former has been effectively checked by the introduction of its parasite, *Aphelinus mali;* perhaps,

the only place in India which can make this claim. The San Jose scale pest, however, proved intractable and with financial assistance from the I. C. A. R. a seven-year scheme of investigations on the pest has just been concluded. As a result of this work a single dormant spray with a six per cent Diesel oil emulsion in fish oil rosin soap has been found to be the best control measure. A law has now been introduced for compulsory spraying of orchards and it is claimed that this measure has reduced the pest to negligible proportions. The fruit growers of Northern India are unanimous in their opinion that the Kashmir formula is the best for the control of the San Jose scale pest. The only other investigation of any importance on apple is another scheme financed by the I. C. A. R. for the identification of the different varieties now being grown at Kashmir and their proper nomenclature. Many of the varieties introduced from abroad are reported to have lost their identity, and it is the purpose of this scheme to name them after a comparison with the description of standard varieties. The attempt should prove valuable for the dissemination of promising types under their proper names.

Though the area under other fruits such as cherry, peach, plum and the apricot is by no means negligible, Kashmir considers them as important only for local consumption. Thus, there are no large scale orchards under these and it is common to see a few trees of each interspersed in what may be classed primarily as an apple orchard. Not much attention has been paid as to what actually the varieties grown are, but the following among them seem to be of greater popularity than others:— plum — Burbank, Wickson and Golden Drop; peach — Silver peach and Quetta peach; cherry — Black Bigareau; pear — William and *Naspathi*. It was interesting to learn that four 'strains' (mutants?) are recognised of the William pear according to time of maturity which extends from August to October.

Walnuts and almonds form an important category for export as dry fruits. They have been long in cultivation but they do not seem to belong to any named variety. The only distinction between the types grown is that some are thin-shelled *(Khagzi)* and others are thick-shelled *(Khatta)*.

The impetus given to vegetable seed growing, for which Kashmir is undoubtedly suitable, seems to have slowed down with the withdrawal of the support extended by the I. C. A. R. until recently. Due to the great demand for seeds from all over

India during the war years, nearly four hundred seed growers are reported to have come on the scene. This brought in its wake difficulties in adequate segregation of allied types or different varieties of the same type. The work of selection of plants true to type, roguing, careful harvests, threshing and cleaning of the produce could not be supervised effectively and a large quantity of dubious seed flooded the market, giving a bad reputation to the Kashmir produce. With this the industry collapsed and it was reported that not a few growers had on their hands large stocks of unsold seed even as old as three years. The Partap Model Farm also which was producing seed under the aegis of the I. C. A. R. has had to curtail its activities. During my visit to this Station, the methods employed in raising a cabbage seed crop were gone into, as of special interest to the Nilgiris. The crop is raised by sowing seeds in August in nursery beds and transplanting seedlings a month later. The crop matures in November—December when selected heads are uprooted and transplanted on a new site. This crop remains inactive during the winter. In early spring when the snowfall and winter rains are over in March, the heads are given two cross slits to enable the flower stalks to emerge. Practically all the heads go to seed and the seed crop is harvested in June. In harvesting, the entire seedstalks are cut, stacked and fermented for about a week. This is said to ripen the seed and promote its colour. After this, they are dried in the sun for a day and threshed. The seed is cleaned and gathered. It is reported that 25 cents of land planted to a cabbage seed crop (variety — Drumhead) gives about four maunds of seed (1 maund — 82 lbs.) This works out to 1,312 lbs, of seed per acre, which appears to be a high figure.

Incidentally it was learnt that cauliflower does not set seed at Kashmir. This experience was corroborated by seedsmen at Kulu and Quetta both of which places are suited to cabbage seeding. Considering that cabbage does not set seed at Coonoor on the Nilgiris while cauliflower does so with falicity, it strikes me that these two crops are mutually antagonistic in their climatic requirements, so far as seeding is concerned.

Baluchistan: Baluchistan grows about 11,500 acres of fruit. Of these about 5,000 acres are estimated to be under the 'Sarada' melon, about 2,500 acres under grape and the rest under the apple, pear, plum, peach and apricot. It is expected that the total area under fruits would increase to about 20,000 acres within the next decade by special schemes launched by Government for the purpose.

The annual rainfall amounts to about ten inches inclusive of snowfall and is confined to the winter months. The maximum temperature reaches up to 100 degrees F. while the minimum goes even as low as 12 degrees F.

