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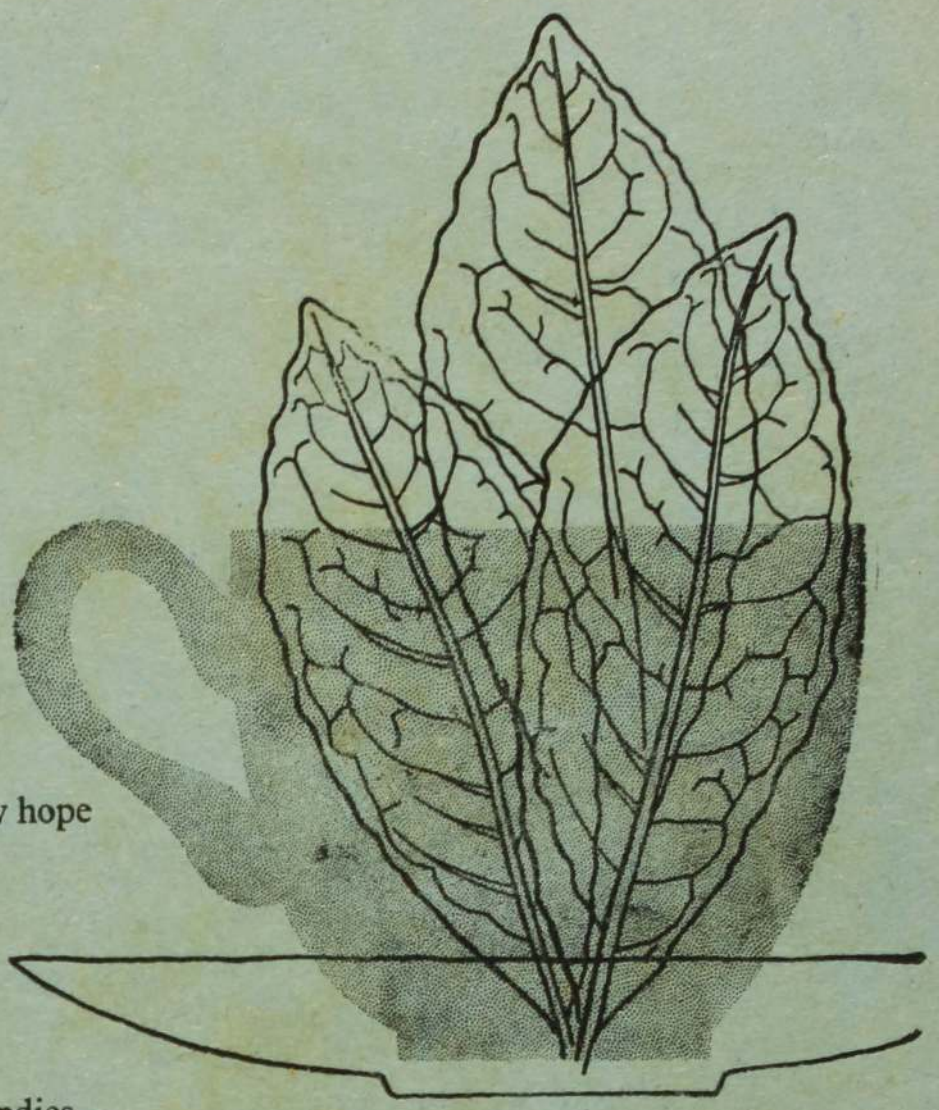

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Vol. CXI No. 2 **April–June 1955**

CONTENTS

EDITORIAL

Minor Agricultural Products of the Island

IN ADDITION to the four major crops of the Island, viz., tea, rubber, coconuts and paddy, a number of economic crops which contribute their quota towards the Island's trade are cultivated in areas suitable for them. Over twenty of these products can be listed, but only the following, which are exported, need be mentioned: cacao, cinnamon, citronella, cardamoms, cloves, pepper, kapok, tobacco, and papain. There are other crops cultivated mainly in home gardens or chenas which do not find a place in the Island's external trade but which have a ready local market and play a part in the development of cottage industries, e.g., sugar cane, cotton, arecanut, coffee, *kitul*, betel, cashew, and fibre plants such as *wetakeiya* (*Pandanus foetidus*), *hewan pan* (*Cyperus dehiscens*), *indi* (*Phoenix zeylanica*), &c. In this review reference will be made primarily to products coming under the former category as they are the most likely to contribute towards the Island's economy.

With the present demands made on the Department of Agriculture for concentrated attention on food crops, but little time has necessarily been devoted by its research staff to the study of the problems relating to these relatively minor agricultural products. Government has, however, realized that this state of affairs must be remedied and has directed that more attention should, in the future, be directed to their study. As a first step a Minor Agricultural Products Sub-Committee of the Board of Agriculture was formed to survey the position in regard to these crops and to determine what steps should be taken in order to rehabilitate the industries which they give rise to. This Committee, with the Horticultural Officer (now Chief Research Officer) of this Department as its Convener, has already set to work and detailed the position in regard to two of these crops, viz., cacao and coffee.

In this connection reference is invited to the useful study carried out by a Governmental inter-departmental Committee on the Citronella industry, extracts from whose report are reproduced in this issue of the *Tropical Agriculturist*. It is apparent that surveys of this nature are of considerable importance as they furnish data which are likely to lead to quick results so far as the rehabilitation of the particular industries are concerned. An example in point is the investigational work carried out by the Industries Department and referred to in the report on the distillation of the oil. By the adoption of a simple modification in technique a marked increase in oil output was obtained. Another example relates to the manuring of the crop in regard to which it was conclusively demonstrated that by the judicious application of fertilizers yields of oil are very appreciably increased and more than compensated for the extra expenditure incurred. These surveys also draw attention to any defects in the trade of particular commodities which may be existent and suggest how they can be rectified. It has been agreed that adulteration, which is widely prevalent in this industry, can be reduced, if not entirely eliminated, and grades of oil well defined by the adoption of a system of certification.

The Sub-Committee in its study of the cacao crop has made a valuable contribution to the development of the industry by recommending to Government that areas suited for cacao and which are now under marginal or sub-marginal rubber should

be replanted with the crop under the Rubber Rehabilitation Subsidy Scheme. The proposal has been accepted by Government and a sum of approximately one million rupees per annum is to be allocated for underplanting rubber lands of elevation 1,200 feet and over in the Kandy, Matale and Badulla districts with cacao. It is proposed to subsidize the inter-planting of cacao in these rubber areas at the rate of Rs. 350 per acre. The Committee has also demonstrated its usefulness in indicating which of the numerous crops referred to should or should not be developed on a plantation scale. In the case of coffee, for example, it has clearly indicated that in view of the inability of Ceylon to compete with foreign coffee-producing countries, the cultivation of this crop for export would be of no advantage. It was, however, the view that coffee should be cultivated as a home garden crop in the villages and that marketing facilities should be improved. The Committee has also recommended that the guaranteed purchase scheme which exists for coffee should be continued and that Government should consider the imposition of an import tariff on the commodity as local production increases. In these various ways the Committee has demonstrated its balanced, sound, and practical outlook, and its further deliberations should be of the greatest value to our research workers, the industry concerned, and to Government.

To pass on to some of the crops themselves. Mention should first be made of the growing economic importance of cacao as a crop both for cultivation on a plantation scale and in peasant holdings. With the impetus given by the high prices prevalent for the commodity since the Korean War—the present average is about Rs. 180 per cwt.—there has been a very marked increase in the extent cultivated with the crop, largely as an inter-crop between rubber. The present extent of cacao in the Island is estimated at about 50,000 acres, but with the subsidized cacao replanting scheme another 25,000 acres would be brought under cultivation during the next ten years. There is reason to believe, however, that the prospect for cacao will remain bright in the near future because of the wide gap between world supply and demand which is not likely to be bridged for quite a long time because of the high incidence of pests and diseases in the major producing areas where most of the plantations are senile owing to failure to replant adequately during the 1934-38 depression. Ceylon cacao which is of the *Trinitario* type has a steady demand because of its fine flavour, and as it constitutes only about 0.4 per cent. of total world production, there is no danger that increasing the extent under cultivation locally by 50 per cent. will upset the supply position and influence prices.

A crop which has been closely connected with the economic life of the people of the Jaffna Peninsula is tobacco, where for several decades chewing tobacco has been grown widely for the Travancore market. With the imposition of restrictions on the import of this commodity by India, there has been a decrease in the production of this variety of tobacco and greater attention is being paid to the cultivation of other crops like onions and chillies. The cultivation of cigarette tobacco is also gradually being extended in the Peninsula but the extent cultivable is limited by soil and other factors. Cigarette tobacco has, however, made considerable headway in other parts of the Island and there are today about 5,000 acres under this crop due to the encouragement given to its cultivation by the Department, the fixing of fair, guaranteed prices, and the provision of facilities by cigarette manufacturing companies. The report of the Commission to inquire into the tobacco industry in the

Island, which has just published its report as Sessional Paper XIV of 1955, is commended for study by those who are in any way connected with the industry. The main recommendation of this Commission is the creation under a Tobacco Industry Act of a Tobacco Board which will control the production, distribution, sale and marketing of tobacco and its products, and be the adviser to Government on matters relating to the industry. With the creation of some such Board there should be a marked advance in the development of the tobacco industry in the Island.

A crop with distinct possibilities is pepper, of which approximately half the total production of about 5,000 tons is exported. Prices rose to a very high level in 1951 owing to a fall in world supplies but have now reached a point when agronomic research is called for in order to ensure production at economic prices. The small grower is, however, protected by the operation of the Agricultural Products Regulation Act. New methods for the vegetative propagation of the crop are proving quite successful.

A review of this nature must take note of cinnamon of which there are about 35,000 acres in the country and of cardamons, of which there are about 6,000 acres. But little investigational work has been done on these products locally and their study would doubtless repay the time and attention paid to them.

Ceylon was the principal producer of papain not very long ago but in recent years production has increased in East Africa and prices have dropped very markedly. Here again adulteration has been responsible for the fall in the quality of the product exported and Government has, therefore, prescribed certain standards of purity which papain for export should conform to before the necessary permits are issued.

No reference to sugar cane need be made here as this has been the subject of an earlier editorial in this journal. It would suffice to state that there is every prospect of a successful cane sugar industry being established in the Island if the project is tackled with adequate preparation and care. Experimental work carried out at the Polonnaruwa Station has shown that high yields of cane of good quality could easily be obtained by adequate cultivation and manuring.

Reference should now be made to a promising dry zone and semi-dry zone crop, viz., kapok for which there is scope for appreciable development in the Island. This crop should respond to good cultivation, and early agronomic investigational work on it is called for. A selection of kapok has been imported from Indonesia and its cultivation is being extended. There is a good export trade in the commodity but care has to be taken that quality standards are maintained. A Committee appointed by Government recommended the adoption of suitable standards but their recommendation has yet to be implemented.

It is clear from this brief survey that there are great possibilities in the development of the minor agricultural products of the Island. With the establishment of a Rice Research Institute in the Department of Agriculture with its own staff, the other research sections of the Department will have the time and opportunity to investigate some of the problems connected with these minor products. There is little doubt that in a comparatively short period results of considerable value should accrue from these investigations and thus appreciably increase the importance of the minor crops in the country and bring greater profits to those engaged in their cultivation.

Agricultural Conditions in the Uva

DUNCAN J. de SOYZA

Geography

The Uva Division, which comprises the whole of the Uva Province, occupies a land area of 3,277 square miles and ranks fourth in size among the nine provinces of Ceylon. On the basis of topography and climate it may be divided into the Upper and Lower Uva regions.

Upper Uva stretches southwards from the borders of Nuwara Eliya along the Hakgala ridge embracing the D. R. O. Divisions of Udukinda, Yatikinda and Wiyaluwa. It comprises the rolling *patanas* and hills of the Uva, the elevation ranging from 2,000-4,500 feet.

Lower Uva stretches from the foot of Horton Plains through the D. R. O. Divisions of Wellawaya, Buttala, Wellassa and Bintenne. The area covers a considerable section of hills, wide undulating plains and vast expanses of flat forest land varying in elevation from 2,000 feet to a few feet above sea level. The hills are largely planted with tea and rubber. The plains of Lower Uva are scattered with varying extents of paddy fed by a net-work of thousands of tanks strung together by a multiplicity of streams and *aras* that ultimately run into the rivers. Here, the natural tree growth is abundant and vast stretches of high jungle (*mukulana*) are found lying contiguous with park land known locally as *damanas* and *talawas*.

Climate

Uva falls within the rain shadow region during the South-West Monsoon; very little rain is therefore received from June to September During the two inter-monsoonal periods and during the North-East Monsoon, Uva receives a fair quota of rainfall, though the distribution is relatively uneven.

In Upper Uva, from October to January, the normal rainfall is characterized by light drizzles of long duration, punctuated often with heavy violent downpours lasting a few minutes. Temperatures are lower in Upper Uva and the air is relatively crisp and dry, which explains the salubrious climate of the dry Uva Uplands. Strong winds of very high velocities are experienced during June and August, so much so that roofs of houses in exposed situations, such as at Palugama, are weighted down firmly against the wind.

In general, Lower Uva receive more rainfall than Upper Uva, the temperatures are higher, and the atmosphere more humid.

Soils

The soils of Uva are mostly lateritic loams derived from ancient crystalline rocks belonging to the Archean or

Precambian Age. They are generally formed from the residual deposits of various basic and intermediate metamorphic and igneous rocks, such as gneisses, quartzites, khondolites and limestone. The pure carbonate limestone is rare, but the magnesium limestone dolomite is found as out-crops running almost east-west in a narrow strip popularly known as the Badulla band. The soils on the whole are deficient in plant nutrients and respond well to treatment. The *patana* soils are yellowish red, fairly heavy loams, very often banded, and sometimes embedded in the matrix are found concretionary material intermixed with undecomposed boulders. Large patches of ferruginous deposits are often seen in bared hillsides.

In the region of dolomitic limestones, the soil is red to chocolate in colour, deep and well drained. In some areas these soils are very near the *terra rossa* type, being almost red. Soils show an acid reaction and are generally deficient in potash.

The soils of the wet *patanas* over 4,500 feet, on the slopes of the Hakgala and Kandapola hills, are characterized by a shallow peat-like horizon of varying depth. This region is constantly moist and imperfectly drained. With good cultivation annual crops particularly temperate vegetables could be grown successfully.

The *patanas* of the dry Uva Uplands may be classed as tropical mountain *savannahs* or *steppes*. They comprise poor, shallow soils with rock outcroppings and are devoid of organic matter. The moisture content is low as these lands are subject to long periods of drought, *patana* fires and erosion by rain and heavy winds. With adequate soil conservation measures and judicious manuring, particularly with organics, good crops could be raised. Fertile patches of good deep soil are however met with in the low-lying areas.

The paddy (gley) soils in the valleys are fairly deep, but badly drained.

The soils of Lower Uva are generally deep, well drained and fertile, but rapidly lose fertility after a few seasons of cultivation unless manured. Regions with deep heavy clays are not uncommon, particularly alongside rivers such as the Telulla area along the Kuda Oya and stretches along the Kumbukkan Oya.

Flora

The *patanas* of both wet and dry Uva Uplands are natural grasslands of coarse, wiry, tufted grasses, such as *Cymbopogon confertiflorus* (*Mana* S), *Chrysopogon zeylanicus* (*Gawara* S), *Themeda tremula* (*Pini-boru-tana* S), *Themeda cymboria* (*Karavata-mana* S), and *Arundinella villosa*.

The forest wealth of Lower Uva is immense, abounding in valuable timber trees such as *Chloroxylon Swietenia* (Satinwood), *Tamarindus indicus* (Tamarind), *Pterocarpus marsupium*, (*Gawalu* S), *Chickrossia tabularis* (*Hulanhik* S), and *Azodirachta indica* (Margosa).

The parkland *damanas* and *talawas* carry a large proportion of xerophytic and deciduous trees, the ground cover

being invariably made up of coarse grasses such as *Cymbopogon confertiflorus*, Mana (S) ; *Chrysopogon aciculatus* (Love grass) ; *Chloris barbata ;* and *Dactyloctenium aegyptiacum*. A pre-dominating fern is the *Gleichenia linearis* (*Kekila* S).

The well known herb gardens of Lower Uva are situated in these parklands. Medicinal trees such as *Terminalia belerica* (*Aralu* S), *Terminalia chebula* (*Bulu* S), and *Phylanthus umbelica* (*Nelli* S) are found in gregarious associations. These trees are annually rented out to the villagers by the Forest Department. The fruits are greatly valued in native medicine.

There are several indigenous fruit trees found in the province. *Rubus lasiocarpus* (Ceylon Raspberry) and *Rubus macrocarpus* (Ceylon Blackberry) are found in Upper Uva. In Lower Uva the following fruit trees are met with : *Elacocarpus serratus* (Ceylon Olive, *Veralu* S), *Dialeum ovoideum* (Velvet tamarind, *Galsiyambala* S), *Psidium guyava* (*Pera* S), *Schleichera oleosa* (Ceylon Oak, *Khon* S), *Dimorphendra Mora* (*Mora* S), *Ziziphus jujuba* (*Masan* S), *Manilkara hexandra* (*Palu* S), and *Hemicyclia acidissima* (Wood apple).

Population and Labour

Of the total population of 4-500,000 about half is agricultural, made up of about 46,500 families. Scarcity of labour is felt in the Lower Uva where villages are thinly populated and cultivable land is readily available. In Upper Uva, though there is sufficient labour, the desire for manual work is fast diminishing and the growing generation is moving to towns and urban areas in search of other employment.

Land Utilization

Though this district has a land area of 2 million acres only about 12.7 per cent. of this is cultivable. The area under actual cultivation is about 8.4 per cent. of the total area or two-thirds of the cultivable extent. Nearly two-thirds of the cultivated area is under permanent crops, such as tea, rubber, citrus and coconuts. The annual cropped area is made up of 34,000 acres paddy, 20,000 acres chenas, and 14,000 acres home gardens and highland cultivation.

Whilst in Upper Uva cultivation in the *maha* season depends on water availability, in Lower Uva it depends on its accessibility and proximity to villages. The hill slopes of Upper Uva, although deficient in organic matter and non-retentive of moisture, can be grown with tea or cultivated with temperate vegetables if proper agricultural practices are resorted to. The lower hill slopes are terraced with paddy fields. Fields at the bottom of these valleys are invariably ill-drained marshes with a water table at ground level.

In Upper Uva, there are about 7,000 acres of such paddy lands optimistically referred to as rain-fed fields. Hill streams tapped for irrigation provide water for nearly 11,000 acres of terraced paddy. However, insufficiency of water makes it impossible to cultivate every year all these fields with the result that some tracts get a sufficient irrigation supply only once every four seasons. Where such irrigation water is found insufficient for paddy work, the available water is used for vegetable

cultivation. Above the level of these paddy fields, but still low down in the valleys are villagers' homesteads and gardens. The water table being high, water is available from shallow wells for domestic needs and for their home garden plots. The gardens contain trees like jak, arecanut, *kitul,* citrus, coffee and one or two temperate fruit trees such as loquat, cherimoyer and pear.

Higher up the slopes in some instances the land is cultivated with such subsidiary crops as cereals, pulses, yams and vegetables during the *maha* season.

The highest slopes or *patanas* are used for grazing cattle. To encourage a palatable new flush in the coarse grasses, the *patanas* are habitually burnt every year during the dry season from June to August. The high winds prevalent during this time of the year carry away the ashes and bits of charred vegetation, depositing them lower down. This vicious circle of burning and close grazing depletes the *patanas* of humus, lowering the useful micro-organic population so essential to support tree life, while simultaneously destroying any tree seedlings that try to establish themselves.

In Lower Uva all arable lands in close proximity to villages are under some form of cultivation. The low-lying lands are paddy fields, while the highlands are either home gardens or *chenas*. Villages are normally situated near tanks.

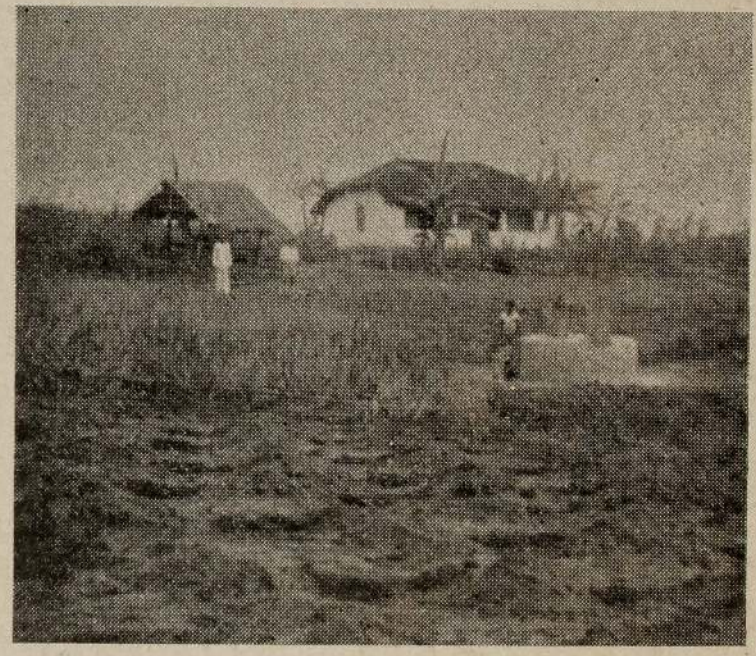
An important aspect of land use is the long-term policy of the Forest Department in providing wind belts over large extents in the *patanas* and afforestation with valuable timber trees.

The proper conservation of forest as an important factor in influencing the climate and arresting soil erosion is hardly appreciated by the villager and it is not uncommon to find forest and shrub jungle on steep hill slopes burnt down annually for *chena* cultivation.

Crown Land Alienation

Land is alienated to the peasants under the following schemes :—

1. Village expansion—L. D. O. Allotments.
2. Colonization :
   (*a*) Peasant colonization,
   (*b*) Middle Class colonization.



L. D. O. Allotment—Upper Uva

Under the above schemes 14,000 allotments have been given out so far, of which 252 allotments of ½ to 2 acres in extent have been alienated under the L. D. O. Scheme.

The three peasant colonies of Bathmedilla, Okkampitiya and Sorabora-wewa hold 561 allotments covering an area of 3,249 acres, the average size of

a holding being 4 acres paddy land and 2 acres highland. Under the Middle Class Colonization Scheme 43 allotments have been settled over an area of 1,200 acres, the size of a holding being 5 to 25 acres.

The proposed peasant colonization schemes of Yudaganawa, Soraborawewa Right Bank, Mapakadawewa and Kotiyagala linked with major irrigation schemes presently under construction will cover 1,360 acres paddy and 1,490 acres highland. The middle class schemes of Pelwatte and Bakinigahawela which are under development will absorb 1,050 acres.

Land Ownership

Several kinds of land ownership prevail in Uva and the extent to which land is developed and made use of for any purpose depends on the type of ownership.

The "Gambaraya" System. In this system, which is mostly prevalent in Lower Uva, *Gambarayas* (village caretakers) are appointed by absentee landlords or owners of large tracts of paddy fields to see to the cultivation of these fields by leasing them for cultivation to the villagers. The absentee landlord gets only a small quantity of paddy per acre, the quantity depending on the fertility of the particular tract.

The *Gambarayas* profit the most, as they get a good return in kind for other services such as the loan of seed paddy and buffaloes to cultivators.

Uncertainty of Title. Large extents of land in Lower Uva come under the Waste Land Ordinance. All forest and scrub jungle used by villagers in rotation for *chena* cultivation became the property of the Crown under the Crown Lands (Encroachment) Ordinance of 1840. These lands have since been alienated to capitalists, after the needs of the local village population are met. Until the uncertainty of title to most of this Crown acquired land to which villagers make claim is settled under the land Settlement Ordinance, the development of Lower Uva will be retarded, as the claimants never bother to develop or improve such land or buildings until they are sure of their claims.

The "Ande" System. This system involves the seasonal lease of land to a cultivator on a share basis. In most areas it is on the half-share basis. A few decades ago, when the price of paddy was low and the number of cultivators in relation to cultivable fields was about the same, this practice worked satisfactorily and the exploitation of either party did not arise.

However, during World Wars I and II, when scarcity of rice was felt, resulting in soaring prices, a new system known as *mandaran* was introduced, by which the paddy fields were auctioned, the highest bidder getting the field. With the rapid increase in population during the last decade, the number of paddy cultivators has increased, though the acreage under paddy has not kept pace with the increasing population. The resulting competitive demand for cultivation of fields incited the field owner to dictate his own terms to the prospective lessees. The cultivator on the other hand has no abiding interest in the paddy field as the chances are that he may not get the fields next year. Consequently he does not take the trouble to adopt high standards of cultivation or

effect any permanent improvements to the fields, as he has to share the yield with the owner who offers no assistance. This apathy on the part of the cultivator is reflected on the low yields of paddy throughout the country.

The Service Tenure System. The system that operated in respect of Crown land was abolished soon after the British took over the Kandyan Provinces. The system however continued in respect of private lands, *nindagamas*, and land owned by temples and *devales*, i.e., *viharagam* and *devalagam*. The services due from tenants were specified by an Ordinance passed in 1870. The temple lands are leased out to cultivators by calling for tenders. Invariably some rich person gets the lands and sub-lets them to cultivators. The tenants are expected to perform certain services, failing which the trustee gets the particular work done by some other person and recovers the cost from the tenant. According to the *panguwa* system the lands are divided, and invariably the rich and the influential get the larger portion, paying very small sums as compensation, while the local cultivators have to rest content with small shares.

Tenure of Crown Land. Crown land is alienated to the peasant under the 99-year lease system governed by the Land Development Ordinance. Under this Ordinance fragmentation of holding is not permitted.

Irrigation

Over 21,000 acres of paddy land are irrigated with the help of 23 major schemes which include the Kumbuk Wewa, Handapanagala Wewa and the Balaharuwa tank. Nearly 1,200 acres are irrigated by minor schemes. Under the minor schemes, particularly in the montane zone, the sowing season is inordinately protracted due to the fact that the poor supply of water takes time to reach the lower areas, after being put to full use by the cultivators along the channel higher up the slopes. Owing to this the *maha* sowing season in Upper Uva extends from November to May, the longer duration paddies being sown in higher elevations while shorter duration paddies are sown in the *yayas* below. Several irrigation schemes in Upper Uva have harnessed mountain streams to supply water to vegetable cultivations, particularly in the Udukinda Division where splash irrigation is generally resorted to.

Kumbukkan Oya Anicut—Lower Uva

Paddy

This is the principle crop of the cultivator, occupying about 34,000 acres. Although about two-thirds of the paddy extent is irrigable, owing to the scarcity of water in some areas, several *yayas* are cultivated once in four years and as a result only about 29,000 acres are brought under cultivation in *maha* and about 10,000 acres during the *yala*.

