THE AGRICULTURAL DEVELOPMENT OF THE DRY ZONE OF CEYLON

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THE problem of the progressive agricultural development of the dry zone of Ceylon is one whose successful solution will have the following important results: (i) the improvement of the economic and physical condition of the existing villagers, (ii) the utilisation of large areas of uncultivated land to produce sufficient foodstuffs to render Ceylon self-supporting, and (iii) the provision of land for the normal expansion of population. The successful attainment of these three results is so obviously of paramount importance to the well-being of the Island that a discussion of the problem is desirable no matter what the merits or demerits of the suggestions made in this paper may be. In a problem so involved as this no simple cut-and-dried solution is possible and any suggestions made will almost certainly need modifying or changing in the light of further experience.

The dry zone of Ceylon may somewhat loosely be defined as that part of the Island where the annual rainfall is less than 75 inches and where the growing of swamp rice by direct rainfall, unsupplemented by irrigation water, is either precarious or impossible. To agriculturists in other countries areas receiving an annual precipitation of even 50 inches would hardly be termed " dry " and it must be explained that the dry zone of Ceylon receives the greater part of its rainfall during the north-east monsoon from October to April. During the south-west monsoon the precipitation is generally less than 20 inches and in the N.W. and S.E. corners of the Island less than 10 inches. The following table gives the average rainfall during October-March and April-September in representative places in the dry zone. The meteorological records give the south-west monsoon as prevailing from May to September inclusive, but is considered to be agriculturally more useful to give rainfall figures for the period April to September as dry season crops are generally sown in April.

MEAN RAINFALL IN INCHES

Place	*October-March*	*April-September*
Jaffna	40·25	9·62
Mannar	31·34	7·62
Anuradhapura	37·50	17·76
Trincomalee	46·99	16·52
Topawewa	41·05	13·94
Batticaloa	53·42	10·83
Hambantota	24·39	14·85
Maho	38·45	22·58
Maha Oya	58·36	24·30
Bibile	63·50	18·53

The last two places do not strictly come within the above definition of "dry zone" as their total rainfall exceeds 75 inches. They are representative, however, of a large tract of land in the lower areas of the Province of Uva and a wedge of land in the Eastern Province, at present largely uncultivated but particularly suitable for development in the same way as the dry zone proper.

The dry zone as defined above includes all the low-country of Ceylon (land mainly below 500 feet above sea level), with the exception of the low-country in the south-west lying roughly between Kurunegala and Matara, and extends to well over half the area of the Island. It forms a belt between the foothills of the central mountainous region and the sea whose width varies from about 120 miles in the north to about 40 miles in the south. The dry zone includes the Northern and North-Central Provinces, part of the North-Western and Southern Provinces, the low-country of Uva and the whole of the Eastern Province.

Except in the thickly populated Jaffna peninsula and along the sea-board of part of the Eastern Province cultivation in the dry zone consists essentially of scattered blocks of paddy land, generally under large or small-sized irrigation tanks, surrounded by large areas of jungle or scrub jungle a small fraction of which is cultivated annually on what is known as the *chena* or shifting system of cultivation. There is a certain amount of garden cultivation in and near villages and a comparatively small amount of intensive cultivation in the dry season

of chillies and tobacco irrigated by hand from wells and, chiefly, rivers. The intensive cultivation of the Jaffna peninsula will not be discussed here as little land is left for development. The garden cultivation previously mentioned might conveniently include land near villages regularly cultivated with cassava.

Essentially the characteristics of the dry zone are a scattered cultivation, large areas of primary and secondary jungle and scrub jungle and a sparse population with, except under tanks, a low and precarious *per capita* production. The agricultural practices have been formed by generations of painful experience and are generally the best possible under existing conditions. It is all too easy to condemn the *chena* system of cultivation which is universally described as wasteful, but condemnation must be accompanied by practical proposals for a permanent system which will maintain the land in a high state of fertility, will keep weeds under control, and provide a reasonable market for the crops grown.

The shifting or *chena* system of cultivation is met with in most parts of the tropics where there is more land than is immediately necessary for the population. *Chena* cultivation consists essentially in felling and burning primary or secondary jungle during the dry season and broadcasting seeds at the beginning of the rains in the loose top soil and ashes. The tallest available jungle is chosen ; where land is scarce low secondary jungle is used but primary jungle is preferred. Successful cultivation depends upon having sufficient jungle-growth and on getting a good burn. A good burn depends to some extent on skilful felling of the trees and largely on suitable weather conditions. In Ceylon a *chena* is generally cultivated for two seasons, the first season with kurakkan, maize, rice, chillies and vegetables and the second season with gingelly. In Ceylon where *chena* permits are given a family will generally cultivate about an acre. The advantages of the *chena* to a villager include the following : (a) little equipment and no cattle are required, (*b*) the accumulated fertility of a varying number of years is utilised for the crop, and (*c*) weeds are almost entirely absent during the first season.