There are two main limiting factors to any great expansion of area under fruits in this province. First, the rains are precarious and all too insufficient for the optimum growth of most kinds of fruits and, secondly, alternate sources of supply of water are either prohibitive in cost or are unobtainable. Even so, the Quetta Zamindar has devised interesting methods of tapping the under-ground supplies of water available at the base of the mountain sides. One of these is by means of a series of narrow but deep wells (called *karezes*) sunk at short distances from one another and connected together by under-ground tunnels. These lead the water from its source, which may be even several miles away to the patch of land to be cultivated. The extent of the land commanded by any one such water source may vary from a few hundred acres to a thousand acres or more. It is said that the initial outlay for digging these '*karezes*' is enormous and it is common for a whole village to share the cost and own them as a joint property. An additional expense is the maintenance charge on them which require cleaning and deepening every year. For this reason, fruit production is likely to be prohibitive in cost unless cheaper sources of irrigation are devised. Expansion of area under fruits, therefore, on new unbroken land may not be easy unless existing land under vegetables or grain crops is encroached upon.

Generally speaking, in Baluchistan, a distinctive feature of the tree orchard is its composite nature, that is to say, it contains a fair representation of all such fruits that can be grown in the tract. One common defect of established orchards is the very narrow spacing of the trees which is as little as six to eight feet in some cases, giving them a characteristic dense crowded appearance. Scarcely any light penetrates into the garden and I was not surprised to learn from the Entomologist of the province that insect pests and fungal diseases are much more numerous here than in other parts of India. There is thus a strong case here for thinning out rigorously the number of trees in each orchard so that the rest may thrive.

I consider the grape as the best fruit of this tract though the local opinion is in favour of the apple. The apple tree at Baluchistan even in the better-kept orchard, appears both as regards growth and bearing to be inferior to that of Kashmir or the Kulu Valley. The cultivation of the grape in this region

dates back to several hundred years ago and the finer points of its requirements are well understood. As such a brief description of the methods will be justified. There are two main systems under which it is grown. First, there is the 'head' system *(mundathak)* where the vines are planted so as to be above the ground and a specified number of short branches are retained on a trunk. This method accomodates a larger number of plants and the handling of cultural operations is relatively easy. In the second, the vines are planted in trenches *(juvathak)* which run parallel to each other from east to west. The idea of the trenches seems to have originated from the necessity of sheltering the vines from the severely cold north winds as well as sun scald. About six or more of such trenches *(joa)* are connected by another trench *(samari)* which runs at right angles to them. This set of trenches forms a plot. A vineyard comprises of a number of such plots which are connected together by irrigation channels. The vine is propagated from cuttings which are planted *in situ* in the vineyard. The rooting of cuttings in beds is deprecated, as transplanting them later is believed to result in weak and unthrifty plants. Therefore, as a rule, grapevine nurseries are not maintained. Pruning for the first four years is done to form a strong cordon frame-work and in subsequent years it is done to regulate vegetative growth so that fruiting and development of bunches is promoted. Manuring is done every third or fourth year when each vine gets about four pounds of cattle manure. Sheep, goat or camel dung are avoided as they are said to scorch the foliage. Frequent irrigation during rainless periods is common. During flowering and when the grapes approach maturity water is withheld. In the first instance, the flowers are said to drop without setting and in the second the grapes lose in sweetness, become watery, and deteriorate rapidly after harvest. A vineyard once established is said to live for several hundreds of years. The varieties of grape met with, fall into two main groups—(1) Seeded, which may be coloured or colourless; among the latter are *Haitha* and *Shendaokhani*, and of the former, *Kairaulaman* and *Sahibi* are the more important, (2) Seedless, of which the *Kishmish* is the most widely cultivated. This occurs as both a coloured and colourless grape. The export of grapes is confined to *Haitha* and *Kishmish* while the others are for local consumption. The yield per vine per year in this tract varies from 14 to 20 pounds.

At Millezai, an interesting attempt is being made by the State for the extension of the grape in the tract. A block of 100

acres has been taken over from certain zamindars and a vineyard established. The terms of the contract are that the Government would undertake the entire project initially at its own expense and continue to maintain the vineyard until the whole outlay is recovered from the profits accruing from it and then hand it back to the owners of the land as a running concern. The plantation is now eight years old and is in its third year of bearing. Unfortunately, however, it was found at too late a stage that the land was not ideal for a vineyard, nearly forty acres being very alkaline and also the limitations in staff, finance, etc., were standing in the way of paying adequate attention to it. An additional disturbing factor is reported to be, that cuttings of diverse varieties were procured for the planting and to-day the vineyard is composed of several types flowering and maturing their crop at different times. This has brought in difficulties in regard to irrigation because while one variety would need water another would suffer if watered, being either in flower or maturing its crop. The Government is feeling pessimistic about the outcome of this venture and even the zamindars are resisting offers made to restore the land to them in its present condition.