According to the Census Report of 1946 there are about 34,500 holdings of one-acre extent and below, occupying in all about 13,400 acres. Roughly half the total paddy acreage made up of 25,000 holdings is owner cultivated. The other half is held in cultivation under some form of tenancy.

Over fifty local varieties of paddy ranging in age from 3-6 months have been listed as cultivated throughout the province. It is possible that the same variety is known by different names in different areas. Some of the popular varieties are *Pannity, Karayal, Thatuvel, Baduluwi, Rathkunda, Vellai Illankalayan, Murunga, Galkada, Sudu balawi, Pachchaiperumal, Kirikunda, Madarawi, Pusparaga* and *Sulai*. In the Udukinda area the long duration varieties *Pannity* and *Thatuwel* are often sown mixed for the *maha* season, the belief being that *Thatuwel,* though a low yielder, withstands frost and cold winds, and at least one variety will succeed if the weather conditions are not favourable.

Owing to the conservative nature of the villager the replacement of local varieties with departmental purelines is slow. The purelines *Vellai illankalayan* and *Pachchaiperumal* are cultivated over 4,000 acres annually. Recent trials show that the 4½-5 months Indonesian variety *Mas-M24* and the 3½-4 months pureline *Murungakayan* are promising.

The cultivation seasons are very vague and ill-defined. Various stages of paddy cultivation from sowing to harvesting are often seen in the same *yaya*. Paddy is cultivated throughout the year except in September and October, when the cultivator is normally busy in his *chena*. The standard of cultivation is low and the yields are poor in relation to most parts in the Island. Though newly 'asweddumized' lands in peasant colonies have yielded up to 80 bushels or more per acre at the beginning, by the fourth year of cultivation the yields have dropped to 45 bushels. Ultimately these fields will share the same fate as the rest of the old paddy tracts in Uva unless manuring and other improved methods of cultivation are adopted. Apart from the inherent infertile conditions of most paddy fields, the low yields are directly attributable to the slip-shod cultivation methods in vogue. The seed rate varies from 2 bushels per acre in the colonization schemes to 5 bushels in the rainfed fields of Upper Uva. The explanation given by the cultivator for the high seed rate used is that a dense stand prevents lodging and suppresses weeds.

In Upper Uva tillering is poor in low-lying fields, which may be due to the dense stand of plants and unfavourable soil conditions caused by faulty drainage.

Broadcast sowing under wet conditions is generally the practice. Transplanting which was unknown until recent times is gaining ground and about 3,500 acres, about one-tenth the total paddy acreage, are transplanted during the *maha*. The spread of transplanting is limited by the scarcity of labour and poor response to tillering : consequent yields do not compare favourably with broadcast fields.

Where transplanting is impracticable harrowing the standing crop is gaining ground. In the past paddy was rarely weeded, but today about 3,500 acres are hand-weeded to some degree during the *maha* season.

Manuring with organics is new to the Uva cultivator. It is, however, now gaining ground and during the *maha* about 3,000 acres are dressed with organic manures annually. One sixth of the total extent is now dressed with fertilizers. The cultivators obtain fertilizers on credit from the C. A. P. & S. Societies. About 6,000 acres were fertilized during *maha* 1953-54, compared to 840 acres during *maha* 1952-53. This was the culmination of a special fertilizer drive launched during the year 1953.

Improved Methods

The terraced nature of the paddy fields, small size of most of the *liyaddes* and general marshiness of fields in the valleys do not permit the use of tractors in Upper Uva. In Lower Uva where the conditions are more favourable over 1,500 acres were tractor-ploughed during *maha* 1953-54.

The Uva peasant is on the whole apathetic towards the use of proved scientific methods. Improved methods which would produce higher yields offer no lure to the tenant-cultivator as no extra assistance is offered to him and since half the produce plus the seed paddy has to be given over to the owner of the fields. Besides this, the insecurity of tenancy militates against any special effort on the part of the cultivator to effect any permanent improvement to his fields.

However, convincing results obtained through demonstrations in the fields of cultivators by the officers of the Department of Agriculture are gradually weaning the cultivators away from their conservatism and prejudice of the following improved methods :

(*a*) Tractor ploughing.

(*b*) Use of light iron ploughs.

(*c*) Use of ' Burmese Harrow ' in preparatory tillage operations.

(*d*) Use of pureline seed.

(*e*) Green manuring and use of other organics.

(*f*) Use of fertilizers.

(*g*) Weeding.

(*h*) Transplanting.

(*i*) Harrowing the standing crop.

(*j*) Adoption of pest and disease control measures.

Improved Cultivation

Perennial Crops. Among the plantation crops tea occupies an area of 92,225 acres confined to Upper Uva. The extent under rubber is in the neighbourhood of 20,576 acres. In recent times cacao intercropped with rubber is showing promise. There are over 1,480 acres under coconuts mostly grown in home gardens in Lower Uva. The wide range in elevation, climate and soil permits the cultivation of several temperate and tropical fruits ; but except for a few varieties grown round homesteads, the only fruit grown extensively is the citrus of which the Bibile Seedless Sweet Orange is well known.

Citrus is the main perennial crop of the villager and is largely confined to the more or less triangular area stretching between Bibile in the north, Buttala in the west, and Dambagolla in the east, where the famous Bibile oranges and Moneragala limes are

found. Though these crops have been very methodically planted out, continued neglect and uncontrolled diseases have caused premature ageing of trees. In some gardens neglect is so pronounced that jungle has started encroaching on the once lucrative orchards. Unless a replanting campaign is started immediately with proper crop sanitation and attention to the existing younger trees, the citrus industry will be wiped out in the not distant future.

With the decadence of the citrus industry in the Bibile area the prospects of growing pineapple in Lower Uva are heartening.

Estimated Acreage under Citrus in Uva

Orange	..	3,000 acres
Lime	..	800 „
Mandarin	..	400 „
Grape fruit	..	50 „
Total	..	4,250 acres

The extent under plantains is about 2,000 acres, mostly grown as a home garden crop. Over fifteen varieties are found. In the hill country the varieties Chinese Plantain, the *Anamalu,* and *Marthamana* are commonly grown; while in the plains *Kolikuttu, Puvalu,* Ash plantain, *Suwandal, Mondan,* and *Ebmul Hondarualu* are cultivated.

Moringa oleifera, the drumstick, though not normally considered a cultivated crop, brings a considerable annual income to villagers in the Bintenne and Wellassa D. R. O's Divisions; a tree yielding on an average 500 fruits valued at Rs. 5. Other perennial crops normally found in home gardens are: jak, arecanut, bread-fruit, *kitul* and a few temperate fruit trees such as the pear, avocado, peach, cherimoyer, hill guava and loquat.

Annual Crops. Though rice is the staple diet of the villager, his subsidiary food and money crops are raised seasonally both in the *chenas* and in the home gardens.

Chena cropping which is mostly carried out in Lower Uva involves low intensity cultivation, as opposed to garden cultivation in Upper Uva which requires a high degree of intensive work.

There are over 35,000 acres of *chena* in the Uva, of which about 26,000 acres are in Lower Uva. Each cultivator cultivates about five acres of *chena.* The cropping is mostly confined to the *maha* season.

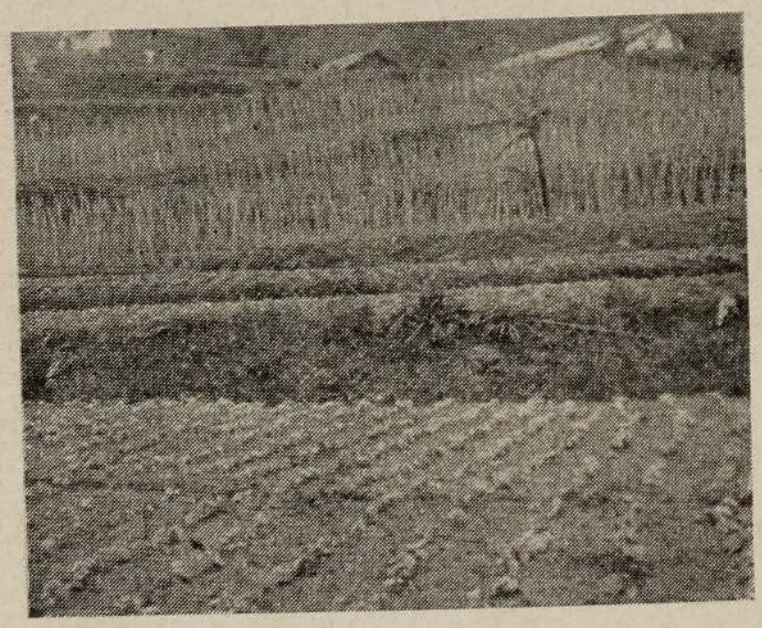
Any type of land varying from high jungle to shrub land, steep hill sides not excepted, depending on the availability of land is cleared and burnt during the dry spell in June-August and sowing is done either by broadcasting or dibbling with the first showers in September-October.

As mixed cropping is the rule, it is difficult to give a fair estimate of the acreage under any particular crop. The main crops of a *chena* are maize, kurakkan, hill paddy, green gram, sorghum, horse-gram, chillies, mustard, gingelly, cotton, manioc and sweet potatoes.

About 600 acres of cotton are cultivated in the Wellawaya and Buttala D. R. O's Divisions, the seed being supplied by the Spinning and Weaving Mills, Wellawatte, who buy the seed cotton. On an average an income of Rs. 150 is obtained from one acre of cotton.

The land close to the homesteads is grown with vegetables such as : *bandakka*, brinjal, tomato, pumpkin and other gourds. The harvest of these perishable commodities from the *chenas* produce a glut in the local fairs, accompanied by a fall in prices during the months of December-February.

In the Udukinda Division the cultivation of temperate vegetables in terraced hill slopes is a specialty and is comparable to the market gardens and truck cropping farms of the more advanced countries. The standard of cultivation is very high and nearly everyone uses fertilizers. Owing to the scarcity and difficulty of transport, bulky organic manures are mostly restricted to home gardens. The average land area cultivated by a family is about quarter of an acre, where single crops or a variety are handled.



Terraced Vegetable Gardens—Upper Uva

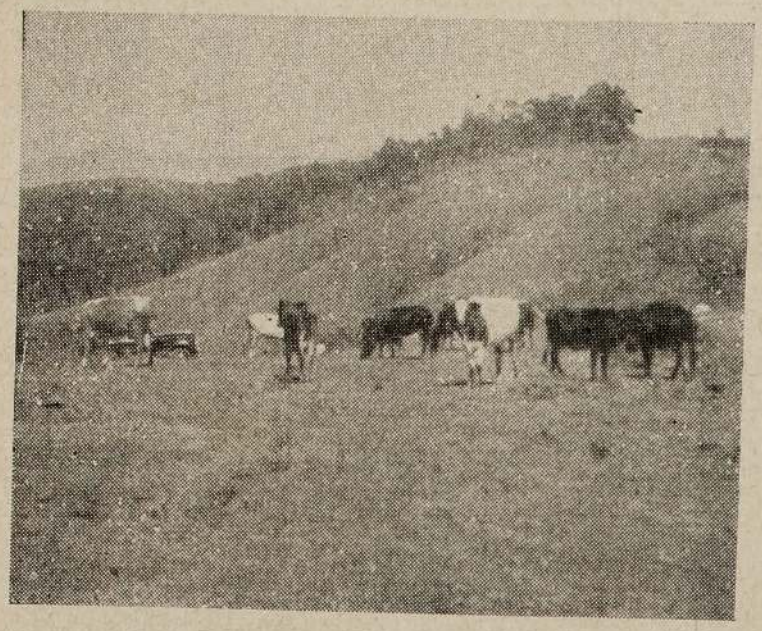
Livestock

The total number of milk animals are enough for the normal economy of the people of this province. The problem, however, is that a few people own all the cattle, the result in most cases being the utter neglect of the animals. In many parts of Lower Uva the buffaloes are left to fend for themselves after the cultivation season is over and they roam about in the neighbouring jungles until they are rounded up again in the following season. Neat cattle are used for draught but roaming herds are found everywhere and are a constant nuisance as they damage gardens and stray on to public highways.

Stall-feeding is rare and promiscuous breeding is rampant, little use being made of stud animals provided by the Department of Agriculture at various centres. A good percentage of the cows are not milked as it is sanctimoniously felt that the milk rightly belongs to the calf. The condition of the animals are so poor during the long periods of drought that there is hardly any milk for the calves. Generally speaking about 25 per cent. of the cows are in milk, the average daily milk production being in the order of one to two bottles.

The Sinhala breed predominates in the villages ; cross-breeds are found in urban areas. In Upper Uva both in the towns and in estates good European breeds and their crosses are popular. These animals are well looked after and dairying seems to be a sound business, the milk being sold in the towns. Large herds, mostly the local type and cross-breeds are maintained in Upper Uva

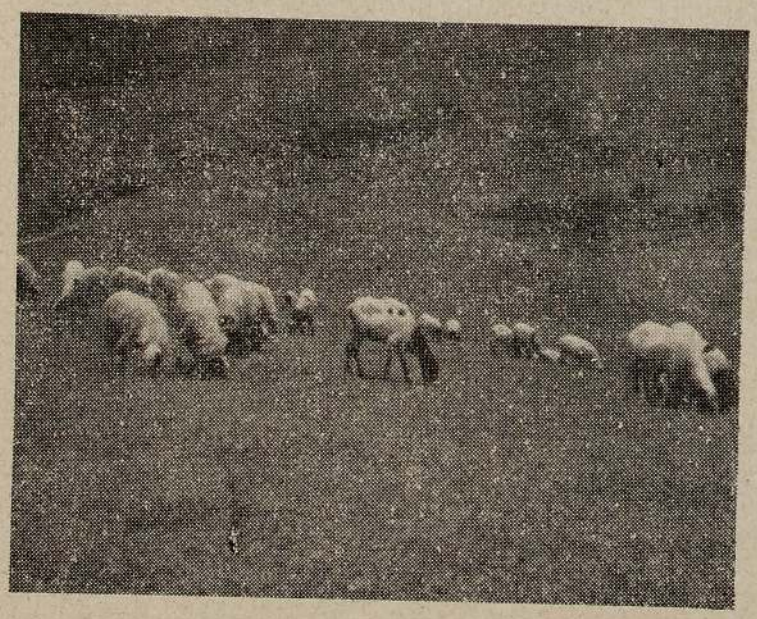
tea estates on the scanty grazing found on the *patanas* for the purpose of obtaining manure for composting.



Cattle grazing on *patanas*

The absence of good pasture is keenly felt. Exploratory trials carried out at a couple of centres have proved that *Brachiaria brizantha* does extremely well ; it survives the drought while the *patana* grasses die out temporarily.

The prospects of sheep-farming for slaughter on the dry Uva uplands offers promise. A start has already been made by a private concern and the Department of Agriculture, and from the promising results obtained so far one could confidently recommend this activity in Upper Uva.



Sheep-farming on *patanas*

Pig-farming as a side line in the tea estates in Upper Uva is fast becoming popular, the dung forming a valuable ingredient in compost-making. The animals are slaughtered periodically for pork, a small quantity being cured into home-made bacon. With systematic management the prospects for bacon and ham manufacture are good.

Although goats are found in variable herds in Lower Uva and in small numbers on tea estates, little heed is being taken to improve the stock, although stud animals are provided by the department at various centres.

The poultry in the province is not in proportion per capita of population. Mixed breeds are the rule. However, of late, the R. I. R., White Leghorn and Austrolorp breeds are finding their way to the villages from the agricultural stations which provide hatching eggs and cockerels at concession rates to *bona fide* villagers. In the urban areas there is evidence of better poultry management.

Pests and Diseases

Several common crop pests and diseases are readily controlled by the use of chemical insecticides and fungicides made available to villagers through the C. A. P. & S. Societies. The following, however, become problematical at times : Blast and Swarming Caterpillar of Paddy, Fruit Fly, Fruit Piercing

Moth, Powdry Mildew, Pink Disease, Physiological and Virus Diseases of Citrus and Bunchy Top of Plantain.

Among poultry, Raniket disease becomes fairly serious during certain seasons, while Pullorum and intestinal worms show up at times. As regards cattle diseases, sporadic outbreaks of Foot-and-mouth and Black Quarter occur in the remote areas of Bintenne Korale, these diseases being more or less endemic to the area and sometimes contracted through *tavalan* or pack animals that cross over from the Eastern Province.

Marketing

Vehicular traffic is restricted to the trunk roads, hence agricultural produce is transported to the markets and towns by pack animals.

Private dealers and the Marketing Department purchase vegetables and fruits directly in the villages of the Lower Uva. Of 29 C. A. P. & S. Societies that buy agricultural produce, twenty-six deal chiefly in paddy, one in vegetables, and two in oranges. The guaranteed price scheme has helped the majority of cultivators to market their produce, specially paddy, at fair prices.

Government Assistance to the Farmer

The field staff of the Department of Agriculture instruct the cultivators in proper agricultural practices.

Apart from demonstrations of improved practices in agricultural stations, demonstration plots have been opened up in cultivators' fields to convince them of the advantages of good agricultural practice. These plots have given striking results.

Further assistance is readily offered in the form of seed and livestock propagation material, free stud service, castration of scrub animals, and the immunization of poultry against disease ; but the response of the villager on the whole is far from satisfactory.

Some Aspects of the Chemistry of Rice Soils

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THE CHEMISTRY of flooded rice soils is a subject of unusual scientific interest and great practical importance. Its scientific interest derives from the many unusual features of flooded soils. Its practical importance needs no emphasis because rice, perhaps the most important crop in the world, is almost universally grown on flooded soil.

Although rice is almost everywhere grown on submerged land no systematic attempt has been made to understand the behaviour of the rice plant in terms of its peculiar chemical environment. An analysis of the chemical regime in a flooded soil in the context of the rice plant is therefore desirable.

The chemical regime in a flooded rice soil is radically different from that in a normal upland soil and is characterized by :

(i) a deficiency of oxygen,

(ii) an excess of carbon dioxide,

(iii) the presence of large amounts of reduced iron and manganese,

(iv) the absence of nitrates,

(v) the presence of sulphides,

(vi) the anaerobic decomposition of organic matter,

(vii) an increase in the solubility of phosphate and silica,

(viii) an increase in *p*H,

(ix) a decrease in redox potential,

(x) an increase in electrical conductivity.

Deficiency of Oxygen. When a soil is flooded the normal gas exchange that takes place between soil and air is drastically curtailed. Oxygen can enter the soil and soil gases escape into the atmosphere only by a process of molecular diffusion through water. Since this process is about 10,000 times slower than diffusion in air the entry of oxygen into the soil and the escape of soil gases such as carbon dioxide is severely restricted. The net result is that the concentration of oxygen in a flooded soil is reduced to a very low value while that of carbon dioxide and other soil gases is increased. The depletion of oxygen and the accumulation of carbon dioxide have important chemical and biochemical consequences which will be taken up in due course.

The drastic restriction of the diffusion of oxygen does not imply that the entire profile of a submerged soil is uniformly devoid of oxygen : the concentration of oxygen can be relatively high at the surface (34, 36) and perhaps again at some depth in the soil. The surface layer, usually a few millimetres to a centimetre in thickness, in which the oxygen concentration is relatively high, is characterized by its brown colour and the presence of typical oxidized radicals such as ferric iron, nitrate, and sulphate. Also microbiological processes in this layer are much the same as in a well-aerated soil. The direct evidence for the presence of a high oxygen concentration at any depth in a submerged soil is meagre but the accumulation of ferric oxide and manganese dioxide concre-

tions below the plough sole of old rice soils (27, 32, 43) and the high redox potential in this zone (12) suggest that oxidizing conditions prevail. Sandwiched between these two oxidized layers is a zone which may be practically devoid of oxygen. Rice roots are thus subjected to an environment very low in oxygen.

Rice roots, like all other roots, require oxygen for respiration, growth, and accumulation of nutrients. How then do rice roots thrive in a medium so low in oxygen ?

Harrison and Aiyer (18) suggested that rice roots derived their oxygen from the oxygenated surface water that drained past the roots. The beneficial effect of a moderate amount of drainage, on the rice plant, they attributed to improved aeration of the roots. They even ascribed the benefits of green manuring to increased oxygen supply to the roots. Green manuring produced methane which according to Harrison and Aiyer favoured the development of the algal film at the surface, which in turn enriched the surface water with oxygen.

It is unnecessary to go into the patent inconsistencies of this theory. Suffice it if it is said that there is very clear evidence now that rice roots do not depend on their immediate environment for their oxygen supply.

Sethi (42) showed that mature rice roots contained large air spaces. Juliano and Aldama (23) reported the presence of small rhombohedral air spaces even in young rice roots. But it was left to Van Raalte (39) to demonstrate the continuity of these air spaces with the air channels in the shoot system and to provide convincing proof of the transport of oxygen from the aerial parts to the roots. Subsequent work by Vlamis and Davis (51) in America and Mitsui (32) and others (28, 52) in Japan have confirmed this observation.

Not only do rice roots receive sufficient oxygen from the aerial parts for their metabolic needs, but they are also able to exude oxygen into soil and maintain an oxidized environment. Around young roots which actively secrete oxygen (32) a deposit of ferric hydroxide is formed in the soil. As the roots grow older and get suberized the flow of oxygen into the soil gets restricted. Deposition of ferric hydroxide then occurs on the root surface, giving the older roots their reddish brown colour.

Excess Carbon Dioxide. The carbon dioxide concentration in a flooded rice soil can assume a relatively high proportion, especially if fresh organic matter is present. Concentrations as high as 20 per cent. have been reported by Harrison and Aiyer (19) in Indian rice soils. A high concentration of carbon dioxide, even in the presence of an adequate concentration of oxygen, is injurious to plants. It seriously reduces water and nutrient uptake and can be lethal to plants. According to Chang and Loomis (9) a concentration of 15-20 per cent. carbon dioxide in the root zone may kill some plants. Vlamis and Davis (51) found that bubbling carbon dioxide through culture solutions in which rice, barley and tomato were grown was 'immediately lethal' to all plants.

Fortunately, the carbon dioxide concentration of rice soils is below this lethal level, largely on account of the diluting effect of methane invariably present in rice soils. The possibility, however, cannot be excluded of toxic concentrations of carbon dioxide during

the initial stages of the decomposition of organic matter. The failure of rice seedlings on newly green-manured fields may be due partly to carbon dioxide toxicity.

Presence of Ferrous Iron. The reduction of iron is the most striking chemical change that takes place on flooding a soil. The reddish or yellowish brown colour of the soil changes to blackish shades and large amounts of iron are brought into solution.

The reduction of iron is almost entirely the result of the anaerobic decomposition of organic matter. Aside from lowering the redox potential, the anaerobic decomposition of organic matter generates a variety of organic compounds which can not only reduce ferric iron but also combine with the ferrous iron formed to give fairly stable soluble complexes. Two factors that influence the amount of iron reduced in a flooded soil are the content of organic matter and the duration of submergence. This is shown in Table I.

TABLE I

Treatment	*Fe^{+2} (lb./acre) on days from start*			
	0	*8*	*23*	*76*
Well drained	20	32	18	19
Submerged	19	54	3090	6120
Submerged (+0·5% straw)	18	809	4160	7160

Although large amounts of iron are reduced in flooded soils only a very small proportion is present in the soil solution (37). The concentration of ferrous iron in the soil solution is governed by the *p*H of the soil, the carbon dioxide concentration, the amount of decomposable organic matter and the drainage conditions. A low *p*H, a high content of organic matter, and the absence of drainage favour the accumulation of ferrous iron in extremely high concentrations. This is brought out in Table II.

TABLE II

Treatment				*Fe^{+2} in p. p. m. in soil solution after 64 days*
*p*H	straw %	drainage		
4·9	0·0	well drained		0·1
4·9	0·0	submerged, with drainage		155
4·9	0·0	submerged, no drainage		354
4·9	0·2	submerged, no drainage		435
6·0	0·0	submerged, no drainage		80
6·0	0·2	submerged, no drainage		148

The reduction of iron appears to be one of the important benefits of flooding the soils in rice culture for there is abundant evidence that the iron requirement of rice is higher than that of other cereals (5, 15, 17, 50). There are indications (37) also that the need for extra iron coincides with the step up in metabolic rate associated with the initiation of the reproductive phase.

While a slight increase in the solubility of iron in the soil appears to be beneficial to rice there are strong indications that an excess may be harmful. A widespread physiological disease of lowland rice known as 'mentek' in Java, 'penyakit merah' in Malaya, and browning or bronzing disease in Ceylon may be a manifestation of the toxic effect of reduced products, especially iron. Symptoms strongly suggestive of this disease were observed in a greenhouse experiment and found to be associated with very high concentrations of

ferrous iron (38). Some of these observations are summarized in Table III.

TABLE III

Symptoms	*Ferrous iron (p.p.m.) in soil solution on days from flooding and transplanting*		
	16	*31*	*64*
None	3·2	20·5	80·0
Mild	35·8	81·6	354
Moderate	88·3	207	435
Severe	146	275	525

The build up of high concentrations of iron can be prevented by providing subsoil drainage and minimizing the addition of organic matter, as already indicated. Other practical methods are delaying submergence after transplanting, the addition of sodium nitrate to retard the reduction process, and, simplest of all, liming the soil (37). The effect of the last three treatments on a soil with an initial *p*H of 4.9 is shown in Table IV.

TABLE IV

Treatment	*Ferrous iron in p.p.m. in soil solution on days from start*		
	1	*28*	*50*
Submerged continuously	1·3	80·0	328
Submerged continuously $NaNO_3$ added	0·8	6·4	78·5
Submerged after 30 days from start of exp.	—	—	82·0
Three tons per acre $CaCO_3$ added and submerged continuously	0·5	48·0	69·5

It is clear from Table II that the accumulation of ferrous iron in the soil solution is highest when a low *p*H soil with no drainage is submerged for some weeks. It is interesting to note in this connection that bronzing disease of rice in Ceylon is almost exclusively confined to the ill drained, acid soils of the low country wet zone.

Presence of Reduced Manganese. Simultaneously with the reduction of iron or slightly preceding it, occurs the reduction of manganese. Under anaerobic conditions this proceeds so readily that it is only the low content of manganese in soils that prevents a submerged soil from being deluged with soluble manganese.

There is no evidence that the manganese requirement of rice is unusually higher but there are reports that an excess may be harmful (25, 26). There are instances also of manganese deficiency (43). On account of the ease with which it is reduced and rendered soluble, manganese is readily removed from the furrow slice and deposited at lower depths. In sandy soils with drainage manganese deficiency may therefore be expected.

Presence of Sulphides. Like other oxygen-rich substances, sulphate undergoes reduction under anaerobic conditions. The chief end product is hydrogen sulphide. This is also produced during the anaerobic decomposition of proteins, along with other evil-smelling substances.