The *chena* system is undoubtedly wasteful of timber and land, but it dies a natural death when the population increases sufficiently. In some places the noxious weed *illuk* or *lalang* (*Imperata arundinacea*) succeeds the crops taken on a *chena*

and the natural regeneration of the jungle is greatly retarded or even prevented. A harmful result of widespread and continued *chena* cultivation is the effect on climate. This effect is not known precisely, but there is no doubt that the destruction of large areas of high jungle will bring about a drier climate. If it is assumed that chena land regenerates sufficient jungle for re-chenaing in ten years the total area of jungle necessary for a yearly *chena* of 1 acre is 10 acres. If a permanent system of cultivation can be devised on 5 acres of land the saving of jungle will be considerable. The end of the *chena* system can be hastened by providing larger areas of irrigated rice land, or by evolving a system of permanent cropping by which the fertility of the land can be maintained at a high level and weeds kept under control. Such a system will call for implements and cattle and will involve the provision of sufficient credit facilities to enable the cultivator to obtain these. Until the villager can be demonstrated an economic system of permanent cropping and be furnished with sufficient credit for implements and live-stock the arbitrary abolition of *chena* permits will mean hardship and even starvation to the many who at present rely on *chena* cultivation for their livelihood.

The dry zone can be developed by (i) increasing the existing irrigation facilities and (ii) evolving a practical system of permanent dry land cultivation. The first method undoubtedly presents the most immediately attractive prospects for several reasons. The crop grown on the irrigable land will be rice, the production of which in Ceylon is at present about one-third of the requirements. There is, therefore, a large potential market for the rice that can be produced from an additional million and a half acres of paddy land and there is no reason why the rice produced, if milled in a modern type of mill such as that recently erected by the Department of Agriculture at Anuradhapura, should not meet the quality requirements of the market. Moreover, rice cultivation is familiar to and extremely popular with the villager and the equipment necessary for cultivation is simple and comparatively easy to obtain. Finally, rice in the husk can be stored with little risk until a buyer is found ; the grower is not forced to sell to the first bidder by fear of losing his produce as may happen with perishable crops like vegetables and root crops.

The provision of increased irrigation facilities is a matter for, and the energetic policy of, the Irrigation Department. At present many of the thousands of small village tanks are being restored and new tanks are being constructed. Recently the Director of Irrigation has announced that work is being started which will eventually involve the storage of all the rain which falls in the dry zone. It is the hope of many cultivators that ultimately ways will be found of using in the dry zone some of the water which is carried from the mountainous regions of the Island by, for example, a river like the Mahaweliganga.

The second method of developing the dry zone is the organization of a permanent system of agriculture on unirrigated land, and it is now proposed to discuss this in detail.

The maintenance of soil fertility at a sufficiently high level to produce remunerative crops is particularly difficult under tropical conditions where solar radiation is responsible not only for an extremely rapid rate of humus decomposition but also, it is believed, for the direct loss of nitrogen. Corbett* has recently drawn attention to the fact that " the nitrogen and organic matter of the soil varies inversely with the soil temperature and the amount of solar radiation received. At temperatures below 25°C (77°F) there is an accumulation of organic matter in the soil, but at temperatures about this humus decomposition outpaces its formation." Vageler† states that " The widely held view of native cultivators in the Dutch East Indies that felling of tree cover for a period of three years, combined with exposure of the soil, is enough to destroy the richest bed of humus is precisely what one would expect from such a procedure. It is unfortunately true that even now unreflecting introduction of European practices in the matter of bare fallow occasions much damage in many tropical regions." Loss of fertility together with a large increase of weed growth make the *chena* cultivator seek new jungle for clearing after a year or two. It has recently been found in the United States that nitrate-producing organisms are rendered inactive or destroyed by exposure to sunlight, damage which, like the destruction of humus, will undoubtedly be hastened by the

**Biological Processes in Tropical Soils.* Steven Corbett, W. Heffer & Sons, Ltd., Cambridge, 1935.

†*An Introduction to Tropical Soils.* P. Vageler. *Macmillan & Co., Ltd.*, 1933.

mechanical disturbance of the soil inevitable in any permanent cultivation of annual crops. Without a definite system of fertilizing the soil the cultivation of crops will be unremunerative. An examination of the yields obtained at the dry zone experiment stations in Ceylon for the period 1932 to 1934 shows that, even after making allowance for unusual weather conditions, they are generally well below what are considered good yields in India.