There are no special features of interest in regard to the cultivation of the other fruits. The Government Fruit Station has under trial several varieties of the apple, plum, cherry, apricot and the pistachio. At the present stage of their investigations, Kulu variety of apple, Shah Pasand peach, Black and White Heart cherries, Santa Rosa and Alu Bokhara plums, Chermaghz and Nari apricots are considered to be the promising types.

There has not been hitherto any research programme of work but for postwar development, the following scheme has been formulated. Collection of varieties and their trial; selection of promising types and their extension at the Research Station in the first instance; rootstock trials with peach, plum, cherry and the apple with standard clonal stocks; determination of best methods of propagation of the stocks and the scions; water and manurial requirements of the various fruits; pollination studies with infertile fruit varieties; and the optimum pruning practices for each fruit. Alongside of this work it is intended to study the economics of nursery and orchard maintenance. Extension work will comprise of replanting of old orchards and extending the area under commercial varieties.

The I. C. A. R. sponsored two schemes of vegetable seed production, one at Kashmir and the other at Quetta. The former, as has been detailed elsewhere, proved a failure, but the one at Quetta is being continued. Quetta now claims to be the largest seed production centre in India for English vegetables. The organisation for this work consists at present of seven registered growers who between them are reported to have nearly 300 acres under vegetable seed crops. None excepting licensed growers are allowed to raise vegetable crops for seed. The entire work of selection of types, segregation of allied types and different varieties of the same type, cultivation, roguing, harvests and seed collection is supervised by Government staff appointed for the purpose. The seed when collected is transferred to a central warehouse where the bags are sealed on arrival and stored. These are released as and when indents are received, but before they are sent out, the seeds are cleaned and labelled in the presence of the supervisory staff. No seed, registering less than 70 percent germination or which is more than two years old is distributed. The system is claimed to work satisfactorily and evidence of the popularity of the seed is based upon the large indents placed with these growers. A surer test of reliability of the seeds would perhaps be to study their performance in Quetta itself. This I was told is not being done at present but should offer no difficulty in as much as there is an appreciable area under vegetables in and around Quetta. This work would provide a firsthand check and prove of value in further improvement of the quality of the seed produced. The more important vegetables whose seeds are produced are the cabbage, radish, carrot, knolkhol, turnip, French beans, peas, leeks, celery, beet, lettuce, onion, parsnip, parsley and tomato. The methods of seed production of various types were gone into and on the whole it appeared that the work was being carried on well. The procedure for cabbage seeding does not materially differ from that at Kashmir. It was learnt, however, that since the seedstalk by its own growth tension pushes up the enfolding leaves in the form of a cap, which is then removed, the operation of slitting the head across is rendered unnecessary. The average yield of cabbage seed per acre is about 500 pounds. When going round the cabbage plots in seed two interesting abberations were noticed. In the first, the plant was seen to be abnormally stunted, the floral axes forming bushy short-stalked tops. The growers are familiar with this phenomenon which they attribute to the plant being a male. These plants do not show symptoms of any disease or insect pests. A cursory examination of the flowers showed ill-developed stamens and a flattened sterile

ovary. It appeared to me that the plants were exhibiting genetic sterility. In the second type of abberation met with, the plants exhibit extraordinary vigour. The rachis is flattened out into a wide sheath about two inches in breadth. On the lower half of the rachis short axes are borne on which the flowers arise in clusters, but on the upper half, the flowers are normal and such plants in an advanced stage show prolific bearing of well-filled pods. Such plants are reported to yield even as much as one pound of seed per plant. It should prove an interesting study to collect the seed from such plants separately and observe the performance of the crop raised therefrom.

