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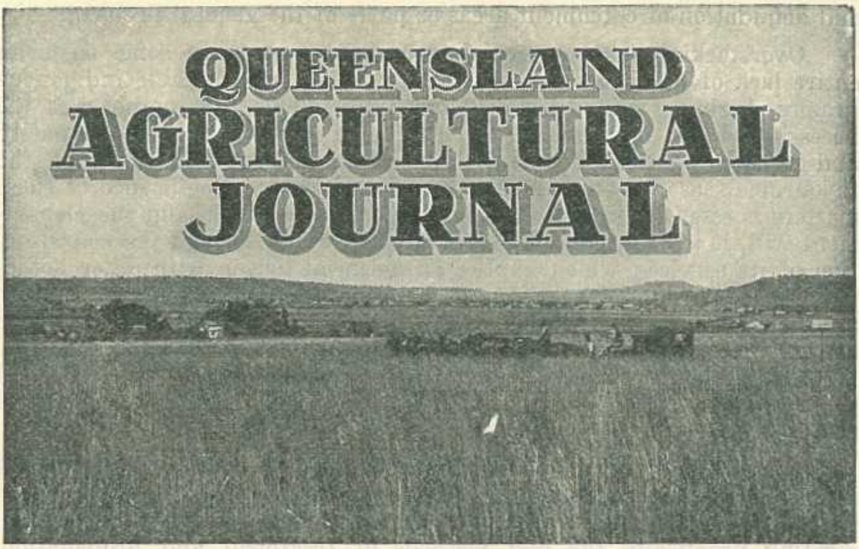

VOL. XLVI. 1 NOVEMBER, 1936. PART 5

Event and Comment

A Record of Agricultural Progress.

MATTERS of outstanding importance are dealt with in the Annual Report of the Under Secretary and Director of Marketing, Mr. E. Graham, to the Minister for Agriculture and Stock, Hon. Frank W. Bulcock. In the course of a comprehensive survey of agricultural facts and tendencies, Mr. Graham said:—There is scarcely any phase of farming to which departmental influence does not extend, to the advantage of the man on the land. While the Department continues perseveringly in its enormous task, success would be unattainable without the goodwill and co-operation of the farmers themselves. On them devolves the practical side of the business, the application of preventive, corrective, or ameliorative measures evolved or recommended by the Department, and the necessity of close collaboration with administrative, scientific, and technical staffs. Obviously, in dealing with the problems of primary industry little could be done without the farmers' cheerful and practical co-operation.

Another important chapter in the history of agriculture in Queensland was opened by the initiation in January last of a scheme of co-ordinated scientific research. Professor E. J. Goddard, B.A., D.Sc., Dean of the Faculty of Agriculture and Professor of Biology in the University of Queensland, was appointed Science Co-ordinating Officer temporarily to assist in implementing the scheme. The general principle is a recognition of the fact that conditions in agriculture influence largely the level of prosperity in industries dependent on it. Consideration is being given to several of the major problems with which primary industry in Queensland is faced to-day. Among them is the problem of soil erosion, a matter of vital importance to both farmers and graziers. To loss of soil must also be added deterioration of pastures and denudation of catchment areas as parts of the general problem.

Overstocking and wrong pasture management—in some cases an entire lack of management—are taking toll of our valuable indigenous grasses, herbage, edible shrubs, and trees. This fact emphasises the necessity of the maintenance of a balance between carrying capacity and number of stock depastured on grazing areas, and of which the favourable season should not be the sole criterion. Cognisance of these matters is essential in any system of scientific research, and the Department will, it is believed, achieve practical results through the co-ordination of its services, which implies an essential liaison with other bodies working towards the solution of pressing national problems. There are, obviously, certain fundamental facts and principles involved which can only be considered fully under a system of co-ordinated research. In fact, all departmental activities—field work, control of plant and animal diseases, regulatory administration and general agricultural economy—are but an expression of scientific research.

During the year close attention was given to pasture improvement based largely on fundamental research involving two important purposes—the testing of indigenous and introduced grasses and demonstrating practically the best methods of treatment and propagation. Other matters dealt with in this connection included proper subdivision of grazing areas, systematic grazing and the prevention of overstocking, and, incidentally, adequate and protected water supplies.

It is pleasing to report that farmers have evinced a keen interest in all these and related projects.

Within the realm of agricultural economics much was accomplished by the Department in the course of the year. Organised marketing has occupied a prominent place amongst its many activities, especially since the inception of the Marketing Branch. By a diversity of methods, legislative and otherwise, it has endeavoured to ensure that the producer receives the best possible price for his products. Fundamentally, however, the improvement of the marketing system rests with the primary producers themselves. The Department may devise enabling machinery and give the necessary direction, but it is really a matter for the farmers themselves, acting collectively, through their local producers' organisations, to work out their own economic salvation.

It is easier to talk of new and better markets than to capture or establish them. Further effort must be made to improve the quality of our export products so that, whatever competition we may have to encounter on oversea markets, we shall at least hold our own on point of intrinsic quality.

The marketing side of the agricultural industry is still beset with problems both vast and intricate, and any shortcomings in our export trade must be eliminated by the closest co-operation of all concerned.

In the course of the year a system of periodical staff talks, under the presidency of the Honourable the Minister, was inaugurated. As a means of interchanging ideas, co-ordinating services, and stimulating thought and action, the regular assembly of heads of branches has been productive of much benefit in departmental administration, and has been entirely successful generally.

Development of Export Trade in Farm Products.

DISCUSSING the marketing situation generally, Mr. Graham remarked:—It is gratifying to pool boards, particularly boards that engage in the export trade in primary products, to know that the Premier (Hon. W. Forgan Smith, LL.D.), during his visits to Great Britain, had made opportunity for an examination of the conditions under which Queensland products are marketed overseas.

As a result of the survey of the marketing conditions that was made by the Honourable the Premier, pool boards have been furnished with valuable information and advice that will be of very material benefit and guidance to the marketing organisations concerned in the conduct of their functions.

The Premier ascertained that the quality of our products, particularly the produce that was up to the standard of our highest grade classification, and the manner in which the product had been prepared and presented for market, met with the general approval of those trading in the produce. The Premier was assured of and greatly impressed by the necessity for pool boards to give increased attention to the utilisation of British ports other than London. It is common knowledge that both on the eastern and western British coasts there is a number of first-class ports which serve large industrial and manufacturing centres of England and Scotland. These ports are used for the intake of the major portion of the foodstuffs required to meet the needs of a population several times greater than that of the Commonwealth. These cities and large towns provide potential avenues for trade in our products, but the trade is not to be captured without some initial effort on the part of the exporters. The fuller utilisation of these ports would be at least a gesture that would contribute towards the annexation of a fair proportion of the trade which, for the greater part, is being enjoyed at present by other countries that consign butter, cheese, eggs, and meat (principally pork) to Britain.

It is the case that the ports outside of London are being used to an increased extent each year, but it is highly desirable that the volume of the trade should be augmented considerably. The evidence is that we are producing products of the kind and quality suitable for the trade, and the consumers there are favourably disposed towards Australian produce, with a bias towards foodstuffs produced in Queensland.

As a result of the experience that has been gained by the application of the principle of collective marketing to primary products, it can confidently be claimed that the system of collective marketing has proved to be of very material benefit to the primary producers concerned. It has created a stability in marketing operations that otherwise would be lacking. Collective marketing has made possible the expansion of many of our agricultural industries, and generally orderly marketing has rendered it possible to mould a marketing programme, and in other ways assist the growers in a manner that could not have been achieved by individual effort. There are many instances where the volume of production in pre-pool days has, since the inception of pooling, been increased manifold.

There are, however, indications that, although pools have met with a very considerable degree of success, the value of pools has not yet been fully exploited.

The Queensland Pine Beetle and Its Control.*

A. R. BRIMBLECOMBE, B.Sc., Assistant to Entomologist.

THE Queensland pine beetle* is a pest of major importance to house-owners in South-eastern Queensland. Its damage is confined almost entirely to hoop pine, and records of its occurrence have been obtained only in buildings which have been erected a number of years. Attack in dwellings usually commences on the under surface of flooring boards, from which subsequent generations spread to other parts of the building.

Nature of Damage and Timbers Attacked.

Damaged timber externally reveals numerous small circular holes (Plate 257; fig. 5) one-twentieth of an inch in diameter. These are emergence holes made by the mature beetles in liberating themselves from the wood. Internally, the wood reveals meandering tunnels (Plate 257; fig. 5) of various sizes filled with frass. Heavily damaged timber may very well be compared with sponge rubber, and can be crumbled away by the hand.

The emergence holes are usually the first external signs that borers have been at work. However, their presence indicates that the damage caused by these particular individuals has already been completed. Eventually the timber is so extensively riddled that it retains little, if any, structural strength, but this is the case only if it is subjected to repeated infestation, a development which readily occurs. Often it is not till this state is reached, followed by collapse of the wood, that damage is found, as instanced in flooring.

Queensland hoop pine timber is the natural food of the borer. However, there is one other timber, New Zealand white pine, which in one instance only has been found attacked.

In all cases of recorded damage, the timber was of some considerable age, but at the time it was noticed, the damage was also of some age. Consequently, it is difficult to say how soon after felling of the timber or erection of the building attack is likely to occur. From evidence to date, it sems reasonable to state that attack will not take place for some few years after felling.

Life History and Habits.

The female beetles when commencing an attack lay their eggs in cracks in boards or between boards or on undressed surfaces. Subsequent generations choose similar positions or return to the emergence holes. The minute white globular egg (Plate 257; fig. 1) is just discernible to the naked eye. After a period of a few weeks it hatches into a small white curved larva or grub (Plate 257; fig. 2) which immediately tunnels into the wood. The grubs do all the damage. They tunnel backwards and forwards through the wood, month after month, extracting nourishment from the digestible parts in the chewed material. How long these grubs continue to tunnel is not exactly known, but it must be about two years. When fully grown, each grub seals the tunnel with a transverse wall so as to form an oval chamber in which it changes into a pupa (Plate 257; fig. 3). This is a resting stage which after a few weeks completely transforms into the sexually mature beetle (Plate 257;

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* *Calymmaderus incisus* Lea, subfamily Anobiinæ, family Ptinidæ.

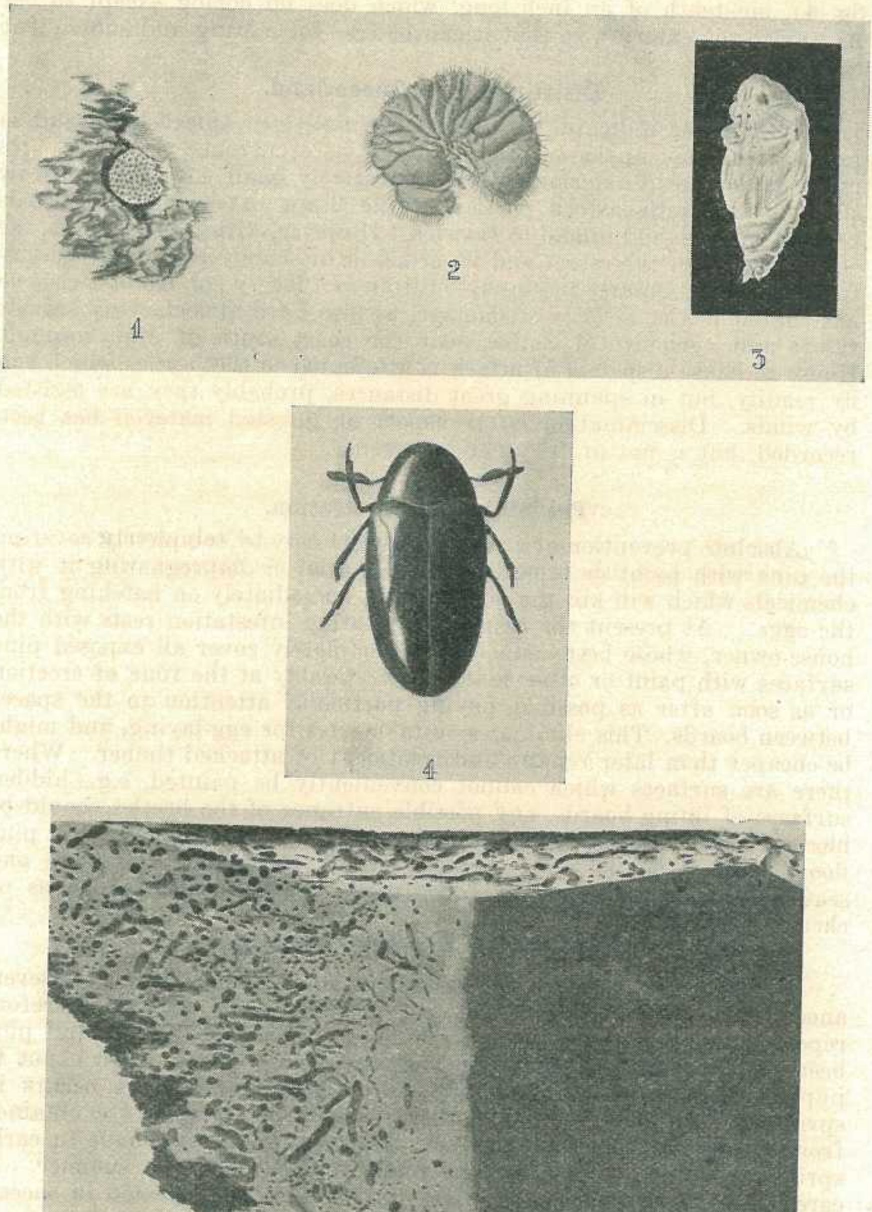


Plate 257.

THE QUEENSLAND PINE BEETLE (*Calymmaderus incisus* Lea).

Fig. 1.—Egg *in situ* × 24.
Fig. 2.—Larva × 8.
Fig. 3.—Pupa × 8.
Fig. 4.—Adult × 15.
Fig. 5.—Hoop pine showing internal damage and exit holes.

fig. 4), one-tenth of an inch long, which does no boring except to eat its way to the exterior, so that it can be free for mating and subsequent egg-laying.

Distribution in Queensland.

As its name indicates, this insect is a native of Queensland, and so far there has not appeared any record of its occurrence elsewhere. Its range as at present determined is comparatively small, covering a narrow strip of the south-eastern portion of the State, extending northwards to Maryborough and inland to Ipswich. However, within these limits, the concentration of the insect and its attack is of some considerable magnitude, more particularly in closely-built areas. Every suburb of Brisbane has shared in the records of damage, as also have almost every seaside resort and agricultural centre near the coast south of Maryborough. House to house dispersal of attack is attributed to the beetles which can fly readily, but in spanning great distances, probably they are assisted by winds. Dissemination by transport of infested material has been recorded, but is not of frequent occurrence.

Prevention of Infestation.

Absolute prevention of attack is possible only by completely covering the pine with paint or other suitable material or impregnating it with chemicals which will kill the young grubs immediately on hatching from the eggs. At present the onus of preventing infestation rests with the house-owner, whose best method is to completely cover all exposed pine surfaces with paint or other material, preferably at the time of erection or as soon after as possible, paying particular attention to the spaces between boards. This eliminates suitable sites for egg-laying, and might be cheaper than later repairs and treatment of attacked timber. Where there are surfaces which cannot conveniently be painted, e.g., hidden surfaces of lining boards, any possible entrance of the beetles should be blocked with material other than pine or with treated pine. As pine floors seem to be the most liable to attack, adequately desapped and seasoned hardwood could be substituted, and this is as cheap as or cheaper than pine.

Methods of Arresting Damage.