For villagers with little or no credit to buy artificial fertilizers, even if their use so far away from the source of supply should prove economic, the maintenance of the fertility of the soil must depend either on cattle manure, compost or green manure. A system of permanent cropping involves the use of cattle so cattle manure will be available but almost certainly in insufficient amount and it would appear advisable to use what is available for turning into compost along with any green vegetable material than can be obtained. Some simple modification of the Indore method of compost making is within the capability of the villager. It must be remembered, however, that the coconut black beetle breeds in decaying vegetable matter and where the heat generated in the compost heaps is insufficient to kill the larvae or to deter the beetle from laying eggs it will be necessary to turn the heaps and kill the larvae at suitable intervals. The making of compost, although for centuries a fundamental part of Chinese and Japanese agricultural practice, will take time to become popular with the Ceylon villager and where the holding is comparatively large as it would be in Ceylon the fertility can more usefully and easily be maintained by the growth, *in situ*, of green manures, leaving the cattle manure and compost for a small garden of fruit trees and vegetables, and for the patch of fodder grass. The use of green manuring in maintaining fertility in Nigeria is described by Faulkner and Mackie in a book* which is of particular interest to Ceylon. The system in use at Ibadan which produces good crops year after year is to grow *in situ* a green manure in between each crop. Experiments have shown that this system of manuring is successful in maintaining the soil in a sufficiently high state of fertility and it is even thought that the green manuring need not be so frequent. The authors state

**West African Agriculture.* D. T. Faulkner and J. R. Mackie, *Cambridge University Press*, 1933.

that ' . . . green manuring is generally regarded as being in the nature of a permanent improvement of the soil, the benefit of which will be seen for many years. Our experience is exactly the contrary ; it seems to be rather of the nature of a quick-acting manure, of which the full benefit is obtained, and the effect fully exhausted in at most two succeeding crops.' It was found that the treatment of the green manure had little effect on the succeeding crop whose yield was the same if the green manure was cut green and allowed to decompose gradually before burial, if the green manure was allowed to grow until it died of drought before burying or even if it were burnt *in situ*. The only treatment which had an adverse effect was the removal of the green manure from the land and merely ploughing in the stubble. Although chemical investigations appeared to show that the green manure should be cut and buried green practical yield trials did not confirm this.

Any green manure grown requires incorporating with the soil and for this purpose a plough that will invert the furrow is necessary. The " Ceres " plough is recommended and can be pulled by good village cattle providing the cattle are not worked for too long at a time and are well fed, but the cost of the plough (about Rs. 35·00) is comparatively high. Shift can be made with a " Meston " plough which costs just under Rs. 5·00 for the ironwork but this plough does not completely invert the furrow. If imported in bulk the price of the " Ceres " plough could be appreciably reduced. It has been found at the Experiment Station, Peradeniya, that the best way of dealing with a green manure crop is to cut the standing crop into lengths of six to nine inches and to plough in after a few days. A green manure like *Crotalaria anagyroides* when grown under favourable conditions produces a stem whose lower portion is woody and it is convenient to remove these woody stems (without cutting) from the field before ploughing. Whether a green manure crop can successfully be grown depends chiefly on the rainfall during the growing season. In the dry zone there is invariably sufficient rain during the season from October to March (generally known as the *maha* season); from April to September (generally known as the *yala* season) the rainfall is low, but except in the extreme north and in some places on the east coast about 15 inches to 18 inches of rain can be expected. During the *yala* season gingelly (*Sesamum indicum*)

is grown in many parts of the dry zone and it is probable that a quick-growing green manure like *Crotalaria juncea* or dhaincha (*Sesbania cannabina*) could also be grown. Green manures worthy of a trial for *maha* are *Crotalaria anagyroides, Crotalaria usaramoensis, Crotalaria juncea* and *Sesbania cannabina*, the first two sown at 10 to 15 lb. per acre and the last two at 15 to 20 lb. For *yala* the last two are recommended.

The control of weeds presents a difficult problem in Ceylon. It is probable that all crops (except the green manures) will have to be grown in drills to permit of weeding by hand or by a simple form of cultivator like the Burmese Harrow. Seed can easily and successfully be drilled by the Indian seed drill, an implement which can cheaply be made by the village carpenter. In the permanent system of cropping here advocated the land will be cultivated every season alternately with crops and green manures. The crops will be weeded and the green manures will, to some extent at least, smother the weeds. Where conditions are suitable for a luxuriant growth of the green manure (especially if this be *Crotalaria anagyroides*) the smothering effect will be great.