There are about 1,000 acres under fresh vegetable production in this tract. The output of 400 acres is absorbed by the Military, an equal area meets the demand from Sind and the rest of the area supplies the local requirements. The production cost of vegetables is said to be very high, due firstly to the enormous expense on the maintenance of the '*karezes*' which supply the water and secondly, to the scarcity of labour and the prevalent high wages. There seems to me, however, that there is considerable room for improvement even under the existing conditions. The vegetables are grown either on flat land or on ridges and furrows. In flats, seeds are broadcast leading to a waste of seed and appreciable waste of labour in hoeing and weeding operations. There is moreover no uniformity in the growth of the crop and this leads to the extension of the harvest period which again means additional labour. If on the other hand, the seed is dibbled in lines on the flat, all these defects can be obviated and the cost of production lessened. The ridges and furrows in the second system are much too wide extending even upto three feet and land and water are thereby wasted. If the plot is laid out more systematically than at present with the ridges and furrows of, say one foot width, the same quantity of vegetables, can perhaps be raised in about half the land and with half the water and labour now being spent. Indirectly the area under cultivation can be increased appreciably with the extra water now being wasted in merely wetting the surface of the soil.

Kumaun Hills (U. P.): The Kumaun Hills represent the main deciduous fruit-growing tract of the United Provinces, with an estimated area of about 10,000 acres. The main region for fruits on these hills is located between elevations of 5,000 and 7,500 feet above sea level.

The annual rainfall is about 50 inches. The temperature varies from 23 degrees F. in winter to about 90 degrees F. in summer.

The earliest venture in fruit-growing dates back to 1870 when the Chaubattia orchard (which is now the Fruit Experiment Station) was laid out by one Mr. Crew, whose services were obtained by the Forest Department for the purpose. At present fruit-growing has extended to several parts of the Hills, the more important places being Chaubattia Ramgarh, Kausani, Bowali, Jelna, Khali, Ranikhet, Seoni and several others.

Among the fruits grown, the apple holds the field with about 6,000 acres under it, though the area under peach, plum and pear is not inconsiderable. Judged from the standpoints of tree growth and bearing habit, Kumaun probably occupies only the fourth place in India in so far as deciduous fruit-growing is concerned. Its importance seems to lie in the fact that it is the produce, especially of the apple, from this region that reaches the markets in the plains the earliest in the season, when the fruits of Kashmir and Kulu are still ripening on the trees. This is a decided advantage in the development of the hill fruit industry on the Kumauns. On the other hand, the tract is generally very slopy and very steep in some places, and the area suitable for fruit cultivation is therefore, likely to be limited. Moreover, the summer weather characterised by severe hailstorms is generally unfavourable to the young crop of fruits. These factors make one seriously to doubt if the Kumaun Hills will ever succeed in more than supplying a limited market.

The problems that confront the grower of fruits in this region are more or less the same as elsewhere. The I. C. A. R. has financed a Hill Fruit Research Scheme at Chaubattia Fruit Experiment Station for the last nearly twelve years. Under this, several investigations were undertaken on different aspects of fruit cultivation. The work is now in its second stage and that is the development of the orchards in the tract on the basis of results achieved. A summarised version of the conclusions derived from this scheme is given below:

A major part of the work has been on the apple. Rootstock trials with three scion varieties, viz., Delicious, Jonathan and Rymer, and five rootstocks, viz., Crab C, Malling II and XIII, Mertons 779 and 793, have indicated that Rymer among the

scions and Crab C among the stocks are the most vigorous. With Jonathan, the only variety which has come to bearing yet, it is concluded that Malling II induces earliness in first cropping. Between 'frame-working' and 'top-working' as a means of superimposing good market varieties on unprofitable trees the former has been determined to register greater scion take, greater total growth and a larger number of spurs and fruits. For frame-working, the month of March is recommended. A manurial trial to study the effect of nitrogen, phosphoric acid and potash, singly and in combination on the vigour of apple trees is in its fourth year. Data of the first year indicated that the main effects of superphosphate were significant but in the next three years no significant results have been registered. Application of various plant hormones by different methods have been of little avail in rooting hardwood and softwood cuttings of apple rootstocks. To induce shy-rooting stooled and layered stocks to root more profusely, wire-ringing the half mature shoot and mounding it with earth has shown promise. For the clonal propagation of weak stocks such as Malling II and Merton 793, stooling is recommended, while the vigorous types like Crab C, Malling XIII and Merton 779 are best raised from layers. In the propagation of apple scion varieties budding in September is the best; it does not materially effect the results whether the bud is inserted on the stock with wood piece attached to it or without it; for grafting, the whip and tongue method is the most successful; and, a bandage made of melted resin, beeswax and tallow in the proportion of 4 : 2 : 1 is superior to ordinary clay. By thinning of fruits, the size and colour improves and no loss in the gross weight of the crop from thinned trees is sustained. It is maintained that the early varieties of apple should be thinned 30 days after full blossom while with late varieties the period may be extended by another ten days. It is also determined that the severity of thinning with early varieties should be restricted to leave 'one fruit to 30 leaves' and with the late varieties 'one fruit to 25 leaves'. Ringing of the bark performed in the first week of April has forced unbearing trees to crop within one season of the operation. The fruits on pyramid shaped trees are found to suffer much less damage than those on vase shaped trees when hail storms occur. Of several methods tried for storing apples, a paper wrap coated with linseed oil was seen to retain the fruit in sound condition for two months after harvest.

