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Mixed Cropping—A Review.

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Mixed cropping is a system of Agriculture in which two or more crops are grown together at the same time in the same land. It is a common practice in tropical countries both with annual field crops and with perennial plants like fruit trees, flower plants and plantation crops. This type of cropping prevails in Africa, India, Ceylon, Malaya, China and West Indies. It is also usual to grow annual herbaceous crops in the midst of woody perennial trees of economic importance such as coconut, mango, jack and other fruit trees. "The group of plants growing together form a 'plant society' like the natural plant societies that occur on any piece of land left to nature." (Willis, 1909).

The system of mixed cropping is practised in various ways. The most common is one in which the seeds of different crops are mixed together and then sown. In parts of the Coimbatore district *periamanjal cholam* (sorghum) and cowpea or *naripayaru (Phaseolus aconitifolius)* are grown as a mixed crop by sowing a mixture of the seeds; while lablab, red gram and castor, one or more of which are also usually grown mixed with sorghum, are sown in lines soon after the mixed seeds of sorghum and cowpea or *naripayaru* are sown. In places where crops are usually sown with a drill different crops are sown in different lines, as in the case of cotton and Italian millet in the Bellary district. In some mixtures different crops are sown at different periods. In the South Arcot district groundnut is planted between rows of *ragi (Eleusine coracana)* when the latter is in the flowering stage. In parts of Mysore horsegram is recommended for sowing between *ragi* plants when the latter are in flower, and *ragi* between lines of cotton when the latter is two months old (*Mysore Agricultural Calendar*, 1940-41). This system of cropping in which different crops are sown at different times is reported to be a common practice in parts of China (King, 1911). It is also common to grow annual crops among perennials, like fruit trees and plantation crops, especially when the latter are young. Mixed cropping is referred to in some literature as inter-cropping or inter-planted crops, or growing multiple crops.

Nicol (1935), in his paper on "Mixed cropping in primitive agriculture", has stated—"In his survey of agricultural India (*India in 1887*) Wallace devoted a special chapter to rotations and mixed crops. He wrote—'The growth of mixed crops is a widespread practice which is well worth consideration and study..... The advantages under Indian conditions are distinctly great..... There is but one explanation of the existence of these

practices (mixed cropping), viz., that they have been found advantageous after long experience and much careful consideration on the part of a body of workers who, for power of observation and an intelligent interest in and knowledge of every day occurrences would put to shame those classes which hold a corresponding position in educated Europe". Voelcker (1893), in his *Report on the Improvement of Indian Agriculture*, wrote, "It is quite a mistake to suppose that rotation is not understood or appreciated in India. The contrary is the case. Frequently more than one crop at a time may be seen occupying the same ground, but one is very apt to forget that this is really an instance of rotation being followed. The next year the same mixed crops may be sown again and thus to the casual observer it might appear that continuous cropping was being practised. This however is not so, for there is a perfect rotation of cereal and legume. This is, perhaps, the simplest form of rotation, but there are many more complicated than that of mixed cropping." The simplest form is thus one in which individuals in cereal and pulse and other crops in the mixture get the fullest chance of exchanging their places with each other. Mollison (1901) wrote —"The system of mixed crops so common in India is undoubtedly a successful and profitable method which probably has done more to uphold the fertility of the Indian soils than any other practice..... The successful practice of growing mixed crops in India points to the fact that the practical experience of the uneducated Indian *rayat* has determined centuries since a means of providing an inexhaustible supply of nitrogen for the soil, whilst enlightened European agricultural chemists have only recently begun to see the way".

In the 1903 Proceedings of the Board of Agriculture in India, Appendix C, dealing with the improvements in methods of cultivation in connection with the progress of agricultural experiments and programmes of work, the system of mixed cropping is characterised as 'most slovenly'. The verdict thus swings between two extremes. No serious, systematic and sustained attempts have been made to understand the rationale of this long-existing practice. Even the Royal Commission on Agriculture, while devoting some attention to the problem of rotation of crops, make no mention of this widely prevalent practice of mixed cropping. In the reports on the progress of the action taken on the recommendations of the Commission, Bombay and Madras touch on mixed cropping while dealing with the rotation of crops.