Hydrogen sulphide even at a concentration as low as 0.1 p.p.m. is toxic to rice. It is fortunate indeed that so long as ferrous iron is present this toxic level is never reached for hydrogen sulphide is removed from solutions as the innocuous ferrous sulphide. But in soils low in active iron such as very sandy soils long under rice cultivation, hydrogen sulphide toxicity might be a serious problem. 'Akiochi' disease of rice in Japan has been attributed to hydrogen sulphide toxicity. The incidence of the disease has increased with

the use of ammonium sulphate as fertilizer (32). Among the remedial measures are draining the fields and adding red upland soil. The use of lime on these soils is avoided because a high *p*H favours the reduction of sulphate.

Absence of Nitrates. Nitrate, in common with sulphate and the oxides of iron and manganese, gives up its oxygen under anaerobic conditions and is reduced to nitrogen. This is known as denitrification. Denitrification is favoured by a *p*H near neutrality and the presence of organic matter.

An intermediate product of denitrification is nitrite. Nitrite, however, has only a transitory existence in rice soils and concentrations in excess of 3 p.p.m. have not been encountered in rice soils (11, 21, 24, 40, 47). This is true even of soils with a high initial nitrate content (37). There is no evidence that nitrite at this low level is toxic to rice. In this connection it may be noted that plants can assimilate nitrite without ill effects from solutions containing as much as 50 p.p.m. nitrogen as nitrite (8).

The use of nitrates as fertilizers for rice has been discouraged on the grounds that nitrates are (i) lost by leaching (ii) converted to toxic nitrite (iii) lost by denitrification (iv) not utilized by rice. Losses due to leaching and denitrification may be considerable but nitrite toxicity or the unavailability of nitrate to rice are not supported by facts. There is clear evidence (5, 17, 29) that rice can utilize nitrate provided the presence of nitrate does not render iron unavailable. In acid soils rich in iron, nitrate may even be beneficial because it retards the reduction of iron.

Anaerobic Decomposition of Organic Matter. The decomposition of organic matter in a flooded rice soil differs from that in a well drained soil in two aspects : (i) it is slower ; (ii) the end products are different.

In a well-drained soil, decomposition of organic matter is accomplished by a variety of micro-organisms of which fungi are the most active. Owing to the high energy release associated with the aerobic respiration of these organisms, decomposition of substrate and synthesis of cell substance proceeds at a rapid rate. This results in a rapid release of nitrogen with nitrate as end product if the C : N ratio is less than 16 and the immobilization of nitrogen in the decomposition of highly carbonaceous materials like straw.

In rice soils, on the other hand, decomposition of organic matter, except in the thin surface-oxidized layer, is almost entirely the work of anaerobic bacteria. Since these function at a much lower energy level and are more sensitive to *p*H, the decomposition is sluggish and *p*H sensitive. Also, owing to their lower synthetic activity, assimilation of nitrogen is slow. Thus materials with high C : N ratios may be applied to rice soils without risk of immobilizing soil nitrogen. The findings of Acharya (1, 2, 3) and Sircar *et alia* (44,45) confirm these theoretical conclusions.

Although the C : N ratio is relatively unimportant from the point of view of nitrogen immobilization it does have a marked influence on the rate of release of ammonia as the figures of Joachim and Kandiah (22) and of Mitsui (32) indicate. In some of Mitsui's experiments peak ammonification was

reached two weeks after incubation in flooded soil for all materials with a C:N ratio less than 9.1 ; as the C: N ratio increased peak ammonification was delayed. The beneficial effect of lime on ammonification to which Japanese workers (32) have drawn attention may be attributed partly to the stimulation of anaerobic bacteria by a *p*H near neutrality.

The most striking difference between the aerobic and anaerobic decomposition of organic matter lies in the nature of the end products. In a normal well drained soil the end products are carbon dioxide, nitrate, sulphate and resistant residues. The products of organic matter decomposition in a submerged soil are chiefly carbon dioxide, methane, hydrogen, and organic acids derived chiefly from the carbohydrates ; ammonia, amines, mercaptans and hydrogen sulphide from proteins ; and resistant residues.

The anaerobic decomposition of organic matter may affect the rice plant through (i) the products of decomposition and (ii) its influence on chemical equilibria in the soil.

Of the products of decomposition, ammonia is the most important, for nitrogen holds the key to productivity in rice as it does with other cereal crops. The chief merit of organic matter as the source of nitrogen for rice is that the nitrogen is slowly released as ammonia. Heavy applications of ammoniacal fertilizers, on the other hand, lead to losses (i) by leaching in spite of ammonium being a cation, (ii) by denitrification following the formation of nitrate in the surface layer. They have the added disadvantage that in sandy soils with impeded drainage a heavy dressing of an ammonium fertilizer may cause ammonium toxicity (7, 14, 30).

Among the other products of the anaerobic decomposition of organic matter, butyric acid and methane require comment.

Butyric acid is present in appreciable amounts in the early stages of the anaerobic decomposition of organic matter, may persist in acid soils, and is toxic to plants. The common failure of rice seedlings on newly green-manured fields may be ascribed to the toxic effect of butyric acid and carbon dioxide.

The presence of methane in rice soils appear to be beneficial to rice. Aside from its stimulation of the algal film at the surface and the lowering of the carbon dioxide concentration by dilution, methane, according to Vlamis and Davis (51) produced a marked improvement in the root growth of rice. This interesting observation merits further investigation.

The decomposition of organic matter in a rice soil has undesirable secondary effects : (i) it leads to a rapid loss of nitrate ; (ii) it intensifies the reduction of iron, magnanese and sulphate and (iii) it generates carbon dioxide and organic acids which increase the solubility of iron and maganese. Organic manures should therefore be used with caution on acid rice soils with impeded drainage.

Increase in Solubility of Phosphate. When a soil is submerged the availability of phosphate whether judged by plant response or chemical tests increases.

Several investigators (4, 6, 32) had reported that rice grown under flooded conditions did not respond to phosphatic fertilizers although crops grown under well-drained conditions on the same soils did show marked responses. Aoki (4) was the first to suggest that this was due to increased availability of phosphate under flooded conditions brought about by the conversion of insoluble ferric phosphates to soluble ferrous phosphate.

There is very clear chemical evidence that the solubility of phosphate in water and in acid solvents increases when a soil is kept submerged (31, 33, 53). The increase is due principally to the reduction of ferric phosphate. Among the other reasons are (i) hydration of ferric and aluminium phosphates, (ii) hydrolysis of ferric and aluminium phosphates and (iii) solvent action of organic acids and carbon dioxide on soil phosphates.

Conclusion of practical interests are: (i) phosphate may be leached and lost from the furrow slice in rice soils with drainage; (ii) soluble phosphates may be used on acid soils without fear of phosphate fixation and (iii) differences among phosphatic fertilizers will be less marked with lowland rice than with upland crops.

Increase in Availability of Silica. Submergence of a soil brings about an increase in the availability of silica (46, 48, 49). Mortimer's (33) figures show that the increase is associated with the reduction of the soil.

Silicon is not generally recognized as an essential element and direct beneficial effects of slica on upland crop plants are discounted (41). But in the case of the rice plant there is evidence that increased absorption of silica is beneficial.

Solution culture studies by Japanese workers (20, 35) have shown that silicic acid causes an increase in growth and in yield of straw and grain and that it counteracts the harmful effects of excess nitrogen. They have also drawn attention to the beneficial role of silica in increasing resistance to fungal infections (49, 54).

Increase in pH. When a soil is submerged its *p*H value increases. The magnitude of the rise in *p*H depends on the initial *p*H and the duration of submergence. This is shown in Table V.

TABLE V

*Initial p*H	*p*H *value on days from flooding*		
	8	*23*	*51*
4·7 ..	5·1 ..	6·2 ..	6·3
5·8 ..	6·3 ..	6·6 ..	6·7
6·7 ..	6·8 ..	6·9 ..	7·0

The increase in *p*H is due largely to the production of ferrous and manganous hydroxides. When a rice soil dries these compounds take up oxygen and are converted to the insoluble oxidized forms. The *p*H value then decreases. These reversible *p*H changes in paddy soils were first reported by Dennett (13).

The *p*H value *per se* of the soil probably has little effect on the rice plant. The secondary effect of the *p*H of the soil may, however, be considerable.

A low *p*H favours the presence of excessive amounts of iron and manganese in the soil solution. Besides, it may

retard considerably desirable microbiological transformations such as the destruction of butyric acid and ammonification of organic nitrogen. It is interesting to note in this connection that " Japanese farmers have laid more importance to the application of lime to paddy rice field than to the upland " (32) and that dramatic responses to lime have been reported on the acid rice soils of Taiwan (10).

Decrease in Redox Potential. The redox potential of soil decreases on submergence. The fall in potential, especially in the early stages, is marked if readily decomposable organic matter is present. Accompanying the fall in potential is an increase in the concentration of reduced substances such as ferrous iron, manganous compounds, and sulphides. The drop in potential and the release of soluble iron, particularly, is considerably retarded by the presence of nitrate. The highest yields in a green house experiment were found to be associated with the treatments which by virtue of the presence of nitrate maintained their redox potentials at a high level for a good part of the growing season (37).

In acid soils where iron toxicity may be a problem it may be desirable to make heavy applications of lime, preferably a few weeks before flooding. The accumulation of nitrates and the increase in *p*H following liming should cause a marked reduction in the amount of iron brought into solution.

Increase in Electrical Conductivity. The electrical conductivity of a soil initially low in nitrate and sulphate will increase on submergence, the increase being due largely to the release of iron and manganese ions. But in view of the complications caused by denitrification, sulphate reduction, and assimilation of ions by the rice plant it is doubtful whether electrical conductivity will be of much use in the study of rice soils.

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Coffee—Its Cultivation and Curing

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Introduction

ALL VARIETIES of coffee are native to different regions of Africa and have probably been used as a drink by the inhabitants of these countries from early times. Coffee, as a beverage, however, only came to the notice of the rest of the world after its introduction into Arabia somewhere about the 4th century, and its cultivation as a plantation crop dates from the 17th century. From small beginnings, the use of coffee as a beverage, and its cultivation on a plantation scale have spread to such an extent, that at the present day it is cultivated throughout the tropics, and in world trade is reported to be commercially more important than either tea or cacao, the two other important beverages. Brazil is the largest coffee producing country in the world, but the crop is grown to a fairly large extent in other parts of South and Central America, as well as East and West Africa, India and Indonesia, while smaller producing countries such as Jamaica are justly famous for the excellent quality of their produce.

It is likely that Arab traders had introduced the coffee plant into Ceylon even before Portuguese times, but large-scale cultivation in Ceylon dates from 1825 when Sir Edward Barnes, Governor of the Island, opened a coffee estate at Gannoruwa on the present site of the Experiment Station at Peradeniya (1). From this beginning, coffee cultivation expanded so rapidly in Ceylon that by 1867 it was estimated that about 125,000 acres were under the crop and considerable quantities of coffee were being exported. This was, however, the peak of the coffee 'boom' for in 1869 the coffee leaf rust, caused by the fungus *Hamileia vastatrix,* was first noted in Ceylon (2). The disease spread so rapidly and caused such destruction that within a brief period of about 20 years coffee cultivation was no longer one of the major planting industries of Ceylon, and attention was being turned to tea. Although the collapse of the coffee industry is blamed on the fungus which caused the leaf disease, it is possible that faulty land usage, leading to erosion and soil acidity in a tropical climate with high rainfall, may have contributed to declining yields, as the coffee plant is known to be highly sensitive to soil reaction. Whatever the cause of the collapse, however, in 1953 it was estimated that only 47 acres were under coffee in Ceylon, while imports of coffee in 1953 amounted to 1,074,090 lb., valued at Rs. 2,658,720 (3). With the availability of rust-resistant varieties and with a better appreciation of land use methods, there is no reason why coffee should not once more be cultivated successfully in Ceylon. Such is the view of practical planters, and the volume of applications for planting material indicate increasing interest in coffee cultivation. It is with the idea of providing some basic information for those interested in coffee cultivation that this article is being published.

Varieties

In its native habitat, coffee is an evergreen bush or small tree, growing under the shade of other tropical forest trees. But although the coffee plant was first described by Linnaeus and assigned to the family Rubiaceae as far back as 1753, up to date the classification of the genus *coffea* remains confused and unsatisfactory. Commercially many varieties are described, but botanically all these varieties fall into five fairly distinct species, each species containing numerous subspecies and varieties (4).

(i) *Coffea arabica*—**Arabian coffee.** Up to the time that the leaf disease destroyed the coffee industry of the East, *arabica* was the only species cultivated, and even now this species produces the greater part of the world's output. It grows wild in the subtropical highlands of Ethiopia. In Ceylon, arabian coffee is most likely to thrive at elevations over 2,500 feet under shade. It produces coffee of the best quality. The species includes a number of varieties such as Maragogie and Nacional of Brazil, Bourbon of Martinique, Erecta and Padang of Indonesia, Moka or Mokka of Yemen in Arabia, and the famous Blue Mountain Coffee of Jamaica.

(ii) *Coffea liberica*—**Liberian coffee.** This is a lowland variety of coffee, indigenous to West Africa, and is more suited to the high temperature and humidity of the low country of Ceylon. It is a large, vigorous tree, capable of growing without shade, and fairly resistant to leaf disease. Experience in Indonesia, however, has shown that this resistance sometimes breaks down. Another disadvantage is the poor quality of the produce. The species includes such varieties as Klainii, Excelsa, Arnoldiana and Abeokutae.

(iii) *Coffea robusta* (*C. canephora*) —**Robusta coffee.** It is a lowland coffee, thriving from sea-level to 2,000 feet under Ceylon conditions, but needs shade for its successful growth. The species is resistant to leaf disease, and has the added advantage that ripe berries are held on the tree. The quality of the cured beans is said to be inferior to that of *arabica,* but superior to that of *liberica,* and in marketing is used for blending with *arabica,* to give the latter coffee added "body". The species includes varieties such as Kouilou or Quillou, Congo and Uganda.

(iv) *Coffea stenophylla*—**Sierra Leone coffee** or **Rio Nunez coffee.** This species is a medium elevation coffee, growing into a medium sized tree with small, leathery leaves, which are very resistant to leaf disease, and distinguished from other species by bearing small, ovoid berries which ripen black. The cured beans have a characteristic odour, but the quality is said to be good, although this species is not grown extensively.

(v) *Coffea congensis*—**Congo Coffee** or **Shallot coffee.** The species is of no commercial importance.

In addition to the above species, numerous hybrids bred for qualities such as rust-resistance exist.

Climate and Soil Requirements

From a study of the climates of the different native habitats of species of coffee, it appears as if temperature controls the altitude at which coffee can be grown successfully. *Arabica* coffee,

which has its origin in the highlands of Ethiopia with a subtropical climate, does best at the highest elevations. Thus, an elevation of 4,500-6,500 ft. with a temperature of 64°F.—69°F. is considered best for *arabica* coffee in Kenya (5). In Ceylon, *arabica* coffee has been found to grow best at elevations over 2,000 ft. On the other hand, *liberica* and *robusta* coffees grow wild in tropical lowlands where the temperature rarely falls below 80°F., and as such are suited to lower altitudes. In Ceylon these two species thrive from 0—2,000 ft. Wide variations in temperature are unfavourable to the crop, although slight seasonal fluctuations in temperature, humidity and rainfall influence flowering and fruiting. It should also be borne in mind that the general climate of an area can be considerably modified by factors such as the slope of the ground, spacing of the bushes, pruning, shade, windbreaks, cover crops and mulches (6). It has also been thought that elevation has an effect on the quality of the crop ; the higher the elevation the better the quality (7).

The rainfall requirements of the coffee crop have to be considered not only from the point of view of the requirements of the growing plants, but also from the point of view of flowering, berry formation and ripening, and curing of the harvested crop. As regards the growing plants, 70-80 inches of rain, well distributed over the year with no long spells of drought, is best. At the same time yield depends to a large extent on rainfall at and after flowering, as will be explained under the section on harvesting and yields. Protection from strong winds is also essential.

Coffee can be cultivated on a variety of soils as long as they are not very gravelly or sandy or rocky, and are not heavy clays. Experience has indicated that, although soils of good to average fertility are preferred, the physical properties of the soil are more important than the chemical—depth, good drainage and sufficient aeration being especially important. For optimum growth the soil should, in addition, be neutral in reaction and never very acid.

Opening Up of Land

On land which is being newly opened up for coffee cultivation, it is essential that measures to conserve the soil be taken from the outset. Otherwise costs of manuring and liming are bound to increase from year to year, in a continual battle against deteriorating yields. Soil conservation is especially important during the first few years of a plantation, because in later years the coffee trees themselves as well as the shade trees provide a certain amount of protection to the soil.

Very steep land should not be planted in coffee at all, but gently sloping and undulating land is very often preferred because of good drainage conditions that obtain on such land. Since platform terracing is usually too expensive a practice, broad-based ridge terraces, either on the contour, or if the soil is impervious and rainfalls of high intensity are experienced, on a gentle gradient, seem to be sufficient for gently sloping land. Whatever mechanical measures for soil conservation are chosen, silt pits, drains, bunds or terraces, they should be supplemented from the very beginning with contour hedges of suitable bush green manures,

and cover crops. Many of the *Crotalarias* and *Tephrosias* are suitable for contour hedges, while any of the commoner cover crops such as *Calapagonium mucunoides, Pueraria phaseoloides* and *Desmodium ovalifolium* serve for low cover. Naturally occurring weeds could also be used as covers as long as grasses and deep-rooted herbs are avoided, but in the long run it is cheaper to establish a good leguminous cover from the start.

The coffee should be planted on the contour and spacing for holes should be adopted with this in mind. With *arabica* varieties of coffee a spacing of 6-8 ft. between trees appears suitable, while with *robusta* varieties the standard spacing is 12 ft. Liberian varieties are more vigorous growers and become larger trees ; they consequently require a wider spacing of about 20 ft. The usual size of hole dug for establishing coffee seedlings is 2 ft. square by at least 2 ft. deep. Such holes should be opened up at the required spacing, and left open for as long a period as possible to allow the bottom and sides of the holes to weather, before being filled up. They should subsequently be filled with a mixture of top soil and well rotted cattle manure or compost, heaped to a point in the centre, marked with stakes, and left to settle before planting.

The establishment of some form of shade is usually required for the successful cultivation of coffee, and it is usual to establish such shade well in advance of the time of planting, so that the young transplanted coffee will benefit from it. Temporary low shade is also advantageous to the young coffee, and this is best provided in the form of *Crotalaria brownei* or *Crotalaria striata* grown in rings round the planting holes. Such shade should be established at least one year ahead of the probable transplanting date. Temporary shade can be also provided by a catch crop of bananas.

Propagation

The usual method of propagation of coffee is as yet by seed. Seed for planting should be extracted either in small hand pulpers or by treading under foot. The seed should then be sifted by floating in water and removing all "floaters" or light seed, and allowed to dry in the shade. It is sometimes a practice to mix wood ashes with the seed while it is drying, to combine with the sugary matter of the parchment and form a coating which prevents premature splitting of the parchment (8).

The seed is first germinated in sand beds and then transplanted into nurseries. In the former the seed is spaced about an inch apart and pressed down to a depth of about half an inch, then covered with a mulch of straw or cut grass and kept regularly watered. As soon as germination commences, in about four weeks time, the mulch is removed and overhead shade substituted. When the seedlings are 2-3 inches tall they are transplanted into the nursery beds.

Since the seedlings are to remain for about a year in the nursery beds, the latter should be carefully made by digging the soil well to a depth of at least 12 inches, removing all stones, roots and other debris, preparing the soil to a fine tilth and incorporating well rotted cattle manure or compost. The beds should be 3-5 feet wide, 4-6 inches high and of any convenient length. They should be provided with overhead

shade in the form of cadjans or bamboo slats to permit chequered light. The seedlings should be carefully uprooted and transplanted into the nursery beds at a spacing of 6 inches. At first, watering is done at least twice a day with a fine rose, but gradually both watering and shade are reduced to harden the seedlings, till shade is completely removed about a month before the seedlings are to be transferred to the field. Basketed plants can also be raised by transferring the new seedlings from the germinating beds into the baskets instead of into the nursery beds. Subsequently, these basketed plants are treated in the same manner as seedlings in nursery beds. Seedlings are ready for transfer to the field at any time from 6 months to 2 years, but if they are older than one year they should be treated as stumps, and stems and roots pruned back before planting out.

Coffee trees grown from seed vary considerably in their yield capabilities. By establishing vegetatively propagated plants of high yielding clones, an even stand of high yielding coffee trees is attainable. Other advantages in the use of vegetatively propagated planting material are that the ripening period becomes more closely defined and, as such, economy of labour is a possibility, while the use of vigorous resistant root-stocks for budding or grafting enables the plants to withstand the attack of such pests as nematodes. But vegetative propagation has not as yet become an established practice under estate conditions, probably because high yielding clones are not as yet available, and the information on the subject is limited. In Kenya it has been established that hard-wood cuttings could be easily and successfully grown in the open in areas of high rainfall and generally forcing conditions, but that soft-wood cuttings require special propagating chambers (9). Cuttings should always be taken from upright suckers growing from the base of trees and never from lateral branches. In India soft-wood single node cuttings have been established successfully, and the nutritional status of the shoots at the time of extracting cuttings has been shown to be important (10). The rooting medium for cuttings is usually sterilized sand and forest loam. Work in Costa Rica has indicated that the type of rooting medium could have an effect on the type of root system and the subsequent success of the tree (11). Layering, marcotting and inarching could very likely be practised with success, but would be too slow and too wasteful of material to be adopted on a large scale. In Indonesia, grafting is popular, but no information is available on the details of procedure (12). Care should, however, be taken in establishing such vegetatively propagated plants on an estate scale, as work in Indonesia has shown that certain clones of *robusta* coffee are self-sterile, and large plantations of one such alone may give reduced yields (13).

Planting Out

Transplanting seedlings from the nursery into the field is done carefully in rainy weather. In the process all seedlings with deformed and twisted roots should be discarded, and if the tap root is too long and whippy it may be pruned back. To prevent excessive transpiration of the seedlings soon after transplanting, it is usual to cut all leaves in half, although this is not essential in

high rainfall areas. Young seedlings need a certain amount of shade and this should be provided in the form of *kakilla* or other jungle fern, or as described earlier under the section on opening up of land.

Vacancies should be supplied as soon after transplanting as possible, and should subsequently become a routine operation once a year. Where vacancies are being supplied in old coffee, the pits should be larger than usual and a fertilizer mixture should be given to enable the seedlings to grow rapidly and compete successfully with adult trees.

Shade

It has been shown by experiment that the efficiency of the leaves of the coffee plant in manufacturing food is at a maximum under diffused sunlight, and is reduced in intense sunlight as well as under excessive shade (14). Practical experience has also shown that the correct degree of shade is essential for the successful cultivation especially of *arabica* and *robusta* coffees, whereas liberian varieties can do with little or no shade. The provision of overhead shade has the added advantage that it aids in conserving the soil and can be made to serve as a wind-break, while it also provides plenty of loppings for green manurial purposes. The incidence of pests and diseases is also reduced in coffee growing under the appropriate degree of shade.

It is very important that the most suitable shade tree be selected for cultivation, keeping in mind the type of coffee grown and the climatic conditions of the area. Other considerations that should be kept in mind in selecting a variety of shade tree are rapidity of growth, a root system which competes little with the coffee crop for soil moisture and nutrients, and freedom from pests and diseases. *Albizzias, Erythrinas, Grevilleas* and *Gliricidia* are all used as cover, but under Peradeniya conditions *Leucaena glauca* has proved the most suitable. One disadvantage of this variety is that it does not root readily from cuttings and has to be established as seedlings. Other varieties which might prove suitable are *Derris dalbergioides, Derris robusta* and *Indigofera teysmanii.* Shade should be kept under control by periodic lopping, and the loppings used as mulch or green manure. The possibility of using bananas as a catch crop and as temporary shade for the first few years of a plantation should be borne in mind.

Soil Management

The establishment of a thick leguminous ground cover as early as possible, especially on newly opened land, is very important from the point of view of soil conservation. But it is as important in older coffee from the point of view of adding soil nutrients and weed control. Once the coffee and overhead shade are both well grown, it becomes more difficult to maintain a satisfactory cover, but by this time the shade provided by the trees themselves suppress weeds and protect the soil. During the first few years of a plantation it is also sometimes the practice to grow bushy leguminous green manure plants in strips between the rows of coffee. These are used as mulch or forked in periodically.

In areas which experience a fairly prolonged dry period, the cover crop,

bushy green manure and the shade trees may compete with the coffee for soil moisture, and this has to be guarded against. Investigations carried out in Kenya have shown that loss of soil moisture under such conditions was greatest with a vigorously growing cover crop, but least with a grass mulch (15). Thus, it is the practice under such climatic conditions to use the cover crop, bushy green manure and loppings from shade trees as cut mulch at the commencement of the dry period and then fork them in at the time of manuring, when the material will have rotted down and when the manuring will ensure that even a temporary state of nitrogen deficiency, due to the incorporation of highly carbonaceous material, will not take place. Guatamala grass has also been used with success as a mulching material.

No implemental cultivation, other than hand-forking, is carried out under local conditions.

Pruning

Coffee bears two kinds of branches, viz., (*a*) uprights which can produce other uprights and also laterals, and (*b*) laterals which can only produce laterals of a lower order but never give rise to uprights. In addition, the lateral branches of various orders as well as the leaves are borne in opposite pairs. This peculiar branching habit and the fact that flowers and fruits are borne only on young lateral-branch wood, determines the pruning of the coffee bush.

The purpose of pruning is to get rid of superfluous, unproductive wood from the coffee tree, and thus direct the vigour of the tree into producing more young lateral-branch wood which bears the crop. At the same time pruning aims at removing all diseased wood, and allowing light and air to penetrate the bush, while under certain systems of pruning another aim is to keep the bush down to a height within easy reach for harvesting. There are two main systems of pruning—the single-stem system and the multiple-stem system—each with its different modifications.

Single-Stem System. In this system, after the first year, all upright suckers or 'gormandizers' which grow from the bottom of the plant are continuously broken off while still tender and green. When the plants are about 6 ft. tall they are cut back or 'topped' at a height of about 4½ feet, removing with a slanting cut one primary lateral branch at the point of origin of a pair. This branch is removed to prevent the main stem from splitting down the middle due to the weight of two opposite branches. Pruning of lateral branches only becomes necessary in the third to fifth year of growth. Primary laterals are never touched, while the practice is to remove one of each pair of secondary and tertiary laterals alternately. At the same time, 'centering' or the removal of all suckers and secondary wood in close proximity to the main stem is carried out.