Several other miscellaneous investigations have also been conducted, the more important results of which are, that (1) a

north aspect is to be preferred for the laying out of orchards, (2) it is better to grub out an old orchard and plant out a new instead of inter-planting it with a view to clear the old trees later, (3) inter-cropping of young orchards with diverse crops like potatoes, chillies, radish, soya bean, etc., has no effect on the growth of the fruit trees but excepting the potato none of the other crops give a return commensurate with the expense incurred on them, (4) an oak leaf mulch given to peach orchards reduces natural fruit drop, and (5) dehorning of unproductive peach trees followed by manuring rejuvenates them.

There are several important pests and diseases affecting fruit trees in this tract. Several years of trial with the parasite, *Aphelinus mali*, on the woolly aphis pest of apples has proved to the workers here that it fails to check the pest effectively. In Kumaun, it is now controlled by soft soap nicotine solution applied in the summer months. Parallel to the control of the pest, the inherent resistance of several rootstocks to it has been examined and the Merton group, Chaubattia local type and certain Russian seedlings of wild apple have been isolated as promising. Efforts are now being made to multiply these stocks and study their rootstock qualities with a view to the possibility of confining propagation of apple varieties on these alone. The pink disease of the apple caused by a fungus is controlled by cutting away affected branches and applying red lead — copper carbonate paste to the exposed surfaces. The San Jose scale pest is effectively checked by the dormant spray of Diesel oil emulsion recommended at Kashmir.

The tracts between 4,000 and 5,000 feet on these hills seem to be very well suited for citrus cultivation. In an orchard about three miles from Ranikhet, Malta, Sangtra and the lemon trees were showing prolific bearing in spite of the fact that the orchard is maintained under purely rainfed conditions. While the Malta trees are dwarf, their fruits have attained normal size, exhibit a thin peel and are juicy. The Sangtra trees on the other hand are well grown but the fruit is small sized, scanty of juice and pithy. It appeared as though these fruits could be further improved upon if the orchards were irrigated.

At the Chaubattia Fruit Station, a pyrethrum plantation of nearly fifty acres is in its third year of growth. It is reported that flowering is confined to the months of May and June and the annual average yield of flowers comes to only about 60

pounds per acre. Trials have shown that the flower contains the maximum pyrethrin when half the disc florets have fully opened. The pyrethrin content of the flower in the first year is said to be as high as 1·4 percent, decreasing to one percent in the third year of cultivation. The crop is neither manured nor irrigated. There has been no impetus to the extension of this crop for want of markets.

Sabour (Bihar): Bihar is reported to have 3,29,400 acres under fruits of which nearly 70 percent is occupied by mango, 15 percent by litchi and the rest by miscellaneous fruits such as the banana, papaya etc.

The average annual rainfall at Sabour is about 45 inches. The maximum temperature goes up to 110 degrees F. and the minimum comes down to 39 degrees F.

The general practices of this tract are much the same as elsewhere demanding certain basic improvements such as, trial and isolation of promising types, propagation and planting of clones from known performers, application of the best manures in economic doses etc. Bihar, however, claims to have two problems peculiar to itself. One is the phenomenon of irregularity in bearing of the mango and to this considerable importance is being attached. It is said that a bumper crop year may be followed by one, two or more lean years. Since there is no definite periodicity in the cycle of years yielding large crops the orchardist remains uncertain of the returns from his mango trees until the crop is actually on. This defect of the mango is believed to be due to complex environmental and physiological causes and therefore, capable of correction to some extent. The second problem is that Bihar soils are deficient in nitrogen. It is visualised that regular application of nitrogen manures would promote growth and bearing of fruit trees.