Borer control is not a simple matter, and often demands perseverance. Any one treatment will not give complete control, therefore repeated treatments are necessary. The grubs of the Queensland pine beetle are usually well entrenched within the wood, but when about to pupate, they come comparatively near the surface. This occurs in spring and summer, so during these periods best results are obtained from attempts at control. The first treatment should be made in early spring, followed by at least one other treatment in the summer. A careful watch will then be required, and treatments repeated in successive seasons until the attack is arrested.

Treating infested timber involves brushing and injecting or spraying and injecting some liquid which will penetrate the wood and kill the insects by contact, suffocation, or poisoning. Several suitable products are already on the market or can easily be prepared, and several firms handling these materials hire out the apparatus necessary for the application of the treatments.

When attack has been located all infested boards should be tested by hitting them with a mallet. Any that collapse under the blow should be removed and burnt. Replacements and lightly-infested wood may be treated with one or other of the liquids mentioned below.

Heavy grade creosote is the most effective for general application. It possesses fair penetrative power and evolves a good concentration of fumes. It is not recommended for use within the building since it causes a dark flat stain which usually is not desired, and the success of subsequent coats of paint, polish, &c., might be impaired. It is most suitable for the under surface of floors and the hidden surface of linings, for which purpose some weather boards must be removed temporarily.

This creosote can be diluted with kerosene to reduce the amount of stain produced, an effective mixture being equal parts of each. A dilution of one part of creosote to eight of kerosene leaves only a faint stain, and later a paint or varnish finish is possible. A light grade creosote of clear colour does not leave a stain, and, though it might not be so effective as the heavy grade, it might meet requirements in certain cases.

Heavy grade creosote can also be applied as an emulsion prepared by adding one part of 5 per cent. soft soap solution in water to four parts of creosote, followed by thorough stirring to ensure complete and even dispersal of the creosote throughout the mixture.

A suitable mixture for use within the building is one pound of paradichlorobenzene dissolved in one gallon of kerosene. Kerosene or turpentine alone may be used; however, it has been stated that a mixture containing equal parts of each possesses better penetrative power than either alone. None of these liquids leave any stain.

On an average, one gallon of liquid is sufficient for 150 square feet of timber. Brushing is the most general method adopted. Spraying might be more convenient and quicker, provided the instrument is equipped with a nozzle that does not produce splashing or a mist so fine that there is little adherence of the liquid to the wood. The most satisfactory method is to inject the liquid by a syringe pump into the emergence holes, followed by brushing or spraying.

WHAT IS AN ACRE?

5 yards by 968 yards	contains	1 acre.
10 yards by 484 yards	,,	1 acre.
20 yards by 242 yards	,,	1 acre.
40 yards by 121 yards	,,	1 acre.
80 yards by 60½ yards	,,	1 acre.
70 yards by 68 1.9 yards	,,	1 acre.
220 feet by 198 feet	,,	1 acre.
440 feet by 99 feet	,,	1 acre.
110 feet by 369 feet	,,	1 acre.
60 feet by 726 feet	,,	1 acre.
120 feet by 363 feet	,,	1 acre.
240 feet by 180½ feet	,,	1 acre.

Studies on the Biology and Control of the Large Roundworm of Fowls, Ascaridia galli (Schrank 1788) Freeborn 1923.

F. S. H. ROBERTS, D.Sc., Animal Health Station, Yeerongpilly.

[*Continued from p. 479, Part IV., Vol. XLVI.—October, 1936.*]

PART V.

6. THE CONTROL OF ASCARIDIA GALLI.

1. THERAPEUSIS.

INVESTIGATIONS into the therapeusis of ascaridiasis have followed two lines (*a*) individual treatment, in which each individual bird is given a vermifuge, and (*b*) flock treatment, in which a number of birds are treated simultaneously by means of a vermifuge, which is mixed with the mash. Greater success is claimed for individual administration, for this method ensures that each bird receives the full dosage. Flock treatment as originated by Herms and Beach[65] is apparently not as successful in the field as it is under laboratory conditions. This is probably due to the fact that the efficiency of this method of treatment depends solely upon food consumption—a factor very difficult to control among birds in the field Herms and Beach[65], for example, when recommending an infusion of chopped tobacco stems in the mash, point out that care should be taken to see that each bird receives its share. Freeborn[53], who found that a mixture of tobacco dust in the mash gave very satisfactory results under laboratory conditions, noted that these results were not always repeated in the field, one of the reasons being that the treated mash was distasteful to many birds. An impaired appetite, moreover, frequently accompanies an advanced helminth infestation, and under such conditions, the efficiency to be expected from a flock treatment would be rather low. Such inability to control the intake of food by each bird would also be likely to prove dangerous, especially in the case of such drugs as are employed for a flock treatment administered once only.

Individual treatment also apparently has its disadvantages, as it has been shown that the treated birds may become so affected by a vermifuge that their vitality and egg production may be lowered. Atwood and Clark[24] first drew attention to these ill-effects as a sequence to individual treatment. Hall and Shillinger[61], however, reported that in a field trial, which they carried out on 16 pullets given carbontetrachloride at the rate of 2·27 ml. per kilo. no deleterious effects on egg production were noticed by them. This observation is supported by Stafseth and Thomson[98], who concluded from their field trials with "Iodin Vermicide" that birds, used to being handled, frequently failed to show any noticeable reduction in egg yield, and usually show a marked improvement in condition.

On the other hand, work by Bleecker and Smith[34 to 37] on the use of vermifuges under field conditions was reported as indicating that the repeated use of an individual treatment vermifuge on pullets ranging on infested soil was of no advantage in increasing egg production or in improving the health and vigor of the birds. In one experiment[35], however it was found that although the rate of egg production of treated birds may be very uneven, due to a marked decrease following treatment, the number of eggs per treated bird over a season may be greater than the number produced per untreated birds.

Thomas[100], using tetrachlorethylene plus kamala and "Iodin Vermicide," found that there was a marked decrease in egg production following treatment, and that, thereafter, the production of the treated birds did not at any time equal that of the untreated birds. There was also a higher mortality rate among the treated birds, whose food consumption per dozen eggs was also greater. Thomas concluded that treatment was valueless, because birds on infested soil became rapidly reinfested owing to the ill-effects of the vermifuge upon their vitality.

Maw[74] has recorded that the use of kamala may seriously affect egg production and finally, Ackert and Graham[22], using carbontetrachloride at the rate of 4ml. per kilo, have noted that with two treatments with an interval of three weeks, the egg production of ten treated birds decreased from 62.38 per cent. to 52.38 per cent. over a six weeks' period, while the production of ten untreated birds increased from 50.48 per cent. to 70.48 per cent. over the same period.

In the following series of trials both individual and flock treatment have been considered. Although flock treatment has received scant attention from poultry helminthologists during recent years its inclusion in this series of experiments was considered warranted for two main reasons:—

(*a*) The majority of poultry farmers in Queensland will not employ individual treatment, owing to the time, labour, and expense involved. If, therefore, a flock treatment, simple in its application, could be made available, even though its efficiency were only moderate, its regular use by these people would, in all probability, be followed by an improvement in health of the poultry they control.

(*b*) It is possible that a flock treatment, in which treatment is applied over a number of days, so that the amount of a vermifuge consumed per day is relatively small, may not be followed by the ill-effects on egg production, &c., which have been reported by several investigators as a sequence to individual treatment.

1. INDIVIDUAL TREATMENT.

(i.) Résumé of Previous Investigations.

The principal drugs employed in the individual treatment of poultry infested with *A. galli* are (1) a solution of nicotine sulphate (40 per cent. nicotine), (2) iodine, which is used very largely in the United States as "Iodin Vermicide," (3) tetrachlorethylene, and (4) carbontetrachloride. Other drugs which have ben critically tested include oil of chenopodium, oil of turpentine, copper sulphate, pyrethrum, derris, kamala, normal butilydene-chloride, benzine, and a few others of minor importance only, such as oil of eucalyptus, arecoline, and oil of aniseed. Some of these have given relatively high efficiencies, and others have proved to be of no value whatsoever.

Nicotine Sulphate and Its Compounds.

The use of nicotine sulphate (40 per cent nicotine) as an anthelmintic for *A. galli* was first investigated by Freeborn[52]. Previously, flock treatments employing the admixture with the mash of an infusion of chopped-up tobacco stems (Herms and Beach[65]) and of commercial tobacco dust (Doughterty and Beach[48]) and (Freeborn[51]) had given satisfactory laboratory trials and were in use in the field. Freeborn[52], however, found that flock treatment with tobacco dust was not always reliable under field conditions, and, as a result, commenced experiments with Blackleaf 40—a proprietary nicotine sulphate solution containing 40 per cent. nicotine. His work showed that this extract if given in sufficient quantities to be efficient, was decidedly toxic. Subsequently, however, Freeborn found that when the extract was mixed with Lloyd's alkaloidal reagent, a special type of Fuller's earth, high efficiencies, namely 97.2 per cent., could be secured against *A. galli*, and, moreover, that the inclusion of this reagent protected the birds from any toxic action of the nicotine sulphate. The formula recommended consisted of 6.6 ml. (7.92 gms.) of Blackleaf 40, and 16 gms. of Lloyd's reagent. The dosage was given as 350 mgms. to 400 mgms. of this mixture, which, Freeborn stated should be given without any previous starvation, and is well tolerated by birds as young as eight to ten weeks.

Carpenter[39], using nicotine caseinate, reported that this derivative was 99 per cent. effective and non-toxic. In the annual report, 1923-24, the Missouri Poultry Station[85] state that good results were secured by them with a 4 ml. dose of a 4 per cent. solution of nicotine sulphate in mineral oil.

Extensive investigations into the use of nicotine sulphate as a poultry vermifuge, including several proprietary preparations, were reported by Bleecker and Smith in 1933[34,35,36]. These workers found Freeborn's formula highly effective, but when given with 15 grs. kamala as a "double duty" treatment, the efficiency was somewhat reduced, being 72.5 per cent. in the 32 birds so treated. Nicotine sulphate (Blackleaf 40) in doses of 2.5 minims to .3 ml. plus 15 grs. kamala was 65.7 per cent. effective in 135 birds against all helminths, excluding *Heterakis gallinæ*. Doses of nicotine sulphate up to 1 ml. were employed, and it was reported that although as much as ten drops could be given with safety to large cocks and five drops to grown hens, the efficiency of the drug was decreased, and its toxicity increased if doses larger than .3 ml. were employed. Bleecker and Smith[34] considered nicotine sulphate in 2.5 minim to .3 ml. doses effective and reasonably safe, except for badly depressed birds, but after further trials[35] they reached the conclusion that "Whilst Blackleaf 40 appeared to be an effective vermifuge, its depressing action on producing birds and the fact that toxic symptoms follow its use in some birds, makes it of questionable value, and, therefore, it cannot be highly recommended."

In recent work in Russia, Skriabine and Schultz[96] noted that of the several drugs tested by them, nicotine sulphate was most satisfactory.

Carbontetrachloride.

In 1923, Hall and Schillinger[61] reported that this drug was highly effective against *A. galli*. The doses used ranged from 1 ml. to 20 ml. per kilo and while a dose of 1 ml. per kilo failed to remove any worms from the one bird to which it was administered, doses of 2 ml., 4 ml., and 5 ml. per kilo. were 100 per cent. effective in each case in which they were employed. Their report does not indicate any toxicity, even from the dose of 20 ml. per kilo. Graybill and Beach[57] noted that a 2 ml. dose to adult birds in hard capsules was 98 per cent. effective. Freeborn, however, was unable to report satisfactory results from the doses employed by him. Graham and Ackert[54] found that a dose of 4 ml. per kilo.

would remove all *A. galli.*. No toxic symptoms followed this dose rate, but a dose of 10 ml. per kilo. was reported to be decidedly toxic. These trials were repeated in 1935[22], and it was found that whilst doses of 8 ml. and 10 ml. per kilo. were effective but toxic, a dose of 4 ml. per kilo., while removing all the worms, had only transitory effects. A field trial with this dose rate to ten laying pullets showed, however, that inactivity and diarrhœa may be present for two days subsequent to treatment.

Von Mocsy[76] did not find carbontetrachloride very satisfactory, and Skriabine and Schultz[96] reported that whilst the drug gave good results in their hands, it was not as effective as nicotine sulphate or tetrachlorethylene.

Tetrachlorethylene.

Schlingman[89] first tested tetrachlorethylene against *A. galli* and reported that a dose of 1 ml. was highly effective in birds up to 2 lb. 12 oz. in weight. When used in conjunction with kamala[91], its efficiency was reduced, but Schlingman considered that this would not have occurred if a three days' interval had been present between the use of the two drugs.

In 1929, further tests were carried out by this worker[92], and he found that doses less than 1 ml. were not particularly effective in birds up to 2 lb. in weight, and that even at this dose rate, the drug was not always reliable in its action. With Guzhit[93] Schlingman found that no toxicity followed doses of 1 ml. to 5 ml. to chickens ·91 kilogrammes to 1.6 kilogrammes in weight or following a dose rate of .83 ml. per kilo.

Ackert and Graham[22], comparing the toxicity of tetrachlorethylene and carbontetrachloride, found the former more toxic, for whereas a dose of 6 ml. per kilo. of carbotetrachloride produced transitory effects only, due principally to inhalation intoxication, tetrachlorethylene, given at a similar dose rate, caused visible toxic symptoms for five days subsequent to its administration. Skriabine and Schultz[96] mention tetrachlorethylene as being very effective.

Iodine.

The use of iodine as a vermifuge for poultry was first investigated by Chandler[40, 41]. He found an iodine suspensoid which was claimed to be not only highly effective against both roundworms and tapeworms, but also lethal to their eggs. This preparation is known in the United States as "Iodin Vermicide." Stafseth and Thomson[98] reported a 100 per cent. efficiency in 29 birds against *A. galli* from this compound, which was also noted to be entirely harmless. In field trials, they found that repeated treatments were followed by an improvement in health and rate of production. Bleecker and Smith[34] recommend "Iodin Vermicide" as being effective, and particularly safe for badly-depressed birds. The adult dose is 1 fluid oz., and the efficiency depends entirely upon delivering the preparation directly into the gizzard, for which purpose a special bulb syringe fitted with a long slender nozzle is provided.

Von Moèsy[76] reported an organic compound of iodine, the glycerine ester of 9-10-di-iodo-12-oxy-octadecylic acid to be safe and 100 per cent. effective.

Other Drugs.

Copper Sulphate.—The Missouri Poultry Station[85] noted that a 1 gram dose of copper sulphate was 78 per cent. effective in adult birds. Von Moèsy[76], however, reported that this drug used either as a powder or in solution did not give very satisfactory results.

Oil of Turpentine.—Hall and Foster[60] tested oil of turpentine on six chickens, ·45 kilogramme to ·9 kilogramme in weight. The birds were given 2 ml. of the drug in 2 ml. of olive oil, which dosage was followed by 8 ml. of castor oil. An efficiency of 76 per cent. was obtained. These results were confirmed by the Missouri Poultry Station[85]. Von Moċsy[76], however, was unable to report satisfactory results from his tests with this drug.

Pyrethrum.—In 1934, Rebrassier[82] reported that a 200 mgr. dose of a sample of pyrethrum containing ·8 per cent. pyrethrin I. removed 95 per cent. of the Ascaridia from 30 birds.

The allied drug, derris, was used by Freeborn[51], who was unable to obtain any degree of efficiency with the dosages employed.

Normal Butilydene Chloride.—This drug was used by Wright et. al. [101]. Their report indicated that doses of 2 ml. to 6 ml. were well tolerated and 100 per cent. efficient. A dose of 1 ml., whilst not so effective, gave very satisfactory results.