The practice of mixed cropping in agriculture is more commonly adopted in the cultivation of lands which depend upon rainfall for water supply. Out of a total area of about 360 million acres under cultivation in India, in more than 80 per cent. crops are raised with the help of rain. The crops in these dry lands are mainly millets and partly pulses, oil seeds, fibre and other crops. Weather conditions are precarious and the problem of manuring is not easy. This vast extent of arable land has thus to be maintained on an efficient system of tillage and cropping. Mixed cropping is a widely prevalent practice and its importance is thus obvious.

While the full understanding of prevalent mixtures in the cropping of dry lands has not been examined critically, industrial crops like cotton, groundnut, tobacco, etc., began to figure very prominently in the agriculture of dry lands, and they stimulated the need for a system of rotation and mixtures with a view to ensure the success of the expansion of the area of these industrial crops, while at the same time maintaining soil fertility and catering to the current economic needs of the cultivators. The result is that what little knowledge we have on mixed cropping is recent and with reference to problems arising out of cotton and groundnut cultivation. The factors behind this ancient practice still remain subjects for guess and speculation.

The Director of Agriculture, Mysore, has stated, "I attribute the perennial poverty of the dry land cultivator in Mysore to his inability to earn money in addition to food and fodder out of his agriculture." "The largest scope for increasing income per acre from dry farming and raising it from a means of bare livelihood to a lucrative industry lies in inter-cropping or in raising of two compatible crops from the same land in the same season so as to double the income from dry farming." (*Mysore Agricultural Calendar*, 1940—41.) Inter-cropping of a cereal with a legume is common. Fresh areas have been thrown open to cultivation in the Irwin canal area of Mysore. More cotton is required by the State. A successful method of inter-cropping cotton with the staple cereal, *ragi*, has been evolved and introduced. Similar problems are to be faced and solved in other parts of India.

Almost every field crop grown in India is often grown as a mixture with some other crop or crops, in some part of the country or other. An idea of the various crop combinations commonly met with in some parts of India can be obtained by a reference to the *Imperial Gazetteer of India*, Vol. III and Mollison's *Text-book of Indian Agriculture*. Mann (1917) and his associates have given the various mixtures which they observed in a Deccan village. A paper on crops grown mixed with sorghum in the Madras Presidency was published in the February 1941 number of this Journal (Rangaswami Ayyangar and Sankara Ayyar).

Pulses, oilseeds and fibre plants are grown mixed with or subordinate to cereals like sorghum, *bajri (Pennisetum typhoides)* or wheat. Almost all the pulse crops except gram (*Cicer arietinum*) are grown with sorghum and *bajri*. The most common mixtures are some of the following:—Redgram, *Phaseolus mungo, P. radiatus, P. aconitifolius, P. sublobatus, til (Sesamum indicum)*, castor, *Hibiscus cannabinus* and cotton. The seeds of the different crops are generally mixed together before sowing, and the mixture is sown with a drill. Gram is grown mixed with wheat or barley also. Cotton is usually grown alone or mixed with redgram or sorghum. On alluvial soils it is commonly mixed with redgram, maize or sorghum. In parts of Bengal and the United Provinces linseed is grown mixed with wheat, rape seed and various rabi pulses. Gingelly when grown as a *kharif*

crop is usually mixed with sorghum, *bajri* or cotton. *Bajri* is usually a mixed crop and "as a mixed crop it may be grown on the same land continuously without any apparent exhaustion of soil or diminution of outturn if the cultivation is fairly liberal" (Mollison, l. c.). Subordinate crops sown with *bajri* are redgram, in separate rows, and a sprinkling of *Phaseolus mungo, P. aconitifolius, Dolichos biflorus, Hibiscus cannabinus,* etc., in the same row as *bajri*. In Gujarat, cotton in rows is found with *bajri*. In some places rice and sorghum are grown together, while rice is sometimes grown subordinate to cotton also. In areas where rainfall is not a limiting factor a number of crops, with a wide range in habit and duration, such as rice, sorghum, *ragi*, redgram, gingelly, cotton and other similar crops are all grown together on the same land. They are all sown at the same time, but harvested according to their ripening. This practice is prevalent in the uplands of the coastal districts in North Madras. A mixed crop of wheat and gram is reported to be a common practice in the wheat zone in Berar. This mixture is sown, harvested and threshed together, and the mixed grain thus obtained is ground and used as food by a large section of the people. It is stated that this practice of mixed cropping has been the salvation of the wheat soils, which otherwise would have long ago reached a state of exhaustion for remunerative crop production.