The Fruit Research Scheme, Bihar, in progress at the Horticultural Research Station, Sabour is for the purpose of carrying out research on fruits in the plains of the two neighbouring provinces of the United Provinces and Bihar. The programme for each of the crops dealt with has a manurial trial included in it. Much of the work on mango has for its object the elucidation of factors which would make it a regular bearer. In addition to these, a few investigations on rootstocks, performance of hybrids, renovation and rejuvenation of old

mango orchards, propagation of the litchi and inbreeding the papaya to evolve pure lines, are also included. The scheme is now in its twelfth year. While several of the experiments are either still in progress or have been suspended for want of adequate facilities, results of some have become available and are now being recommended for general adaption in the tract. A brief account of the results of research is given below:

Favourable climatic features such as dry spells and cloudless weather from December onwards till March result in good fruit set in the mango. Severe hopper attack is associated with rainy, damp weather during the same period and spray trials with fish oil rosin soap and soapnut decoction and sulphur dusting have been proposed for its control. Deblossoming and defruiting of the trees in one season with a view to stimulate flowering in the succeeding, have given no conclusive results. Smudging of trees has shown a stimulating effect on growth and enhanced to some extent the breaking of already differentiated flower buds. The trees can be ringed to induce flowering but the operation has a deteriorating effect on the trees. It is considered, however, that if this is done judiciously in the first week of August confining ringing to the branches, limiting the width of ring to one-fourth inch and applying a dose of manure to the tree soon after, no harmful effects may result. Trees, resulting from eight crosses between the more important commercial varieties, are in their second year of growth. An experiment to study the effect of stock — scion relationship on flowering and fruiting of the mango has been laid out with six scions on ten seedling stocks. The trees are five year old and have yet to come to bearing. Another trial to study the effect of what is termed as a dwarf mango variety (Kalapady) on a vigorous type (Langra) when used directly as a seedling rootstock and also as a foster mother has just been commenced. The performance of budded plants and side-grafts is being compared. Air—layering (gootie) as an alternate method of propagation of the mango is being tried but the success amounts to only about forty per cent. It is thought that the use of growth promoting substances would give better results, though work in this direction has not yet been commenced. It is not clear what special advantages this method is expected to offer, when budding and side-grafting are already tested and found to meet with more than average success. Pot culture experiments conducted with puro quartz sand as the medium and N. P. K., and their different combinations as nutrients have brought out typical deficiency symptoms on the mango plants. Potash starved plants show withering and scorching of leaf and die back of twigs. Phosphate deficient plants exhibit

peculiar reddish eruptions on the blade of the leaf leading to their premature fall. Those without nitrogen are etiolated. It has been found that a corrective application of Potash to trees suffering from its deficiency brings about their complete recovery. It is also seen that the plants which receive full doses of N and K record a steady increase in growth. They come to earlier bearing but the fruits do not reach maturity. This premature fruit drop is attributed to the young age of the trees under experiment and the fact that they are being grown in pots.

Renovation of neglected young orchards is accomplished by clean culture and manuring. Overcrowded orchards are improved by thinning out alternate trees. Rejuvenation of old trees by dehorning and forming a new head is not successful as such trees fail to make sufficient new growth. Replanting of old orchards by a new set of plants on the same site is feasible. It is found possible to intercrop the land with all kinds of food crops as long as the land is not shaded by the trees and afterwards by growing, in the rainy season only, crops that thrive even under shade. The important commercial varieties of the mango in this region are Langra, Bombai, Zardalu, Sepia and Alfonso Local.

The cultural trials at Sabour struck me to be on lines similar to those pursued at Chaubattia. In some instances the results are similar and in some others they provide a sharp contrast. Bark ringing in both places induces flowering and brings unthrifty trees to bearing, but while at Chaubattia the method is now being recommended for wider application in the tract, Sabour is still to decide if it is safe enough in regard to its effects on the future growth of the tree. Grubbing out old orchards and planting out anew is attended with no harmful effects in either place. Raising of intercrops has been seen to have no effect on the growth of the orchard trees both at Chaubattia and Sabour but in the former place excepting the potato, none of the other crops tried gave any profitable outturn. Sabour, on the other hand, finds growing of food crops in the early years and fodder crops during the rainy season, in the later years, not only pays but incidentally keeps the orchard clean, a proved requisite for maintaining the orchard healthy. Dehorning old peach trees rejuvenates them at Chaubattia, giving them a new lease of life while the same operation with mango at Sabour fails to promote new growth which would build up the tree afresh.