Multiple-Stem Systems. Although single-stem pruning is the method almost exclusively practised in Ceylon, various modifications of multiple-stem systems of pruning have come into prominence in other countries and merit attention if coffee is to be grown on a commercial scale in Ceylon too, especially as it has been claimed that the latter method produces more crop than

the former, while being less complicated and expensive (16). In one variation of the multiple-stem system, the young plants are topped at 12-15 inches and then again at about 36 inches from ground level, so that the tree develops four lateral branches. In the third year after transplanting the weakest of these four branches is removed and the three remaining branches are trained to form the permanent framework of the tree. This system of pruning is very similar to the single-stem system, the berries being still borne on secondary and tertiary lateral branches, except that the framework of the tree is supported by three branches instead of by one stem only. But other variations of the multiple-stem system of pruning are radically different in that bearing takes place on primary branches, which are constantly and regularly renewed, and no attempt is made to keep the bush down to a low height. In all cases, when one sucker has borne two to three crops it is removed and replaced by another which has been trained in the meantime. In this manner a large and regular supply of young wood is ensured, on which the tree bears large crops. One disadvantage of this method of pruning, however, is that cost of harvesting is high, since step-ladders may have to be used to pick the berries.

Stumping or 'rejuvenation pruning' is sometimes practised to develop a completely new aerial part of the tree on the old root-stock, or to convert single-stem trees into a multiple of stems. In such cases a sloping cut is made at the required height close to ground level and immediately dressed over with some wound disinfectant. Sucker growth soon takes place, and when one or more suckers have been selected the others are removed while still green and tender. In drier areas it is sometimes the practice to modify this method of stumping. All the primary branches on the stem, except for a few at the top of the tree, are removed flush with the stem. These latter serve to shade, and so encourage, the growth of a number of suckers from the base of the stem. When these latter are sufficiently grown, a selection is made as desired and the original stem removed as before (17).

All superfluous sucker growth should be removed when green and tender, but more mature wood should be carefully pruned with pruning knife or saw without leaving any snags. The best time for pruning is soon after the main fruiting season.

Manuring

There is little precise information on the manurial requirements of the coffee tree, except for the belief that it requires comparatively large quantities of nitrogen and potash but little phosphate, and manurial practices vary widely. But, as in other crops, if the best results are to be expected from the addition of expensive fertilizers, attention should first be paid to conservation of the soil and soil moisture, and to maintaining the good physical structure of the soil together with a good proportion of organic matter.

Most of the above requirements are met by the addition of organic matter to the soil, and the mulching and incorporation of the loppings of shade trees, green manures and cover crops should be carried out as a routine operation. When bulky plant residues are to be

incorporated into the soil it should be done in rows across the slope of the land. Compost, if available in sufficient quantity, may be applied at the rate of 2-2½ tons per acre; but if only available in limited quantity, as is often the case, is better utilized in backward areas which require it most.

In addition to the application of organic manures, the regular application of more concentrated and more readily available inorganic fertilizers is a necessity if the maximum yield is to be obtained. In the absence of experimental data under local conditions, no specific manurial recommendations can be made, but the following general fertilizer mixture per acre per annum, which is used at the Experiment Station, Peradeniya, seems to compare well with those recommended in other countries.

Sulphate of ammonia— 2 cwt.

Saphos phosphate— ½ to 2 cwt.

Sulphate of potash— 1 cwt.

On estates in which regular manuring has been done, there will usually be a tendency for residual phosphates to accumulate in the soil, and under such conditions this constituent in the mixture may be reduced to ½ cwt. per acre. The sulphate of potash is preferable to the muriate where the quality of the crop is important, as in coffee. The above mixture is preferably added in two doses, one in May or June and the other in December. If it has to be applied as one dose for the sake of economy, May or June is the best time. In adult coffee the mixture is enveloped, forked or broadcast and turned in. In young coffee it is best distributed in expanding circles round the tree.

In very rainy districts, soils tend to become acid and coffee does not thrive under such conditions. As such, periodic liming may become necessary. The lime requirement should be determined in consultation with a soil chemist.

Coffee may also at times show signs of chlorosis and yellowing, owing to either a deficiency of nitrogen in the soil or to more deep-seated causes arising from poor soil moisture conditions or nutritional unbalance in the tree caused by bad conditions of shading. Chlorosis caused by nitrogen deficiency is usually temporary and easily remedied with a special top-dressing of sulphate of ammonia at the rate of 1—2 cwt. per acre. The second type of chlorosis is more difficult to remedy and should be treated by attention to the shade, and stripping of the berries from trees which appear unable to stand the strain of bearing a large crop.

Harvesting and Yields

Under normal conditions trees begin to flower and bear fruit for the first time in about the third year from planting, but economic crops only begin to be realized after about the sixth year. The economic life of the coffee tree is generally considered to be from 30-50 years, depending mainly upon climate, but under good conditions of cultivation it may be prolonged beyond this.

Yield is seen to depend to a large extent on weather conditions at and after flowering, dry weather favouring flower bud or "spike" formation, but rain being generally required to induce the flower buds to blossom. Dry weather again seems to be required at flowering to ensure fruit setting, while a constant supply of moisture is needed by the young berries which have set and

begun to grow until ripening (18). The time taken from flowering to ripening depends on climate and variety, and in Ceylon the main fruiting season is from September to January with the *arabica* variety fruiting first, followed by *robusta* and then by *liberica.*

The fruit of the coffee tree—the berry or 'cherry'—usually contains two seeds, but sometimes only one of them develops at the expense of the other, giving rise to one large 'peaberry". Fruits with four or more seeds—'plurisperm fruits'—may also be borne.

Harvesting of berries is done by hand, only ripe berries being picked ; three to six pickings are necessary to complete a harvest. If immature berries are harvested and mixed with ripe ones, pulping becomes difficult and gives a high degree of breakage, while fermentation is also uneven, and the quality of the produce is impaired. Yields vary according to climate, variety and cultural conditions. In Ceylon *robusta* coffee yields 13-16 cwt. of fresh berries per acre. As the out-turn of parchment coffee from fresh berries is about 25-30 per cent. the yield should vary from 3 to 6 cwt. of parchment coffee per acre per annum.

Preparation for Market

To obtain commercial coffee the beans must be freed from the pulp, the 'parchment' and the 'silver skin'. Cleaning and grading then complete the process. There are two methods of preparation, the wet and the dry. The small grower usually prefers the dry method because it is simpler and cheaper, no elaborate and expensive equipment being required, and because it allows for mixed berries of different stages of ripeness to be treated together. But this method has the disadvantage that it is only practicable where the dry season is sufficiently long and coincides with the time of ripening. The trade, however, prefers coffee produced by the wet method as the product is cleaner and more uniform. On a plantation scale the latter method is usually preferred, as the initial outlay on equipment is compensated for by the better price fetched from coffee prepared in this way.

Dry Curing. In the dry method, the berries are exposed to the sun in thin layers 3-4 inches thick on a drying floor for 10-12 days, being constantly turned during this period. The berries may sometimes be graded before being sun-dried, the ripe berries which settle to the bottom of a water tank being treated separately from the green or withered berries which float. If wet weather is normally experienced during harvesting time, artificial drying may have to be resorted to, but coffee sun-dried at low temperatures is said to possess a better flavour than that dried artifically. Dry-cured coffee stores well, the dried pulp forming a hard protective covering round the beans. Finally, the dried pulp is removed by pounding in a mortar under village conditions or by hulling where larger quantities of berries are processed.

Wet Curing. In the wet method, the day's pick of berries should be pulped as soon as possible, preferably on the day of harvest itself. If this is not possible premature fermentation must be prevented by stacking the berries overnight in a tank of water or in heaps well moistened with water. Before pulping

any stones and grit that are mixed with the berries must be removed to prevent damage to the pulpers. For optimum efficiency of the pulpers, immature berries should be separated ; and if the berries vary considerably in size, two or more size grades treated separately. Pulping is one of the most important operations in the wet preparation of coffee. Ordinary pulping machines are of two different kinds—disc pulpers and breast pulpers. The latter are power-driven and can pulp more coffee in a given time than the former, which can be hand-operated or power-driven. With either kind of pulper, efficiency depends on regular feeding, a good flow of water, exact adjustment of the pulper to suit the size of berry being pulped, and a uniform speed of working. At the completion of each day's pulping the whole machine should be thoroughly washed down. The pulp should not be allowed to go waste, but may be collected, dried and used for manuring the coffee trees.

The next operation is **fermenting.** The need for fermentation arises from the fact that, soon after pulping, the parchment of the beans is covered with a sticky, saccharine slime which has to be removed before drying, or the beans quickly become mouldy in storage and acquire a musty smell. This gummy coating cannot be removed by washing alone, but fermentation causes it to disintegrate when it can be easily removed by washing. Unlike in cacao, fermentation does not seem to have any effect on the quality of the finished product, and it has recently been suggested that an alkaline carbonate could be used to achieve the same ends as fermentation (19), and that pecticenzymes be used to hasten and control the process (20). For a small crop, the pulped beans may be heaped and left covered with gunnies, but for larger crops fermenting boxes or tanks similar to those used for cacao fermentation become necessary.

The pulped berries are drained of water, placed in these tanks, covered and weighted down, when bacterial activity soon commences. The fermenting mass should be stirred and turned frequently to ensure even fermentation. The time taken for the correct degree of fermentation varies with the variety of coffee and the degree of ripeness of the berries at harvesting. A handful of sufficiently fermented beans when squeezed should give a slightly gritty feeling. At Peradeniya, fully ripe *robusta* coffee is fermented for 24-36 hours, but never more than 36 hours, while *arabica* coffee is fermented for a shorter period. Over-fermentation should be prevented at all costs, as this leads to a discolouration of the beans and reduces their value. A similar discolouration may be caused if the berries are left too long before they are pulped.

After the coffee has been adequately fermented it should be thoroughly washed in running water until all the stickiness has disappeared from the beans. This opportunity may be taken to separate light and inferior coffee from the better grades. Imperfect washing can result in fermentation recommencing, while dust and dirt may adhere to the parchment if any of the gummy substance is left on the beans and so again reduce its value. The Raoeng cylinder pulper avoids the necessity for fermentation, the pulping and washing being done in the same

operation by friction under pressure in water. The only apparent disadvantage of the machine is its cost, but this disadvantage seems to be offset by economy in labour and by the rapidity and cleanliness of preparation (21).

The coffee is now in the 'parchment' stage and has to be dried either in the sun or by means of artificial heat. Sun drying can be carried out on barbecues, wire trays, tables covered with jute hessian or on coir matting, but it should be noted that prolonged contact with metallic surfaces while drying is said to impair the quality of the coffee. The coffee should be spread thinly, and raked over frequently to ensure even drying and uniform colour of product. Although overdrying may result in the parchment splitting, the beans shrinking and shrivelling and the coffee becoming pale and discoloured, it is always safer to overdry than to underdry, as undried coffee may blacken in colour, become mouldy in storage and acquire a musty odour. If weather conditions at curing time normally do not permit of sun-drying, the use of artificial heat for drying may have to be resorted to, where like in cacao factories, the beans are spread thinly on lofts and heat conveyed to the lofts from a furnace through flues. The moisture-laden air is kept moving by means of fans. Under such conditions too rapid drying under very high temperatures should be avoided. It is sometimes the practice to sun-dry wet parchment coffee initially and then complete the drying in flue-heated barns.

Coffee is usually stored and sold by the grower as well dried parchment coffee. Milling or hulling, which involves the removal of the parchment and 'silver skin' and a certain amount of polishing, as well as grading are normally performed by firms at the port of export, the chief reason for this being the need for specialized and expensive equipment.

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Food Yeast–A Source of Proteins and Vitamins

C. CHARAVANAPAVAN

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THE AVERAGE Ceylonese diet is reported to be deficient in proteins of high biological value and B vitamins. This deficiency can be remedied by supplementing the diet with small doses of food yeast, which is rich in these constituents. Food yeast contains 5 per cent. moisture, 50 per cent. protein, 2 per cent. phosphorous, 2 milligrammes per cent. vitamin B1, 6 milligrammes per cent. vitamin B2, and 40 milligrammes per cent. of nicotinic acid. It also contains the other members of the vitamin B complex in balanced proportions including minerals like magnesium, potassium, calcium and iron. A daily dose of 3 grammes to 14 grammes of food yeast per person has been recommended by the British Medical Research Council (1).

The production of food yeast was investigated in England by Dr. A. C. Thaysen at the Teddington Research Laboratory. Ultimately, the large-scale manufacture of food yeast was undertaken in a factory in Jamaica. The raw material used was sugar cane molasses (2), (3).

Investigations were conducted in the Chemical Division of the Department of Agriculture, Peradeniya, using coconut water, the dried pulp of the palmyra fruit ("Pinattu") and sugar cane syrup, as raw materials for the production of food yeast.

Laboratory Investigations

A culture of the yeast—*Torulopsis utilis* (variety *major*) was obtained from the Government Mycologist, Coimbatore, India, and maintained by the Plant Pathologist of the Department of Agriculture, Peradeniya.

As many as 40 tube cultures were prepared and allowed to grow for 3 weeks at 25°C. The tubes contained nutrient agar slants of the following composition— 2 per cent. cane sugar, 1 per cent. ammonium nitrate, 0.5 per cent. potassium dihydrogen phosphate, 0.25 per cent. magnesium sulphate and 2 per cent. agar. The tubes were sterilized for half an hour at 15 lb. per sq. in. pressure and allowed to cool before inoculation with yeast.

The yeast from each tube was washed with distilled water into a flask containing 250 c.c. of liquid nutrient medium of the same composition as the nutrient agar but without the agar. The medium was sterilized by boiling and allowed to cool before inoculation with yeast. The 40 flask cultures were shaken once daily for one week.

A laboratory food yeast generator was then assembled. It consisted of the following items :—

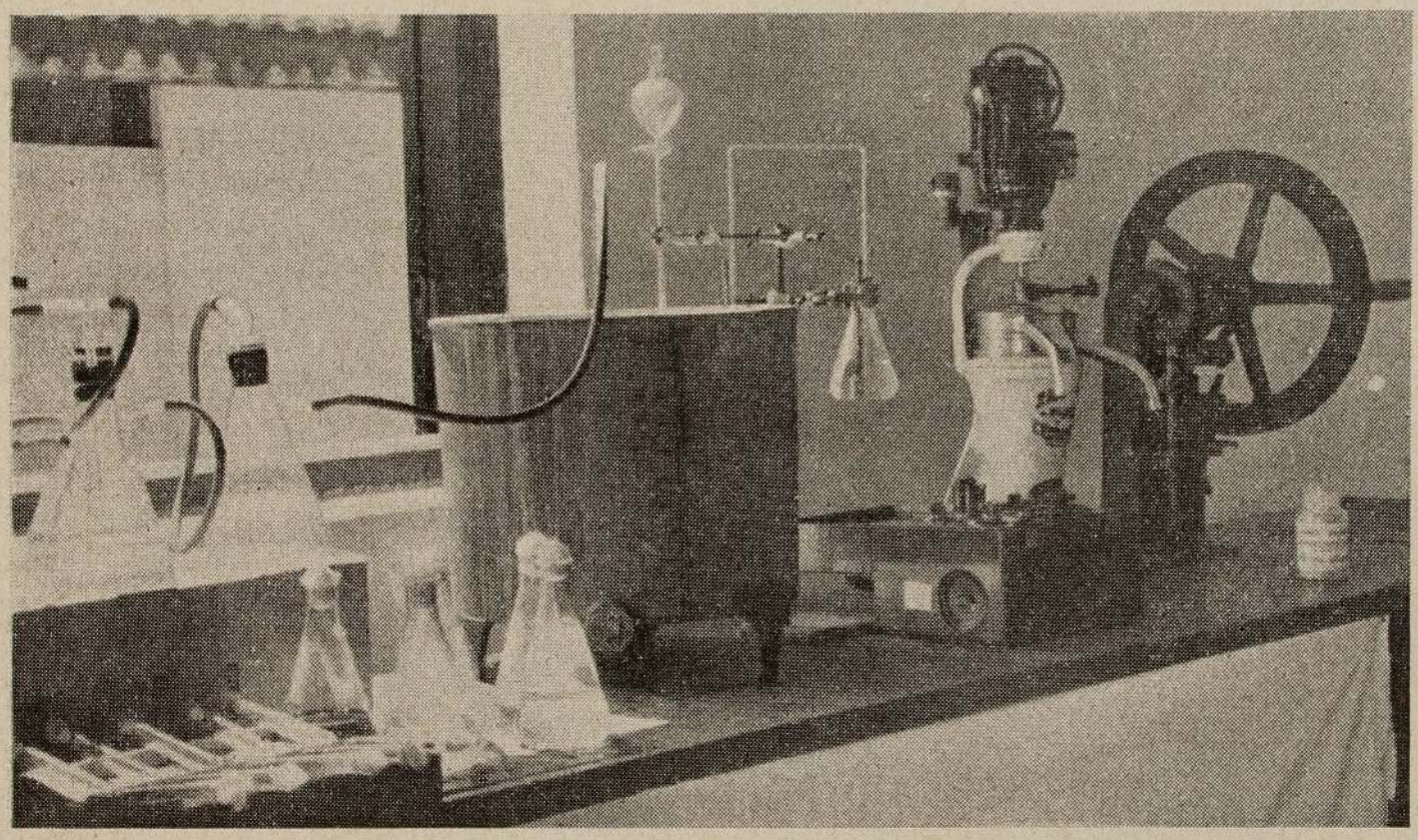
1. A cast iron vessel—enamelled inside—of capacity 10 gallons.
2. An electrically operated air blower with air tank, control valves and pressure gauge.
3. Three porous ceramic candles—type Aerox P. 32, fixed at the bottom of the cast iron vessel.
4. An arrangement for purifying air, viz. :
   (*a*) One flask containing glass wool smeared with glycerine to trap dust.

(*b*) One flask containing concentrated sulphuric acid to destroy bacteria.

(*c*) One flask containing distilled water to absorb sulphuric acid fumes.

5. A *p*H meter with antimony electrodes.
6. Sharples Centrifuge.
7. A stringhopper mould.
8. An electric oven with fan to create draught..
9. An electric grinding mill.
10. A tablet-making machine.

A photograph accompanying this article, shows the layout of the equipment.



The yeast generated in the 40 flask cultures was poured with the medium into the cast iron enamelled vessel. The pH of the medium was adjusted to 4.8 with 10 per cent. sulphuric acid. The medium containing the yeast was aerated with clean air and the *p*H which began to fall was maintained at 4.8 by the addition of 10 per cent. aqueous ammonia at half-hourly intervals. The generation was continued for 8 hours. The yeast was then separated from the medium by means of the Sharples Centrifuge. The yeast which was separated in the form of a paste was stored in a refrigerator, to be used as seed yeast in the generation of food yeast from coconut water, "Pinattu" and sugar cane syrup, respectively.

In the case of coconut water, the impurities present were removed by straining through muslin cloth. The sugar content was found to be about 1.5 per cent. The coconut water was diluted with clean water to a strength of 1 per cent. sugar. Five gallons of the

diluted coconut water were treated with 200 c.c. of a solution of ammonium phosphate prepared as follows :—

100 grammes of arsenic free superphosphate of lime were treated with 800 c.c. of water and 1.5 c.c. of concentrated sulphuric acid. The mixture was boiled for half an hour and allowed to settle. The clear supernatant liquid was decanted. To 500 c.c. of this solution was added 50 c.c. of a solution of ammonium sulphate prepared by dissolving 20 grammes of ammonium sulphate in 40 c.c. of water. The precipitate formed was allowed to settle and the clear liquid was filtered and used.

The bulk medium so prepared was sterilized by boiling and allowed to cool. This was then poured into the generating vat. Seed yeast in weight equivalent to 20 per cent. of the total quantity of sugar in the medium, was added. The *p*H was adjusted to 4.8 by adding 10 per cent. sulphuric acid. The medium was then ærated, and the *p*H was maintained at 4.8 by the addition of 10 per cent. aqueous ammonia at half-hourly intervals. The concentration of sugar was maintained at 1 per cent. by the addition of sterilized undiluted coconut water, every hour, until one hour before stopping the generation. The generation was continued for 8 hours. The yeast was separated by centrifuging and washed by mixing with clean water and centrifuged again. The paste of yeast obtained was squeezed through a stringhopper mould on to drying trays and dried to a moisture content of 5 per cent. in an electric oven at 70°C. for 7 hours. Pathogenic organisms that may infect the yeast are destroyed when drying at 70°C.

In the case of "Pinattu" which contains about 50 per cent. sugar, and sugar cane syrup which contains about 70 per cent. sugar, the impurities were removed by dissolving the raw materials in three times the quantity of water by weight. The mixture was brought to the boil and treated with superphosphate of lime in weight equal to 1 per cent. of the sugar present in the raw material. The solution was made neutral to litmus by the addition of 10 per cent. sodium hydroxide. The precipitate formed was allowed to settle on cooling and a clear solution was obtained by centrifuging. The clear solution so obtained was diluted with clean water to give 1 per cent. sugar in the final solution. Five gallons of this solution were treated with 200 c.c. of ammonium phosphate solution as in the case of coconut water described earlier. The process of yeast production was carried out in the same way as described under coconut water.

In the case of all these three raw materials used, it was found that the yields of food yeast were of the order of 45 per cent. to 50 per cent. of the total quantity of sugar used in the generation. This indicated that coconut water, "Pinattu" and sugar cane syrup were all equally suitable for food yeast production.

In the case of "Pinattu"—dried palmyra fruit pulp—it was found that extensive frothing was produced during the generation, due to the presence of small quantities of some unknown froth producing principle. This was overcome by the addition of 0.015 per cent. by volume of oleic acid which is recommended to overcome undue frothing in yeast production (4).

The food yeast produced from these three raw materials had, at a moisture level of 5 per cent., protein contents

ranging from 46 per cent. to 52 per cent. The vitamin B1 contents were in the order of 2 milligrammes per cent. to 4 milligrammes per cent.

The dried food yeast produced was ground into a powder by means of the electric grinding mill and converted into tablets by means of a tablet-making machine.

Factory-scale Production

The manufacture of food yeast on a large scale in Ceylon depends primarily on the availability of a cheap raw material containing sugar. Coconut water is available as a by-product in the copra-producing centres in the Western and North-Western Provinces. The water from as many as a million nuts per day would be required to operate the smallest commercial plant producing 1,000 pounds of food yeast per day. It may be feasible to collect the required quantity of coconut water from a number of copra factories in a large centre, to feed the food yeast plant. The plant alone may cost nearly five lakhs of rupees. The building might cost about 2 lakhs of rupees, together with other ancillary units.

Dried palmyra fruit pulp, "Pinattu", can be produced in large quantities in the Jaffna District at a nominal price of about 10 cents per pound. About 4,000 pounds of "Pinattu" would be required per day to operate a plant producing 1,000 lb. of food yeast per day. "Pinattu" can be produced in large quantities in the Jaffna District during the palmyra fruit season in the dry months of July to October. According to the 1946 census, there are as many as 5,120 acres under palmyra in the Jaffna District (5). In this acreage, it can be estimated that there would be nearly 2,500,000 palmyra trees, of which about a million trees would be fruit-bearing trees. Assuming that a fruit-bearing tree can yield as many as 40 fruits on the average per season, as many as 40 million fruits are available per year for the production of "Pinattu" as a cottage industry. If only quarter of this number of fruits is collected, about 1,200,000 lb. of "Pinattu" can be produced per year during the palmyra fruit season. This would ensure a supply of about 4,000 lb. of "Pinattu" for use per day to work a plant producing 1,000 pounds of food yeast per day for 300 days per year.

Considering the above factors, it appears to be quite feasible that food yeast can be manufactured on a large scale in Ceylon. Two factories, one in the copra area and one in the palmyra area, would produce in all about 300 tons of food yeast per year. This quantity of yeast can be easily consumed by the local population on the basis of the requirements to overcome malnutrition, as mentioned earlier in this article.

The cost of production has been worked out as about 1 shilling for a pound of food yeast in Jamaica, while it has been worked out as only 6 annas per pound in India, where food yeast can be produced from cheap molasses which is a by-product of the sugar industry.

In Ceylon, owing to high labour costs, it may not be possible to manufacture food yeast at such low costs of production. However, judging from the figures quoted from Jamaica and India, and even at a price of 2 cents per gallon of coconut water which is normally thrown away at the copra factories, and 10 cents per pound of "Pinattu", it can safely be assessed that the cost of production of food yeast would not exceed two

rupees per pound. If the selling price of the yeast is fixed at three rupees per pound, the cost of a daily dose of quarter ounce of food yeast per person, on the average, would not exceed 5 cents.

Acknowledgments

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A Modified 'Deep Litter' System for Poultry

J. S. L. WHITE

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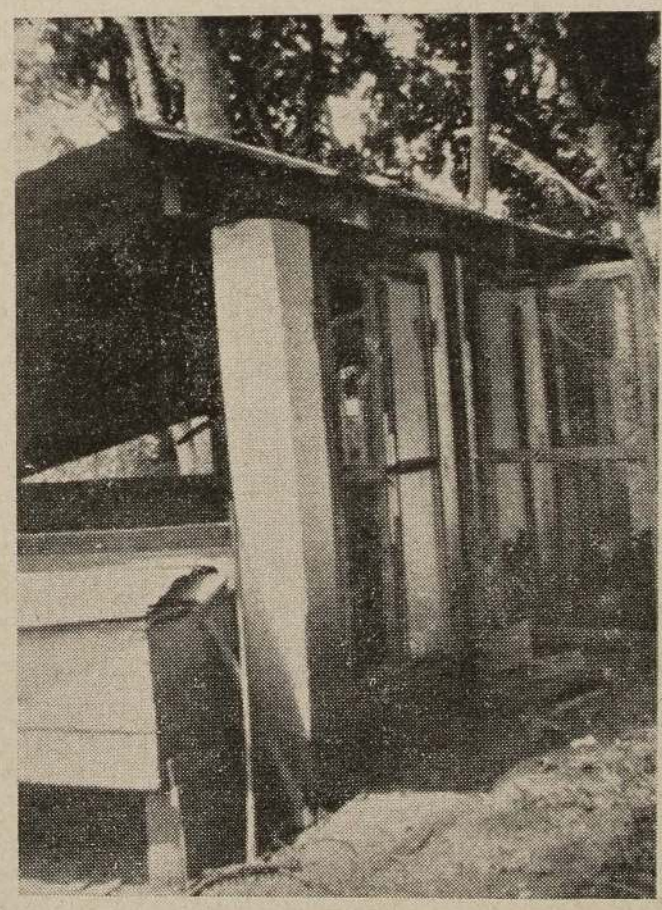
THE STRICT deep litter system of rearing poultry is an intensive system in which birds are continually confined to a well ventilated house, the floor of which is built up to about one foot with an absorbent material such as paddy chaff, saw dust, chopped straw or a mixture of these. This litter is stirred frequently and not removed for about one year. The house is a self contained unit, the birds being provided with all their needs—food, water, laying nests and perches. In this system nutrition is very important and rations have to be perfectly balanced to ensure that the birds receive all their protein, carbohydrate, vitamin and mineral requirements. In countries with severe winters this system is ideal as there is no other alternative but to keep birds indoors, while in tropical countries it is becoming popular especially where land is limited. In Ceylon until very recently this system was not adopted at all. Just a few poultrymen are now trying it with success.