Benzine, arecolin, oil of eucalyptus, and kamala have also been tested by Von Moċsy[76], but were all regarded as unsatisfactory.

(ii.) Laboratory Experiments.

In the laboratory trials reported herein, the various drugs selected were first tested on young birds. These birds were secured as day old chickens and infested with *A. galli* when one month old, treatment experiments being commenced several weeks later, by which time the majority of the worms had reached maturity, and were of a conspicuous size. The breed employed was Single Comb White Leghorns.

Owing to insufficient accommodation it was not possible to carry out trials involving single subjects and groups of birds of from three to twelve in number were employed.

Previous work by the writer on the life history and pathogenicity of *A. galli* had shown that it was very rare for chickens when given a single small dose of eggs at 30 days old to be, after a few weeks infestation, entirely worm-free. The chickens used in these tests were given single doses of 100 eggs to 200 eggs, and it is considered reasonably safe to assume, therefore, that the drug employed had been 100 per cent. effective in those birds in any group in which no worms were found after treatment.

With each series of experiments carried out with these young birds a group of control untreated birds was always maintained. In this way the possibility of the expulsion of worms by the treated birds being due to factors other than treatment was guarded against. The number of worms passed by the control groups during any critical test was never more than three, which number, it is considered, is too small to have any significant effect upon the efficiencies obtained.

The drug giving the most promising results among the young birds was then tested on adult birds—hens one to two years old. In the case of the adult birds, it was possible to obtain the efficiency of the drug in each individual bird. Controls were not maintained in this series of trials, as the adult birds varied in age and came from different poultry farms.

In all cases the birds were placed on wire-mesh floors and the droppings were collected on iron trays beneath. The majority of the worms voided were collected during the first twenty-four hours. Very few were passed on the second and third days, and it was extremely rare to find voided worms on the fourth day.

The drugs tested included nicotine sulphate, carbontetrachloride, tetrachlorethylene, oil of chenopodium, oil of turpentine, pyrethrum, copper sulphate, and carbonbisulphide, all of which, with the exception of carbonbisulphide, have been employed by other investigators and noted as being reasonably or highly efficient. It is regretted that "Iodin Vermicide" was omitted from these trials, but this preparation is not obtainable in Queensland.

Nicotine Sulphate.

Prior to its use in the tests described below, the sample of nicotine sulphate used was analysed and found to contain 40·8 per cent. nicotine. The results obtained are summarised in Table XIX.

TABLE XIX.
RESULTS FROM NICOTINE SULPHATE.

No. of Experiment.	No. Birds Used.	Weights of Birds.	Dosage.	No. Worms Passed.	No. Worms Remaining in Individual Birds.	Total Worms Remaining.	Per cent. Efficiency.
		Oz.	Minims.				
1	10	18–24	1·5	37	5, 1, 7, 14, 2, 0, 0, 0, 0, 0	29	56·0 } 55·4
2	10	21–26	1·5	35	2, 6, 7, 3, 7, 4, 0, 0, 0, 0	29	54·7 }
3 *	5	15–19	2·0	18	2, 3, 8, 0	13	58·0
4	5	17–21	2·5	15	4, 9, 1, 7, 4	25	37·5
5	12	16–23	‡ 250 mgm.	15	1, 8, 3, 16, 1, 4, 7, 1, 4, 0, 0, 0	45	25·0
6 †	5	18–28	‡ 350 mgm.	24	5, 8, 7, 7, 9	36	40·0

* 1 bird died shortly after treatment. † No starvation. ‡ Freeborn's formula.

Discussion.

All birds except those in experiment 6, which were unstarved, were starved for approximately 17 hours before and for 3 hours after treatment, the drug in all cases being administered in hard gelatine capsules.

In experiments 1 to 4 inclusive, all birds displayed symptoms of toxicity, drowsiness, a staggering gait, and prostration following shortly after administration, being very marked in the case of the larger doses. Where 2·5 minims were used, the birds did not recover completely till about 24 hours after treatment. Of the five birds given a 2 minim dose, one collapsed and died within thirty minutes.

The highest efficiency was secured from a 2 minim dose, which removed 58 per cent. of the worms from four birds, from one of which no worms were collected on autopsy (Exp. 3). A 1·5 minim dose to 20 birds (Exps. 1 and 2) was apparently 100 per cent. effective in nine birds, but left a sufficiently large number in the remaining eleven to reduce the efficiency of this dosage to 55.4 per cent. The highest dosage employed, namely 2.5 minims, was less effective than either of the two smaller doses, and gave an efficiency of only 37.5 per cent (Exp. 4).

In Experiments 5 and 6, where a 250 mgm. and a 350 mgm. dosage of Freeborns' formula were employed, it was evident that the addition of the Lloyd's reagent was successful in protecting the birds from the toxic action of the nicotine sulphate. With the exception of two of the birds given 250 mgm. (Exp. 5) no symptoms of toxicity were observed, and in these two birds only very slight evidence of toxicity was manifested. In the twelve birds subjected to seventeen hours' starvation before and three hours' starvation after the administration of a 250 mgm. dose (Exp. 5) the dosage appeared to have been 100 per cent effective in only three birds, giving a total efficiency of only 25 per cent. The 350 mgm. dose was given without any starvation to five birds, but was only 40 per cent. effective (Exp. 6).

These results are not in agreement with those claimed by other workers in whose hands a nicotine sulphate solution containing 40 per cent. nicotine has given evidence of relatively* high efficiencies. The optimum dosage as noted by the writer to birds 15 oz. to 26 oz. in weight is in the vicinity of 2 minims, and apparently dosages greater than this are not only more toxic, but also less effective. Whilst previous starvation may have increased the toxicity, there is no evidence that such preparation is responsible for a decreased efficiency. A 1·5 minim dose removed 55·4 per cent of the worms present in birds previously starved for seventeen hours, whilst 350 mgr. of Freeborn's formula, which contains approximately 1.6 minims of nicotine sulphate, given without starvation, was only 40 per cent. effective. From these tests it must be concluded that nicotine sulphate was in the writer's hands both ineffective and dangerous.

Tetrachlorethylene.

The results obtained with this drug are set out below in Table XX.

TABLE XX.

RESULTS FROM TETRACHLORETHYLENE.

No. of Experiment.	No. Birds Used.	Weights of Birds.	Dosage.	No. Worms Passed.	No. Worms Remaining in Individual Birds.	Total Worms Remaining.	Per Cent. Efficiency.
		Oz.					
7	10	18-24	·5 ml.	31	3, 1, 2, 2, 23, 1, 0, 0, 0, 0	32	49·2
8	5	16–20	·5 ml.	44	2, 2, 3, 0, 0	7	86·2
9	10	16–29	·75 ml.	74	2, 2, 2, 18, 0, 0, 0, 0, 0, 0	24	75·5
10	10	17–27	1 ml.	77	31, 8, 2, 0, 0, 0, 0, 0, 0, 0	41	65·2

Discussion.

All birds were starved for seventeen hours before and for three hours after treatment, the drug being administered in hard gelatine capsules.

In the first test, a ·5 ml. dose was given to ten birds, varying in weight from 18 oz. to 24 oz. A total of thirty-one worms was passed, and on post mortem it appeared as though this dosage had been 100 per cent effective in four birds, and highly effective in five others. From the tenth bird, however, twenty-three worms were collected,

* NOTE.—The writer's experience with the therapeusis of Ascaridiasis has led him to consider that worms may be more readily removed from old grown birds than from young birds. As most of the tests by other investigators with nicotine sulphate have, so far as it can be determined, been carried out on grown birds, it is possible that this factor may have been responsible for the poor results secured with this drug in these investigations.

this number thereby considerably reducing the efficiency of the dosage in this experiment, only 49·2 per cent of the total number of worms present being removed. In the second trial with a ·5 ml. dose on five birds, somewhat lighter in weight, better results were secured, and an efficiency of 86·2 per cent. was obtained.

When the dose was increased to ·72 ml. to ten birds, 16 oz. to 29 oz. in weight (Exp. 9), autopsies showed a very high efficiency in nine birds, being apparently 100 per cent. in six of these, but the presence of eighteen worms in the remaining bird was responsible for a decrease in the efficiency of this dosage to 75.5 per cent.

A 1 ml. dose to ten birds of about the same weight as those to which a ·75 ml. dose had been administered (Exp. 10), proved to be less effective than the ·75 ml. dose. This was due to the fact that although the 1 ml. dose had apparently been 100 per cent. effective in seven birds and highly effective in the eighth bird, it failed to remove the bigger proportion of the infestations from the remaining two birds, especially from one of these from which thirty-one worms were collected, giving an efficiency for this group of only 65·2 per cent.

No symptoms were at any time observed as might be associated with a toxicity from these dosages, except in the case of one bird in the group given a 1 ml. dose, which was slightly depressed for a few hours after treatment.

The results secured with this drug are rather better than are indicated in the accompanying table. In the majority of the birds the dose employed gave relatively high efficiencies, but as in some birds it appeared to be without any effect on the infestation, it was concluded that the drug was unreliable in its action, and no further trials were carried out.

Oil of Chenopodium.

The oil of chenopodium employed was from a sample sold by W. J. Bush and Co., London. The results secured in these tests against *Ascaridia galli* are given in Table XXI.

TABLE XXI.

RESULTS FROM OIL OF CHENOPODIUM.

No. of Experiment.	No. Birds Used.	Weights of Birds.	Dosage.	No. Worms Passed.	No. Worms Remaining in Individual Birds.	Total Worms Remaining.	Per cent. Efficiency.
		Oz.					
11	10	19–26	·15 ml. + 2 ml. castor oil	52	5, 1, 2, 0, 0, 0, 0, 0, 0, 0	8	86·6
12	9	18–24	·2 ml. + 2 ml. castor oil	87	3, 4, 3, 4, 0, 0, 0, 0, 0 ..	14	86·1
13	5	20–26	·3 ml. + 3 ml. castor oil	54	1, 3, 2, 2, 0	8	87·1
14	5	26–29	·4 ml. + 3 ml. castor oil	45	3, 0, 0, 0, 0 *	3*	100·0

* One bird died within 24 hours after treatment and contained three worms. This dosage was therefore 100 per cent· effective in the remaining four birds.

Discussion.

The dosages of oil of chenopodium were given in hard gelatine capsules, followed immediately by the castor oil. The birds were starved for seventeen hours before and for three hours after treatment.

In the first test (Exp. 11) a ·15 ml. dose of oil of chenopodium, followed by 2 ml. of castor oil was employed, the ten birds receiving this dose weighing from 19 oz. to 26 oz. Fifty-two worms were passed, and on post mortem no worms were found in seven of the birds, and five, one, and two respectively in the remaining three—an efficiency of 86·6 per cent. No ill-effects from this dosage were observed in any bird.

When the dosage was increased to ·2 ml. to birds of somewhat the same weight, 86·1 per cent. of the worms present was removed. One bird was apparently affected by this dosage and did not recover completely for about two days (Exp. 12).

A ·3 ml. dose followed by 3 ml. of castor oil, removed fifty-four worms from five birds, 20 oz. to 26 oz. in weight, and left a total of eight worms, an efficiency of 87·1 per cent. One bird was markedly affected by this dosage, and in all birds the droppings were diarrhœal for about two days. (Exp. 13).

A final test with a dose of ·4 ml. of oil of chenopodium, followed by 3 ml. of castor oil to five birds, 26 oz. to 29 oz. in weight, showed this dosage to be decidedly toxic. One bird died within 24 hours, and the remaining four were affected for from four to five days. The efficiency was 100 per cent. (Exp. 14).

These trials indicate that oil of chenopodium in a dose of ·15 ml. with 2 ml. of castor oil appears to be safe and highly efficient. Increasing the dosage to ·2 ml. and ·3 ml. was not followed by any marked increase in efficiency, though there was a very definite increase in toxicity. A ·4 ml. dose was 100 per cent effective, but decidedly toxic. The birds employed for these higher dosages (Exps. 12, 13, and 14) were found on post mortem to be affected to varying degrees with an intestinal form of coccidiosis. Such a condition contraindicates the use of this drug, and it is probable that with healthy birds of the same weights there might have been little or no evidence of toxicity from the ·2 ml. to ·4 ml. doses—from the ·2 ml. and ·3 ml. doses at any rate. As, however, enteritis is a fairly common condition among poultry, it was felt that the drug could not be recommended and no further trials were therefore carried out.

Copper Sulphate.

Two tests were carried out with copper sulphate. In the first experiment eight birds were each given 1 gm. in 4 ml. of water. The birds weighed 20 oz to 26 oz. and were subjected to the usual periods of starvation. Within two hours of treatment all birds were visibly affected, and were all dead within three days.

When the dose was reduced to ·5 gm. an efficiency of 66.6 per cent. was secured from five birds of approximately the same weights. No birds died, but all were affected to varying degrees for several days after treatment.

TABLE XXII.

COPPER SULPHATE.

No. of Experiment.	No. Birds Used.	Weights of Birds.	Dosage.	No. Worms Passed.	No. Worms Remaining in Individual Birds.	Total Worms Remaining.	Per Cent. Efficiency.
		Oz.					
15	8	20–26	1 gm.	35	..	..	All birds died
16	5	18–25	·5 gm.	30	5, 2, 0, 4, 4	15	66·6

Copper Sulphate and Nicotine Sulphate.

In the first experiment with this combination, a dose of ·5 gm. supper sulphate in 2 ml. of water plus 1 minim of nicotine sulphate was employed. This proved 97·5 per cent effective in eight birds, removing seventy-seven worms and leaving two. This dosage proved rather toxic however. A smaller dose of copper sulphate, namely ·2 gm., with 1 minim of nicotine sulphate was only 51·6 per cent. efficient in four birds. While a reasonable efficiency may have been secured with ·3 gm. copper sulphate, it was felt that this dose would not leave a sufficient margin of safety, and no further trials were therefore carried out.

TABLE XXIII.

COPPER SULPHATE PLUS NICOTINE SULPHATE.

No. of Experiment.	No. Birds Used.	Weights of Birds.	Dosage.	No. Worms Passed.	No. Worms Remaining in Individual Birds.	Total Worms Remaining.	Per Cent. Efficiency.
		Oz.					
17	8	19–25	·5 gm. cop. sulph., 1 min. nic. sulph.	77	1, 1, 0, 0, 0, 0, 0, 0 ..	2	97·5
18	4	21–25	·2 gm. cop. sulph., 1 min. nic. sulph.	32	7, 5, 10, 8..	30	51·6

Oil of Turpentine.

The efficiencies secured with doses of 1 ml. and 2 ml. of this drug are given in Table XXIV.

TABLE XXIV.

RESULTS FROM OIL OF TURPENTINE.

No. of Experiment.	No. Birds Used.	Weights of Birds.	Dosage.	No. Worms Passed.	No. Worms Remaining in Individual Birds.	Total Worms Remaining.	Per Cent. Efficiency.
		Oz.					
19	3	21–24	1 ml. + 2 ml. castor oil	32	14, 6, 8	28	53·3
20	5	21–27	2 ml. + 2 ml. castor oil	65	3, 2, 0, 0, 0	5	92·9

Discussion.

In both groups of birds the oil of turpentine was mixed with castor oil and the required dosage delivered into the crop by means of a syringe and rubber tube. All birds were starved for seventeen hours before and for three hours after treatment.

No ill-effects followed the use of a dose of 1 ml. oil of turpentine in 2 ml. castor oil, but the percentage of worms removed was only 53·3. Where 2 ml. of turpentine was employed two birds were definitely affected by the increased dosage, but had recovered completely by the third day. The efficiency from this dosage was very high, namely 92·9 per cent, being apparently 100 per cent. in three birds.