Bengal: It is reported that 7,29,200 acres are under fruits and vegetables, but the area under fruits separately or under different fruits is not known.

The maximum temperature is reported to reach 104 degrees F. in the summer and the minimum down to 48 degrees F. in the winter. The average rainfall amounts to nearly 60 inches, received chiefly between June and September.

Several fruits including the mango, banana, papaya, litchi, jack, guava, custard apple, pineapple, roselle, olive etc., find a congenial home in Bengal. The plum, peach and pear are grown in a limited area on the Darjeeling Hills. Murshidabad is noted for its mango and litchi crops and Dacca, for its Rampur variety of banana.

Fruit-growing in the province is still in an undeveloped state. Though several fruits are under cultivation, others yet may probably be introduced with advantage. Of those in existence, some have become popular due to their adaptability to the tract and their extension appears to be overdue.

As a marked distinction from other provinces and States of India where fruit research is in some stage of progress, Bengal has yet to plan a scheme of basic research concerning problems of propagation, nursery and cultural practices, etc. The Horticultural Research Station at Krishnagar is about 46 acres in extent. Work on fruits and vegetables is envisaged. Variety collections of mango and litchi are now about 11 years old but no performance records are being maintained. There is also a mango propagation plot where trees of commercial varieties are being grown so as to yield propagation material of these for supply of plants to the public. The only experiment in progress is a spacing trial for pineapples.

Vegetable crops of beans, spinach, brinjal, capsicum, ladies fingers, etc., are being raised for seed multiplication.

For post-war extension, the following programme in regard to fruit and vegetables has been drawn up—(1) Extension of area under quick-growing fruits such as papaya, pineapple, Cape gooseberry, bananas, etc. (2) Renovation of old orchards. This is contemplated to be put into effect by arranging application of Ammonium sulphate at one ton per acre. This manure and its dose have been decided upon through personal experience of the cultivator but has no experimental support to it. (3) Multiplication of seed of plains, vegetables (4) Training of malis for helping the orchard owners and vegetable growers, and (5) Fruit research for the plains of Bengal, details of which have not yet been worked out.

Bangalore (Mysore State): The Mysore State claims to possess nearly 50,000 acres under fruits. The mango leads with 26,000 acres, followed by banana with 18,000 acres, oranges with 2,000 acres and the rest under miscellaneous fruits such as the apple, pomegrante, pineapple etc. The annual rainfall averages about 33 inches distributed uniformily from March to December. The maximum annual temperature reaches up to 100 degrees F. and the minimum comes down to 46 degrees F.

The Mysore State represents the meeting line of tropical and sub-tropical zones and therefore combines in itself a set of climatic features which lend themselves in some degree to the culture of fruits normally differing very widely in their requirements. It is for this reason that a typical tropical fruit such as the mango and a typical temperate fruit such as the apple can both be found growing here in juxta-position. It is open to question, however, if either of these do reach perfection in such an environment. The tract lying as it does about 3,000 feet above sea level, should on the other hand, be ideally suited for fruits characteristic of a semi-tropical zone. A set of such fruits may probably consist of the loquat, fig, sapota, phalsa, jujube, pomegranate, avocado, lime, lemon and the mandarin oranges.

The general pattern of the problems that confront the grower of this region does not present any unusual features. The fertile surface soil, the well-distributed rainfall extending from March to December, the moderate summer heat, the mild winter the aspect and the lay of the land, all promote early rapid growth and thrifty bearing of the trees. But it is doubtful if the critical requirements of temperature and humidity of each type at specific stages of growth and maturity of the fruit, in order to bring out the best colour, flavour and taste, are met with. It may, therefore, be interesting to compare the quality of such fruits as the mango grown in this region and of those grown in other representative tracts in order to test the superiority of each fruit that is grown in Mysore.

The main horticultural research (which is being financed by I. C. A. R.) has for its object the investigation of possibilities of apple cultivation in the State and also a trial of nine different kinds of miscellaneous fruits viz., pineapple, fig, peach, papaya, guava, litchi, avocado, sapota and strawberry.