It is a generally accepted principle that the deep litter cannot be worked successfully, unless the birds are confined to the house all the year round. This article gives details of a study carried out by the writer at St. Anthony's College, Kandy, where birds were housed on deep litter and also allowed the advantage of natural pasture.

Particulars of Housing

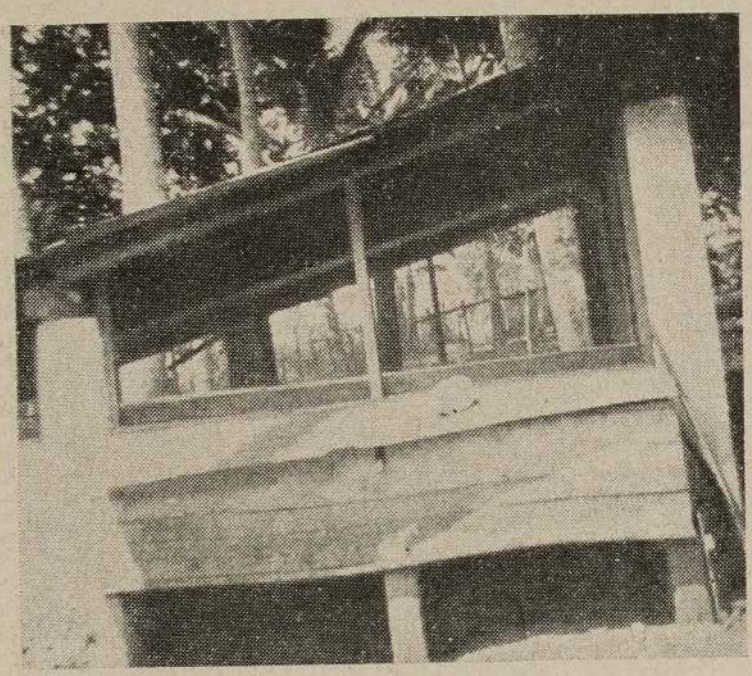
The house, internal dimensions of which were 17 ft. long and 12½ ft. broad, consisted of a floor paved with bricks, roughly cemented and a wall three feet high and four and half inches wide, on the sides and behind. In front, the wall was only 1 ft. high and above it were three separate entrances to the house, the doors of which were made of half inch wire-netting. The space on the sides, between the walls and roof was



Front view of Deep Litter House

also covered with half inch wire-netting. The roof was a 'lean-to' made of galvanized iron sheeting with a hood in front to keep off driving rain. Ample shade was provided by a large tree close

to the house. The house was a self-contained unit with movable perches, tunnel-type community laying nests, metal feed troughs and waterers. The essential features of the house were proper ventilation and freedom from dampness. Each of the three runs adjoining this building was about 1/24th acre in extent, the total area of runs being about 1/8th acre.



Side view of House showing Tunnel-type nesting box

Stock

Two hundred Australorp chicks, one day old, were obtained from the Government Farm, Ambepussa on the 24th November, 1953, and reared on wire-netting-floor brooders, up to the end of two months. At the end of this period they were transferred to natural pasture consisting predominantly of *Axonopus compressus* approximately 1/8th acre in extent. They were housed at night in slatted-bottom range shelters. 168 chickens survived at this stage ; the majority of deaths was due to cannibalism and overcrowding as a result of the runs not being ready to transfer them to the range earlier. There were no deaths subsequently. On the thirtieth of April, 1954, at the age of five months approximately, there were seventy five pullets of which seventy one were transferred to the deep litter house.

Litter Management

Before introducing the birds, about 10 lb. of lime were sprinkled on the floor and over this was spread a four inch layer of paddy chaff. This litter was lightly stirred every day and thoroughly stirred and turned over once a week. It was built up to a depth of 10 in. by addition of about 1½ in. fresh paddy chaff once a month up to the end of four months. Thereafter, no more paddy chaff was added. Air-slaked lime was sprinkled once in two months after the sixth month at the rate of about 1 lb. for every 20 sq. ft. and mixed with the litter. The litter remained in very good condition up to the end of one year, free from dampness and bad odours.

Something noteworthy was the fact that hardly any flies were present at any time. The litter was completely removed at the end of April, 1955, exactly one year after it was first put in and fresh litter was introduced.

Feeding and Management of Flock

Chicks were given broken grain only on the first two days after hatching out. After that dry mash was supplied *ad libitum* (1). Tender grass was made available after the second week, and so was Cod Liver Oil mixed with the mash at one teaspoonful per two pounds mash. No other supplements or antibiotics were given. After the second month the Cod Liver Oil was given only three times a week and after four and half

months only twice a week. Ample water was available at all times. Vaccination against 'Fowl Pox' was done at ten days of age and innoculation against Ranikhet at three and half months. The sexes were separated at three months. Phenothiazin in the form of 'Phenovis' was administered according to directions, mixed with the mesh, at four months of age, again on the twenty seventh April, 1955, just before putting the birds into the deep litter house, and thereafter once a month.

On the thirtieth April, 1954 there were seventy five pullets in all, of which four were culled and seventy one introduced to the deep litter house. The floor space per bird was 3 sq. ft.

Dry mash and water were kept in the house and were available to the birds at all times. Shell grit was provided in a separate container. The birds had access to the pasture in the runs from 9 a.m. to 5 p.m. every day except on very wet days when they were confined to the house. Each run was used for one month at a time and regularly rotated. The pasture looked better at the end of one year than at the beginning except for a bare patch near each entrance to the house, due to excessive trampling and grazing.

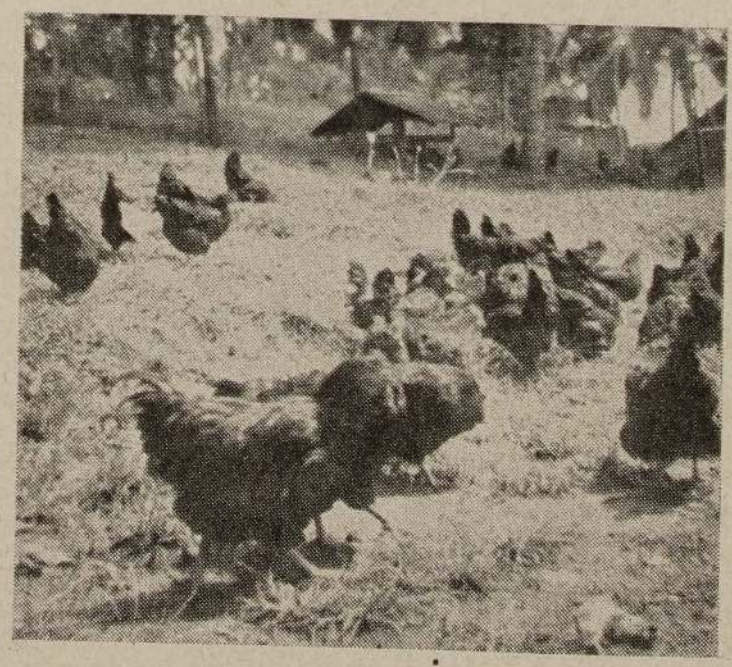
The following mash mixtures were used for chicks and growers respectively :—

Ingredients	*0–8 weeks (chicks)*	*9 weeks to 4¼ months (growers)*
Maize meal	50%	44%
Coconut poonac (" Expeller ")	6%	15%
Fish Meal	22%	18%
Rice bran (Grade I) ..	20%	20%
Skim milk powder ..	2%	1%
Sterilized bone meal ..	—	1½%
Salt	—	½%

The mash mixture for pullets older than 4½ months and hens is given below. It will be noted that 'Morlac' coconut poonac which contains only two per cent. fat was substituted for expeller coconut poonac. The former was not available earlier. No whole grain of any kind was given.

Maize meal	38%
Coconut poonac " Morlac " ..	30%
Fish Meal	8%
Rice bran (Grade I)	20%
Sterilized bone meal	1½%
Oyster shell (ground)	2%
Salt	½%

The birds were in perfect health throughout and did not show even the semblance of a cold or any other ailment. The precaution of dusting the laying nests and litter lightly with Gamexane powder once a month was taken. External parasites such as lice were absent. There was no cannibalism or egg eating. The quality of eggs both external and internal was very good. Broody hens were promptly dealt with by removing them to an adjoining run



Flock at the end of the first year, showing rich pasture and broody house in the background

with a separate night house and supplying them ample food and water. Most of these hens came back into production in three or four days after this treatment.

Six cockerels from the same batch as the pullets, were introduced to the house at the end of June, 1954, and a week later hatching commenced. Fertility and hatchability were good. Results of the first three hatches are shown in the following table :—

Eggs Set	*Date*	*Infertile*	*Hatched out*
50	3. 7.54	9	32
55	28. 7.54	4	44
56	9. 9.54	3	44

On the 14th August, 1954 six backward pullets were culled. On the 18th August another pullet was culled because of an injury. On the 8th December, 1954, three more pullets were killed by pole-cat. Sixty-one pullets were left.

Egg Production

The following are monthly egg production figures :—

Month	*No. of Pullets*	*No. of Eggs*
1954 :		
May	71	444
June	71	1346
July	71	1,333
August	65	1,146
September	64	1,089
October	64	1,087
November	64	1,071
December	61	964
1955 :		
January	61	1,010
February	61	822
March	61	1,035
April	61	971
May (up to 24th)	61	507
	Total	12,825

On the 24th May, 1954, when the birds were six months old, 24 eggs were laid while one week later on the first of June there were 40 eggs. There was no appreciable difference in egg production during any of the months except of course in May, 1954, when the pullets had just come into production and in May, 1955 when they were moulting. First signs of the moulting of the primaries were observed after eleven months of continuous production. Every bird was handled at the end of the period under review. All were in very good condition except seven that showed signs of putting on fat and four that were underweight. Handling revealed that the majority of the birds had commenced moulting their primaries, some were about half way through their moult, while a few had not commenced at all.

The average egg production per bird was as follows :—

(*a*) 171 eggs—based on the unculled population of 75 pullets originally in the flock.

(*b*) 180 eggs—based on the 71 pullets housed.

(c) 197 eggs—based on the average number of pullets, during the year, i.e., 65.

Such a high average for a flock of this size has not been recorded before in Ceylon and shows what results can be achieved with proper feeding and management of the stock presently in this country.

Acknowledgment

My sincere thanks are due to the Principal of St. Anthony's College, Kandy, who so willingly constructed the buildings and gave me all the co-operation and assistance to make this study possible.

Reference

(1) WHITE, J. S. L. (1954). "A feeding trial with chickens under backyard conditions", *Tropical Agriculturist, Vol. CXI. 1955.*

Rice in California

M. F. CHANDRARATNA

In October, 1954, the generosity of the Asia Foundation made it possible for me to visit rice research centres and production areas in the U. S. A. The following account of California's rice industry, and of the contribution made to it by the rice breeders and agronomists in that state is the outcome of that tour.

California and the three southern states, Texas, Louisiana and Arkansas, contribute the bulk of the rice produced in the U. S. A.; acreages and production figures for 1953 are listed below :

States	*Paddy Acreage*		*Paddy Production*	
	Acres	*Per Cent.*	*Centals*	*Per Cent.*
California	394,207	18·4	12,154,547	22·8
Texas	573,385	26·8	14,666,571	27·5
Louisiana	604,505	28·3	12,220,387	22·9
Arkansas	485,152	22·7	12,311,378	23·1
Total for the U. S. A. ..	2,139,274	100·0	53,328,125	100·0

California's rice acreage in 1954 approximated 450,000. Of the major rice-producing states, California's industry is the youngest. When yields of wheat and barley on the heavy adobe clays of the Sacramento and San Joaquin Valleys commenced declining rapidly, farmers turned to rice. In 1908, for the first time in California, an experimental area of 40 acres near Biggs was planted in Japanese varieties. Commercial production commenced after the establishment in 1912 of the Biggs Rice Experiment Station, on land and finances provided by the Sacramento Valley Grain Association. Sacramento and San Joaquin soils appeared eminently suitable for rice. The heavy clays permitted the maturing of a rice crop with four acre-feet of irrigation water. These soils crusted and cracked when drained before harvesting, and were capable of carrying combines. Moreover, temperatures were sufficiently high, although occasionally cold water damage was recorded.

Biggs Rice Experiment Station

The Biggs Station, which bred the varieties and perfected the cultural practices in use in the state, may be said to have parturated California's rice industry. The station, whose initial extent of 56 acres has expanded to 127, has been particularly fortunate in its succession of Superintendents: Mr. E. L. Adams (1912-18), Mr. Jenkin W. Jones (1918-31), Mr. Loren L. Davis (1931-47), Mr. A. H. Williams (1947-53)

and Mr. Dwight C. Finfrock (1954-). These eminent men made California's thriving rice industry possible.

The Sacramento Valley Grain Association, under whose auspices the station was opened, has been reconstituted under the name California Rice Research Foundation Inc. This foundation contributes 25 cents per bag of paddy milled to a fund devoted to rice research. The expansion of both the staff and scope of the Biggs Station has accordingly become possible. Dr. J. R. Thysell who has had extensive experience of rice in Thailand is a recent recruit to Biggs and heads the breeding section. The station maintains close liaison with research workers in the University of California. Dr. D. S. Mikkelsen of the University directs the fertilizer investigations at Biggs.

Varieties

California's rice industry is based on varieties bred at Biggs. The short-grain "pearl" varieties of California possess a large proportion of *japonica* blood. From the commencement of commercial cultivation in 1912 till about 1921, when breeders at Biggs released Caloro, varieties native to Japan, like Watari-bune and Shinriki, were grown. Caloro is a bold-grained, short-awned, widely adaptable, high-yielding, photoperiod-sensitive variety that can mature in 150 days. The grain shows "abdominal white", and does not mill too well. Nevertheless, Caloro commands the greatest popularity in California.

Colusa 1,600, which was released in 1917, never covered more than a fraction of the acreage under Caloro. It is also bold-grained, but possesses higher fertilizer response and less sensitivity to the photoperiod. It is, moreover, about 15 days earlier. The sterility caused by low temperatures at pollination is particularly high in Colusa.

Cody, which derives from the cross Colusa × Lady Wright, is stiff-strawed, but has never been extensively grown.

The desire to produce a fine-grained rice has dominated breeding programmes in California for many years. The antecedents of the medium-grained selections Calady 40 and Calrose are indicated below :

CALORO (*Short-grain*) × LADY WRIGHT (*Long-grain*)

CALORO × CALADY 40 (*Medium-grain*)

CALROSE (*Medium-grain*)

Calady 40 and Calrose were released in 1940 and 1947 respectively. Although Calady 40 mills well, it has not found favour with farmers. It is about a week later than Caloro, and, on account of its lush growth, does not combine well. Calrose is as early and as high-yielding as Caloro, but has a longer grain and better milling performance. In 1953, Calrose covered 4.5 per cent. of California's rice acreage. In view of the known antecedents of all these selections, one would expect them to possess high tillering capacity. Under the conditions of dense seeding that obtain in California, however, tillering is surprisingly sparse.

Dr. Thysell has an extensive range of introductions from Japan, Korea, Italy and Iran under test at Biggs. Selections

for earliness, grain length and straw strength will be used for grading up Caloro and Calrose.

Rotations

Nearly three-fourths of California's rice acreage follows the "idle fallow" system under which rice alternates annually with a weed fallow. The rest of the rice acreage is either cropped continuously in rice or carries rotations with a variety of crops. The number of crops that thrive on the heavy clays that compose most of California's rice soils is not large. The lighter soils are more versatile and carry a greater diversity of crops. Wheat, barley, beans, safflower and sugar beets rotate with rice in California. These crops are rarely as profitable as rice.

Tillage

The heavy adobe clays are difficult to work. The land is spring-ploughed to a depth of 4-6 inches. The lighter soils are often disced except where continuous cropping or the "idle fallow" system prevails. Preparation is completed by harrowing and dragging. Too fine a seedbed promotes the drift of rice seed and the growth of weed, and is accordingly avoided. Dikers reconstruct levees in each season.

Seeding

Seed soaked for two days is broadcast by airplane at the rate of 150 lb. per acre direct on the water, immediately after flooding of the fields. A long interval between flooding and seeding allows time for weed and algal growth, and aggravates anaerobic conditions with consequent damage to germination. The practice of seeding into standing water contributes to weed control, and if fungus and bacterial damage to germinating seed is not excessive under the high temperatures that obtain in Ceylon, the practice may have value in the rain-fed areas in this country.

Fertilizer Practice

It is only to nitrogen that California's rice soils show striking response. The application of phosphate and potash usually gives no apparent benefit. Trials at Biggs indicate that the optimum dose of nitrogen is about 40 lb. per acre. Maximum yields are obtained at about 60 lb. N per acre. Heavy applications of nitrogen may force flowering into periods of falling temperature, and cause high sterility.

The nitrogen fertilizers in general use are ammonium sulphate, urea and calcium cyanamide. At the same nitrogen content, these fertilizers appear to be equipotent. Ammonium sulphate is often top-dressed by airplane within two months of seeding. Nitrogen placement has been the subject of investigation by Dr. D. S. Mikklesen at Biggs. Fertilizer drilled four inches deep has given yield increases of 36 per cent. as against increases of 11 per cent. with broadcast fertilizer.

The use of anhydrous ammonia is being explored at Biggs in collaboration with the Shell Chemical Co. The practice of injecting ammonia into the soil has given strikingly high yields, and is extending steadily.

Weeds

Since its introduction in 1946, the use of the weedicide, 2, 4-D has spread steadily and now extends to over half

of California's rice area. The possibility of serious damage to adjacent cotton crops excludes the use of 2, 4-D from the rice tracts in the San Joaquin Valley 2, 4-D is generally satisfactory but the prevalence of high temperatures at or after spraying, and the use of high concentrations cause considerable damage even to rice. A spray strength of 18-24 oz. per acre is recommended. Studies at Biggs indicate that the optimum spraying time is about 50 days after seeding. Very early and very late sprayings depress rice yields.

In recent tests, 2, 4, 5-T has proved less injurious to rice, but is also less effective weedicidally than 2, 4-D. MCP is almost as innocuous to rice as 2, 4, 5-T, and is as potent a weedicide as 2, 4-D. Its high cost, however, prevents its general use.

Unfortunately, the ubiquitous watergrass (*Echinochloa* spp.) resists both 2, 4-D and MCP. Submergence for about three weeks is necessary for the control of watergrass. Water plantain (*Alisma plantago*), redstem (*Ammannia coccinea*), bulrush (*Scirpus fluviatilis* and *S. mucronatus*) and burhead (*Echinodorus cordifolius*) succumb readily to 2, 4-D.

Rice farmers agree that their most obnoxious weed is red rice. One red grain in 200 places the grade of rice below No. 1. Farmers fight this menace by using clean seed and avoiding infested fields.

Crop Hazards

The rice crops that I saw in Sacramento number among the cleanest I have seen in any part of the world. The diseases and pests that ravage rice in most countries are conspicuously scarce in California. About the only grave hazard to Californian rice is cold-water damage. Fields irrigated from main channels may suffer severe injury in the area surrounding the point of water intake. Affected portions amounting to 20 per cent. of a field may be left unharvested. Research in California indicates that water temperatures below 70°F. damage the rice crop. Methods of minimizing cold-water injury include the use of prewarming basins and reduction in the intake of irrigation water.

The Cultivation and Curing of Cigar Wrapper Tobacco

S. V. MANUEL PILLAI

THE CIGAR consists of three portions of tobacco leaf : the filler, the binder, and the wrapper, in the proportion of about 85, 10 and 5 respectively. Countries which produce high quality cigars use tobacco leaves of different types for the filler, binder, and the wrapper ; each having its own particular qualities contributed by inherent and environmental factors. Of these the wrapper is the most important, as the finish, appearance and, to a certain extent, the burning quality depend on it. The leaves of certain varieties of *Nicotiana tabacum* only can be used as wrappers. Sumatra produces the world's best wrapper tobacco, where it is cultivated under the natural conditions prevailing there. Experiments conducted in Florida from 1900 indicated that thin wrapper tobacco, comparable with what is imported from Sumatra, could be produced by growing tobacco under artificial shade. The area under wrapper tobacco consequently has steadily increased to about 15,000 acres at present. Production of this type of tobacco requires a large amount of capital investment to provide shade over the entire field. Shade reduces sunlight and makes it possible to grow thin leaves of fine silky texture.

The general methods adopted in regard to the care and maintenance of nursery and preparatory tillage of the field are the same as for cigar and cheroot tobacco. Light sandy soils, sandy loams and alluvial soils are suitable. Slightly acid or neutral soils favour the production of good quality tobacco. Seedlings are transplanted eighteen inches in rows which are spaced two feet apart. Weeding and intercultivation are carried out in the usual way.

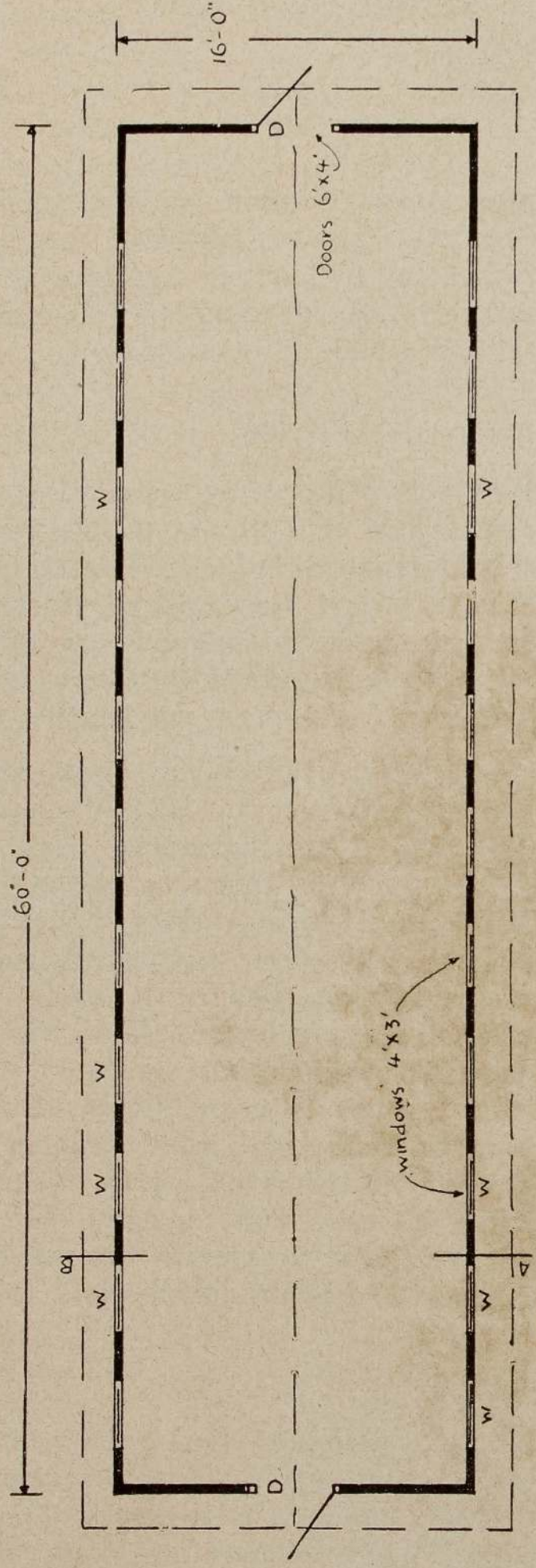
After-care of Crop

Wrapper tobacco is not topped as the object is to get thin leaves. The plants should be supported with bamboo chips or thin twigs of trees to prevent lodging and consequent damage. Irrigation should be quite frequent so as to maintain humid and warm conditions.

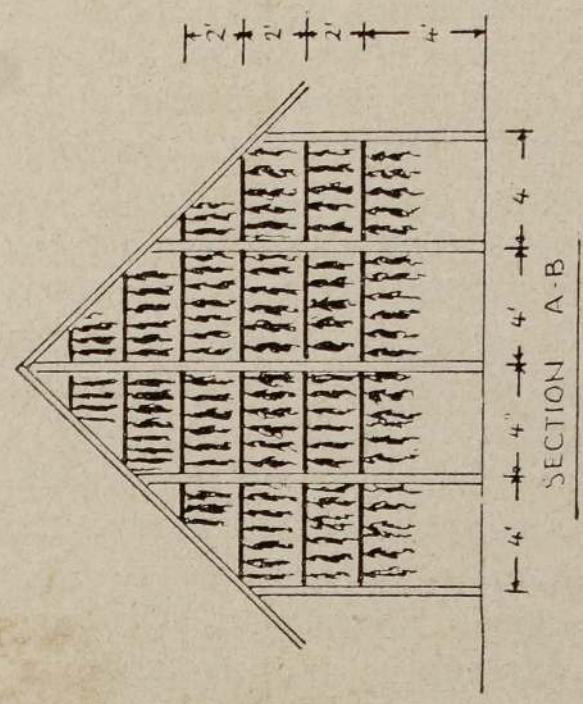
Harvesting commences from about two months from the date of planting. The leaves are harvested from the bottom upwards, removing two to three leaves at a time, depending on maturity as indicated by the light green colour and incipient yellowing along the margin. Harvesting is done in the evening and the leaves are allowed to wilt at night. Scissors should be used for harvesting to avoid damage to leaves. The harvested leaves should be collected the next morning in flat baskets, lined with moist hessian cloth and removed to the curing room.

Curing

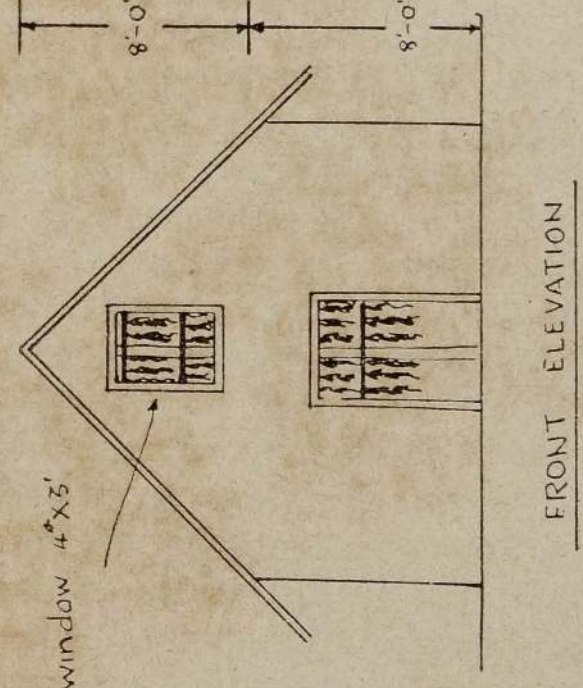
A well constructed room with windows and ventilators to regulate the temperature and humidity is necessary. Wooden tiers 2 feet vertically and 4 feet horizontally are constructed as in the case of a flue curing barn.