These two experiments indicate that whilst a 2 ml. dose to birds 21 oz. to 27 oz. in weight removed the majority of the worms, the toxic symptoms displayed by two of the five birds employed precludes its recommendation. The toxicity of this dosage may have possibly been reduced by the use of larger quantities of castor oil. However, as this, if effective, would considerably increase the costs of the treatment, and as it did not appear as though the results secured with carbontetrachloride would be approached, no such tests were made.

Pyrethrum.

In Rebrassier's report[82] on the use of pyrethrum, a 200 mgm. dose of a sample of pyrethrum containing ·8 per cent. of pyrethrin I. gave a 95 per cent. efficiency. This dosage, therefore, contained 1·6 mgm. of pyrethrin I. The sample of pyrethrum used in the writer's test was analysed as containing only ·24 per cent. of pyrethrin I., and therefore to give a dosage of pyrethrum containing an amount of pyrethrin I. equivalent to that in the 200 mgm. dose used by Rebrassier, each of the ten birds on which the test was made was given 750 mgm. (1·8 mgm. pyrethrin I). The birds were starved for 17 hours before and for three hours after treatment, and weighed from 19 oz. to 26 oz. The results of this test (Exp.. 21) were very disappointing, as only one worm was passed, 146 being collected on autopsy.

TABLE XXV.

RESULTS FROM CARBONTETRACHLORIDE (YOUNG BIRDS).

No. of Experiment.	No. Birds Used.	Weights of Birds.	* Preparation.	Dosage.	No. Worms Passed.	No. Worms Remaining in Individual Birds.	Total Worms Remaining.	Per Cent. Efficiency.
		Oz.						
23	10	18–22	*a*	·5 ml. (hard capsule)	57	2, 3, 2, 1, 1, 0, 0, 0, 0, 0	9	86·4
24	6	15–19	*a*	·5 ml. (hard capsule)	24	10, 4, 2, 0, 0, 0 ..	16	60·0
25	10	16–20	*a*	·75 ml. (hard capsule)	80	..	0	100·0
26	8	18–24	*a*	·75 ml. (hard capsule)	68	3, 7, 7, 8, 4, 0, 0, 0	29	70·1
27	9	22–26	*a*	·75 ml. (hard capsule)	69	5, 7, 1, 2, 0, 0, 0, 0	15	82·1
28	10	16–23	*a*	1 ml. (hard capsule)	144	3, 0, 0, 0, 0, 0, 0, 0, 0, 0	3	97·9
29	10	17–25	*a*	1 ml. (soft capsule)	194	..	0	100·0
30	8	20–24	*a*	1 ml. (soft capsule)	58	..	0	100·0
31	10	18–25	*a*	1 ml. (syringe)	64	7, 4, 4, 3, 2, 2, 0, 0, 0, 0	22	74·4
32	11	16–24	*b*	1 ml. (syringe)	88	2, 3, 3, 1, 1, 0, 0, 0, 0, 0, 0	10	89·8
33	9	22–26	*b*	1 ml. (soft capsule)	55	..	0	100·0
34	10	18–24	*c*	1 ml. (soft capsule)	128	3, 2, 1, 3, 2, 4, 2, 0, 0, 0	17	88·3
35	9	17–23	*c*	1 ml. (syringe)	34	5, 2, 6, 3, 12, 3, 3, 0, 0	34	50·0
36	8	19–24	*a*	1 ml. plus 1 ml. liquid paraffin	37	53, 30, 8, 0, 0, 0, 0, 0	91	28·9
37	8	22–26	*a*	1 ml. plus 1 ml. liquid paraffin	45	1, 1, 0, 0, 0, 0, 0, 0	2	95·8
38	8	17–25	*a*	1 ml. (soft capsule) and 8 gr. kamala	98	1, 1, 0, 0, 0, 0, 0, 0	2	98·0

* *a* 17 hours' starvation before and 3 hours' starvation after treatment.
b 17 hours' starvation before, fed about 5–10 minutes after treatment.
c No starvation.

Carbon Bisulphide.

In a single test (Exp. 22) with carbon bisulphide three birds, 23 oz., 22 oz., and 19 oz. in weight respectively, were given ·3 ml. in a hard gelatine capsule after seventeen hours previous starvation. No food was allowed for three hours after treatment. Within two hours after dosing all three birds were noticeably distressed. Next day two had recovered to a slight extent, and were inclined for food. The third bird did not assume a normal appearance till about the fifth day after treatment. A total of twelve worms were passed. Post mortem showed that this dosage had removed all worms from one bird and had left a single worm in each of the other two birds, an efficiency of 85·7 per cent.

Carbontetrachloride.

A large number of tests were carried out with this drug on both young and adult birds as the results secured in the early stages of the work gave indications that carbontetrachloride promised to be more effective than any of the other drugs tested. The results of the trials with young birds are given in Table XXV.

Discussion.

In the first experiment with carbontetrachloride, a ·5 ml. dose in hard capsules to ten birds, 18 oz. to 22 oz. in weight, gave very promising results, an efficiency of 86·4 per cent. being secured (Exp. 23). The same dosage on six birds, somewhat lighter in weight, however, removed only 60 per cent. of the infestation. (Exp. 24). Evidently this dose was not large enough to give good and consistent results in birds of this weight range.

In the next three experiments (25, 26, and 27) a ·75 ml. dose in hard capsules was employed. The effectiveness of this dosage varied from 70·1 per cent. to 100 per cent. in twenty-seven birds, 16 oz. to 26 oz. in weight, giving a total efficiency of 83·1 per cent. It was evident that whilst this dose was highly effective in those birds in the vicinity of 16 oz. weight, it was not so efficient in the heavier birds.

The dose was, therefore, increased to 1 ml., given in hard capsules. The ten birds given this dosage weighed 16 oz. to 23 oz. A total of 144 worms were passed, and three were present on autopsy, an efficiency of 97·9 per cent (Exp. 28). In a further experiment with this dosage, all worms were removed from eighteen birds, 17 oz. to 25 oz. in weight, to which the drug was administered in soft capsules (Exps. 29, 30).

These results indicated that a dose rate of about ·75 ml. per pound weight would be highly effective against *A. galli*. Tests were then undertaken to ascertain the best methods of preparation and administration. In the first place, it was obvious that there was little difference in the efficiencies of the drug given in hard or soft capsules (Exp. 28, 29, and 30). Administration of the drug into the crop by means of a syringe and rubber tubing, however, did not give as good results as when capsules were used. In the twenty-one birds given the drug per syringe the efficiency was 82·6 per cent. (Exps. 31 and 32), whilst that from capsules was 97.9 per cent. to 100 per cent. Experiments were also carried out to see whether the inclusion of equal parts of liquid paraffin would impair the efficiency of the drug to any marked extent. In the first trial (Exp. 36) only 28.9 per cent of the worms were removed. This low efficiency was due to careless administration, the dose being regurgitated by at least two of the birds immediately after its administration. In a further trial, however, an efficiency of 95·8 per cent. was secured (Exp. 37).

As regards preparation of the birds to be treated, experiments were carried out to ascertain to what extent starvation before and after treatment assisted towards the efficiency of the 1 ml. dose. The results quoted above were secured with pre-starvation and after starvation periods of about seventeen hours and three hours respectively.

With a 1 ml. dose in soft capsules and starvation before and after treatment for these respective periods the efficiency was 100 per cent (Exp. 29 and 30). Without any starvation at all the efficiency was decreased to 88·3 per cent. (Exp. 34), whilst as shown in Experiment 33, a 1 ml. dose given to nine birds with previous starvation only (seventeen hours), food being given five to ten minutes after treatment, gave an efficiency as high as that secured with both pre and after starvation. These results were confirmed by a similar series of experiments in which a 1 ml. dose was administered by means of a syringe. The efficiencies in this group of trials showed that whilst prestarvation only (Exp. 32) did not interfere with the anthelmintic efficiency of the drug, being 89.8 per cent. as compared with 74·4 per cent. with both pre and after starvation (Exp. 31), the omission of starvation entirely gave comparatively poor results, namely 50 per cent. (Exp. 35).

In the final trial (Exp. 38) a 1 ml. dose of carbontetrachloride was given in a hard capsule with 8 gr. kamala, to see whether the inclusion of the kamala would decrease the efficiency of the carbontetrachloride or be followed by toxic symptoms. Neither of these two effects were noted, the efficiency of the treatment being 98 per cent.

As regards the toxicity of carbontetrachloride, an experiment was carried out in which twelve chickens were given dosages varying from 1·5 ml. to 4 ml. per pound weight per syringe, with seventeen hours previous starvation. A dose of 1·5 ml. per pound to three birds, 11 oz., 12 oz., and 13 oz., in weight respectively, was followed by a momentary period of depression in one bird, and during the next six hours the droppings were slightly diarrhœal. Next day all birds appeared bright and normal. A dose of 2 ml. per pound weight to three birds, each 14 oz in weight, was followed by slight inactivity up to about six hours after. After twenty-four hours, the birds were quite bright in appearance, though the droppings were slightly diarrhœal in consistency. A dose of 3 ml. per pound weight to three birds each of 14 oz. weight was followed almost immediately by inactivity, which, however, was only momentary, and was considered to be due to inhalation intoxication. After about three hours, however, all birds were noticeably depressed, which condition, accompanied by diarrhœa, persisted for another thirty-six hours. With a dose of 4 ml. per pound weight, three birds, 11 oz., 12 oz., and 16 oz. in weight respectively, immediately showed the effects of inhalation of the drug, and remained very depressed and inactive with diarrhœa for about ninety-six hours, their recovery commencing from about the third day, and being apparently complete on the fifth day.

During the trials a total of ninety-three birds from 16 oz. to 26 oz. in weight received 1 ml. of the drug, and any symptoms as might be associated with toxicity were rare. On a few occasions the droppings were slightly diarrhœal for up to twenty-four hours after treatment, and in some of the birds given the dose per syringe there was evidence of inco-ordination of movement and inactivity, which effects were of comparatively brief duration, and were considered to be probably due to inhalation of the volatile principles of the drug.

The results from these tests may therefore be summarised as follows:—

1. Carbontetrachloride is highly effective against *A. galli*.

2. The optimum dose for young birds is in the vicinity of ·75 ml. per pound weight.
3. The drug appears to be more effective when administered in capsules than when given per syringe. The type of capsule employed is not apparently of any importance. Carbontetrachloride given with an equal quantity of liquid paraffin appears to be almost as effective as carbontetrachloride when used alone.
4. The experiments on the preparation of the birds before and after the treatment show that a previous starvation period of about seventeen hours (overnight) is necessary for high efficiencies, but starvation after treatment for longer than about five to ten minutes is not required.
5. A single trial, where 10 grains of kamala were administered immediately after the carbontetrachloride did not give any evidence that the inclusion of the kamala impaired the efficiency of the carbontetrachloride to any marked extent.

The results from trials with carbontetrachloride in adult birds are tabulated below. In every case, the birds were subjected to previous starvation for about seventeen hours, but were fed about ten minutes after treatment.

TABLE XXVI.

RESULTS FROM CARBONTETRACHLORIDE (ADULT BIRDS).

No. of Experiment.	No. of Bird.	Weight. Lb. oz.	Dosage.	No. Worms Passed.	No. Worms Remaining.	Per cent. Efficiency.
39	1	3 1	1·5 ml. per syringe	1	..	100·0
	2	3 1		201	..	100·0
	3	3 5		1	1	50·0
	4	3 15		21	2	91·3
	5	2 5		3	2	60·0
	6	2 13		41	1	97·6
40	7	3 5	2 ml. per syringe	43	..	100·0
	8	3 1		125	..	100·0
	9	3 3		77	..	100·0
	10	5 7		5	..	100·0
	11	4 1		148	2	98·7
	12	3 8		19	..	100·0
	13	5 0		81	..	100·0
	14	5 5		26	..	100·0
	15	3 5		39	..	100·0
	16	3 11		1	3	25·0
	17	3 11		7	..	100·0
	18	3 0		4	..	100·0
	19	2 14		2	..	100·0
41	20	4 2	2 ml. in soft capsule	14	..	100·0
	21	3 8		22	..	100·0
	22	2 8		20	..	100·0
	23	3 0		23	..	100·0
	24	3 4		8	1	88·8
	25	3 12		9	..	100·0
42	26	4 11	2 ml. + 2 ml. liquid paraffin	3	..	100·0
	27	3 3		4	1	80·0
	28	4 13		15	2	88·2
	29	5 5		2	..	100·0
	30	3 4		74	8	90·2
	31	4 5		88	16	84·6

Discussion.

In a preliminary experiment, six birds, 2 lb. 5 oz. to 3 lb. 15 oz. in weight were each given 1·5 ml. of carbontetrachloride per syringe. The dosage was very successful in the three cases where a good number of worms were present, being 100 per cent. efficient in No. 2 with 201 worms and 91·3 per cent. and 97·6 per cent. efficient in Nos. 4 and 6, which contained twenty-three and forty-two worms respectively. The dose, however, was only 50 per cent effective in No. 3 with two worms, and 60 per cent. affective in No. 5 with five worms.

In the next trial, the dose was, therefore, increased to 2 ml., which was also administered by means of a syringe. Of the thirteen birds given this dose and which weighed from 3 lb. 1 oz. to 5 lb 7 oz. all worms were removed from eleven, in five of which the infestation was fairly high, namely 39, 43, 77, 81, and 125 worms respectively. In the twelfth bird, the 2 ml. dose removed 148 out of 150 worms, but in the remaining bird three out of four worms survived. These results indicate that 2 ml. dose is very highly effective, but, like the smaller 1·5 ml. dose, may not be as efficient where only a slight infestation exists.

Simultaneously with the above trial, six birds, 2lb. 8oz. to 4lb. 2 oz. in weight, were given 2 ml. in soft capsules. The efficiencies secured, as denoted in Table XXVI. were practically equal to those given by the unencapsuled drug.

In a final test, six birds, 3 lb. 3 oz. to 5 lb. 5 oz in weight, were given 2 ml. of carbontetrachloride with equal parts of liquid paraffin. In the only two birds which were heavily infested Nos. 30 and 31 the mixture removed 90·2 per cent. and 84.6 per cent. of the worms present respectively, whilst in the remaining birds with 2, 3, 5, and 17 worms, the efficiencies were 100 per cent., 100 per cent., 80 per cent., and 88·2 per cent. respectively. It would, therefore, appear that in this experiment the effectiveness of the carbontetrachloride was impaired by the inclusion of the liquid paraffin.

Including birds that were treated but subsequently proved to be non-infested, a total of forty-five adult birds were given a 2 ml. dose in these trials. Symptoms which could be associated with toxicity, were displayed by six birds, in four of which they were only of a temporary nature, and were considered to be due to inhalation of the drug. The remaining two birds, however, remained inactive and depressed for a period of two or three days after treatment. In both of these birds, subsequent autopsies showed disease conditions to be present, which had no doubt lowered the bird's tolerance to the drug. In some of the birds, which were otherwise unaffected, the droppings were slightly diarrhœl in consistency for up to twenty-four hours after treatment.

Conclusions.

Of the various drugs employed in these trials against *A. galli*, carbontetrachloride is considered to be the most efficient.

The effective dose rate is in the vicinity of ·75 ml. per pound weight, but not to exceed a total dose of 2 ml. This dose rate appears reasonably safe, though it may cause momentary inactivity and a slight degree of diarrhœa. The margin of safety is fairly high for a dose rate of 4 ml. per pound weight whilst toxic is not lethal.