The research on apple is considered to be the most important. It is reported that there are only 57 acres under this

fruit and that appreciable extension is not possible because the cultivation of apple meets with success only in some specially favourable areas in the tract such as those that occur in the neighbourhood of Bangalore. Broadly speaking, it appears as though the Mysore State is unfit for apple growing because it fails to provide the basic requirements of this fruit viz., considerable winter cold which is necessary to release the trees from dormancy. It is for this reason that, though numerous varieties have been tried, only one, Rome Beauty, has met with a fair amount of success so far. It is not possible to establish an apple industry of any dimensions with a single variety which at best compares poorly with standard commercial varieties of other parts of India such as Kashmir or Kulu. The research on this fruit therefore, is being pursued with a purely limited objective and that is, to put into the hands of growers favourably situated for the cultivation of the apple, a reliable guide to the improvements they might effect on the existing practices. The investigations on hand at Hassarghatta Fruit Research Station include trials (1) to increase the life of the apple tree which is inordinately short in this region being only about 12 to 15 years, (2) to determine rootstocks which would resist collar rot and woolly aphis (3) to ascertain the most effective and economical combination of fertilisers with or without the normal dose of sheep manure (4) to isolate varieties more promising than Rome Beauty (5) to study in detail the incidence of collar rot with a view to its effective control and (6) to provide suitable insecticides and fungicides to combat other pests and diseases.

The investigations are in different stages of progress and the results of several are awaited. The rootstock trial has given indications that Malling XII and XV are the most vigorous followed by Malling I and II. Rome Beauty on Malling XV stock is reported to have given the highest yields so far. Multiplication of these stocks along with the introduction of plants of *Pyrus baccata* from local orchards is in progress. An attempt is being made to raise gooties of the different varieties of the apple at the station to study their possibilities as root-stocks. Nine desert varieties and four culinary varieties are being observed for performance. Rome Beauty and Glengyle Red among the former and Lord Wolsley among the latter are said to show signs of promising performance in regard to vigour and yields. For propagation of the apple scion varieties, stocks of any sort are best when they are one year old. The best month of operation is December and the optimum method is T-budding, with or without the piece of wood attached to the

shield. In a combined manurial and irrigation experiment with variety Rome Beauty, ring and furrow methods of irrigation, and N. P. K. combinations, applied with and without a basal dressing of sheep manure, it is seen that plants under both systems of irrigation, with or without sheep manure and with K, have yielded well. A pollination experiment has brought out that Rome Beauty and Versfields are the two best pollinizers for other varieties. Hand pollination is found superior to wind or insect pollination. Thinning trials indicate that leaving three or four fruits to a spur is the most economical.

One peculiar characterestic of the apple in this tract is its bearing of two crops of fruit in the same year. The trees are reported to blossom naturally for a second time soon after the main crop is harvested in June. These flowers set fruit which matures in February next. It is noted that because of this phenomenon the trees are thrown out of equilibrium making them irregular in bearing if this phase is left to work out by itself naturally. Therefore, it is a common practice now to control the conditions under which the second crop matures. Soon after the June crop is harvested, the trees are brought to artificial rest by defoliation and hard root pruning. The second crop of blossoms is encouraged by manuring and irrigation. These steps, it is claimed, regulate the bearing habit ensuring a dependable double crop in each year. To this feature may probably be attributed the very short life of the apple tree in this region.

In the trial of miscellaneous fruits no outstanding types have, as yet become available. Some interesting side-lines of work on the fig varietal collection are worthy of mention. Of the several varieties of fig introduced is one from Bezwada identified as *Ficus palmata*. This type is seen to produce fruits which do not reach maturity and examination revealed that the flowers borne were all male. Thereafter, the plants of this variety have been top-worked to the other varieties at the station. A summary of the observations in relation to this type is as follows (1) *Ficus palmata* plants are more vigorous in growth than the other varieties under trial (2) Budding of fig varieties on this species is feasible (3) The girth of *Ficus palmata* plants top-worked to other varieties is greater than of those not worked but of the same age (4) the girth of stock, budded when six months old is less than that when budded at 18 months, which in its turn is less than that budded when 26 months old. This refers to the orchard performance

of the stocks and is indicative that early budding lessens the vigour of the stock. The general inference of the workers at the station from these observations is that *Ficus palmata* can be used as a stock for fig scion varieties and that it is preferable to do the budding on this stock when the plants are two years old.

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a Author's Note: Since the writing of this report, there have been changes in the composition of some of the Provinces but since the survey was made of the Provinces as a whole as they then existed, it is felt that the presentation of the material as collected would be the best, instead of trying to recast it to fit it into the revised boundaries.