Brash (1939) has stated that "most Africans when they plant their gardens plant a mixture of crops. In one garden it is possible to find maize, peas, beans, potatoes and sweet potatoes all growing mixed up together." In West Africa yams and millets are reported to be grown along with Guinea corn (sorghum). "In the upland rice fields of Sierra Leone several crops are planted in small quantities amongst the rice. Okroes, peppers and pumpkins are grown amongst the rice, and young cotton plants follow on, maturing later after the rice is harvested". (Irvine, 1934).

Cereals grown in dry lands are thus usually grown mixed with many other crops which produce some article of every day need to the cultivator. The nature and number of crops mixed differ in different areas. It is difficult to obtain definite information as to why certain crops are mixed in certain areas and in what proportions, and what are the definite advantages of growing such mixed crops. Economies in cultivation and land, provision for the domestic needs of the cultivator, a system of insurance against weather and pests, some vague ideas of maintaining soil fertility, etc., are some of the observations with which this well established practice has been dismissed without a rational analysis.

Among the various reasons why some crops are often grown as mixtures, the most important appears to be to guard against the risk of a total failure of harvest in an unfavourable year; but there are no long range experiments to prove this. The average holding of the Indian cultivator is small. To ensure that he obtains some produce or other from the limited land he has, he grows a mixture of crops so that even in years of deficient rainfall he is able to secure some produce for his household needs. On

the other hand if the season is favourable he may harvest a plentiful crop. It is a common practice in some parts to grow even different millets like sorghum, *cumbu (Pennisetum typhoides)* and *tenai (Setaria italica)*, besides pulses and oil seed crops, all together in the same plot of land. Moreover the *rayat* with limited land is not in a position to grow different crops separately; he presumably resorts to mixed cropping to obtain most of his personal needs from the bit of land he has. There is a saving not only in land but in labour also. Usually the average *rayat* does not engage outside labour but cultivates his land with the help of the members of his family. As different crops come to harvest at different times, the limited labour is utilised to the fullest advantage in the harvesting and preparation of the produce of different crops. The system of *udu* cultivation in the Tanjore delta in which two varieties of rice of different durations, *kuruvai* and *ottadan*, are planted together, is an instance of mixed cropping with a view to economise land and labour (cultivation expenses). Both are planted together at the same time as a mixed crop. The *kuruvai* is harvested in about three months, and the *ottadan* another four months later. This aspect of saving in land and labour has been stated by King (l. c.) as that which appeared to him to be the main reason for growing multiple crops in China. These aspects need scrutiny from an economist's point of view.

It is recorded that the process of nitrification in soils is much more active when a growing crop is on the ground than when the land is left fallow. Sometimes a long and short duration crop such as sorghum and *tenai* or sorghum and redgram are grown mixed to get the maximum outturn from the land. The short duration crop is harvested first and the other continues in the field and if the season is favourable yields almost as much as a pure crop. What are known as catch crops come under this category. Maize, pulses, onions, melons, vegetables, etc., are grown in sugarcane fields when the cane crop is young. Similarly such crops are also grown in gardens among fruit trees when the latter are young.

Various pulses are cultivated in India, and most of them are usually grown as mixtures among the cereals or other crops of commercial value. This is considered to be a sound agricultural practice as the legumes help by their symbiotic activity to keep up the supply of combined nitrogen in the soil and maintain soil fertility. It has been recorded by Loehwing (1937) that under American conditions natural processes of fixation restore on the average about 60 lb. of nitrogen per acre per year under legumes and 10 lb. under non-legumes. Not all leguminous crops increase the nitrogen content of the soil; Howard has recorded that Java indigo seriously depletes the supply of combined nitrogen in the soil. Inter-cropped legumes are said to increase also the available lime, potash and phosphorus in the soil by their greater solvent action and the ability of their deeper root system to raise these nutrients to the surface layers (Loehwing, l.c.) This

* Royal Commission on Agriculture in India Report, 1928. P. 85.

probably explains how the Indian *rayat* is able to grow the same mixed crops year after year on the same land without the addition of manure.