Birds to be treated should be starved overnight, treated early next morning and fed a few minutes after treatment.

As regards the method of administration, the experiments with the young birds indicate that the efficiencies of the methods employed may be placed in the following order:—(1) Hard or soft capsules, (2) carbontetrachloride with equal parts of liquid paraffin per syringe, (3) carbontetrachloride per syringe. With the adult birds, on the other hand, the efficiencies secured from the administration of drug per capsule and per syringe were about equal and greater than that of the drug plus liquid paraffin. The liquid paraffin was originally included with the object of increasing the bulk of the dose and also of protecting the bird from any possible toxic effects. The costs of these respective methods of administration, computed from Brisbane wholesale prices on the basis of a 1 ml. dose are as follows:—

(*a*) Soft capsules, 4s. per 100 birds.

(*b*) Hard capsules, 2s. 10d. per 100 birds (exclusive of labour costs for filling the capsules with the drug).

(*c*) With equal parts of liquid paraffin, 10d. per 100 birds.

(*d*) Carbontetrachloride alone, 6d. per 100 birds.

The cost of treatment, using capsules, would on these figures be prohibitive to most poultry farmers. It is also considered that the inclusion of liquid paraffin is not warranted. It is therefore recommended that the drug be given to all birds irrespective of age, by means of a syringe, any loss of efficiency among the younger birds being more than compensated for by the low costs of this method of administration. Admittedly the use of a syringe may be followed by unfavourable sequelæ more frequently than the capsule method of administration, such sequelæ being a temporary period of inactivity, due to inhalation of the drug vapour and not considered to be of any important consequence or death from the introduction of the drug into the lungs through careless administration.

[TO BE CONTINUED.]

POINTING POSTS.

Plate 258.

A simple set-up for pointing stakes or posts is illustrated. All that is required is a fork from a stout sapling, driven a short distance into the ground, at an angle to steady it. The stake to be pointed is rested in the fork, and lies at a convenient slope for slicing with a sharp axe.

Principles of Botany for Queensland Farmers.

C. T. WHITE, Government Botanist.

[*Continued from p. 505, October, 1936.*]

PART III.—PHYSIOLOGY.

THE STUDY OF LIFE PROCESSES OF PLANTS.

CHAPTER XIII.

General.

WHEREAS morphology and anatomy deal respectively with the external form and the internal structure of plants, the study of plant physiology is concerned with the work performed by the various parts of the plant in maintaining the life of the whole. In the lowest forms of life, the different kinds of work or functions may be performed equally by all parts of the plant, but in the higher forms specialisation takes place and there is a division of labour, various members and tissues being adapted to perform the specific functions; these members and tissues are termed the organs of the plant. Thus, in a tree the general functions of the roots are to absorb the mineral food in solution from the soil and to anchor the tree firmly in the earth; those of the stem are primarily to bear the foliage leaves and reproductive organs, and to serve as a means of communication between the roots and the leaves, and so on.

The satisfactory performance of the various functions is dependent partly upon the external conditions being favourable; for instance, growth is checked by very low or very high temperatures, or by the lack of air and moisture, while in the case of green leaves, a sufficient intensity of light is necessary if they are to fulfil their main purpose to the plant. Thus the object of the study of physiology is not only to ascertain the various functions performed by the different organs, but also to trace the relation between the action of the organs and the various internal and external conditions affecting them. It must be realised, however, that the performance of the functions is dependent primarily upon the activity of the living protoplasm, without which all vital processes cease.

General Functions.

The functions of plants, in general, may be divided into two main groups:—

1. The *nutritive functions,* which are concerned with the maintenance of the life of the individual; and
2. The *reproductive functions,* concerned with the production of new individuals resembling itself.

Functions of the Tissues.

Distinction must be made, in dealing with this subject, between the vital functions depending upon living protoplasm and the purely physical functions depending upon mechanical properties.

1. The tegumentary tissue, which includes the epidermis of the leaves and the bark of the stem, is primarily of importance, in that it

affords to the delicate interior tissues protection against heat, cold, injury by fire, and other causes.

Excessive loss of water by transpiration and evaporation is also prevented, and, it will be noticed, as a general rule, that the development of this tissue varies directly with the rate of transpiration which external conditions promote. The leaves of Eucalypts, Wattles, and other plants growing in open forest country are better protected than the leaves of those species which are found under the shade of dense forests—as the shrubs and smaller trees of the scrub or rain-forest. In like manner, the leaves of trees of hot, dry climates, are, as a rule, better protected than those of the more temperate regions.

Provision is made for the escape from the plant of water vapor, to which the tegumentary tissue may be impermeable by the development of lenticels and stomata (Plate 210), transpiration being regulated by the opening and closing of the latter.

2. The parenchymatous tissue consists principally of active cells containing living protoplasm, and discharges primarily the different nutritive functions, which vary according to the position of the tissue; thus, that present in the leaves and exposed to the influence of light contains chlorophyll and is responsible for the assimilation of carbon and the manufacture of organic food material.

The parenchymatous cells also serve as storehouses of reserve material, such as starch, and help in the transfer of organic material. Being frequently glandular, they excrete waste products.

The cell-walls not being lignified or cutinised, the cells are generally capable of extension, and, consequently, of becoming turgid and giving rigidity to the member of which they form part. When deprived of water they contract, the rigidity of the member being thus affected; this is well shown by the wilting of leaves under the influence of drought.

This tissue frequently contains numerous intercullular spaces which are of special importance in assisting the movement of gases in the interior of the plant, and in connection with transpiration, communication with the external atmosphere being affected through the stomata and lenticels.

3. The sclerenchymatous tissue, especially when fibrous, exercises the mechanical function of giving strength to the member, and hence is but slightly developed in aquatic plants, while it is of much greater importance in the stems of land plants.

4. The tracheal tissue of the wood functions primarily as a conducting agent, through which water and the mineral solutions absorbed by the roots are transferred to the leaves, it being incapable of vital action in that it contains no protoplasm.

If the stem of a tree be completely girdled by a cut which goes through the sapwood into the hardwood, the continuity of the tracheal tissue is interrupted and the leaves are deprived of moisture and mineral food, with the result that they wilt and die, causing the death of the whole tree unless adventitious shoots—"suckers"—arise from the stem below the cut and thus maintain the life of the roots and butt.

5. The sieve tissue of the phloem or bast contains living protoplasm, which in some way or other enables the tissue to perform its principal

function—viz., that of conducting the organic food material manufactured in the leaves to those parts of the plant which either consume it or store it as reserve material.

The effect of destroying the continuity of the sieve tissue by removing a ring of bark from the stem of a tree—i.e., ringbarking—is that the roots cannot receive the organic food manufactured by the leaves, and are forced to subsist on the reserve food material stored by them. After this reserve supply is exhausted the roots succumb and, therefore, the whole tree dies. It is important to note that death caused by ringbarking is caused in a different way from death due to ringbarking and sapping—as dealt with under the tracheal tissue—and, moreover, takes place more slowly. It is possible with some species that ringbarking alone will not cause death, because the reserve supplies stored in the roots are sufficient to enable them to exist until a new layer of bark is formed and continuity of the sieve tissue re-established.

6. The glandular tissue has for its chief function that of secretion either of waste products or plastic substances. Of the former, the resin in the resin-ducts of Conifers, and kino in the "gum veins" of certain Eucalypts, the ethereal oils in the leaves of Eucalyptus, Citrus, and many other plants, and the milky latex in rubber-producing trees are familiar examples. The particular service which the secretion of waste products does for the plant itself—apart from the removal of waste material not needed for the formation of plant tissue—is not always understood. In the case of conifers, the "bleeding" of a wound certainly helps to afford mechanical and antiseptic protection to the exposed wood, preventing the entrance of fungi liable to cause disease.

The secretion of plastic substances is frequently concerned with the relation of insect life to the life of the plant—e.g., the excretion of sugar by a flower serves to attract insects which bring pollen from other flowers and thus ensure cross-pollination. The excretion of sugar on parts other than flowers frequently attracts ants, which help to check the attacks of other insects which are injurious.

Functions of the Members.

The root system of the plant has two functions—namely, to ensure by its hold on the soil the stability of the plant, and to absorb in solution all the mineral food required for its existence.

When first developed, the whole of the root performs both functions, but in trees and shrubs that portion of the root system nearest the stem develops a woody nature in order that it may be strong enough to hold the plant firmly in the soil. The absorptive power of the woody portion is lost, and that function is performed by the more delicate parts of the root system further removed.

The root system also serves as a storehouse for reserve organic food material manufactured by the plant, and in some cases, particularly in vegetables such as the Carrot, Turnip, &c., tuberous roots are specially adapted for the storage of large quantities of food.

The absorptive power of roots is dependent primarily upon the walls of the superficial cells of the absorbing parts being not cuticularised, but readily permeable by aqueous solutions. These superficial cells frequently send out fine root-hairs, by which the absorbing surface is greatly increased and more intimate contact with the moist soil obtained. This absorptive portion is relatively short, being situated just behind the growing tip.

It has been taken as a general rule that the water content in herbaceous plants averages 75 per cent. or more of the whole; in plants such as trees or shrubs with a considerable amount of dead tissue and thick, woody cells and fibres the percentage would, of course, be below this, but it would seem safe to say that in all cases the living cell contents consist of 80-90 per cent. of water, or even more.

It naturally follows that the amount of water required by large freely-growing trees is tremendous, and consequently their root systems, especially under dry conditions, extend very widely and branch extensively in order that sufficient moisture may be obtained from the soil.

The Stem.—The physiological function of the stem is simply that of connecting the roots with the leaves, acting as a support for the latter and the reproductive organs, and serving as a conducting channel for the transference of sap from the roots to the leaves, and organic food from the leaves to the roots.

The development of the stem depends upon the extent of the leaf surface which it has to support and the strains which the exposure to winds, &c., renders it necessary to bear. The tremendous strains which the trunks of large trees have to withstand show what wonderful structural qualities timber must of necessity possess.

The Leaf.—The main functions of the foliage leaf are:—

(i.) The absorption from the air of carbon dioxide and the utilisation of the carbon in building up organic food compounds;

(ii.) The exhalation of water vapor or transpiration;

(iii.) The absorption of oxygen from the air in the process or respiration.

The structure of the mesophyll of the leaf is such as to enable these functions to be performed satisfactorily.

As previously described, beneath the epidermis on the upper surface of an ordinary flat leaf or on both sides of a vertically placed leaf, such as in Eucalypts, is the palisade parenchyma; it is very rich in chlorophyll, whose action is possible only under the influence of light. The elongated form of the palisade cells enables the chloroplasts to arrange themselves along the outside walls so as to receive as much light as possible in diffuse light, or when light is very intense to remove to the lateral and interior walls.

The spongy parenchyma, which is on the lower or less exposed side of the leaf (or in the middle of a round or in a vertically placed leaf), also contains chloroplasts, but is especially adapted for transpiration and absorption of oxygen. Its cells are very irregular, and the tissue contains many intercellular spaces which communicate with the air by means of the stomata and with the interior of the plants as a whole. Thus rapid exchange of gases and water vapor is rendered possible.

CHAPTER XIV.

Osmosis, Absorption, and Transpiration.

Osmosis.—If a bladder be filled with a solution of sugar, the opening tightly closed and the bladder placed in a vessel containing water, it will be found that the bladder will expand, there being a transference from the vessel into the bladder, even though there be no visible openings through which the water can enter. At the same time the water in the vessel will become sweet, showing that sugar passes outwards through the bladder. The weaker solution diffuses faster than the stronger; thus dried fruits rich in sugar, when placed in water, swell rapidly, and the water in which they are soaked becomes sweetened. Eventually a degree of stability is reached and transfusion apparently ceases.

This transference or diffusion of liquids and solutions through the wall of the bladder or any other permeable membrane is known as osmosis, and the pressure which is set up inside the bladder is called osmotic pressure. The bladder in the distended condition is said to be turgid. If the pressure set up is too great, the bladder may burst.

The splitting of ripe fruits in a wet season is due to the turgid cells rich in osmotic substances such as sugar not being able to cope with the pressure set up by the excess of water supplied by the roots.

Not all substances which are soluble in water can diffuse through membranes permeable to water, and a distinction is made between diffusible substances, or crystalloids, and the non-diffusible, which are termed colloids.

The Plant Cell.—A living thin-walled parenchymatous cell is essentially a compound osmotic cell, of which the bladder is a simple model. The plant cell has more than one osmotic membrane through which diffusion takes place, for the cell-wall is one, while the protoplasm with its internal and external layers is a series of osmotic membranes, which may refuse to allow the passage of a substance which has passed through the cell-wall. Taken as a whole, however, and in a broad general sense, the cell-wall and the protoplasm may be compared with the bladder, the cell sap with the internal solution, and the moisture in the soil or in the adjoining cells with the solution in which the bladder is immersed.

The turgidity of the plant cell, which, in spite of its very delicate structure, gives firmness and rigidity to the growing parts of a plant, is due to the osmotic pressure of the cell sap, causing the protoplasm to be pressed firmly against the cell-wall.

The wilting of leaves on a cut stem is due to the fact that the water which is evaporated through the leaves is not replaced by water supplied by the roots, with the result that the cells in the leaf lose their turgidity. If the cut stem is immersed in water before the loss has proceeded too far, the cells obtain water through the cut surface and become turgid again; but this recovery is not effected if the upper part of the shoot only be placed in water, for the external cell-walls of the epidermis of the leaf and branchlet are cuticularised and do not allow the passage of water into the interior of the leaf, which must be supplied through the stem, either by the roots in the living plant or through the newly cut surface in the case of a cut stem.

Similarly, wilting takes place during drought, when the loss of water from the leaves is greater than can be taken up from the dry soil, and under very severe conditions death may be caused, even in such deep-rooted plants as many of our western trees and shrubs.

Absorption.—The food of the plant is built up from the materials which the plant is able to absorb from the air and the soil—carbon dioxide from the air, and mineral salts from the soil.

No plant cell is able to take in solid matter from the soil through its cell-wall, and consequently the supply of mineral salts must be obtained in aqueous solution by the process of osmosis, which is at the foundation of all plant life.

The absorption of solutions is rendered possible by the fact that the external cells of root-hairs and of the younger parts of roots have thin, uncuticularised walls, which allow the passage of water from the outside as freely as the transference from cell to cell is allowed inside the tissue. Owing to the absence of cuticularised tegumentary tissue, those parts of the roots which are capable of absorption are very delicate; consequently, they are easily broken during the process of transplanting, so that transplanted seedlings frequently suffer from want of water until new root-hairs are formed.

Transplanting is specially liable to failure if followed by hot, dry weather, which causes loss of water when the seedling is temporarily deprived of its absorbing rootlets and root-hairs and is thus unable to maintain the necessary supply of water.

If the strength of the salt solutions in the soil is greater than that of the cell sap of the rootlets, not only will the latter not be able to obtain food materials by osmosis, but their cell contents may shrink, and death may ensue; hence the effect of manuring a young plant very heavily with a readily soluble manure may not be improved but diminished growth, and in some cases even death. It has been found that solutions containing over 2 per cent. of dissolved substances are injurious to plant growth, and very weak solutions containing under 5 parts of dissolved substances in 1,000 give the best results.

The quantity of soluble material absorbed by the roots decreases with low temperatures, and consequently in cold winters growth may cease, while warm rains cause much better growth than cold rains. Also, the rate at which a plant is growing determines the amount of substance absorbed, for if there be no internal movement of cell sap in the plant it is obvious that—as in the case of the bladder—a position of equilibrium will be reached between the sap of the absorbing cells and the moisture of the soil. If, on the other hand, the plant is growing vigorously, there is continuous transference of sap from the roots to the leaves, the equilibrium is continually destroyed, and absorption by the roots continues.