GROUND PLAN



SECTION A-B



FRONT ELEVATION

PLAN OF A CURING BARN

Wrapper tobacco leaves are strung in pairs, with backs touching each other, through a three-pliered jute thread, passing the threaded needle through the midrib of the leaves about one inch from the base. About 30 leaves are strung on a string four feet long. The free ends of the string are tied to a stick about 4½ feet in length and 1½ inches in diameter. A dry and wet bulb thermometer is fixed in the centre of the curing room. The ventilators are adjusted in such a way that the difference between the dry and the wet bulb thermometers is 5°F. to 7°F. in the early stage and about 7°F. to 10°F. in the latter stage of curing. If the difference is less, the ventilators may be opened, and closed it more. If necessary water may be sprinkled on the floor of the room. Curing is completed in two to three weeks after stringing. Leaves wilt, turn yellow first and finally to light brown and the midrib starts drying. Soon after the midribs become completely dry, the leaves are removed when they are in a pliable condition and tied in bundles. Properly matured leaves cure to a light brown colour with good shine ; immature ones to a dull colour and over-mature leaves (i.e., when the yellowing is pronounced) cure to a dark brown colour.

The tobacco is fermented in rectangular bulks, and the bulks are turned over till the temperature is about 115°F. to 120°F. Three to five turnings are necessary. During fermentation and storage for about a year, the leaf burn improves and the aroma is refined due to loss of nitrogenous compounds. The burning quality is governed, however, by the ratio of potassium to chlorine originally present in the leaf. The loss of chlorine is very negligible in storage. Fermentation tends to distribute the leaf-burn more uniformly over the entire leaf. The proper humidity should be maintained during storage. The leaves must be stacked in a raised wooden platform four inches from ground level. This facilitates aeration. Water may be sprinkled if necessary in the room. Finally the tobacco is graded according to colour, size and soundness of leaves. The colour desired is lustrous light brown. Good wrapper tobacco should have thin veins, be uniform in colour, silky in texture, elastic, and of low ignition point.

For good burning the potash content must not be less than 2.5 per cent., chlorine not more than 0.4 per cent. and nitrogen less than 4 per cent. Potash promotes softness in the cured leaves by encouraging the absorption of moisture and this facilitates handling. The fire-holding capacity is dependent on the potassium salts ; but an excess makes the ash dark in colour.

Quality in tobacco is a complex factor and varies according to the likes and dislikes of individuals. Quality is judged in smoking. If the smoke is alkaline it irritates the throat. As the nitrogen content increases the alkalinity of the smoke also increases. An acid smoke is what is required and a high sugar content is conducive to an acid smoke. About 160 leaves make up one pound and are sufficient to make 1,000 five-inch long cigars.

Reference

Annual Report on Tobacco Statistics, U. S. D. A.

DEPARTMENTAL NOTES

Rehabilitation of the Citronella Oil Industry in Ceylon

(Extract from the Report of the Inter-Departmental Committee)

SUMMARY AND RECOMMENDATIONS

1. EXPERIMENTS conducted by the Department of Agriculture have revealed that manuring is very effective in increasing the yield of oil per acre of citronella grass. The increase in yield of oil under experimental conditions from manured plots has been found to be three to four times that from unmanured plots. The extra cost of manuring as recommended by the Department would be more than compensated for by the resulting increase in oil.

2. The Department of Agriculture should conduct experiments in a typical citronella area to test out strains of *lenabatu* from plantations reputed to give high yields. Simultaneously the Department should conduct experiments with imported strains of *maha pangiri* from Java in order to select the best under local conditions.

3. Fertilizer trials should be undertaken on old citronella plantations.

4. Investigations conducted by the Department of Industries have shown that the distillation efficiency could be very appreciably increased by the adoption of simple technique without extra expenditure.

It is recommended that—

(*a*) 10-12 lb. of loosely packed grass per cubic foot of still is used.
(*b*) Distillation be limited to three hours.
(*c*) The boiler be fired at regular intervals of ten minutes to maintain a steady steam pressure.

5. A system of certification for Estate Quality and F. A. Q. Oils before export should be introduced.

6. The administration of the scheme should be entrusted to the Department of Commerce.

CENTRAL BOARD OF AGRICULTURE

PROCEEDINGS OF THE NINTH MEETING OF THE CENTRAL BOARD OF AGRICULTURE HELD AT THE SCHOOL OF AGRICULTURE, PERADENIYA, ON MAY 2, 1955, AT 2.30 P.M.

Dr. A. W. R. Joachim, Director of Agriculture, presided, and the following were present :—Mr. C. A. M. de Silva, Vice-Chairman ; Mr. S. H. Mahadiulwewa, M.P. ; Mr. A. G. Divitotawela ; Gate Mudaliyar N. Wickremaratne ; Mr. T. B. Naranpanawa ; Mr. A. D. Paranavitana ; Sir James P. Obeysekera ; Mr. J. V. Fonseka, Director, Land Development ; Mr. L. B. Rajakaruna, representing the Commissioner for Development of Marketing ; Mr. D. B. Ellepola ; Mr. A. E. C. de S. Gunasekera ; Mr. Ray Wijewardena ; Mr. C. J. Strachan ; Mr. M. B. Samarakoon ; Mr. S. Vythilingam, M.P. ; Mr. S. Thondaman ; Mr. A. M. Clement Dias ; Mudaliyar N. M. Abul Cassim Marakar ; Mr. N. R. Rajavarothiam, M.P. ; Mr. R. T. Chelliah ; Mr. A. Perumynar ; Mr. J. M. Sabaratnam ; Mr. S. Pathmanathan ; Mr. R. H. de Mel ; Mr. S. L. Bandara Dharmakirti ; Mr. G. B. Portsmouth, Acting Director, Tea Research Institute ; Mr. Kenneth Morford ; Mr. M. Atkinson ; Mr. N. H. Keerthiratne, M.P. ; Gate Muhandiram Arthur D. S. Jayasinghe ; H. B. Rambukwella Dissawe, M.P. ; Mr. S. C. Fernando, Commissioner of

Co-operative Development, Registrar of Co-operative Societies, Acting Director of Food Production ; Mr. K. W. Devanayagam ; Senator Thomas Amarasuriya, O.B.E. ; and Mr. N. P. Wijeyeratne, C.C.S., Secretary.

The following visitors were present by invitation :—

Mr. T. M. Z. Mahamooth, Deputy Director, Animal Husbandry ; Mr. J. C. Drieberg ; Mr. A. V. Anker, General Manager of Animal Husbandry Farms ; Dr. P. Mahadevan, Veterinary Research Officer ; Mr. W. D. E. Perera, Livestock Officer ; Dr. F. N. Ponnamperuma, Chemist, Department of Agriculture.

Letters and telegrams regretting inability to attend were received from the following :—

Mr. T. C. Rajaratnam, C.B.E., J.P., U.M. ; Mr. W. M. Cumaraswamy ; Mr. S. A. Selvanayagam, O.B.E. ; Mr. K. Kanagaratnam ; Major E. C. de Fonseka, M.B.E.; Mudaliyar M. M. Ebrahim ; Mr. C. Wijesinghe ; Sir Wilfred de Soysa ; Senator (Mrs.) Clodagh Jayasuriya ; Director of Rural Development ; Mr. S. Sivapalan ; Mr. Vernon Rajapakse ; Senator Justin Kotalawala ; Mudaliyar S. Armstrong ; Mr. R. H. Spencer Schrader ; Mr. S. Pararajasingham, J.P. ; Dissawa S. A. I. Elapata, M.B.E. ; Mr. A. C. Ponnampalam ; Mr. H. A. Pieris ; Mr. Gladwin Kotalawala, M.B.E., M.P. ; Senator (Lady) Molamure ; Mr. Marcus S. Rockwood ; Mr. S. M. Rasamanickam, M.P. ; Director, Coconut Research Institute ; Senator E. W. Kannangara, C.B.E. ; Mr. U. B. Dedigama ; Gate Mudaliyar M. S. Kariapper.

I—Confirmation of the Minutes of the last Meeting

The minutes of the previous meeting of the Central Board of Agriculture were unanimously confirmed.

II—Matters arising from the Minutes

Chairman—" Gentlemen, I have to refer at this meeting to the action taken in regard to the resolution moved at an earlier meeting by Mr. Kenneth Morford. The practice is for us to have minutes confirmed and thereafter to take action in regard to any items or motions which have been passed. Mr. Kenneth Morford at the meeting previous to the last one, moved a resolution in regard to the provision of Mobile Veterinary Dispensaries so that veterinary aid may readily be available in rural areas by arranging scheduled visits. We have written to the Permanent Secretary and asked for permission to include provision for these vans in our estimates for 1955-56. This was obtained. The matter has since gone up to the Treasury for final consideration and the Treasury has approved one mobile Veterinary Dispensary for a start. In addition to taking that step, we have also asked the Colombo Plan authorities whether they could come to our aid in this matter and very recently we had a visit from the Canadian authorities. We put before them this proposal and this item has been included in their proposals for aid. Therefore the chances are that it may be possible to get three of these units from Canada in the course of next year.

In the discussion on this resolution reference was also made to the employment of more Veterinary Officers in the interests of Animal Husbandry development in the country. This suggestion too has received the favourable consideration of the Ministry and the Minister himself directed that provision be made for a number of veterinary posts. These were duly included in the estimates and I am glad to say that the Treasury has approved eight new posts of Assistant Veterinary Surgeon. These are the only matters I have to bring to your notice regarding the meeting previous to the last.

At the last meeting a number of resolutions were passed, and now that the minutes are confirmed, I propose to take action on them in the next few weeks. Although, in some instances, some members may wish us to proceed with action on resolutions, &c., before the minutes are confirmed, you will I think agree that action on matters discussed could be taken only after the minutes have been confirmed."

Members were in agreement with this view.

III—Election of a Member to serve in the Minor Products Sub-Committee of the Central Board of Agriculture

Chairman—" Gentlemen, you will remember that we have now three Sub-Committees of this Board, one for Paddy Cultivation, one for Animal Husbandry and one for Minor Products. These Sub-Committees have met and have drawn up a programme of their activities. Mr. Hensman has written to us that he is unable to serve on the sub-committee for Minor Products. In the circumstances, the Sub-Committee have co-opted a very useful member, Mr. D. B. Ellepola, and I am sure you will all agree with that selection."

This was agreed to.

IV—Resolution to be moved by Mr. R. H. Spencer Schrader

" Having regard to the impetus given to animal husbandry on estates by—

(1) The Food Production Department by allowing liberal rates of exemption under the regulations in the case of dairy type cattle ;

(2) The Milk Board establishing milk collecting centres in estate areas.

The Central Board of Agriculture recommends to Government :

(*a*) That immediate steps be taken to inaugurate an intensive propaganda campaign in the coconut producing and other suitable areas in the Low-country for the proper management and adequate feeding of Sinhala type of cattle with a view to obtaining milk from a new source ;

(*b*) That an Advisory Branch of the Agricultural Services be established to establish to help cattle owners all over the country and in the coconut growing areas in particular with advice on the cultivation of pasture, ensilage of suitable crops, and hay making ;

(c) That the Advisory Branch of the Veterinary Service be re-organised so as adequately to help cattle owners all over the country with advice on the health, the proper management, and care of their animals.

The Chairman read out a telegram from Mr. Spencer Schrader regarding his inability to attend the meeting owing to some unavoidable circumstances and suggested that the resolution be deferred for the next meeting. This was agreed to by the Board.

V—Consideration of the Paddy Sub-Committee's Report on the Report of the Joint U. K. and Australian Mission on Rice Production in Ceylon—1954 (Sessional Paper II of 1954)

Chairman—" Gentlemen, here again I have to say that this Sub-Committee is not in a position to submit their views on this report. Dr. Chandraratne who is the Convenor of this Sub-Committee is not here but he has advised the Secretary to this effect. We have one or two members of this Sub-Committee present here today and Mudaliyar Wickremaratne is one. Unless they like to say something about the present position, we will perhaps have to await their report. "

Gate Mudaliyar N. Wickremaratne—" Gentlemen, with regard to the Paddy Sub-Committee I would like to say that we met on three occasions during the last several months and that the attendance has not been very satisfactory, perhaps because they have more important business to attend to, but at the same time there are areas where activities of the present food production work are going on. I would, however, like to add another name to the Sub-Committee and I asked the Sub-Committee whether there is any objection to their including another name. They told me that they had no objection but the name proposed should come through the Board. Anybody travelling by train from Kandy to Colombo or from Colombo to Kandy will see a vast difference in the paddy fields along the railway route compared to other paddy areas. When Mr. Rhind was Director of Agriculture, I submitted a memo asking him to take some interest in those paddy lands between Polgahawela and Kandy which were not cultivated both seasons, *yala* and *maha*. I think there was a report from one of the Divisional Officers to say that it cannot be done because the cultivators do not want it and that they wanted only one crop. I replied that I was very sorry and

that it gave me much pain of mind to see those lands not being cultivated during *yala*. An officer has even said "ask Mudaliyar not to worry about it". Now I have seen, Sir, when I visited Kandy during last month and this month, paddy cultivation in these areas being done during *yala*. Near Mirigama I found all the land prepared and ready for cultivation. Therefore, I think we must get somebody from that area for the Paddy Sub-Committee and I would like to suggest the name of Sir James P. Obeysekera."

Mr. A. Perumynar seconded this proposal which was unanimously carried.

VI—Resolutions to be moved by Gate Mudaliyar N. Wickremaratne

(i) "That steps should be taken to meet the serious shortage of farm hands and plough cattle in the cultivation of paddy in the country by recruiting young men and women of the ages 16 to 24, who had received some education, for seasonal cultivation in the first instance and by making facilities for them to be absorbed into farm life and also by increasing the availability of plough and draught cattle to farmers ;

(ii) Owing to the serious shortage of uncultivated land in the wet zones of the Island to meet the requirements of the growing population that no more lands should be allowed for growing rubber or tea ;

(iii) That the rice milling industry is a necessary adjunct to the development of paddy cultivation. There should be a better understanding and relationship between the paddy cultivator, the mill owner and the authorities of the departments concerned for their mutual economic benefit."

Gate Mudaliyar Wickremaratne—"Mr. Chairman and Gentlemen, I have sent this motion for discussion in order to obtain the views of the members of this House and it is not one which I want to be proposed and seconded. What I want is the opinion of the House expressed on this motion. Even now I travel at least three times a year in the Southern Province, North-Western Province, North-Central Province, &c., and during my visits I have seen only old people engaged in work on paddy cultivation. What will happen when these old people cease to exist ? Can the younger generation handle the situation ? I know that recently some youth clubs have been organized but what I feel is that that kind of voluntary organization will take years and years to supply the necessary help to the cultivator. First of all, the younger generation must learn to acquaint themselves with the routine of the paddy crop. The work of the paddy farmer at this state will receive a serious setback and that is why I bring up this motion. When I was a boy, paddy cultivation was considered another cottage craft and the father, mother, brothers and sisters all took to it as their daily routine. When I was a boy of 16 or 17, I never failed to take part in these paddy cultivation operations. When I came to Peradeniya to learn practical agriculture, I saw the paddy fields full of people, men, women and children. They all worked together in the field and the result was that yields were very much better than now. The labour was not paid for but the owner of the field who received the labour was obliged to offer the services of himself and his family when those who helped him were doing their cultivation operations. There was a great deal of family co-operation among villagers during that time and the Sinhalese term for this kind of labour is "Attam". Those who were unable to offer their services were in the habit of giving other help in the form of cattle, ploughs, &c. Now this custom is fast disappearing in the villages and as a result yields are declining and the villager does not get a proper return for his labours. One of the reasons for this state of affairs is the wrong education imparted to them in cultivation methods. Now what has happened in the villages is that the father and mother have to work hard in the field and the children are sent to school and these children do not even see the colour of their fields. Especially those children who learn English in school feel ashamed of themselves to assist their parents in the field. Some children feel ashamed even to help the

mother in cooking. This is why we see in the press that thousands of young men who have passed the S. S. C. are waiting for jobs. What is the purpose of their education, is it to find jobs ? What I feel is that in their education, they must be taught how to work a paddy field and other agricultural operations. Another thing I notice is that 30 to 40 years ago each village home had a vegetable garden but today that habit has also faded away. In the olden days the village blacksmith turned out the mamoties that were required by the villagers for their paddy cultivation. Today the village blacksmith has disappeared and the mamoties used by the cultivators are imported ones which are not suited for our conditions.

Therefore, my suggestion, gentlemen, is that Government should recruit the services of these young men and women in the villages during seasonal cultivation to help the cultivators in their cultivation operations. Women can help in work like transplanting and weeding and men and boys can help in other cultivation operations. What I suggest is that Government should formulate a scheme for recruitment of the services of these young men and women in the villages and form them into different age groups, so that women can offer their services for transplanting, men can do ploughing and children can give a helping hand in other operations. A list of persons whose services can be recruited for this purpose must be prepared in respect of every village and D. R. O's Division. Then we should organize a scheme of wages for these people so that they would receive them from time to time according to the work they perform. After some time when they are fully competent some of them could be absorbed in their own field of work, and we could send them to colonization schemes like Gal Oya where they could be of great service.

I read in the papers that S. S. C. men should be given land for cultivation but the difficulty is that these S. S. C. men do not know how to handle a mamoty. Some years ago in 1902 when the old Agricultural School was closed, Government started school gardens. There were hundreds of school gardens all over the Island where boys were trained to do mamoty work and grow vegetables. That was stopped by the Education Department and they were made to learn English after which they gave up gardening and vegetable cultivation and now they are ashamed to even associate with their elders in cultivation operations. Now these boys should be taught to associate with their elders in all matters connected with their cultivation and during the off season they should go to the paddy field and see what is happening. The other day I learnt from a Japanese expert that unlike in Ceylon, the cultivator in Japan is always in the field, during the time of ploughing, sowing, weeding, harvesting, &c. Our people, once they sow the paddy, go to the field again only to reap it. The present younger generation can be easily trained by Agricultural Instructors who are stationed all over the country. They must be taught to see how much water there is in the field, whether any pests are attacking the crop or whether any disease is breaking out in the area and they must be asked to collect all the rubbish they throw in manure pits and make use of it as manure during the next season, for their fields.

American, Canadian and Australian Governments are giving us millions of rupees worth of aid for under-developed areas. Why cannot we start operating a scheme of this nature for the under-developed youth of this country ? I do not think that we should utilize this money that is coming in the form of aid from foreign sources on all kinds of unnecessary ventures. Our younger generation should be trained to co-operate with their elders in paddy cultivation. I read an article in the press that in Italy when there was a shortage of labour during the time of Mussolini, men and women were brought from outstations for cultivation work and were sent back after the cultivation season was over. The people who worked did not only get a training in cultivation work but they were also remunerated for their services. In the same way our men and women can make their services available in places where they are required for cultivation purposes. Those are my views gentlemen, and I would like the opinion of the Board on this matter.

The next point I want to mention is about cattle. I cannot really understand how paddy cultivation can be done without cattle. In my own village, after 1912 there is no ploughing of paddy fields. We all do our paddy cultivation with the mamoty and those mamoties are turned out by the local blacksmith because imported mamoties are not fit for paddy cultivation. But of course the Governor-General now feels fit to get into the field to do ploughing but I do not know whether anybody else does any ploughing ! Any way I was speaking of these mamoties which are used for paddy cultivation. These mamoties differ in shape according to different districts. The mamoty that is used in Jaffna is quite different to that used in Kandy and the Southern Province. We cannot improve paddy cultivation with mamoties unless we have sufficient cattle to do our ploughing. We are all glad to hear that animal husbandry is developing and that good progress has been made. I have to say a word on this since Mr. Schrader has also some resolutions to move on this subject. Countries like Denmark and Australia develop their animal husbandry for the sole purpose of producing butter, milk, &c. But if we in this country attempt that, we will never succeed. Our chief requirement is cattle for ploughing the fields. We cannot do mechanized ploughing in 2/3rds the area of this country. It may be possible in the dry zone but even there I have my objections to it. Is it possible to do mechanized ploughing in the Kandyan areas ? Most of our paddy fields are not suitable for any type of mechanized ploughing. Therefore we must have enough buffaloes to continue this essential operation of ploughing, and I suggest that the Department should pay more attention to the country's requirements of cattle and buffaloes.

I do not like to say anything against the Milk Board, but I would like to ask what they are doing. They are collecting milk from Polonnaruwa and other outstations and are feeding the Colombo folks. I therefore want the Department of Agriculture and the Ministry to take steps to pay more attention to the need of providing more agricultural cattle."

Mr. S. Pathmanathan—" Mr. Chairman, does he mean conscription ? We do contribute towards free education ; does he mean compulsory education or a re-organisation of the education system around areas where we have paddy ? Any way I do not know whether boys from Royal and other colleges will come down to rural areas. "

Chairman—" Mudaliyar, do you mean conscription ? "

Gate Mudaliyar Wickremaratne—" No, Sir, not conscription. That will be the last thing I will think of even if I have to die ! What we want is co-operation and the Sinhalese term for this kind of labour is " Attama. "

Mr. C. A. M. de Silva—" Does Mudaliyar know that today one cannot sell buffaloes ? We find it difficult to dispose of our cattle because there is no buyer. Therefore, most estate owners have given up rearing buffaloes. "

Mr. S. L. B. Dharmakirti—" That I think is because your prices are too high. "

Mudaliyar Wickremaratne—" Can you name a few estates. "

Mr. C. A. M. de Silva—" Palugaswewa Estate is one. "

Mr. D. B. Ellepola—" Mudaliyar Wickremaratne has raised a matter of very great importance to the country. In the form which his motion is presented, it is presumed that there is a very serious shortage of personnel for agricultural purposes. It is for us to decide whether that is a correct presumption. My own view is that the Mudaliyar is right. If it is the correct presumption, it is of very serious importance. If a condition of shortage of labour exists in a country which is 85 per cent. rural or largely agricultural, it behoves us to support this proposal as far as possible together with any proposals that we have in mind. I wish to submit that if this position is correct, then the causes are very fundamental. They are perhaps a part of the educational system in the country or of the social attitude of the country in regard to agricultural employment and in that way very large questions are involved. Therefore, if it is the opinion of this Board that there is a growing shortage of hands for agricultural purposes, particularly for peasant agriculture, then I wish to submit that it is incumbent on us who are members of this Board to address our minds seriously to this

matter. It may be even a matter for a Sub-Committee to go into with great thoroughness as to the extent of the shortage, whether it is growing or whether it is declining and what the reasons are for it and what necessary remedial measures should be taken. If the causes are fundamental and the task is for those connected in the fields of employment and social activity, then I think the remedy will also have to be very fundamental. I think it is for us to decide whether there is an incidence of shortage and if so whether we can approach that matter in this way."

Mr. Kenneth Morford—Mr. Chairman and Gentlemen. As you know my area (Kotmale) does not suffer from a shortage of labour. We do our cultivation and harvesting at the correct time, and in the slack season work is generally available on estates. We are hoping to implement a scheme whereby labour from our areas will proceed to the peasant settlements at Galoya, &c., at harvest time to assist at harvest, but they will return to their Kotmale villages when it is completed, thus fulfilling part of the Mudaliyar's proposals.

A Sub-Committee should be appointed to find out the real needs of each Province otherwise these proposals will come to nought.

Mr. Thomas Amarasuriya—"Mudaliyar Wickremaratne's motion is a very important one. He clearly stated that there are a large number of students who had passed the S. S. C. Examination who are practically idling so that it strikes me that the chief intention of the Mudaliyar is that all these educated youth should be made to devote their attention to agricultural activity as there is a great demand for agricultural hands in this country. One member raised the question whether students from Royal and other colleges would be prepared to go to rural areas to learn agriculture. What Mudaliyar feels is that the present day younger generation should be taught the advantages and the necessity of getting back to the land as this is an agricultural country.

In regard to Mudaliyar's suggestion that men and women between the ages of 18 and 24 should be recruited for seasonal cultivation of paddy, there are a large number of schools in the rural areas where village lads are trained in agriculture. I know of one in the Southern Province where youths get some sort of education in agriculture. I would like to know whether it is not possible to see that these youths make use of their training for agricultural purposes. If all these young men in the villages are trained in agriculture in the various agricultural farms and if they can come up to the standards expected by the Department, the Government may be in a position to get these young men to divert their attention towards what Mudaliyar Wickremaratne has in mind. This is a very wide subject that cannot be settled at a meeting of this type. I think a committee should be appointed to report on the position so that necessary action may be taken."

Mr. J. M. Sabaratnam—"Mr. Chairman and Gentlemen. If the idea of this Board is that there is a labour shortage and that this Board should be in favour of a recruiting campaign in order to see that more labourers are recruited for cultivating the lands of wealthy proprietors, then I think that point of view might be accepted; but if the aim of the Board is to see the creation in this country of a peasant land-owning democracy—that is to say, that every person who leaves school is not turned into a labourer but is offered land also, then I feel that there is no necessity for this motion. In every Colonization Scheme when applications have been called more than double the number of applications than could possibly be entertained have been received. In view of this, Sir, there is no necessity for any sort of recruiting campaign to settle people on the land. On the other hand the aim of this Board should be to see that every young lad who leaves school is in a position to own land and not become a serf under another proprietor.

Regarding the point about shortage of cattle, I think tractor cultivation has solved this problem to some extent. I agree that there are some areas where tractor cultivation is not possible, but large areas in the dry zone have been successfully tractor-cultivated. If as suggested there is a serious shortage of cattle for wet zone cultivation, we should see that cattle are provided to cultivators at reasonable prices. There is no reason to refer this motion to a special sub-

committee and if it is necessary it could be referred to the sub-committee dealing with paddy cultivation."

Mr. A. M. Clement Dias—" A question has been raised whether boys from Royal and other colleges in Colombo will go to rural areas for paddy cultivation. I would like to say that at present boys from Royal College go three miles away to Mahawatta to do agricultural work. Although the emphasis is today on " Swabasha ", children in villages learn English. They get through their Junior which is of a very low standard today and their ambition is to get into a job somewhere as a clerk. Some parents of these village boys who own a few acres of land go to the extent of even selling it and keeping the sons at home idling till they get a job. The remedy I think is to make children of schools and colleges work in the field for a period of their school session so that they could, from their younger days, train themselves in cultivation work. Today conditions are quite different. Even if a young man with a fair education is jobless, he would not think of doing some cultivation. Sometime back it was the intention of the Minister to start agricultural and industrial schools all over the Island for the benefit of those who are out of school. I do not know whether any such industrial schools were started.

About the question raised regarding mamoties, I do agree that they differ according to the nature of land in each province. In Ratnapura District, the mamoties used for paddy cultivation are 14" × 6". The remedy is I think if we can indicate our specifications to the manufacturing firm, we could get down implements that will suit us.