A legume grown mixed with a cereal increases the fodder value of the latter. It is also reported that in some instances the protein content of the cereal grown in combination with a pulse is increased thereby. (Thornton & Nicol, 1934 ; Nicol, 1934 & 1936 ; Hutcheson *et al* 1936). This has been recorded to be obtained in pastures where legumes are grown in combination with grasses. This system of growing legumes in combination with other crops is being now followed in the maintenance of pastures and in the cultivation of silage crops in Europe and America. The full implications of this combination in the case of regular field crops have to be investigated ; the more so, as the only means of toning up quality.

By growing together crops with differences in root habits, the plant food and moisture in the soil is utilised to the best advantage. As their roots feed at different depths in the soil there is no competition for plant food or moisture. Root studies at the Dry Farming Station, Bellary, have shown that Setaria-groundnut and Setaria-horsegram mixtures are ecologically sound combinations; while, *Setaria-cotton* mixture is not sound, as there is severe root competition between the two components of the mixture, both feeding in the same zone. Such root studies should be made on a more comprehensive basis and extended to all crop combinations. The combination of a shallow and deep rooted crop is reported to improve soil tilth and texture also (Loehwing l.c.).

Soil erosion studies at the Dry Farming Station, Bellary, have shown that *Pillipesara (Phaseolus trilobus)*, groundnut, horsegram and mixtures of groundnut and horse gram with Setaria are comparatively more efficient in preventing soil erosion. Trailing crops like *Phaseolus aconitifolius* or horsegram grown mixed with cotton or sorghum, which are usually widely spaced, help to prevent the erosion. This aspect merits a more comprehensive examination.

Some components of mixtures afford protection to weaker crops. Pigeon pea is usually grown as a subordinate crop along with cotton in the Punjab, where it is considered it protects the cotton from the desiccating effects of the hot winds (Milne and Ali Mohammad, 1931). Sorghum and *bajri* when grown mixed with *mung (Phaseolus radiatus)*, afford shade to the latter. The stalks of sorghum serve as supports to lablab and cowpea usually grown mixed with it. Stray plants of sorghum in a field of other crops act as a check on cattle being allowed to trespass and graze on the young crop, as sorghum plants in the young stages are poisonous to cattle. Border crops of linseed in wheat fields are said to keep off cattle ; (Voelcker, 1893) ; so also safflower round sorghum fields. *Sesbaia aculeata*, redgram, *hemp (Hibiscus cannabinus)*, castor etc., are grown on the borders of sugarcane fields to serve as protection to sugarcane.

Some crops may be grown as trap crops for insects or animals. Sorghum or maize may serve useful as trap crops for stem borers of sugarcane.

Damage due to insects and diseases are sometimes lessened by growing mixed crops (Irvine, 1934; Hutcheson et. al. l. c.). The disease or insect does not spread so quickly as when pure crops are grown. It has been recorded by Luthra and Vasudeva (1940) that mortality in cotton due to root-rot disease was reduced considerably by growing cotton and sorghum mixed; a mixture of *moth (Phaseolus aconitifolius)* also reduced mortality of cotton due to root-rot.

It is not economic to grow some crops like green gram or cucumber (a field variety) as pure crops; they are therefore always grown as mixtures. In pastures, a mixture of grasses is considered to be more advantageous as the mixed hay obtained gives a variety of feed and a better balanced one than a single kind (Hutcheson et. al. l. c.). Legumes in pastures are considered to act as a check to the growth of weeds (Loehwing, l. c.).

Attempts at experiments on mixed cropping have been made in various centres with the starting of many Agricultural Research Stations. But in many of these the experiments do not appear to have been pursued long enough or well enough to draw useful conclusions. Experiments on mixed cropping have to be conducted for a series of years and at various centres so as to study the results in relation to soil and climatic variations. The intensity and complexity of the problem seem to have deterred a pursuit of it on sound foundations. Experiments on mixed cropping should be laid to begin with, only in such areas in which the system of mixed cropping is prevalent. The possibility of successful experimentation depends upon the nature of the soil and the seasonal conditions that will admit of suitable sowing facilities and growth period for the crops forming the mixture. The results of experiments in this line are summarised below in so far as they could be gathered from literature available in the Coimbatore library. They tend to emphasise the need for a comprehensive record of existing practices and laying down suitable experiments on modern lines to elucidate the many problems confronting the mixing of crops, both old and new.