The vital processes of the roots are dependent on an adequate supply of oxygen, without which poisonous compounds are formed and an unhealthy condition results. Consequently, except for species adapted to the conditions, growth in badly-drained and waterlogged soils is unsatisfactory, this being accentuated by the fact that wet soils are cold and frequently below the temperature best suited to the plant.

Notwithstanding the fact that the fine rootlets and root-hairs are in very close contract with the soil, they are not capable of absorbing all the water therein, and when the percentage of moisture in the soil falls below a certain minimum the roots are unable to obtain supplies. The percentage of water available to the plant varies considerably with the physical character of the soil; thus in loose sand plants may be able to avail themselves of the water in it even when the water content falls as low as 1 or 2 per cent.; on the other hand, in a heavy, clayey soil the minimum water content may be as high as 25 per cent.

Root Pressure.—The solution absorbed by the external cells of the roots passes by osmosis into the neighbouring cells, all of which in turn become turgid owing to the development of osmotic pressure. Finally the high pressure in the cells adjoining the tracheal tissue causes the cell sap to be forced into the vessels and tracheids, the pressure developed therein being known as the root pressure.

If the stem of the plant be cut, the existence of a positive root pressure is manifested by the exudation of water from the cut vessels, this phenomenon being known as bleeding.

Root pressure is most in evidence during the actively growing periods. In deciduous plants it is most easily seen in the spring and early summer before the plants have used the water with which the roots have become saturated. Later in the season, when the excess supplies have been used up, a partial vacuum is created and a negative pressure is registered, water being sucked in by, instead of forced out from, the cut stump.

Transpiration.—Every part of a plant which is exposed to the air, unless protected by impervious corky layers, is subject to the loss of water by evaporation. The exhalation of water vapour from leaves can be demonstrated by placing a leafy stem under a jar or in a test tube with the end closed by cotton wool, when a deposit of dew will soon be observed on the inside of the glass.

This exhalation of water vapour from living plants is called transpiration, and the flow of aqueous solution necessary to replace the water so lost or otherwise utilised is called the transpiration current. Transpiration, though depending primarily upon the ordinary physical process of evaporation, is distinguished therefrom in that it is evaporation modified and controlled by the living plant.

That a plant cannot control transpiration absolutely and cause it to decrease in proportion to the available supplies of water is, however, shown by the wilting of leaves under the influence of drought, or when the root system is deprived of its absorbing parts.

Transpiration from the exposed external surface of a plant is rendered comparatively unimportant by the development of protective covering layers to the outer tissues, as in the epidermis of the leaves, and cork of the bark, and the cuticle of fleshy fruits and species of cactus. Also, in some cases a covering of woolly hairs or waxy bloom serves as protection against loss of water.

The transpiration which accounts for most of the loss of water is that which takes place from the thin-walled cells beneath the external tissue, these cells being connected with the atmosphere by the intercellular spaces through the stomata (Plate 210) of the leaves and the lenticels of the bark.

The opening and closing of the stomata regulate and control to a large extent the transpiration from the leaves. When the guard-cells are full of cell sap and highly turgid, they curve away from one another, leaving a wide opening through which the water vapour can pass. When the supply of sap is low and further loss is dangerous, the guard-cells become flaccid and are drawn together, thus closing the aperture and preventing transpiration. The guard-cells are affected not only by the condition of the plant but also by the atmosphere. When the air is moist and there is no danger of excessive transpiration, the stomata open, closing, on the other hand, when the air is very dry.

Various means are adopted by plants to reduce transpiration. The leaves, or the flattened stems which take their place, may, like those of the Prickly-pear, be thick and fleshy, capable of storing large supplies of moisture, transpiration of which is prevented by the specially well-developed cuticle. Also, as in the case of Eucalypts, the petiole of the leaf may be twisted so that the leaf lies more vertically than horizontally, and thus does not receive the full rays of the sun. In Casuarina the leaves are reduced to small scales and the stomata situated in the narrow grooves of the cladodes. In some species of *Banksia* or Honeysuckle Oaks (*e.g.*, *B. serrata* and *B. æmula*) the stomata occur in small pits on the under surface of the leaf and are still further protected by hairs. The margins of leaves in many cases are revolute, particularly in drier times, as may be seen in some species of *Banksia*, *Ricinocarpus*, *Westringia*, &c. The protection thus afforded to the stomata decreases transpiration very greatly and accounts in large measure for the ability of the species to resist dry conditions. On the other hand, the leaves of plants which inhabit wet, swampy situations may have special adaptations for furthering transpiration, such as a thin cuticle, a large exposed leaf surface, exposed stomata, and in some cases (*e.g.*, Willows) may even be unable to close their stomatal guard-cells.

Transpiration Current and Ascent of Sap.—In the foregoing pages it has been shown that the supply of moisture to the roots is maintained by osmosis and that the loss of moisture from the leaves is due to tranpiration. There remains to be explained the maintenance of the transpiration current from the roots to the leaves and other transpiring surfaces.

Numerous attempts have been made to ascertain the origin of the force which drives the transpiration current, and the literature on the subject is very wide. The pressure necessary to raise sap to the height of tall trees is obviously great.

At one time it was thought that the sap travelled in the living parenchymatous tissue from cell to cell by the process of osmosis. The rate of diffusion by such means is, however, very slow, and could not possibly supply the needs of large trees, apart altogether from the fact that it has since been established that the tracheal tissue of the xylem is the conducting channel.

In small plants the root pressure may be sufficient to force liquid from the roots to the leaves, but this is quite inadequate in the case of large trees.

Although investigators have been for many years, and still are, at work endeavouring to account for the rise of sap, all efforts have been unsuccessful. The theories advanced take into account various possibilities, such as the movement of water through the walls, instead of the channels, of the conducting tissue, the action of capillarity, the suction force caused by transpiration and osmosis in the leaf-cells, &c. As a result of the various experiments performed, it may, however, be stated that it is practically certain that physical forces are not wholly responsible and that the vital activity of living parenchymatous cells, such as are found in the medullary rays of the wood, cannot be left out of account, but are a prime factor in supplying the necessary force.

CHAPTER XV.

Chemical Composition and Food of Plants.

When a plant is dried and all the water contained in the cell sap, cell-walls, and the protoplasm expelled, the remainder consists of a considerable number of chemical compounds, both organic and inorganic; the latter consist of that part of the absorbed mineral salts which at the time of death had not been utilised, while the former are the compounds manufactured from the food materials absorbed from the soil and the air.

The number of different compounds discovered in plants is extremely large, and research is continually adding to the number, which it is neither possible nor necessary to specify here. For general purposes they may be divided into nitrogenous and non-nitrogenous compounds—*i.e.*, those which do and those which do not contain nitrogen.

Non-nitrogenous Compounds.

The most important substances contained in this group are the carbohydrates, fats, essential or volatile oils, acids, and glucosides.

Carbohydrates are composed of carbon in combination with hydrogen and oxygen, the two latter elements being present in the same proportion as that in which they occur in water. The combinations in which these three elements occur are many, but the most important are cellulose, starch, and sugars.

Cellulose enters very largely into the composition of the cell-walls, which are produced by the protoplasm. In those cell-walls, which are adapted to various requirements, as in the cork, the lignified tissue, &c., the cellulose is found to vary in composition and to be combined or intimately associated with other compounds, such as suberin, lignin, cutin, &c.

The cellulose of plants is the main constituent of paper pulp, in the manufacture of which the chief difficulty is the removal of the combined substances without injuriously affecting the cellulose.

Starch is the form in which the plant stores much of its reserve organic food, and is of very frequent occurence in plants, particularly in the roots. A noteworthy example of the storage of starch in forest plants is furnished by the stems of the "zamia" palms (*Cycadaceæ*), while seeds (*e.g.*, cereals particularly) and tubers (*e.g.*, the potato) are very rich in this compound. Starch occurs in the form of minute grains. They are produced by the plastids, and under the microscope exhibit a stratified appearance, each grain being composed of several successive layers built round a central nucleus or *hilum*. The existence of starch grains can be readily seen on treating with iodine, with which starch gives the familiar blue reaction.

Plants rich in starch constitute a very large proportion of the food of man, cereals, such as wheat, maize, rice, &c., and roots or tubers, such as potatoes, sweet potatoes, yams, taro, cassava, &c., being of value largely on account of their high starch content.

Commercial starch is prepared by mechanical separation with water from any starchy material, such as potato or arrowroot tubers, maize, rice, or other grains.

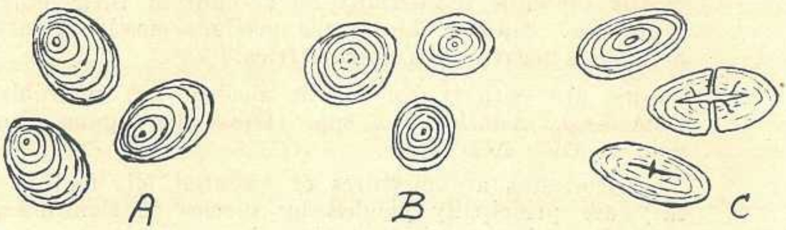


Plate 259.

STARCH GRAINS.

Starch grains are of various shapes. Those of the potato, arrowroot, &c. (A) are oval with an excentric hilum; those of wheat (B) lenticular with a more or less central hilum; those of beans, peas, &c. (C) are oval or somewhat kidney-shaped with cracks or fissures radiating from the centre.

Sugars are generally found in the cell sap and occur most commonly in fruits. The sugar-cane, sugar beet, and the sugar maple of America are familiar examples of species which are specially rich in sugar.

Fats and fixed oils are reserve plant foods, and are found more particularly in fruits and seeds; familiar examples of species rich in oils are the olive, the castor oil plant, the rape, the coconut, the cotton, and the candle nut.

Fats and oils may be extracted from seeds by pressure, solvents, or boiling with water. The numerous commercial oil-cakes, largely used as cattle and poultry foods, are made from the residue of different seeds and fruits after the oil has been extracted by pressure.

Vegetable fats and oils are used for various purposes, as medicine, food, heating and lighting, lubricants, and in the manufacture of soaps. Some oils possess the property of drying and becoming hard when exposed to the air; they are known as "drying oils," and are largely used in the manufacture of paints and varnishes. The most widely used is that obtained from the seeds of the flax plant—viz., linseed oil; another widely used drying oil is that obtained from the seeds of the Chinese tree *Aleurites Fordii*. The oil is known in commerce as Tung oil or Chinese wood oil, and is used in the manufacture of paints, varnishes, linoleums, &c.

Essential oils, resins, &c., are generally waste products and are secreted in special glands or ducts, of which the oil dots of the leaves of Eucalypts and the resin-ducts of Conifers are well-marked examples. To the essential oils is frequently due the characteristic odour of plants, while (as in *Eucalyptus, Backhousia*, &c.) they are the source of valuable commercial oils and perfumes.

Gums, resins, and kinos are yielded by many plants, and, as these terms are of frequent use in technological works, the following brief definitions and notes on them are here given:—

(*a*) Gums are entirely soluble or swell up in water, but are insoluble in alcohol (spirit)—*e.g.*, *Acacia* spp. (Wattle gums), *Melia* (White Cedar), &c. Wattle gums are principally of value industrially on account of their adhesive properties. Gum arabic is the produce mostly of *Acacia Senegal*, a native of Western Africa.

(*b*) Resins are entirely soluble in alcohol, but insoluble in water—*e.g.*, *Xanthorrhœa* spp. (Grass Tree gums, Yacka gum, or Gum Acaroides).

Oleo-resins are mixtures of essential oils and resins; they are principally yielded by species of Conifers and occur in special canals or cavities.

Turpentine or oil of turpentine is obtained from oleo-resins by distillation; the non-volatile residue after being cleaned forms the solid rosin of commerce.

Canada balsam is the oleo-resin of *Abies balsamea*, a North American tree, the resin of which contains a preponderance of turpentine oil.

(*c*) Gum-resins are mixtures of various gums and resins, and are party soluble in alcohol and partly in water—*e.g.*, the gum-resins of *Grevillea robusta* (Silky Oak), *Pittosporum undulatum*, &c.

(*c*) Kinos are dry, hardened juices of plants containing quantities of dark colouring matter—*e.g.*, *Eucalyptus* and *Angophora* kinos. Kinos are used industrially in tanning and dyeing.

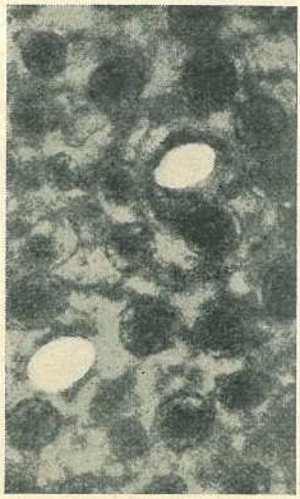
Organic Acids, though occuring free, are more commonly found united with bases to form salts. The acid most commonly met with in plants is oxalic acid, which in combination with calcium forms the crystals of calcium oxalate found in living cells; other well-known acids are tartaric, citric, and malic, common in unripe fruit.

Crystals of calcium oxalate (oxalate of lime) vary somewhat in the form in which they occur in plants. In some cases they occur in an elongated needle-like shape, when they are spoken of as raphides and usually occur in groups.

This form is characteristic of many monocotyledonous plants, especially the Aroids—*e.g.*, the Cunjevoi, Taro, Dasheen, &c. When a piece of green stem or leaf of the Taro, Cunjevoi, or allied plant is chewed, the tongue, roof of the mouth, and lining of the throat seem to be pierced by innumerable little needles giving intense irritation, and, in fact, if chewed to any extent, great agony. After thorough cooking, however, these plants are edible, and the Taros form a large proportion of the food of many native races, particularly in the Pacific Islands.

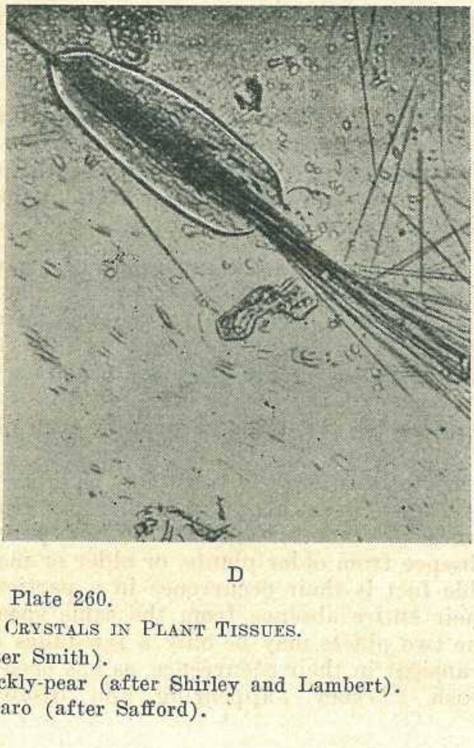
Plate 260, C and D, represent raphides in the tissues of the leaf of the Taro (*Alocasia antiquorum*). The illustrations are taken from photomocrographs by Messrs. Lyman, Kebler, and Howard in W. E. Safford's "Useful Plants of the Island of Guam" ("Contributions

A



B

C



D

Plate 260.

CALCIUM OXALATE CRYSTALS IN PLANT TISSUES.