Where sloping land (even land on a slight slope) is cropped annually precautions will have to be taken to prevent soil erosion. The intensity of the rainfall in the dry zone is frequently such as will cause serious soil wash and a successful farming system entails the conservation of the soil itself as well as of its fertility. The large amount of soil wash on moderately sloping, cropped land in the dry zone is not generally realised ; the prevention of soil wash may make all the difference between success and failure. Anti-soil erosion measures should (i) prevent by means of drains run-off from adjoining areas entering the land and (ii) restrict or prevent the flow of water which falls on the land in the shape of rain. The latter problem is solved in parts of Africa by the construction of contour ridges or bunds and a similar method would appear most suitable in Ceylon. It is suggested that small contour bunds be constructed about 15 inches broad and 6 to 8 inches high (after consolidation) from the earth provided by a series of disconnected silt pits which should run alongside the bund. If the bund is below the silt pits these will provide storage places for some of the excess rainfall as well as soil for the bund. The distance apart of the

bunds will depend on the slope of the land, the type of soil and the rainfall. If the land between bunds is ploughed along the contour there is no reason why the bunds should not be more or less permanent structures. Erosion of the bunds would be lessened by allowing grass to grow on them or, better, by planting a ground cover like *Indigofera endecaphylla*.

The choice of crops for the permanent cropping advocated is governed to some extent by climatic conditions and largely by the market demand. Crops such as kurakkan, yellow maize, chillies, cassava, pumpkins and dry-land rice can be grown for the cultivator's own use. Crops grown for sale must be assured of a satisfactory market. Maize is one of the most successful crops in the dry zone ; not only does it suit the climatic conditions, but it grows above weeds that might smother a crop like kurakkan. Unfortunately, however, the present demand for maize is small and little extension of the demand can be anticipated unless outside markets are found or the dietary habits of the people are modified. Gingelly and perhaps green gram are probably the most suitable crops for the *yala* season and a good market should readily be found. Cotton is satisfactory for *maha* provided the distance it has to be carted to the railway is not too great and provided also the arrangements made by the Department of Agriculture for marketing the seed cotton are continued. The bulk of the chillie crop will have to be dried as there is only a small demand for green chillies. At present there is an unsatisfactory market for dried chillies, due, it is thought, to the small amount available. In some localities tobacco is a suitable crop, but any increased production will have to be of a light flue-cured variety such as Harrison's Special suitable for the manufacture of cigarettes. In regions of heavier rainfall ginger, turmeric and Dioscorea yams can be grown. It is advisable that all crops which are grown should be capable of being stored without loss for several months if the cultivator is not to be at the mercy of the trader. One crop which can be stored and for which there is a large demand is rice and it is desirable to investigate thoroughly the possibility of growing dry-land rice. During the *maha* season of 1935-36 a plot of 1·8 acres on the Experiment Station, Peradeniya, was cultivated with dry-land rice. The soil was in poor heart and the previous crop of cow peas grew badly and was ploughed in. A dry zone swamp rice selection (*Vellai illankalayan*, 28061)

was broadcast at the rate of 2 bushels per acre along with 1 cwt. Nicifos No. 2 per acre. The crop was weeded once and matured in 4½ months. In spite of a partial drought in January and February the yield of winnowed paddy was 24·86 bushels per acre, an extremely promising yield under the conditions of the trial. The rainfall during the growing period was 38 inches.

To supply food for the plough bulls and milk cows maintained by the cultivator it will almost certainly be wiser for him to grow fodder crops rather than to rely on what poor communal pasture there may be. Jowar (*Sorghum vulgare*) is grown as a cattle fodder in India. It is made into hay and fed after being cut into short pieces by a knife or a chaff-cutter and generally moistened with water in which a little poonac has been soaked. A very useful fodder which can be cut and fed green when required is Napier or Elephant grass. Under suitable conditions Napier grass will yield as much as 100 tons of green fodder per acre in a year. Although in some parts of the dry zone the rainfall during the dry season may be barely adequate for the successful cultivation of this grass it is well worth widespread trial.