Sorghum and other millets are usually grown mixed with pulses and other crops. Experiments conducted at various stations in the Province have not led to any definite result with regard to the suitability of any particular subsidiary crop or combination of crops or the benefits derived by growing such mixtures. At the Cotton Breeding Station, Coimbatore, various pulses were grown in combination with sorghum, in different proportions and in different soils. It was observed that on the three different soil types in which the trials were made, the mixing of pulse both with irrigated and rainfed sorghums did not benefit either the sorghum or the succeeding cotton; the mixing of pulse on the other hand lowered the total straw weight. The after effects of growing leguminous crops on cotton were not alike. Cluster beans were observed to be most beneficial in the case of irrigated sorghum, while lablab and cowpea appeared to do good to rainfed sorghum. Soy beans, greengram and cowpea did more harm than good when they preceded Cambodia cotton in summer. *Pillipesara*

likewise depressed the yield of *karunganni* cotton that followed it. In a rotation experiment conducted at the Hagari Agricultural Station, mixtures of sorghum and Bengal gram in two different proportions were tried. But as the experiment was discontinued after two years no conclusions could be drawn from them. Later experiments conducted for a period of five years led to the conclusion that sowing a mixture of sorghum and pulses, except Bengal gram, is not feasible under Hagari conditions, as the pulses have to be sown in the *mungari* (June—July) and the sorghum in the *hingari* season (September--October) Sorghum-groundnut mixture is a good combination provided there is equal distribution of rain, but as the tract experiences mostly unequal distribution of rain this combination is not feasible. And the local practice of mixing Bengal gram and sorghum has been observed to be ecologically undesirable, as the roots of both crops feed in the same level in the soil, resulting in severe root competition. At Nandyal, *pillipesara*, when grown as a mixture with sorghum, had a depressing effect on the yield of sorghum. In a trial with mixtures of blackgram, greengram and horsegram, the mixture of horsegram appeared to be the best. In a rotation experiment conducted from 1920 to 1923, it was observed that cotton after *pillipesara* is more profitable than after pure sorghum or sorghum and *pillipesara* mixture. At Guntur, *pillipesara* was grown mixed with sorghum for fodder. There was no increase in yield by growing this mixture. But this mixture is reported to be common in the area, as the mixed fodder obtained is believed to have a higher nutritive value due to the legume in the mixture. The effect of pulses (blackgram and greengram) in combination with sorghum on the succeeding cotton crop was tried at the Koilpatti Agricultural Station, and it was observed, that this mixed cropping did not reduce the harmful after effects of sorghum.

Experiments conducted at the Koilpatti Agricultural Station showed that *cumbu* when grown mixed with red gram, lablab or Bengal gram yielded as good as and sometimes better than the cereal grown alone, if the crop is sown early. If, however, the sowing is delayed, it is advantageous to grow the *cumbu* as a pure crop. In a rotation experiment at the Poona Agricultural College Farm it was observed *bajri-tur* mixture grown every year gave the highest return over other rotations: *bajri* and sesamum rotation, *bajri* and *kulthi* rotation, and *bajri* every year.

In trials at the Hagari Agricultural Station, mixtures of pulses with Italian millet proved to be comparatively more economic than growing pure Italian millet. Of the pulses, groundnut, horsegram and *pillipesara*, tried, groundnut gave the best results. Ecologically also the combination was sound. Experiments are in progress to test the advisability of growing the two crops millet and groundnut, in 'strips'.

At the Gokak Farm in the Bombay Presidency, a mixed crop of maize and *tur* in rows gave decidedly better results than growing two crops of maize one after another, and it is reported that this practice has been adopted by many cultivators of the canal tract. More recent experiments

have indicated that a mixture of maize and cotton is more profitable than maize and *tur* mixture, as *tur* is sometimes liable to the attack of wilt and consequent reduction in yield. In rotation experiments at Pusa, the highest gain in soil nitrogen was in one series with a mixed crop of maize and *urid* (*Phaseolus radiotus*). (*Review of Agricultural Operations in India*, 1929—30 and 1930—31.)