In regard to the question of the shortage of cattle for cultivation purposes, the best that could be done is to take a survey of the cattle population in each province or district and arrange for the supply of cattle from surplus districts to other districts which are in need. I am sure that in certain districts there is a surplus of buffaloes. Recently I read in the papers that for several months a large number of buffaloes had been slaughtered in the slaughter houses of the Colombo Municipality. I think this Board should take up that matter as to why the Colombo Municipality should allow the slaughter of buffaloes in such large numbers.

Mudaliyar N. M. Abulcassim Marakar—" Mr. Chairman and Gentlemen, this is an important matter from the point of view of production. We are all aware that we desire to exist by ourselves as far as food is concerned. We are a rice eating nation and therefore we have to produce more rice. Today our production does not meet the demand. Therefore, Mudaliyar Wickremaratne's motion is very important from that point of view. The basic principles embodied in that motion are really commendable. Today the question of recruiting labour either by Government or by foreign organisations is not necessary. The Government must give the necessary inducement to the educated young lads. Educated youth of the country must be induced to take to the land. The dignity of labour in that field of activity must be recognised and it must be maintained. We must be conscious of our dignity that we have cultivated our land. What do we do now, especially the land owning class ? They do not even go to the field, but finance the cultivation operations. We should not only instruct our lessees to do the cultivation but as far as possible we must also participate in the cultivation activities. There are a number of items on which our personal attention is necessary. As far as land owners are concerned, they must resort to this method of production and cultivation. As far as young lads are concerned, they must be given sufficient inducement by Government to take to the land if self sufficiency is to be achieved in the production of rice.

At one time there was an actute shortage of buffaloes—I am not referring to neat cattle but buffaloes all over the Island. Today that shortage has disappeared, although there is a shortage in certain districts of the Island where buffaloes are needed for cultivation operations. Now what is done in certain districts is that a man who owns half an acre of land has to finance somebody else who owns buffaloes to do his cultivation. People resort to hiring buffaloes in this manner owing to the acute shortage that exists at the present time. There is an acute shortage of labour too, but not the type of labour that Mudaliyar Wickremaratne refers to in his motion. Actual labourers are

needed for cultivation purposes and that shortage still exists, and the remedy is for Government to come to the rescue of the cultivators. There is one important point in this motion and that is that Government officials and officers of some authority should induce young lads to take to agriculture earnestly by their presence at these various activities, and by organising demonstrations in different areas. When these demonstrations are held once or twice a year, then it becomes an islandwide feature. Nobody will feel that just because a cultivator is old and uneducated he is an unwanted element in this country. Today the position is entirely different, and the cultivator becomes an important element. The cultivator is an important individual on whom the country depends for food and therefore sufficient recognition must be given to these young lads by giving them sufficient inducement, official recognition, official support and by seeing that an organization is set up to enable these young lads to take to the field with a sense of dignity and honour.

As regards a Sub-Committee for this purpose, I think I agree with my friend that there is no need for such a committee as it can be referred to the Paddy Sub-Committee. But if the house feels that this motion is so important that a Sub-Committee is essential to go into it fully, I have no objection."

Mr. K. W. Devanayagam—"Sir, I like to touch on one point in this motion and that is about draught cattle. I think the idea that draught cattle were absolutely essential for paddy cultivation is now very antiquated. I come from the Eastern Province where a large amount of paddy cultivation is being done. Now the cultivators use tractors for their paddy cultivation and not only for ploughing but even for threshing machinery is used and the buffalo is completely eliminated. To find draught cattle for those areas is a very very old idea. I am sure most of you will agree that there was a time when these cattle did a tremendous amount of damage to the cultivators of this country because the owners of cattle had never learnt to look after their cattle. Their cattle were let loose on the high road and they often fed on others cultivations. Therefore, in my opinion the question of making available to cultivators draught cattle is not one of such importance. I feel that draught cattle will not be necessary and that more and more mechanised cultivation should be introduced into this country if we are to produce more food.

Chairman—"We have had the views of some of the members of the Board on the issues raised by Mudaliyar Wickremaratne. I think, as Mr. Ellepola has suggested, this is too big a subject and therefore would like to commend the proposal that it be referred to a Sub-Committee. Now the question is whether it should be referred to a Special Sub-Committee or to the Paddy Sub-Committee."

Mr. D. B. Ellepola—"I do not know the terms of reference of the Paddy Sub-Committee. If it is possible to include it in that I am prepared to withdraw my resolution."

Chairman—"I do not think the Paddy Sub-Committee has any special terms of reference. It deals with all matters relating to paddy that come up before this Board. In the circumstances I think it would be wise if the Paddy Sub-Committee can go into this question with a few additional members if necessary. With your approval I suggest that Mr. Ellepola and Mr. Kenneth Morford be co-opted to the Paddy Sub-Committee for investigating this matter."

At this stage Mr. Morford said he would like to withdraw from his appointment to the Sub-Committee as Mr. Ellepola was a more experienced man than himself and as he felt the co-option of one member was sufficient.

Chairman—"For the information of members I would say that the Paddy Advisory Sub-Committee consists of the following :—

Dr. M. F. Chandraratne (Convenor)
Mr. A. Godamune
Mr. Anton Ponnampalam, J.P.
Mr. U. B. Unambowe, M.P.
Mudaliyar S. Armstrong
Mr. A. M. Clement Dias
Gate Mudaliyar N. Wickremaratne
Mr. S. Sivapalan
Mr. S. H. Mahadivulwewa, M.P.

The Sub-Committee might be allowed to co-opt any other members, if necessary, for the consideration of this subject. I think we should have the advice of some animal husbandry people on this matter and would

suggest that Mudaliyar Wickremaratne, Dr. T. M. Z. Mahamooth, Deputy Director, Animal Husbandry, and Mudaliyar Abul Cassim Marakar be also co-opted to this Sub-Committee."

The Board unanimously agreed to the the names suggested by the Chairman for co-option to the Paddy Sub-Committee to go into Mudaliyar Wickremaratne's motion.

Chairman—"I may say that in recent years there have been attempts made by the Director of Food Production to bring in school children to partake in transplanting and like operations. "Wap magul" ceremonies were also started recently in order to encourage groups of people to join in paddy cultivation ceremonies. We had school children and people from the highest in the land to the humblest at these festivities. This was definitely a measure taken to prove to the people that paddy cultivation was an honourable occupation which all could well be employed on.

There was reference again to educated youth. I would like to point out to members of this Board that Government is shortly embarking on a pilot scheme for the settlement of educated youth in the Northern Province. An area of 800 acres at Paranthan which was previously a cattle farm under the Department of Agriculture is to be converted into a colonization scheme for educated young men, and 250 young men from the Northern Province are going to be settled on this land on the 9th of May. There is going to be a formal opening in a few days and this is the first big experiment in the colonization of educated youth. I think we should watch this experiment with great interest because if it succeeds, it will no doubt be followed by others in different parts of the country. I have mentioned this for the information of members."

Chairman—"We might now proceed to the second part of Mudaliyar Wickremaratne's resolution."

Gate Mudaliyar Wickremaratne—"The wet area of this Island has been cultivated to the very end, and now there is a scheme of giving land to the unemployed people. In the wet area, as I said before, we require cattle not only for agricultural purposes but for milk purposes. I am personally against mechanization because it will only bring our lands into a state of disrepair. When heavy machinery is used on our lands where we get a rainfall of about 70 inches, the soil will be eroded and nothing will be left out for cultivation. During the time of the late Mr. D. S. Senanayake, he definitely refused to extend the area under tea or rubber, and he ordered that the rest of the land must be utilised for food production. As the matter stands today we have utilised every available forest and village reserve for the cultivation of rubber and tea and what is left to us is about hundred thousand acres. If they are going to utilise some more land for tea and rubber, we will have nothing left for food production, and we will have to depend on foreign countries to sell our tea and rubber. In the first place we must provide land for the growing population of these wet zone areas like the Western Province, Galle District and such other places where they have no place to move to. Could you send these people to Minneriya and Gal Oya and such other places? What we have to do is to reduce the area under tea and rubber instead of increasing it and utilise that area for food production. When I brought up my resolution last time I did not know the correct position of the Rubber Rehabilitation Scheme, but since then I wrote to the Director of Agriculture and he referred it to the Rubber Controller who very kindly gave me the report. The Rubber Rehabilitation Scheme I may say I thought would allow some of the rubber land to be used for food production and the settlement of people. But now I find that the Rubber Rehabilitation Scheme is destroying all economic crops except rubber. It is a very serious question. I think the Chairman of the Re-planting Board must consider the question and not take advice of experts. Rubber was planted in areas which flourished with trees like jak and plantains. Now at least the area under tea and rubber should not be extended further.

Therefore, Sir, my suggestion is that this Board should bring to the notice of the Minister that no more land should be given for rubber or tea in the areas of the country in accordance with the policy of the late Mr. D. S. Senanayake."

Chairman—"Do you want to bring this up as a formal resolution ?"

Gate Mudaliyar Wickremaratne—"No, Sir, I do not want to pass resolutions because they mean nothing. I will be satisfied if this is recorded in the minutes and the minutes are sent to the Minister."

Mr. S. Pathmanathan—"You will recall, Sir, that when Sir Oliver Goonetilleke presided at the inaugural meeting of this Board, he said that it was very essential that the major industries should go side by side with the development of food production. Mudaliyar must understand that the country must earn foreign exchange to maintain its standard of living ; and unless we have a certain amount of produce to earn our foreign exchange we cannot maintain this standard. That was the reason why when Sir Oliver Goonetilleke was Minister of Agriculture, he encouraged the Rubber Planting Scheme. We have got down high yielding material for rubber which yields three or four times as much as what the ordinary rubber could produce. A similar scheme is now being formulated for tea. We are also aware that the Tea Research Institute produces as much as a thousand to two thousand pounds of tea per acre. Therefore, you will realise that it is very important that we cannot afford to neglect the present plantations of tea, rubber and coconut because our standards of living will go down. Perhaps as far as coconuts are concerned, if we do not extend the cultivation in new areas, we might not have sufficient even for the consumption of our people of this country.

As far as new land is concerned, the Hon. the Minister addressing the Ceylon Association in London has definitely stated that there is no land available for the extension of tea or rubber. He has definitely made this important pronouncement at the Ceylon Association in London and has said whatever land was available was going to be conserved for the development of paddy and other food crops for consumption of the people of this country. But I want to tell Mudaliyar that as far as rubber is concerned, it is very essential that we should export at least 100,000 tons of rubber if we are to get the money to provide your manures, machinery and implements and the various other necessities which are vitally important for the standards of this country."

Senator Thomas Amarasuriya—"Sir, if this motion is implemented, it is going to have a serious effect on the progress of this country. As you all know the very existence of this country depends on the revenue derived from these two industries—tea and rubber. The mover of this motion says there is a serious shortage of land in the wet zone. Secondly he says that in spite of the growing population of this country no more land should be given for the cultivation of tea and rubber. In other words he wants formal legislation introduced that hereafter we should not grow any tea or rubber in this country. He commented about the Rehabilitation Scheme. This is a scheme for replanting existing land with rubber and not new land. Even as it is, if you want to plant tea or rubber in new land you cannot do so without obtaining a permit. You can replant or rehabilitate existing land, i.e., give up the unproductive old rubber and replant with new rubber. In short, Sir, I am very sorry that an experienced agriculturist like Mudaliyar Wickremaratne had introduced a motion like this, because it is, in other words, going to affect the revenue of the whole country. We all know that 65 per cent. of the revenue of this country is derived from the three major industries. He says that this should be done to meet the needs of the growing population. It is to meet the needs of the growing population that Government has started village expansion schemes. As far as I am aware some tea estates Upcountry have been acquired for village expansion and I think they have now decided to acquire no more. If Mudaliyar Wickremaratne's motion is adopted, it will be very detrimental to the agricultural population of this country and I strongly oppose it."

Mr. G. B. Portsmouth—"Mr. Chairman and Gentlemen, I would also like to oppose this motion particularly because it was pointed out at the Tea Research Institute Conference that those vitally interested in the economy of this country should improve

the tea industry by replanting and by new planting of high yielding varieties. I do not think we have any reason at all for a body of this nature to accept motions of this sort that tend to restrict the growth of development. What we are all concerned with is the best utilization of land whether it be for tea, rubber or coconut. No future planned development will be kept up by this type of motion."

Mr. M. Atkinson—"I have a great deal of sympathy for this motion. The Minister of Agriculture has made it clear that tea, rubber and coconut industries produce 60 per cent. of the revenue of this country, in the form of taxes that are levied. What we are concerned with is the value of an acre of land to the State. A villager might be able to bring up a large family on an acre of land at very little cost. But today a modern tea plantation costs Rs. 3,000 an acre to bring it into bearing. Practically the whole of this amount goes as wages to the people who are employed. It costs Rs. 1,500 for an acre of rubber or coconut. These are facts that we must bear in mind and I consider that a few acres of land well cultivated are far better than many acres of unplanted land."

Chairman—"I see here the Director of Land Development, Mr. Fonseka. Perhaps he might like to say a few words."

Mr. J. V. Fonseka, Director of Land Development—"Only one fourth of the land area of this country is cultivated so that on the face of it there appears to be no shortage of uncultivated land. Of this uncultivated land, however, not more than, I believe, 3¼ million acres can be cultivated at all, and even of this extent only a part can be cultivated with paddy. Paddy cultivation requires irrigation and it cannot be said that the Government will permit the cultivation of irrigable land with rubber or tea in preference to paddy. There is, therefore, no conflict as regards lands that can be cultivated with paddy and lands that cannot, and I do not see any point in abandoning such lands as cannot be cultivated with paddy.

It might interest the House to know that approximately 20,000 acres of new irrigable land are being developed and made available for cultivation with paddy every year under major colonization schemes."

Gate Mudaliyar Wickremaratne—"I am thankful to Mr. Fonseka for supplying us with facts in regard to land available. But as regards Mr. Pathmanathan's idea, I will never accept the economic theories of the previous Minister of Agriculture and Food. When the Agricultural Society was started the population was 3½ million and the revenue of the country was Rs. 30 million. Today it is Rs. 900 million. If they cannot manage with such a sum what is the use of these finances. Selling of rubber to outside countries is "Old economics". I got a shock when Sir Oliver Goonetilleke said at the first or second meeting of the Central Board that he must have rubber and tea. Poor Mr. Senanayake had said that no more rubber and tea should be planted. The economy of a country must be decided according to the nature of the country and not according to a western method of political economy. During the first world war our rubber was sold at 10 cents a lb. and coconuts at Rs. 10 per thousand. I hope Mr. Pathmanathan will appreciate my point of view."

Chairman—"I do not think the Government will go wrong in deciding on the best use of the land. I think the Government has all along done their best in the cause of food production. A Land Utilization Sub-Committee was appointed about two years ago which went into this question very thoroughly and determined which lands should be used for the further development of paddy. The rest of the land was considered for development under other types of food crops. Dry farming loomed large in the eyes of the Committee and also land suited for perennial crops like tea, rubber and coconut. I think it would be fatal for a Board like this to pass resolutions that no land should be set apart for tea, rubber or coconut. I think this is a matter for a land utilization expert to determine. I am as keen as Mudaliyar to see that food production is encouraged in the country but the main thing to consider is the best use to which a particular land should be put, and that can only be determined by an expert bearing in mind the various considerations

such as the requirements of the peasantry, &c. If you want me to ask for a vote on this from the Board, I shall do so, but I think the general opinion is to leave it alone."

Gate Mudaliyar Wickremaratne—"I do not want a vote, what I want is that it be included in the minutes."

Part III of Mudaliyar Wickremaratne's resolution was next taken up for discussion.

Gate Mudaliyar N. Wickremaratne—"I propose that this part of my motion be referred to the Paddy Sub-Committee. I sent a resolution about rice milling on a previous Agenda and the Minister has accepted it and some steps have been taken that the miller will not buy paddy from the cultivator because he was paying less. According to the present arrangement if the miller wants to he should buy from the Co-operative Societies. Now the miller is unable to buy from the cultivator and the cultivator has to somehow sell his paddy to the Co-operatives and it is not in all cases that the real co-operation expected from these societies is forthcoming. What I say is, why not let there be some co-operation between the miller, the cultivator and the Government ? During the State Council days a proposal was made to hand over the milling of paddy in this country to a foreign firm. We have heard what has happened in Burma. The Burmese could not send an ounce of rice out because they had got into an agreement with the miller. They came to Ceylon and wanted the consent of this Government to undertake the milling of paddy. On representations being made to the Ministries a committee of the various Ministries met and decided not to hand over to them the milling of paddy. Then Mr. Bassett started the first mill at Anuradhapura. After that, people have taken to it and now they are doing it. Now the Director of Agriculture or the Director of Food Production must intervene in this matter and see that there is some harmony. We must have our rice millers and we must pay a good price to the cultivators. As you know we have different grades of rice. What Mr. Bassett did was to put all the paddy together and mill it. We have par-boiled rice, unboiled rice, and different varieties like Muttu Samba, Heeneti, &c. Our rice millers have made a great mistake in this respect. We must teach them to mill separately the different varieties. I therefore suggest that somebody must take an interest and arrange that the miller be more reasonable because at the present time milling is very unsatisfactory. For this reason I put the motion before the House."

Chairman—"I think the representative from the Marketing Department will be able to give some information about the milling arrangements at present."

Mr. L. B. Rajakaruna, Deputy Commissioner of Marketing—"I am very pleased about Gate Mudaliyar Wickremaratne's proposal. According to the motion here, the first sentence says that the rice milling industry is a necessary adjunct. Now that we have increased the production of paddy more and more, rice milling has become not only a necessary adjunct but vital. You remember Mr. Chairman that the question of a guaranteed price scheme was discussed before this Board last year. At the meeting the question of Government buying rice from private millers was discussed. In fact it was even suggested that as the Government had guaranteed the price of paddy to the producer, it should not purchase rice from private millers. It was also suggested at that time that the miller was not paying the guaranteed price to the producer. Recently we have worked out a scheme whereby we have registered 450 millers in different parts of the Island from whom Government purchases rice on condition that the miller buys an equivalent quantity of paddy from Government's stores. A reasonable price has been fixed for the miller and we have had no difficulty at all because the miller buys the paddy from Government and mills it at his mill and then sells it back to Government. Government collects the paddy and sells it to the miller at Rs. 12 per bushel. Government in turn buys a bag of rice from the miller at Rs. 64.75. This price allows to the miller a reasonable margin of profit for the expenditure he would incur in par-boiling the paddy and milling it. Therefore, Mr. Chairman, you will see that there is a certain amount of relationship between the paddy cultivator on the one hand and the Government on the other. The Government pays the cultivator a

guaranteed price for his paddy. We issue the paddy to the miller at the same price and the miller in turn offers it to the Government at a fixed price. This condition whereby we have stipulated that millers should buy paddy from Government is only in respect of rice they sell back to Government. Apart from this, they have the option to buy other paddy. The rice from the paddy that he buys from outside can be sold in the open market.

Coming back to Gate Mudaliyar Wickremaratne's suggestion that the miller should mill different varieties of paddy separately I wish to state that we have found it difficult to induce the cultivators to sell to Government different varieties of paddy. The paddy which we get is normally the mixed variety, so that the miller has to mill paddy not from specific varieties but from mixed varieties. One reason for this is that even if the cultivator is able to give separate varieties, the present storage is inadequate to stock that paddy separately in our stores. I suppose once we get the necessary storage this may be possible."

Mr. A. Divitotawela—" May I ask whether there are various prices fixed for different districts by the Marketing Department ? "

Mr. Rajakaruna—" There is a refraction allowed for different varieties."

Mr. Divitotawela—" Paddy sent from the Uva Province is taken at not more than Rs. 10."

Mr. Rajakaruna—" If the variety is a long grain like " dik wee " the price can vary."

Mr. Divitotawela—" Yes, they are long grains."

Mr. Clement Dias—" I was told that in some parts of the Kurunegala District, when paddy is bought by the co-operatives, a certain percentage is taken extra, sometimes as much as a bushel, for driage."

Mr. S. C. Fernando, Commissioner for Co-operative Development and Acting Director of Food Production—" I am not aware of that. There is no authority for anybody to charge an extra bushel for driage. All we are trying to do is to prevent the miller buying paddy for less than Rs. 12 per bushel. We have restricted the operations of the miller so that he cannot buy paddy for anything less than Rs. 12 a bushel. If he brings milled rice he must furnish proof that the paddy was bought at Rs. 12 per bushel.

Chairman—" I would like to suggest that we add the name of the Director of Food Production to our Sub-Committee on paddy. I think that his name must be included because he is very intimately connected with the cultivation of paddy."

This proposal was agreed to by the Board.

VII—Resolution to be moved by Mr. Ray Wijewardena

" That in view of our increased demands on the soil for greater productivity and the present high cost of artificial fertilizers that all Municipalities and Urban Councils be prevailed upon to convert sewage and garbage into organic manure for sale to planters and farmers instead of disposing of them through destructors, incinerators, dumps, &c., and that a section of the Department of Agriculture be devoted to research in organic and humus husbandry in order to develop the most appropriate means of restoring organic fertility and humus to the soils of this country, particularly where they suffer worst through erosion and oxidation."

Mr. Ray Wijewardena moved the above resolution formally and Mr. J. M. Sabaratnam seconded it.

Mr. Ray Wijewardena—" Mr. Chairman and Gentlemen—Only a few days ago our Hon'ble Minister for Agriculture, in reply to a question as to whether a fertiliser plant could be set up in Ceylon, said that although he agreed with the necessity for such a factory he was not certain whether it would be possible to establish one, in view of the present financial position of the Government. Our approximate average yearly imports of the main NPK fertilisers are 72,000 tons of sulphate of ammonia, 42,000 tons of saphos phosphate and 30,000 tons of muriate of potash. That then is our target for the present, with extra in hand for future developments.

Gentlemen, would it surprise you to know that very nearly half this quantity of fertiliser, in the form of sewage and garbage is

at present disposed, incinerated and otherwise destroyed, every year by the Municipality of Colombo alone ? And to destroy it the 35,000 taxpayers in Colombo pay Rs. 1,600,000.

Throughout the world, Municipalities, Urban Councils and Village Committees are now realising the tremendous potential of organic fertiliser—acclaimed universally as the most suitable form of fertiliser for agriculture—present in sewage and garbage, hitherto considered as waste products, deserving only of destruction. Fortunately this era of sanitary suicide is receding and the accent is rather on "conversion" than destruction.

I recently had the opportunity of seeing a number of these plants in operation in Germany, France and England. Those in the towns and cities were tremendous ; those in the villages and suburbs more modest in size, but still coping with the entire output of those two valuable raw materials—sewage and garbage. The process is the well-known one of composting and although towns and cities have continuous-flow plants which manufacture mature compost with a carbon to nitrogen ratio of well below 20, within five days, the suburbs and villages composted using the well-known Indore method of heaps. In every one of these progressive institutions I was amazed by the simplicity of equipment and the cheapness with which the compost was produced. The average price was about Rs. 5 per ton, dried to a moisture content of 40 per cent. and baled ready for easy removal by the farmer.

One of the reasons why sewage is treated before disposal is to destroy pathogenic bacteria and it will interest you to know that the heat evolved within these compost plants causes the temperature of the mixed sewage and garbage to rise to above 150° F. within two or three hours, and this temperature is maintained until the heap is broken down. Amongst the commoner pathogenic organisms bacilli tuberculosis is the most heat resistant but these have been proved unable to survive temperatures above 130° F. for longer than ten minutes, while very much lower temperatures and shorter periods of time would prove absolutely lethal to organisms associated with erisypelis, pneumonia, diphtheria and typhoid and even anthrax. It is in fact Nature's way of dealing with these bacteria if only we would stop trying to oppose the forces of Nature and instead make use of them to our advantage.

So much for the theoretical aspects of the matter. I have since returning devoted much time and study to this matter to investigate the possibilities of converting for example, the sewage and garbage of the city of Colombo, into organic fertiliser and the results are startling. Very briefly the 335,000 population of Colombo produce 250 tons of garbage and 100 tons of solid excrement per day, which after screening to remove bottles, metal, rags, &c., will produce after composting, very nearly 350 tons of mature organic fertiliser, with an approximate composition of 5 per cent. or 17.5 tons of nitrogen, 2 per cent. or 7 tons of phosphoric acid and 5 per cent. or 17½ tons of potash in immediately plant available form, in addition to 22 per cent. or 77 tons of organic matter with very low carbon nitrogen ratio, which in itself is capable of converting a great deal of the non-available nutrients in the soil and subsoil into plant available forms. Taken on an annual basis this compost would contain the equivalent of 30,000 tons of sulphate of ammonia, 12,500 tons of saphos phosphate and 12,000 tons of muriate of potash. As I said before very nearly half the total requirements of the Island. The cost of the plant would be very little, as most of the equipment is already available in various forms. Only the rapid five day composting horizontal cylinder is required. Costs for this completely mechanised and highly hygienic process would result in a sale price of between Rs. 5 and Rs. 7.50 per ton ex Mattakuliya and covering all depreciation and everyday operating costs. For a change the Municipality could work this section at a profit which need not be more than a modest one, considering its original loss of Rs. 1,600,000 annually !

So much for the potential immediately available through the waste products of the 335,000 citizens of Colombo. Multiply these figures by the population under every Municipality and Urban Council and you will soon appreciate that we can well supply very much more than our minimum require-

ments of fertiliser for Agriculture and at very low capital cost. The important thing to realise is that all the food being imported into and distributed around this country is actually fertiliser coming in, and the fact that it would be readily available to farmers at every town and city, makes it even more attractive as transportation costs are hereby greatly reduced. The vast sum spent annually in foreign exchange to bring these fertilisers into the country can be saved, particularly when you remember that these fertilisers cost approximately Rs. 150 per ton for a mixed fertiliser of equivalent NPK composition as the compost produced, but devoid of the 77 per cent. of organic matter so important to our tropical soils.

An interesting by-product for most Municipalities and Councils is methane gas, which is produced by just tipping the mixed sewage and garbage into a sealed digesting tank to ferment for about a fortnight before the composting process is commenced. During this period of fermentation in the digesting tank the anaerobic bacteria get to work on the hydro-carbons and produce methane gas which is very similar to town gas but has appreciably higher heat content and is quite odourless. The gas so produced can be piped into a gasometer and thence into the town gas supply, or else used to power the town's electricity generating machinery. Taking for example the case of Colombo once again, the methane gas which could be thus produced would be more than double the output of the present Gas Company ; that is about 1,400,000 cubic feet daily or the heat equivalent of 6,000 gallons of petrol. This gas could be utilised to power all the engines at the Kolonnawa and Pettah power stations, providing light and power for Colombo in addition to powering the machinery at the sewage and garbage works. The surplus could still be piped to supplement the town gas supply. The facts of these statements are certainly staggering as they mean that every Municipality can afford to light its town without any imported fuel costs whatsoever—providing electricity at a mere fraction of that produced even hydro-electrically ! After fermentation for gas the mixture of garbage and sewage is still in no way impaired for composting. In fact in the post-war German cities, the sale of methane gas entirely subsidises the composting process thus enabling farmers to purchase the compost produced for a mere Re. 1.50 per ton.