The suggested size of a permanently cultivated dry zone holding is about five acres. This is considerably smaller than has previously been recommended, but the writer believes that moderately intensive cultivation stands the best chance of success. Unless crops are grown on soil kept in a high state of fertility (by green manuring) their growth will be so poor that they will not cover the ground which will then be exposed to the disastrous effects of prolonged solar radiation. Unless crops are weeded they will be smothered by weeds. Successful cultivation, therefore, would appear to be possible only on a comparatively small holding. The live-stock on a typical holding, therefore, might well consist of one pair of working bulls, two milk cows to supply the milk and ghee so essential in the villager's dietary and to supply young stock for replenishing or sale. Implements would include a mould-board plough with spare parts, a Burmese Harrow, an Indian seed drill and a few hand tools. Credit facilities will therefore be necessary to enable the cultivator to obtain the requisite equipment.

Whether co-operative credit societies with some Government assistance can finance cultivators must be left to others to determine.

In the same way market facilities are almost equally necessary, for the cultivator will have to sell part of his crops to obtain money for the necessities of life which he cannot produce himself, for the repayment of loans and for the payment of interest on loans. It is hoped that co-operation between the Department of Agriculture and the Marketing Commissioner will in time provide the necessary markets. The market problem is only briefly mentioned here ; it is one which bristles with difficulties and to which a solution must be found before permanent cropping can successfully be established.

It is not possible without continued experiment to lay down a hard and fast sequence of cropping, and even after experiment the sequence will be elastic and respond to price changes. The following diagram gives a suggested sequence of cropping which is intended not as a model but as a suggestion to be modified and improved. Of the 5 acre holding it is assumed that $\frac{3}{4}$ acre would be occupied by the buildings and garden and $\frac{3}{4}$ acre by Napier grass or other fodder crop.

SEQUENCE OF CROPPING ON 3½ ACRES

<table>
<tr><th>Year</th><th>Season</th><th>½ acre</th><th>½ acre</th><th>½ acre</th><th>½ acre</th><th>½ acre</th><th>½ acre</th><th>½ acre</th></tr>
<tr><td rowspan="2">First</td><td>Maha</td><td colspan="2">Rice or Kurakkan or Maize</td><td colspan="2">Cotton</td><td>Chillies or Pump-kins</td><td colspan="2">Green Manure</td></tr>
<tr><td>Yala</td><td colspan="5">Green Manure</td><td colspan="2">Gingelly or Green Gram</td></tr>
<tr><td rowspan="2">Second</td><td>Maha</td><td colspan="2">Cotton</td><td>Chillies or Pump-kins</td><td colspan="2">Rice or Kurakkan or Maize</td><td colspan="2">Green Manure</td></tr>
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In districts of suitable rainfall tobacco might take the place of cotton, and Dioscorea yams, turmeric and ginger be included in the rotation. Manioc (cassava) will grow in most parts of the dry zone and where there is a local demand a small area could be cultivated with this crop. Sweet potatoes can be included as a maha crop where there is a demand, but at least a small patch should invariably be grown for the use of the cultivator and his family. There are numerous varieties of sweet potatoes and trials are being carried out at Peradeniya. Gandia is a variety which had done well over a period of years and lately a Russian variety, N219, has shown considerable promise. It matures at Peradeniya in about five months while Gandia takes about six. It is generally thought that sweet potatoes cannot be stored for more than a week or two, but experiments at Trinidad have shown that when stored in a pit lined with straw and covered with earth the tubers will keep without undue shrinkage for about two months. They also kept well when stored in bags, but there was more shrinkage. It should be mentioned here that where maize is grown the yellow variety is preferable owing to its greater vitamin A content.

An essential part of a dry zone holding will be the home garden, a plot of land, say, of about three-quarters of an acre devoted to fruit-trees and vegetables. Fruit-trees should include mango, lime, orange, pomegranate, plantains and papaw. Other trees which are invaluable are coconuts, jak and bread-fruit. Drum sticks (*Moringa pterygosperma*) not only supply a vegetable but are useful as live fence posts.

Grape fruit flourishes in the wetter parts of the dry zone such as Bibile, but its successful cultivation as a money crop involves considerable care and attention. The trees must be regularly sprayed to guard against citrus canker, mildew and leaf-miner, and it will almost certainly be necessary to bag the fruit in grease-proof paper bags to prevent damage by fruit-fly. The sale of damaged fruits would rapidly destroy the local demand and it is unlikely that grape fruit will be a suitable village crop in the near future. The system of farming here

advocated which entails the keeping of one or two milk cows and the growing of fruit and vegetables in a home garden should supply the cultivator and his family with a complete diet containing the necessary vitamins, and their health should improve rapidly.

To bring this system into being on a large scale will necessitate in the first place extended trials at different dry zone experiment stations and the probable modification of the sequence of cropping suggested. Only after extended trials and demonstration can the system be recommended to cultivators with a reasonable hope of overcoming their engrained and what are, after all, natural prejudices.