With regard to wheat, it was observed by Howard (1916) at Pusa, that there was a marked advantage in growing mixed crops of gram and wheat on soils where combined nitrogen is a limiting factor. Experiments at some stations in the United Provinces have shown that the local practice of sowing mixed wheat and gram on irrigable black soils is less profitable than sowing wheat and gram in rotation. But in spite of this there appears to be a preference to grow the two crops mixed, for in the report it is stated that "the practice of mixed cropping however will probably take a long time to die out."

As early as 1909 experiments were started at the Central Farm, Coimbatore, to try the effect of growing cotton mixed with *tenai*, horsegram and coriander. This was given up after two years trials, which indicated that the combination of cotton and *tenai* was the best. The experiment was again repeated in 1914, in a modified form. The crops in combination were sown both in separate rows as well as mixed. From the results it was concluded that "with cotton at its normal price, it would probably not be profitable to grow any mixture, though the demand for fodder may make it good farming." With the spread of Cambodia cotton as a rain-fed crop in the heavy black soils of the Guntur and Kistna districts it was felt necessary to find out the effect of growing cotton mixed with other crops; so trials of cotton grown mixed with groundnut, Italian millet, and rice were started at the Guntur Agricultural Station in 1935. From the results of three years trials it was observed that cotton and groundnut mixture gave the best monetary return, followed by cotton and Italian millet mixture. Growing cotton alone was financially a loss. Trials of cotton mixed with horsegram were conducted at the Nandyal Agricultural Station from 1909 to 1914. The results indicated that there was no difference in the total outturn whether cotton is grown alone or mixed with horsegram. The main advantage of mixing was that a little horsegram necessary for cattlefood was obtained cheaply. As regards the residual effect of horsegram, this was non-existent or so small as to be negligible.

An experiment to compare cotton grown alone with cotton and Italian millet mixture was conducted at the Hagari Agricultural Station from 1919 to 1924. The results of five years taken together showed that it was more economical to grow a mixture of cotton and Italian millet than cotton alone. The local practice is to grow two rows of Italian millet between two rows of cotton, or alternate rows of Italian millet and cotton. To test the efficiency of this system experiments were again started in 1935. The results of four

years showed that pure cotton was the best economically. The mixed cropping was less profitable compared to pure cotton, whether the sowing is done early or late. It was also observed that both the main and secondary roots of the cotton and the millet feed in the same zone of the soil, and hence there was severe competition between the root systems of these two crops. In view of these findings, experiments have been started in 1939 to try growing these two crops in alternate 'strips'. Experiments with Bengal gram, coriander, and horsegram grown mixed with cotton were conducted at the Koilpatti Agricultural Station from 1912 to 1915. The monetary value of all the mixtures tried was less than that of cotton grown pure. Of the crops mixed coriander gave better returns than the other two. A mixed cropping experiment was again started in 1934 to test how the cotton crop is affected by mixing coriander in different ways and to assess the value of the crop as a whole. Results of three years indicated that a small mixture of coriander with cotton was profitable, and that it did not affect the yield of cotton. With the idea of utilising the excess of moisture in the soil in the early stages of the cotton crop and thus to reduce its bad effects, different crops, such as sannhemp, blackgram, greengram, redgram, horsegram, coriander, *kudiravali (Echinocloa colona* var. *frumentacea)* and onions, were grown mixed with cotton in 1935 and 1936. None of the crops tried had any beneficial effect. A thick stand of cotton reduced the bad effect. *Kudiravali* reduced the yield of cotton considerably. In experiments conducted at the Gokak Farm (Bombay Presidency) from 1924 to 1929, a mixed crop of cotton and Italian millet gave better results than cotton grown alone. At the Dharwar Farm, it was observed, cotton and groundnut sown in alternate rows gave better results than cotton and groundnut in blocks. With regard to after effects, the succeeding crop of sorghum gave higher yield in the former plots than cotton and groundnut in blocks taken together.