A.—In bark of Eucalyptus (after Smith).
B.—In epidermal tissues of Prickly-pear (after Shirley and Lambert).
C. and D.—In leaf tissues of Taro (after Safford).

from the United States National Herbarium," Vol. IX.). In this plant and its allies these authors state that the raphides are enclosed in what appears to be an elongated transparent capsule filled with mucilage. These capsules or cartridges are situated in the partition wall between two vacuoles, their ends projecting into the adjacent vacuoles. When the vacuoles become filled with water by being crushed in chewing or when artificially macerated, the mucilage absorbs water through the capsule walls, increasing in volume so that it exerts such a pressure that the needles are projected with considerable force from the capsule at one or both ends, where the cell-wall is thinner than at the sides.

Among Dicotyledons raphides are well developed in the *Ampelidaceæ* (Grape Vines, Water Vines, &c.) and in *Vitis acris,* a common "scrub" or "brush" climber in parts of Eastern Australia; the green stem, if chewed, causes intense irritation to the soft parts of the mouth and throat, due to the presence of numerous raphides of calcium oxalate in the plant's tissues.

H. G. Smith has shown that calcium oxalate is abundant in the barks of Eucalypts in the form of well-defined simple crystals. Plate 260 (A) represents these crystals, and is taken from a photomicrograph by H. G. Smith in the "Journal and Proceedings of the Royal Society of New South Wales," Vol. 39.

Calcium oxalate commonly occurs in the form of clustered crystals (termed sphæraphides), and Plate 260 (B) shows sphæraphides in the common Prickly-pear or Pest Pear (*Opuntia inermis*), and is taken from an illustration by J. Shirley and G. Lambert in the "Proceedings of the Royal Society of Queensland," Vol. 26, where these authors state that these sphæraphides form an effective armour against insect attack. Sphæraphides are abundant in the Oxalidaceæ (Wood Sorrel, Soursob, &c.) and Polygonaceæ (Sorrel, Rhubarb, &c.).

Glucosides may be nitrogenous or non-nitrogenous; common examples are tannin (in Wattle and other barks), amygdalin (in the seeds of Bitter Almonds), salicin (in the bark of Willows), and dhurrin (in Sorghums). Their exact functions or their nutritive value to the plant is unknown, but a knowledge of their distribution in the vegetable kingdom is of great importance from an economic standpoint.

In some cases the glucoside may have the property of yielding, on disintegration and destruction of the plant cells by the digestive apparatus of animals, the powerful poison hydrocyanic (or prussic) acid. Such glucosides or the plants which contain them are termed cyanophoric or cyanogenetic. Their presence accounts for the poisonous character of the seeds of the Bitter Almond, and some other seeds and nuts, and explains the poisoning of stock by such plants as the Sorghums and some other grasses, by the Native Fuchsia (*Eremophila maculata*), Peach-leaf Poison Bush (*Trema*), &c. A remarkable fact about these so-called cyanogenetic or prussic-acid-yielding glucosides is their common occurrence in immature plants or the young parts of plants and their absence from older plants, or older or matured parts; a further remarkable fact is their occurrence in a particular species in one locality and their entire absence from the same species in another locality, though the two places may be only a few miles apart; they are also often very transient in their occurrence, as has been found in the Peach-leaf Poison Bush (*Trema*), appearing and disappearing in this plant in an apparently erratic fashion. What causes the formation of the glucoside, and its consequent disappearance, has not yet been found, nor is it clear what part these prussic-acid-yielding glucosides play in the life of the plant.

The astringent compounds, known as tannins, are also glucosides; the value of definite knowledge of the tannin contents of different trees, particularly of their barks, is at once obvious; here again the amount present may vary somewhat with the age of the tree and the locality in which it is growing. In South Africa a good deal of attention has been given to the tannin content of the bark of the Australian Wattle (*Acacia mollissima*), cultivated extensively there, with the result that continued breeding from selected trees has much increased the average tannin content.

The saponins are another group of glucosides, a knowledge of which is of importance from an economic standpoint; their presence in a plant or part of a plant can generally be detected, primarily by the marked frothing they cause in water. The commercial value of the Quillaja Bark (*Quillaja saponaria*), of the native Foam Barks (*Sapindaceæ* spp.), is due to the presence of saponins. They are commonly poisonous, and it is thought that the harmful property of the seeds of the Bean Tree, a Moreton Bay chestnut (*Castanospermum australe*), which cause severe purging in stock is due to the presence of a sapo-toxin. Another example is the Finger Cherry (*Rhodomyrtus macrocarpa*), the fruits of which, if eaten in any quantity, cause blindness; parts of this plant apparently contain a poisonous saponin, which has been suggested as the cause of the trouble.

Nitrogenous Compounds.

Prominent in this group are the proteids and alkaloids, the first-named being of special importance because proteid compounds are the main constituents of protoplasm.

The vegetable proteids, proteins, or albuminoids are numerous, and vary greatly in chemical composition. They may occur either in solution dissolved in the cell sap or as solid forms, as the aleurone or proteid grains of cereals and seeds. Proteïd substances are of particularly high food value—in fact, no animal can live unless its food contains a sufficiency of them. In cereals the aleurone grains are usually confined to the outermost layers of the cells of the endosperm; thus comes about the lessened food value of artificially polished cereals, such as polished rice, &c.

Alkaloids are generally poisonous, and are to be regarded as waste products—not as food. They form the basis of many of the drugs used in medicine, and familiar examples are nicotin (tobacco), quinin (cinchona), morphia(poppy). The bitter flavour of the barks of many Australian trees, such as Quinine Tree (*Alstonia constricta*), &c., is due to the presence of alkaloids. To their presence is also due the harmful nature of many plants known to be poisonous to stock in Australia, as the Heart-leaf Poison Bushes (*Gastrolobium* spp.), Thorn-apples (*Datura* spp.), &c.

The Elementary Constituents of Plant Food.—If a dried plant be burned, carbon, hydrogen, oxygen, and nitrogen escape into the atmosphere as gaseous compounds, such as carbon dioxide and ammonia, while the other elements remain behind in the ash in composition with part of the carbon and oxygen. By weighing the green and dried plant and the ash and analysing the composition of the latter, the proportion of water and the various constituent elements in the green plant are obtained.

The existence of any element in the ash of a plant is not proof that that element is indispensable to the plant's existence, for some have been found by the methods of sand and water culture to be not essential to the vital processes. In the grasses and sedges, for example, silica is found in great abundance, principally in the cell-walls, and may constitute from 40 up to even 70 per cent. of the ash of such plants, but experiments have shown that they can be brought to maturity without it, though the resultant plants will be soft and weak, silica being of importance in the strengthening of the cell-walls. Experiments have shown, however, that unless all of the ten elements—carbon, hydrogen, oxygen, nitrogen, phosphorus, sulphur, potassium, calcium, magnesium, and iron—are available, life is impossible; doubt exists as to the absolute necessity for sodium and chlorine, culture without these elements being so difficult, but the general belief is towards their being non-essential. The special functions of the different elements in plant nutrition has long been the study of plant physiologists; thus, among other things it has been found that potash is essential in the formation of starch, while a certain amount of iron seems necessary in the development of leaf-green or chlorophyll.

Carbon.—Carbon is an essential component of protoplasm and comprises in all generally between 40 and 50 per cent. of the dry weight of plants.

An idea of the amount of carbon present in plants is afforded in charcoal-making. In the manufacture of charcoal, the wood is burnt without free access of oxygen, with the result that the hydrogen, oxygen, and nitrogen of the plant are set free, but the carbon remains with a small quantity of ash. When burnt in the ordinary way, the carbon and oxygen combine and are given off in the form of carbon dioxide.

Although green plants may obtain some carbon in combination from the soil, the bulk of their supply of this element is taken up by the leaves from the carbon dioxide of the air, this action being dependent upon the existence of chlorophyll in the leaves and the access of sufficient light.

Certain green plants are said to be insectivorous because they are specially adapted to absorb carbon in organic compounds. Their leaves bear appendages which excrete a viscid liquid, which attracts and holds insects. The glands then excrete an acid liquid, which dissolves the insect into a form suitable for absorption. The common Sundews (*Drosera* sp.) provide well-known examples of this habit.

Fungi and many other plants known as parasites and saprophytes, which exist on and destroy living and dead organic matter respectively, are almost or quite devoid of chlorophyll and obtain their carbon in the form of organic compounds. Others obtain their carbon from green plants without destroying them, the association of two distinct plants in this way being termed symbiosis. The most common example is furnished by lichens, in which fungi and algæ are associated symbiotically.

An interesting case of supposed symbiotic relationship between the lower and higher plants occurs in the association of certain filamentous fungi and the roots of some flowering plants; this association of fungus and root has been termed mycorhiza. It is the common state in saprophytic plants, many of which possess little or no chlorophyll, but has also been observed in green leaf-bearing trees, such as the Pines, which possess few or no root-hairs. The hyphæ (roots) of the fungus may penetrate into the cells, or may only pass between the cells of the root tissues. In trees which exhibit mycorhiza, the roots are usually closely invested by the fungus threads, and it is believed that these latter are not only of importance to the tree as absorbing organs for water and nutrient salts, but possibly in the formation of nitrogen. On the other hand, the fungus obtains carbohydrate food substances from its host, and its hyphæ are, no doubt, first attracted to the root by the presence therein of these food substances; the whole matter, however, is one that is still in the field of investigation. In the case of saprophytes, as these plants contain little or no chlorophyll, they would seem to be entirely dependent on the fungus for their organic food supply, the fungus being able to take up carbon compounds present in the remains of dead animals and plants on which it grows.

Some parasitic plants are well provided with chloroplasts and are thus able to obtain their necessary supplies of carbon from the carbon dioxide of the air and utilise it in the building-up of organic food substances; such plants are only partially parasitic, the best-known examples being probably the Mistletoes, which obtain from the host only water and nutrient salts held in solution, but make no demands on it for complex organic food substances. Other plants rich in chlorophyll, but which rely very largely on other plants for their supplies of water and mineral salts are some, if not all, of the Santalaceæ, among the members of which known to be so parasitic are the well-known Sandalwoods (*Santalum* spp.) and the Native Cherry (*Exocarpus cupressiformis*), also some of the Scrophulariaceæ, one of which—*Striga parviflora*—is a well-known parasite on sugar-cane in Queensland. The Santalaceæ and Striga mentioned are parasitic on the roots of their hosts. The Dodders (*Cuscuta*) and Dodder Laurels (*Cassytha* spp.) are plants that have almost completely lost their chlorophyll and have become practically entirely dependent on the host for their sustenance; the first belong to the Convolvulus family (*Convolvulaceæ*), and several are parasitic or economic plants, one—the common European Dodder (*Cuscuta europæa*)—being a particularly bad pest in lucerne cultivation; the Dodder Laurels, which are degenerate members of the Laurel family (*Lauraceæ*) and are very similar in general appearance to the true Dodders, are principally Australian species, and are commonly seen growing over native shrubs.

Hydrogen and oxygen, as has been seen, are found in combination with carbon in numerous compounds, while combined as water they form more than 50 per cent. of the wet weight of the plant. Oxygen is absorbed directly from the atmosphere, while it is taken from the soil in solution in water and in various salts such as nitrates, sulphates, phosphates, &c. Hydrogen may be absorbed in ammonia compounds, but is obtained chiefly in the water taken from the soil.

Nitrogen is an essential constituent of protoplasm and is very abundant in peas, beans, and other leguminous plants. Fungi, parasites, saprophytes, &c., absorb it in organic form just as they do carbon, but though it is present in the air in large quantities, it is not directly absorbed therefrom, as is the case with oxygen and carbon dioxide.

Certain green plants are able to obtain their nitrogen from the air by virtue of their symbiotic association with bacteria in the well-known nodules of the roots. These symbiotic bacterial nodules are mostly found on the roots of clovers, peas, beans, wattles, and other plants belonging to the pea family (*Leguminosæ*). Generally, however, green plants have to rely for their supply of nitrogen upon nitrates and ammonia salts in the soil.

In forest trees the greatest proportion of nitrogen absorbed is retained by the leaves, this being one important reason for preventing the removal from the forest soil of decaying leaf matter and humus, which is rich in nitrogen.

Phosphorus occurs in proteid compounds; it is abundant in seeds, and, therefore, is particularly important for grain-producing crops such as wheat. It is absorbed from the soil in the form of phosphates, and is supplied in manures such as superphosphate and preparations made from bones.

Sulphur, though not occurring largely in proteids, is an essential constituent of protoplasm. It is absorbed from the soil in the form of sulphates.

Potassium, calcium, and magnesium are all necessary to plant life, though the part they play is not clearly understood. Potassium appears to be closely associated with the formation of carbohydrates from water and the carbon dioxide of the air, and if it is not present the fixation of carbon ceases. The occurrence of calcium in the form of calcium oxalate points to its serving to neutralise free oxalic acid which acts injuriously upon the living cells. These elements are absorbed chiefly as nitrates, sulphates, phosphates, and carbonates. Potassium carbonate left in the ash of plants is valuable as a manure.

Iron is found in plants only in very small quantities, but, since no chlorophyll can be formed without it, the nutrition of green plants is absolutely dependent upon its presence. Sufficient is contained in the seeds to provide for the needs of the first few leaves, but if the plants are then grown in solutions lacking in iron the succeeding leaves are pale and unable to fix carbon.

Numerous other elements occur in plants, some but rarely, others almost universally; in fact practically all the elements that occur in air, soil, and water have been found in plants.

Silicon is used by many cereals and grasses to strengthen the cell-walls, and occurs also in the wood of trees. It is obtained from soluble silicates.

Sodium and chlorine are of widespread occurrence; they are found most frequently as common salt, which in excess is injurious to plant growth.

Bromine and iodine are abundant in many marine plants, especially seaweed, which at one time was the principal source of iodides and bromides.

Manganese also is frequently found in plants, but little is known of its significance.

CHAPTER XVI.

Metabolism.

After the absorption of the various salts and elements, numerous chemical changes occur, which are generally referred to as metabolic processess or metabolism. Those constructive changes which result in the building-up of complex organic food compounds from simple salts and gases are termed constructive metabolism or anabolism, while those which lead to the formation of simpler compounds by decomposition of the more complex are termed destructive metabolism or catabolism. The products of metabolism are either plastic products, which can be further developed, or waste products, which are either excreted or deposited.

Anabolism.—Although roots obtain carbon compounds from the soil, it has been found from growth in water in which no carbon was present that the carbon dioxide of the air is the chief source of carbon supply upon which green plants must rely. As no organic food can be built up without carbon, the first step in the anabolic process of assimilation of food is the fixation of carbon.

Carbon Fixation or Photosynthesis.—Exactly what chemical action takes place when the carbon dioxide of the air enters the cells of the leaf is not known, but briefly it may be stated that the carbon dioxide dissolves in water, forming carbonic acid, which is continuously broken up by the action of sunlight on the living plant cells. Oxygen is set free, and very early in the processes of assimilation simple carbohydrates like sugar and starch are formed.

What actually takes place in the earlier stages of sugar formation is yet obscure, but it has been definitely established that, for chemical changes of this nature to take place, living plants must be exposed to a sufficient intensity of light and suitable temperatures, they must contain chloroplasts, and salts of potassium must be present in the sap.

The primary importance of exposure to light is that the rays of light furnish the energy necessary to cause the chemical change, the plant being unable to do this unaided.

The chloroplasts have associated with them the green colouring matter called chlorophyll, the function of which is to absorb certain of the rays of light whose energy is required. This energy is then utilised by the chloroplasts.

Given insufficient light, green plants are unable to build up carbohydrates from carbon dioxide and water, and plants such as fungi which do not possess chloroplasts have to obtain their organic food from other plants or organic material; also, the fixation of carbon is restricted to those parts of the plant which contain chloroplasts.

The fact that the fixing of carbon is dependent upon the action of light has lead to the term "photosynthesis" being coined to denote the process.