Gentlemen, what I have said must certainly appear startling but these are facts and just go to prove what we can do by trying to get along with Nature.

I now propose the resolution " that in view of the increased demands on the soil for greater productivity and the present high cost of artificial fertilizers, that all Municipalities and Urban Councils be prevailed upon to convert sewage and garbage into organic manure for sale to planters and farmers instead of disposing of them through destructors, incinerators, dumps, &c., and that a section of the Department of Agriculture be devoted to research in organic and humus husbandry in order to develop the most appropriate means of restoring organic fertility and humus to the soils of this country, particularly where they suffer worst through erosion and oxidation ".

Chairman—" I would like to say something on this subject. I was connected with this type of work, as Chemist, about 25 years ago. Compost making from road refuse and night soil was studied at that time in collaboration with the Medical Department. We worked for two years on the subject and a large number of local bodies, including the Colombo Municipality, undertook the process as a result. Of course at that time the only process we knew of was the agricultural process whereby the destruction of pathogenic organisms was secured by regular turning. The final product was secured and utilized as manure. The process was carried on for some time not only in Colombo but in other Municipalities as well. I think the price at which the final product was sold by the Municipalities was Rs. 5 per ton. Then for some reason or other the product did not find a ready sale. Whether it was due to transport difficulties I could not say. I approve heartily of the proposal put forward by Mr. Wijewardena because I am a great believer in putting natural waste into good use, and I would commend it to the Board for adoption.

Particularly in the light of the modern developments to which Mr. Wijewardena has referred by which compost could be made

available in 5 or 6 days, the motion should commend itself to the Municipalities, particularly the Colombo Municipality.

Mr. Wijewardena's efforts in preparing this comprehensive memorandum is very commendable, but I have to state that his analytical figures are a bit on the high side compared to those we have obtained for local samples. But I do not think we need quarrel over this issue. Our analytical figures were about 1/10th of what has been quoted by Mr. Wijewardena. I do not think, however, that it is the function of the Agricultural Department to undertake this work as the public health issue is involved in this. That was why we worked in collaboration with the Public Health Department. It is really one which concerns the Municipalities and other local bodies. We will be very happy to co-operate with any organisation that is prepared to undertake this work. With those reservations I would like to commend the resolution to the House."

Mr. C. A. M. de Silva—" The reason why compost manure did not catch on was because it failed to produce the desired results. The results were not as effective as 7 lb. of artificial manure mixture. On the contrary the results of compost showed diminishing results, while the results obtained by artificials were very encouraging. That is why it did not find a ready sale even at Rs. 7 and bulk handling was also cumbersome ".

Gate Mudaliyar N. Wickremaratne—" To get increased yields from paddy and other crops, we must have manure and Mr. Wijewardena should be congratulated for bringing up this useful resolution. Some time back I wrote to the Department about certain aspects of manuring and I agree that compost can do a lot for our crops. My personal view is that if this is left to the Municipalities, they will never do it. Therefore, what I suggest is that if some of our well-to-do gentlemen can form into a company and run this concern it will be very much better than waiting till the Municipalities do it and it would also be an achievement to our country. When the Japanese Experts were here, one of them told me that paddy fields in Japan are manured about thrice during one sowing season. Some of us do not manure our fields even once and how can we do it without the manure. Therefore, people like Mr. Pathmanathan, Chairman of the Low-Country Products Association, and other members here who own two to three hundred acres of coconut should think of investing some of their money in a venture like this. Most of our rubber, tea and coconut planters do not invest their money in useful ventures of this nature and they always believe in banking it safe. In a place like India it is quite different. They invest every available cent on some productive business."

Mr. G. S. Portsmouth—" This is a problem that must be recommended to the Research Institutes."

Mr. A. M. Clement Dias—" Mudaliyar Wickremaratne always makes reference to the poor man but today he has referred to the rich man. Today compost is available at Rs. 10 per ton. Some time back I sent a memorandum suggesting that all Village Committees, Town Councils, Urban Councils and Municipalities should take an interest in the manufacture of compost, and that it should be given to the cultivator at cost price. We should have more manure for our fields available. In Japan paddy fields are manured three times a year and they use about 800 pounds of manure per acre. In Ceylon we use only 56 lb. of manure per acre. But I am glad to say that I manure my fields three times a year and use about 250 lb. of manure per acre, and the results have been very good with a yield of about 130 bushels per acre."

Mr. Ray Wijewardena—" Mr. Chairman, I am aware that the figures which you have produced are very much lower than the ones that I have. But I got these from actual simple tests conducted and they were corroborated from similar tests from Germany, France, South Africa and England. I am personally at a loss to explain why we differ.

With regard to the demand in Colombo for compost, the composting plant in Prince of Wales Avenue produces about 12 tons a day which is booked long before the compost is ready. They never had to advertise because the demand was always in excess of the production. Most of it is taken away by owners of coconut estates. The difficulty of

bulk handling can be greatly reduced by extracting the surplus moisture and then compressing it into bales.

With regard to the point mentioned by Mr. de Silva about artificial manure, I entirely agree that artificials produce some immediate and startling results particularly where plantation crops are concerned. I would like to mention about Horakelle Estate which had two blocks, one under artificials for the last 30 odd years and the other under cattle manure. Now they have been rather startled by the drop in production in the area under artificial manure. Recently some officials of the Coconut Research Institute went there and found that not a single mother palm had been produced in the artificially manured area, while the area under cattle manure and mixed manures was all right.

Chairman—"I do not think further discussion on this matter is necessary. We should, I think, accept this resolution in principle and recommend that this be a subject for investigation by the new Industrial Institute. If you would leave it to me to pursue action on the resolution and to ascertain how best we could implement it, in consultation with Mr. Wijewardena, we will probably satisfy the purpose of the mover of the resolution."

The Board agreed to this proposal.

VII—Reports of the Sub-Committees

Chairman—"The next item is the consideration of the Reports of the Sub-Committees. The draft Report of the Animal Husbandry Committee, has just been circulated and Dr. Mahamooth will give you a brief resume of it."

Dr. T. M. Z. Mahamooth, Deputy Director of Animal Husbandry—"Mr. Chairman and Gentlemen—the Committee met twice and five items were discussed. The first subject that was discussed was in regard to veterinary aid. It was felt that rural areas were not fully served by the Veterinary Services and therefore that more Veterinary Surgeons should be appointed to the ranges so that each officer will have a small area for efficient working. It was suggested that one Assistant Veterinary Surgeon should be appointed for each D. R. O's Division.

The next item was in regard to the payment of an adequate travelling allowance. It was felt that the present allowance for travelling should be increased. Item 3 was in regard to the control of animal diseases and the Committee felt that more attention should be paid to the control of foot-and-mouth and tick-borne diseases. As regards propaganda in animal husbandry, the Committee felt that while it appreciates the usefulness of films from foreign countries it would be more desirable to show films of local interest on the items that I have mentioned so that they would be of use to the rural population.

The next item was with regard to the release of the Quarantine Station. At the present moment there is no provision for importation of cattle for breeding purposes to Ceylon. The quarantine station at Slave Island was taken over by the Colombo Municipality for the quarantine of goats imported for slaughter. Since the accent is placed on increase in quality and quantity of cattle, people have made inquiries from India and Pakistan about imports, but at the moment importation is at a standstill. It was therefore felt by the Committee that steps should be taken to ask for the release of the Quarantine Station as early as possible.

Item 7 was in regard to animal husbandry in the Jaffna Peninsula. During certain times of the year owners of cattle are hard put to find adequate supplies of fodder. The price of straw soars up and the people experience much difficulty in finding grass for their cattle. It was therefore felt that in order to encourage livestock owners in the Jaffna Peninsula, Government should be requested to instal power driven balers in areas where paddy straw is in abundance, e.g., Hingurakgoda, Paranthan, &c., so that straw could be baled and transported by train to Jaffna.

Finally, in regard to a booklet on cattle-keeping, it was felt that a small booklet on breeding, feeding, management and diseases of cattle be published in all three languages."

Chairman—"I think this report might possibly be considered with advantage along with Mr. Schrader's resolution at the next meeting. Of course a large number of these are administrative matters and could be dealt with by the Department, as, e.g., a book on cattle-keeping, &c. The question of the Quarantine Station has already been taken up with Government and in the interests of all cattle owners we will press for its return very strongly.

I have already told you that the Treasury has agreed to the addition to the cadre of Veterinary Surgeons. Ultimately I hope we could increase the number to serve the needs of every D. R. O's Division in the Island."

Mr. S. C. Fernando, Commissioner for Co-operative Development and Acting Director of Food Production—"Since I might not have the opportunity of being present on the occasion Mr. Spencer Schrader's memorandum is taken up, I should like to clarify a point arising from it. Item 6 of the memorandum states that under the Food Production Regulations the exemption allowed in respect of "Sinhala" type cattle is a quarter acre per head as compared with 1 acre and 2 acres for the medium and superior types of cattle respectively. I must say that the law is not rigid on this point and that any person having "Sinhala" type cattle coming within or near the medium grade could get the same concession allowed to the latter class. For example, Mr. Spencer Schrader refers to a Sinhala type cow which yielded 9 pints of milk per day. Now I am sure anybody having "Sinhala" cattle of this standard could easily obtain the exemption allowed to medium type, viz., 1 acre per head."

Chairman—"Mr. Richards who is the Convenor of the Minor Products Sub-Committee will speak to you on the activities of that Sub-Committee."

Mr. A. V. Richards—"The report of the Sub-Committee has been circulated to members of the Board for consideration. In all, four meetings of the Sub-Committee were held. At its inaugural meeting the Sub-Committee decided on its functions, which were :

(1) to explore the possibilities of expanding and improving the minor products grown in Ceylon ;

(2) to explore the possibilities of introducing other economic minor products to Ceylon.

In all, the Sub-Committee has decided on about 20 minor products, individually and also in groups. The Sub-Committee decided to submit interim reports to the Board in due course and at this meeting it has pleasure in submitting its report on Cacao.

In this report a brief survey has been made of the cacao production and its exports from Ceylon to various countries and also of diseases and pests which threaten its production in other countries, especially in Africa and tropical America. Emphasis is made of the fortunate position Ceylon is, in being fortified against such diseases. There has been considerable replanting of cacao in rubber areas—to about 50,000 acres, 55 per cent. being in the Kandy district and 33 per cent. in the Matale district.

A review was made of the climatic and soil requirements. Cacao can grow well at an elevation of 500 to 2,000 feet with fairly distributed rainfall of not less than 60 inches and not more than 100 inches, and temperatures not below 60° F.

Reference was also made to the Department of Agriculture, Trinidad, West Africa, New Guinea and Indonesia from where certain high-yielding clones have been obtained. We have been fortunate in being able to get such high quality clones. They have undergone a period of quarantine at Kew and Heneratgoda. A brief description of the vegetative propagation of cacao is also given in the report.

Under-planting in cacao is the subject in which the Committee has really been interested. The costs of such under-planting have been supplied by Mr. Atkinson, who has been a pioneer in this field, Mr. Johnson of Urugala and the Superintendent of Pitakanda Group, Mawatagama. The Committee has considered three types of land in which cacao could be encouraged. That all lands above 1,200 feet in the Kandy-Matale district which are presently under uneconomic rubber be put under cacao. The Committee feels that a sum of Rs. 450 is adequate as a subsidy for under-planting uneconomic rubber with cacao. The Committee has also recommended that since

there is already a scheme of assistance for development of Crown land as peasant settlements in either tea, rubber or coconut, &c., cacao should also be included and that a subsidy of Rs. 750 be paid for the development of Crown lands under cacao. The third type of land which the Committee has considered is private land which is not presently under rubber but which may be found suitable for cacao. The Committee recommends that the same subsidy as for the development of uneconomic rubber lands be given for the development of cacao under this category. Finally the Committee recommends that the services of an expert in cacao be obtained through the F. A. O. or Colombo Plan to work on the problems relating to the control of Sickle leaf, Helopeltis, &c.

Chairman—" You have heard a very good report of this Sub-Committee which has laid great stress on the cacao crop. I think a report of this nature needs a little time for discussion. May I suggest that we put this by for discussion at the first item on the Agenda of our next meeting so that those who wish to discuss it could do so ? I must thank the Committee for the systematic way it has proceeded with its work by taking each crop or group of crops successively and providing us with a valuable brochure thereon. I thank the Chairman and Convenor for the useful work they have done.

The Paddy Committee is not yet in a position to issue its report and I hope they will do so before the next meeting. The Committee has had to devote some time to the consideration of the Joint Report of the U. K./Australian Rice Mission and hence the delay. "

Mr. S. Pathmanathan—" We have recommended cacao mainly as a peasant crop because in the Gold Coast, you will realise, that cacao is essentially a vital product in their economy and the price is guaranteed for a period of ten years. It is not going to be a major industry. "

The suggestions of the Chairman in regard to the Sub-Committees and the consideration of their reports were accepted by the Board.

Gate Mudaliyar N. Wickremaratne—" I would like to ask one question, Sir, and that is, if the Minister is unable to attend the meetings of this Board why cannot he send even his Parliamentary Secretary ? He is a gentleman who understands the agricultural needs of the country and he can help us by way of useful criticism. "

Chairman—" I think it will be expecting too much to ask the Minister to attend every meeting of our Board. As Minister he has many urgent matters of the State to attend to and it will be impossible for him to be present at every meeting of the Board. I will certainly convey the Mudaliyar's wish, that if he is unable to attend, he be requested to delegate his Parliamentary Secretary to do so. "

The meeting terminated at 5.30 p.m.

N. P. WIJEYERATNE,
Secretary,
Central Board of Agriculture.

Peradeniya, June 13, 1955.

ANIMAL DISEASES RETURN

January–March, 1955

Province	Disease	Fresh Cases during the Quarter	Total Number to end of First Quarter, 1955				Balance ill at end of Quarter
			Cases	Deaths	Shot	Recoveries	
Western Province (excluding Colombo Municipal area)	Foot-and-mouth	48	48	—	—	48	—
	Rabies	81	81	—	81	—	—
Northern Province	Anthrax	60	60	60	—	—	—
	Rabies	1	1	—	1	—	—
North-Central Province	Black Quarter	38	38	38	—	—	—
	Rabies	2	2	—	2	—	—
	Haemorrhagic Septicaemia	52	52	50	—	2	—
North-Western Province	Foot-and-mouth	1,359	1,359	234	—	1,001	124
	Rabies	4	4	—	4	—	—
Central Province	Foot-and-mouth	72	72	—	—	33	39
	Piroplasmosis	2	2	1	—	1	—
	Rabies	8	8	—	8	—	—
Province of Sabaragamuwa ..	Rabies	9	9	—	9	—	—
Province of Uva	Foot-and-mouth	58	58	1	—	57	—
	Rabies	7	7	—	7	—	—
Eastern Province ..	Foot-and-mouth	172	172	—	—	172	—
Southern Province	Foot-and-mouth	3,732	3,732	435	—	2,787	510
	Rabies	3	3	—	3	—	—

Department of Agriculture,
Peradeniya, June 7, 1955.

T. M. Z. MAHAMOOTH,
Deputy Director (Animal Husbandry)
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METEOROLOGICAL REPORT

January–March, 1955

SUMMARY

Ordinary north-east monsoon weather prevailed generally over the Island during January, with rainfall mainly confined to the north-eastern hill-country and the southern parts of the Batticaloa District. Evening thunder-showers were experienced occasionally in the south-western parts. The weather was unsettled from 6th to 9th on account of a low pressure wave to south of Ceylon. There was widespread rain with gloomy skies on the 6th and 7th, which was considerably heavy in the north-eastern hill-country and the southern parts of Batticaloa District, several stations recording daily falls over 5 inches. These rains resulted in disastrous floods in Uva Province and the Gal Oya Development area. The low pressure wave moved westwards and strengthened into a depression over the Maldives on the 9th, causing considerable damage to house and property. The north-eastern parts experienced heavy rain on the 17th and 23rd also. The weather conditions were dry over the whole Island on the 14th, 28th and 31st. The monthly rainfall exceeded 30 inches in the north-eastern hill-country, Hendon Estate in Rangala area totalling as much as 55.46 inches and St. Martin's (Upper) Estate 50.76 inches. From this region there was a gradual decrease in rainfall towards the east, and monthly totals in the southern parts of Batticaloa District were of the order of 20 inches. In the north-eastern low country the rainfall ranged from 10 to 15 inches and in the south-western parts from 5 to 10 inches, while in the North-Western Province and in Jaffna Peninsula it was below 5 inches. Least rain (totals below 2 inches) occurred in Chilaw-Narammala area. The rainfall was considerably above normal in the north-eastern hill-country and in Pottuvil area, where the excesses exceeded 10 inches. Appreciable deficits occurred in the neighbourhood of Batticaloa, and scattered in places, in the North-Western and Sabaragamuwa Provinces and in Deniyaya area. Elsewhere over the Island the rainfall did not deviate much from average.

Several low pressure waves moving westwards to south of Ceylon were responsible for the most unusual weather experienced over the Island during February. They caused heavy rain in the area extending from sea coast in the southern parts of Batticaloa District up to the hills, and stimulated thunder activity in the south-western low and mid-country, mainly in Kalutara and Galle Districts. Their influence was, however, limited, and did not extend to the northern parts of Ceylon—to north of Chilaw-Trincomalee, where the conditions were mainly dry. The severest of these low pressure waves occurred on the 7th and 8th, when the southern parts of Batticaloa District as well as the Gal Oya Catchment Area experienced heavy rain, over 30 stations recording daily falls exceeding 5 inches. Before the floods that resulted from these rains could subside, another low pressure wave caused heavy rain again in the same area, on the 12th and 13th. Although the rainfall on this occasion was less, it helped to prolong the floods in the area, causing great damage to house and property in the Gal Oya Valley. It also caused the Gal Oya Reservoir to overflow, for the first time since iits construction a few years ago. Similar weather was experienced in a February, previous to this, in 1944. The region affected was nearly the same, but the rainfall was heavier, there being a number of stations which recorded monthly totals over 25 inches. Greater monthly totals in February, 1955, were generally of the order of 20 inches, and occurred in the coastal area near Kalmunai and in the north-eastern hill-country. Elsewhere in the eastern regions, extending from Kalmunai to the hills, the monthly totals were above 10 inches. In the south-western low and mid-country also the rainfall generally exceeded 10 inches, with a few totals over 15 inches in Pimbura-Udugama area. The rainfall was below 2 inches in the northern and north-western parts, a few stations in Jaffna Peninsula recording no rain at all. The rainfall was above normal in the southern half of the Island, remarkably high excesses, of the order of 15 inches, occurring in the southern parts of Batticaloa District, and scattered in places, in the north-eastern hill-country and in Kalutara and Galle Districts. The deficits which occurred in the north and northwest were slight, due to the fact that February averages in that area are low.

The weather over the Island was practically dry during the first fortnight of March. Inter-monsoon thunder activity commenced about the 13th and continued till the end of the month. At the beginning the rainfall was mainly confined to the southern half of the Island, but towards the end of the month it extended to North-Western and North-Central Provinces, too. Some stations in the south-western mid-country experienced rainfall almost every day during this period, with heavy falls occasionally. The greater monthly totals ranged from 10 to 20 inches and occurred in the south-western low and mid-country and among the Haputale Hills. In the Northern and Eastern Provinces and in some parts of North-Central Province the rainfall was mainly below

2 inches, a few stations along the northern and north-eastern coasts receiving no rain at all. The rainfall was generally above normal in the south-western parts, where the greater excesses mainly exceeded 5 inches. The rainfall was below normal in the northern and eastern parts, but the deficits were generally small.

A. P. KANDASAMY,
Acting Director.

Station	January									February			
	Temperature				Humidity		Rainfall			Temperature			
	Mean Maximum	Offset	Mean Minimum	Offset	Day	Night (from Minimum)	Total	Offset	No. of Days	Mean Maximum	Offset	Mean Minimum	Offset
	°	°	°	°	%	%	in.	in.		°	°	°	°
Anuradhapura ..	82·6	—0·7	71·0	+1·8	83	98	5·90	+0·10	20	86·0	—1·1	70·2	+0·9
Badulla ..	75·7	—0·5	65·4	+1·6	86	95	19·72	+9·40	26	78·1	—0·9	64·8	+1·7
Batticaloa ..	81·6	+0·1	75·9	+2·4	80	86	7·69	—5·19	24	82·2	—0·7	74·3	+0·6
Colombo ..	86·1	—0·4	71·9	+0·1	72	90	7·05	+3·09	12	85·3	—1·9	72·3	+0·2
Diyatalawa ..	70·3	—1·5	60·0	+2·3	86	94	11·82	+5·18	20	75·1	+0·2	58·9	+2·1
Galle ..	84·1	+0·3	73·3	+0·3	78	88	5·57	+1·69	11	84·2	—1·0	74·1	+0·4
Hambantota ..	83·6	—1·4	73·4	+0·7	79	90	9·34	+5·34	19	84·8	—1·2	73·5	+0·5
Jaffna ..	83·1	+0·1	74·3	+2·2	72	84	3·84	—0·57	7	85·2	—0·4	72·0	—0·3
Kandy ..	81·0	—1·2	67·1	+2·3	73	87	7·23	+0·49	22	83·3	—2·1	66·1	+1·9
Kankesanturai ..	82·9	—	75·7	—	79	84	2·97	—0·44	9	84·8	—	73·8	—
Kurunegala ..	84·5	—2·0	70·7	+0·8	74	95	3·35	—1·76	12	87·4	—2·6	70·1	+0·5
Mannar ..	82·9	—0·4	75·5	+1·3	76	84	6·40	+2·56	15	85·0	—1·2	74·9	+1·1
Nuwara Eliya ..	65·2	—2·5	52·6	+5·6	80	84	10·50	+3·54	22	67·7	—1·9	51·1	+5·9
Puttalam ..	85·6	+0·1	71·7	+1·7	75	93	3·91	+0·48	16	87·7	—0·6	71·2	+0·9
Ratmalana ..	85·3	—	72·5	—	68	88	4·70	+0·55	11	86·6	—	73·1	—
Ratnapura ..	88·1	—1·2	71·3	+0·2	75	95	9·98	+3·72	15	89·8	—1·8	72·4	+1·1
Talawakele ..	72·3	—1·9	58·7	+3·2	72	83	4·67	+0·80	15	73·6	—2·8	56·9	+2·4
Trincomalee ..	81·4	+0·9	76·7	+1·4	80	82	12·81	+4·50	18	82·2	—0·3	76·8	+1·0

Station	February (contd.)					March								
	Humidity		Rainfall			Temperature				Humidity		Rainfall		
	Day	Night (from Minimum)	Total	Offset	No. of Days	Mean Maximum	Offset	Mean Minimum	Offset	Day	Night (from Minimum)	Total	Offset	No. of days
	%	%	in.	in.		°	°	°	°	%	%	in.	in.	
Anuradhapura ..	75	95	1·21	+0·51	8	91·9	+0·6	71·8	+0·2	67	95	4·71	+0·56	7
Badulla ..	80	94	9·20	+6·03	18	82·5	+0·1	65·2	+0·9	75	95	5·32	+0·27	18
Batticaloa ..	80	90	12·15	+7·94	16	85·3	—0·1	76·4	+1·4	76	88	0·82	—2·65	8
Colombo ..	75	93	6·63	+4·03	11	86·9	—1·0	72·9	+1·1	73	90	5·54	+0·88	15
Diyatalawa ..	77	84	7·93	+5·56	16	79·7	+2·3	58·5	+0·3	74	91	4·17	—0·72	13
Galle ..	78	90	14·05	+10·76	15	86·0	—0·3	74·6	—0·5	76	90	6·67	+1·36	17
Hambantota ..	78	90	3·53	+2·07	14	87·2	+0·3	74·6	+0·3	76	90	5·28	+1·89	10
Jaffna ..	66	88	0·02	—1·44	1	88·9	+0·2	75·7	—0·1	66	86	0·26	—1·32	2
Kandy ..	69	89	6·16	+3·77	13	87·4	—0·5	67·5	+0·4	64	90	6·86	+1·44	14
Kankesanturai ..	74	88	0·10	—0·98	2	89·0	—	75·1	—	68	91	0	—1·47	0
Kurunegala ..	67	95	1·51	—0·48	6	92·9	+0·3	71·3	—0·8	62	95	9·02	+2·74	11
Mannar ..	72	84	0·34	—1·36	4	88·7	—0·6	76·3	+1·0	69	86	0·30	—1·54	5
Nuwara Eliya ..	75	84	6·81	—4·82	17	71·4	+0·5	47·8	+1·3	75	90	4·00	—0·09	14
Puttalam ..	72	93	1·45	+0·08	6	91·2	+1·3	72·8	—0·1	67	90	3·82	+0·74	6
Ratmalana ..	70	88	7·91	+4·55	14	88·1	—	74·0	—	67	86	3·26	—3·22	15
Ratnapura ..	75	95	11·32	+6·02	19	93·0	+0·9	72·3	—0·2	72	95	8·40	—1·98	22
Talawakele ..	72	79	5·47	+3·50	12	75·5	—2·4	56·1	+0·8	71	82	4·24	—0·38	15
Trincomalee ..	76	82	6·33	+3·68	10	87·4	+1·9	78·1	+1·6	71	84	0·03	—2·27	1

GOVERNMENT NOTIFICATIONS

TEA RESEARCH (AMENDMENT) ACT, No. 20 OF 1955

L. D.—O. 4/55.

AN ACT TO AMEND THE TEA RESEARCH ORDINANCE

Chapter 301, Vol. VI, page 441.

[Date of Assent: April 14, 1955]

BE it enacted by the Queen's Most Excellent Majesty, by and with the advice and consent of the Senate and the House of Representatives of Ceylon in this present Parliament assembled, and by the authority of the same, as follows:—

1. This Act may be cited as the Tea Research (Amendment) Act, No. 20 of 1955. Short title.

2. Section 5 of the Tea Research Ordinance, as amended by the Proclamation published in *Gazette Extraordinary* No. 9,773 of September 24, 1947, by Act No. 24 of 1948 and by Act No. 51 of 1953, is hereby further amended in sub-section (1) of that section as follows:— Amendment of section 5 of Chapter 301.

(1) in paragraph (*a*) of that sub-section, by the addition, at the end of that paragraph, of the following:—

"The Chairman of the Low-country Products Association of Ceylon."; and

(2) in paragraph (*b*) of that sub-section—

(*a*) by the substitution, for the words "One member nominated by the Minister to represent the small holders.", of the words "Two persons nominated by the Minister to represent the small holders.", and

(*b*) by the addition, at the end of that paragraph, of the following:—

"One member of the House of Representatives nominated by the Minister."

2

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