Groundnut is an introduced crop, and in certain areas it replaced not only other commercial crops but also food and fodder crops. In the South Arcot district, it is stated, that the area of groundnut increased from 3,000 acres in 1851 to 333,350 acres in 1920. With the increase in area and due to the incidence of diseases and pests the groundnut did not prove quite so remunerative after a period ; so the growing of cereals alone or in combination with it was resorted to. To find out whether the rotation of a cereal or groundnut, or a mixed crop of cereal and groundnut is more profitable, and the particular cereal best suited for this purpose, experiments were conducted at the Palur Agricultural Station from 1907 to 1920. The results led to the conclusion that mixed cropping of groundnut interplanted in a cereal was more advantageous from a monetary point of view, than a cereal groundnut rotation. Of the cereals tried *ragi* proved to be the best to grow mixed with groundnut, and in places of low rainfall *cumbu* was observed to be the best. It was also observed that a change in the cereal had a better effect on the yields of groundnut and the cereal, than when the same cereal was repeated every year. Experiments are in progress at

the Agricultural Station, Tindivanam, in which groundnut is grown mixed with sorghum, *cumbu*, *tenai*, cotton, redgram or castor. Mixed cropping resulted in the depression of the yield of groundnut in all cases, but the monetary return, however, was more from a mixed crop than when a pure crop of groundnut was raised. The best returns were obtained by growing groundnut in association with sorghum, castor, redgram or cotton. Except *tenai* or *cumbu* mixtures all others gave higher monetary returns than the pure cropping. But it was observed the mixtures affected adversely the development of the groundnut plants, and of the different crops grown mixed, sorghum depressed the yield to the maximum extent, while redgram affected it the least. It has been reported to be more profitable to grow groundnut between rows of *arhar* (redgram) in the United Provinces.

In a rotation experiment conducted at the Central Farm, Coimbatore, from 1909 to 1921, a mixture of castor and lablab was compared with castor alone, in rotation with sorghum. It was observed that the legume influenced the yield of cereal, though the increase was slight and not consistent. The yield of castor was comparatively very poor in the mixed crop.

The above review shows the need for a thorough examination of this important agricultural practice of mixed cropping. A full record of all existing practices throughout India should be made and examined. Such experimental work as has been done in this line in the various Provinces should be brought together for scrutiny. The agronomic and economic backgrounds of these practices should be investigated through suitable long range experiments and improvements on them suggested. The introduction and expansion of the area under commercial crops necessitate the designing of suitable mixtures with a view to conserve soil moisture and fertility, and ensure the production of the cultivators' personal needs. In 1937, Sir John Russell, in his Report on the work of the Imperial Council of Agricultural Research, has stated—"The agricultural economic aspects of mixed cropping should be studied in view of the widespread use of this practice and the probability that some crops mix better than others". The initiation of a comprehensive enquiry and the laying down of suitable experiments in this line are necessary in the interests of the cultivators of the vast rain-fed areas in India.

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Our Present Position with Regard to the Control of Fruit Pests.*

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Introduction. It is a welcome sign that increasing interest is being taken in fruit culture by the public. This has been particularly the case ever since the Government opened the Fruit Research Station, Kodur. Expansion of orchards is bound to result in the near future and with it the problem of tackling the pests is bound to come into more prominence. It is therefore thought that a brief account of the major pests of the more important fruit trees and their control will be of special interest to those in the line and also to those who propose taking up fruit culture.

Mango Pests. Of the various fruit trees grown in this Presidency mango is one of the most important. There are about two dozen pests affecting the mango of which the blossom hopper (*Idiocerus* spp), the stem borer (*Batocera rubus*) and the fruit flies (*Dacus ferrugineus* and *Dacus ferrugineus incisus*) are the most important. Among the other insects which do some damage occasionally may be mentioned the leaf caterpillar (*Parasa lepida*), the shoot webber (*Orthaga exvinacea*) and the nutweevil (*Cryptorhynchus mangiferae*). The hoppers both adults and nymphs—infest the blossoms and injure them by sucking the sap with the result that they are either shed or prevented from setting into fruits. Spraying with fish oil rosin soap at a strength of one pound in ten gallons of water is found effective against the pest. In Bombay, dusting with flowers of sulphur is recommended. This treatment is being tested here with a view to finding out its effect against the pest and the cost of the treatment. How far dusting will interfere with the setting of fruits is also receiving attention. The stem

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