Formation of Proteids.—The formation of the first simple carbohydrates is the foundation of all later anabolic processes by means of which large numbers of food products and other organic compounds are built up by the plant. The most important of the more complex compounds are those containing nitrogen, such as the amides and the proteids.

As pointed out previously, the free nitrogen of the air cannot be extracted directly by the higher plants, except in the case of species belonging to the family Leguminosæ and a few other plants, and then only by virute of their association with bacteria in their roots. Even then, the bulk of the nitrogen utilised by them and, of course, the whole quantity required by other green plants must be absorbed from the soil in the form of chemical compounds.

Nitrogen occurs in the soil in organic compounds in ammonium salts and in the form of nitrates. The oxidising action of various soil influences and bacteria results in the nitrogenous soil compounds being converted finally into nitrates, this process being known as nitrification.

Nitrification is hastened by exposure to light and heat and by aeration, and consequently the removal of dense forest cover and the working of the soil greatly accelerates the decomposition of the forest humus and the formation of nitrates in comparative abundance; hence the growth of plants on cleared land, which has also been sweetened by burning, is especially vigorous, particularly so in the case of species which are said to be nitratophilous or nitrate-loving, as vigorous weeds like Thistle, Ink Weed, Wild Tobacco, &c., which spring up following a fresh burn.

In addition to nitrogen, sulphur, and phosphorous are two important constituents of proteids, these being obtained from the soil in the form of sulphates and phosphates.

The chemical changes which these compounds undergo in the plant are undetermined, the synthesis or creation by the union of their elements of proteids being very complex, but it is known that intermediate nitrogenous compounds, such as amides, are formed, and that these are ultimately combined with carbohydrates and other compounds to form proteids, this process taking place largely in the leaves.

Although light is necessary for the fixation of carbon by the leaves, the synthesis of proteid compounds proceeds without the influence of light, and hence, although leaves play the most important part in this work, thus ensuring the utilisation of the carbohydrates before there is an undue and possibly injurious accumulation thereof, similar work is performed by the roots and other parts of the plant.

Utilisation, Translocation, and Storage of Plant Foods.—Of the various organic compounds manufactured by the plant, some are oxidised and consumed in the process of respiration, but, since a growing plant increases in bulk, a greater proportion is used to build up new material than is lost owing to catabolic processes.

Just as special conducting tissue is developed in the xylem for the transference of mineral solutions from the roots to the leaves, so the plant has to arrange for the translocation of organic foods products from the cells in which they are manufactured to those parts of the plant in which development and growth is taking place.

Insoluble carbohydrates, such as starch and colloidal proteid substances, may not readily diffuse by osmosis through the cell-walls, and consequently they have to be decomposed into soluble diffusible compounds in order that osmosis from cell to cell make take place. Starch is converted into soluble sugar, and proteids, into diffusible amides, these products being later transformed back to the higher compounds as required. Thus there is a continual building-up and breaking-down of the food products according as they are to be utilised by the protoplasm or transferred to other cells.

Just as the action of osmosis is not sufficiently rapid to account for the rapid rise of sap in a tree, so it is not adequate to maintain the supply of organic food, and consequently special conducting tissue, situated in the phloem and known as the sieve tubes (Plate 203), is provided for the conveyance over long distances of both diffusible and non-diffusible compounds. It is obvious, in fact, that the upward flow of sap in the tracheæ and tracheids of the xylem must preclude this tissue from being used as a channel for conduction downwards, and that the provision of additional channels elsewhere is essential.

Whereas the tracheal tissue is composed of dead cells, which are enabled by their association with living parenchymatous cells to maintain the transpiration current, the sieve tubes, on the contrary, are living organs containing protoplasm, and cease to function as conducting agents when dead. They are associated also with other living cells, such as companion cells and phloem parenchyma, which all play a part in the conduction of organic food, though in a manner as yet imperfectly understood.

The food current in the sieve tissue is drawn upon as required by adjacent tissue in the bast and cortex, while it is conveyed to the cambium and wood by the medullary rays, which form the connecting link between the wood and the bark.

The effect of breaking the continuity of the phloem or bast and checking the downward motion of the organic food by making a narrow cut through the bark of the branch of a tree is that the food supplies are retained in the branch above the cut, with the result that the shoots and fruit thereof grow more luxuriantly. This is sometimes made use of in fruit culture in order to obtain increased yields, the process being known as "ringing."

Not all of the food manufactured is used immediately in the building-up of new cells, and a considerable surplus is stored in various parts of the plant for future use. In the case of annuals, which die at the end of their growing season, the reserve food is accumulated wholly in the seeds for the use of the next generation, while in such vegetables as carrots and turnips the reserve is stored in the roots.

In the case of deciduous trees, the permanent storage of reserve supplies in the leaves would result in the loss by the trees of their reserve stores when the leaves fall in autumn, and consequently the reserve food of trees is to be found chiefly in the roots and the stem, the parenchyma of the cortex and the medullary rays being the principal tissues concerned therein. Supplies are stored in the leaves temporarily only.

The existence of reserve supplies in the roots enables them to live for some time after ringbarking, and to continue supplying the leaves with mineral food, and it is only when these supplies are exhausted that the roots die and the tree finally succumbs. In springtime the unfolding and initial growth of the buds of deciduous trees are dependent wholly upon the reserves stored by the tree during the previous season, while the coppice shoots which sometimes spring from the base of a ringbarked tree are nourished at first from the same source.

Since the reserve supplies from below must travel upwards in order to reach members at higher levels, the transpiration current is found to contain soluble organic food in addition to the mineral solutions previously referred to. Generally the mineral food in the sap occurs in far greater abundance than the organic material, but occasionally the sap is very rich in carbohydrates, a notable case being the Sugar Maple of Canada, the sap of which is a rich source of sugar.

Catabolism.—The catabolic processes carried on by the plant are mainly those which depend upon the absorption of oxygen, and result amongst other things in the formation of carbon dioxide, which is excreted as a waste product. A similar process is carried on in animals, and is known as respiration.

Respiration is as essential to the life of plants as to that of animals, though the process, except perhaps in the germinating seed, is much less rapid in the former than in the latter. The degree of activity of life depends upon the activity of the catabolic processes and respiration in particular, and if they cease life ceases also. Catabolism is, in fact, the source of energy which enables the anabolic processes to be carried on.

In all cases heat is produced during respiration, this being particularly noticeable in the case of warm-blooded animals. In plants, however, oxidation is less rapid and the rise in temperature is not generally noticeable, especially as it is compensated for by the cooling effect of transpiration. Germinating seeds respire very actively, and if heaped together the effects of respiration are not masked and the rise in temperature is plainly perceptible.

Respiration is thus the converse of carbon fixation, the former being a destructive and the latter a constructive process. In addition, respiration is not confined to the cells containing chloroplasts, but goes on in all living cells both in darkness and in light; also, not only green plants but all plants give off carbon dioxide, while only green plants have the power to fix the carbon of the atmosphere.

The free oxygen required by plants may be obtained directly from the atmosphere by the process of gaseous diffusion or may be absorbed in solution by the roots, the greater amount being obtained by the former method. Entrance to the intercellular spaces of the plant tissue is gained through the stomata and the lenticels.

Just as in the case of animals, plants quickly become unhealthy if not furnished with a sufficient supply of oxygen. Those parts of plants above ground naturally never suffer from want of oxygen, but the ill-effects of insufficient oxygen in the soil for the needs of the roots are frequently apparent.

Excess of water in waterlogged and badly-drained soils means that roots have to rely upon the insufficient supply of oxygen in solution, there being no free circulation of the air through the soil; hence the growth of trees and crops frequently found on such land is poor, while the aerial roots developed by some trees such as certain mangroves, which grow in tidal swamps, are an adaptation by means of which sufficient oxygen is obtained; also, seeds buried too deeply receive insufficient air and frequently do not germinate satisfactorily.

The dependance of vital activity on respiration is well illustrated by the vigorous respiration which is carried on by young, actively growing parts, and its almost complete absence in dormant buds and seeds.

Respiration in dormant seeds is so slight as to be almost unnoticeable, and in absolutely dry seeds and in dry mosses and lichens it is said to be absent altogether, this being the only case in which the stoppage of respiration is not accompanied by death.

Respiration is stimulated by higher temperatures—provided, of course, that the limit at which life is possible is not reached—while the addition of moisture to seeds promotes respiration; consequently, the germination of seeds requires suitable conditions of moisture and temperature, which vary with the species. Seeds may be dormant in the ground for many months on account either of lack of moisture or low temperatures, but when the combination of conditions is favourable rapid germination ensues.

Modern Work on Respiration.—Mr. W. D. Francis, Assistant Government Botanist, who has been in close touch with recent work on this subject, has kindly supplied the following note:—

"In recent years the chemistry of respiration has been closely investigated by Otto Warburg and his colleagues in Germany. According to Warburg, respiration in living cells is carried on by four complex organic compounds. These four complex substances are hæmin compounds which consist of iron, carbon, hydrogen, oxygen, and nitrogen. The principal reactive element in these four compounds is the iron contained in each of them. The four hæmin compounds form a chain. The oxygen consumed in cell respiration first unites with the iron of the first hæmin compound, which is thereby oxidised from the ferrous to the ferric state or from the lower to the higher state of oxidation. The oxygen then passes on to the next hæmin compound, and so on until it reaches the fourth. As the oxygen is transferred from the one compound to the other the iron of the first is automatically reduced and the iron of the second is oxidised, and so on. The oxygen transferred to the iron of the fourth hæmin compound does not appear to react directly with the materials which are usually oxidised to produce energy in the cell. Apparently Warburg considers that there are still one or more enzymes or ferments in the respiration process which require investigation, and these function between the fourth hæmin compound and the materials usually oxidised in the cell. The system of the four hæmin compounds has been found to be very widely distributed in the organic world, as, for instance, in bacteria, yeast, and higher animals. The first hæmin compound in the system is referred to as the oxygen-carrying enzyme. The last three hæmin compounds constitute cytochrome, which has been intensively studied in recent years by D. Keilin."

Enzymes.—Reference was made in the brief remarks dealing with the translocation of food products to the decomposition of higher solid or non-diffusible compounds to soluble products, the plants being able to bring about this transformation as required.

This transformation, which is a form of digestion, is due not only to the action of living protoplasm, but also to the chemical activity of substances known as unorganised ferments or enzymes; these substances are secreted by the protoplasm, and, since they remain unchanged during the chemical processes which they cause, are able to effect the transformation of large quantities of certain substances.

Some enzymes change the insoluble carbohydrates into various kinds of sugars, and some convert insoluble and indiffusible proteids into peptones and amides.

In addition to the enzymes, in these classes there are numerous others adapted to transforming the great variety of reserve products into different forms. One important enzyme, the use of which is of interest commercially, is zymase; this is present in yeast, and is largely used in breweries for the conversion of sugar into alcohol.

In certain cases the plant cells may secrete a peptonising enzyme which acts from without the absorbing tissues; this is found in some carnivorous or insectivorous plants. It occurs in the Sundews (*Drosera*), Pitcher Plants (*Nepenthes*), and perhaps others.

CHAPTER XVII.

Growth.

Influence of External Conditions.—The life of a plant varies very greatly with the species and the conditions under which it is growing. It may extend over a short period of a few months, as is the case with many annual garden and field plants, or may comprise hundreds and even thousands of years, as in the case of the giant Sequoias of California.

The principal conditions necessary for the healthy growth of plants are (1) a sufficient supply of water; (2) an adequate supply of the necessary food materials; (3) the presence of oxygen; (4) light; and (5) suitable temperatures.

Water.—More than half of the weight of green plants is free water, while water figures very largely in the chemical compounds of which the plant's substance is composed. In addition, large quantities are needed to convey the mineral salts from the roots to the leaves. The prime importance of water in plant growth is emphasised by the necessity for irrigation in dry areas and by a comparison of the rank growth in moist localities with the growth of dry and arid regions.

Food Materials.—The various elements necessary for the existence of plants have already been detailed, but if they are to be of use they must be present in a form capable of being dissolved by water. It happens not uncommonly that, owing to the insoluble condition of many of the compounds found in the soil, they are not available to the plant. The more rapid action of superphosphate of lime as compared with that of bone-dust is due to the fact that in the artificial preparation the manure is in a more soluble form, while the bone-dust is only rendered available by the slow action of soil influences.

Experiments have shown also that the growth of plants is not determined by the total quantity of food material which is in an available form, but by the quantity of the element present in the least amount. If the soil contains insufficient phosphates for the vigorous growth of a plant, then an abundance of nitrates and sulphates will be of no avail until the necessary phosphates have been added.

Oxygen is essential for respiration, as has already been emphasised, and well-aerated soils produce far better growth than those which are badly aerated. On the other hand, there are cases in which the soil can be too well aerated, as in very light sandy soils in dry climates. Under such conditions the free circulation of the atmosphere causes more rapid evaporation of soil moisture than is desirable, and also produces too rapid decomposition of decaying vegetable matter, thus causing the loss of the beneficial effects of humus.

Light.—The effect of light on plant growth is twofold. It is essential to the life of green plants in that without it the carbon in the air cannot be fixed by the leaves, but at the same time it exercises a retarding influence on the rate of growing parts.

If a healthy plant be transferred to a dark enclosure, it will be found to grow much more quickly than in the open, the cells formed being much more elongated and delicate. Such a plant is said to be etiolated, and if kept continually in darkness will remain alive only until the reserve food supplies have been exhausted.

Considerable variation exists in the light requirements of different species, some requiring full exposure to develop to the best degree, others requiring moderate shade, and some, such as certain ferns, requiring very deep shade even to grow at all, intense light being fatal to them. Some of the lowest organisms, such as certain of the bacteria, may be killed by even a few minutes' exposure to direct sunlight. The great majority of flowering plants, however, such as trees, shrubs, &c., are light-demanders, as previously explained, a sufficiency of light being essential to their very existence.

The necessity for a sufficiency of light may be seen in forests where the trees are growing thickly together; the lower branches of the trees, being too much shaded, have fallen off and died, this natural self-pruning resulting in the long, straight barrel prized by the timberman. Grown in the open, the lower branches of the same species persist, there often being no distinct central main trunk at all, or, when present, as in the Bunya and Hoop Pines, it may bear leafy branches from top to bottom.

Temperature.—The dependence of plant growth upon heat is clearly evident from the fact that in localities subject to cold winters the winter growth is very slow or may even cease altogether. This diminution in the rate of growth is much more marked in the native trees of colder latitudes and at higher elevations than in the greater part of Australia, where the winters are comparatively mild.

In connection with the effects of temperature on growth, consideration must be given to the temperature of the soil equally with that of the atmosphere, for if growth is to take place the temperature of the soil must be sufficient to enable the roots to perform their functions.

The ability of a plant or a portion thereof to withstand both high and low temperatures is greatly affected by the amount of moisture contained in the parts. In those parts of plants which are growing actively and are turgid the protoplasm may be killed when it reaches a temperature of 130 deg., whereas the protoplasm in many dry seeds is uninjured if they are placed in boiling water (*cf.*, the practice of soaking wattle seed in boiling water); also, dry seeds withstand much greater cold than do moist seeds, and spring frosts kill young, actively growing shoots, whereas more severe winter frosts do no damage to the drier, well-ripened shoots.

Young trees frequently start growth earlier in the growing season than old trees, because the absorbing roots of the former, being more in the surface soil, attain the temperature necessary for growth sooner than those lower down.

Growth in Height.—When germination first takes place, growth goes on in all parts of the seedling, the cells of which are in an embryonic condition, but at an early stage in the life history growth in height or length becomes localised and confined to special parts of the plant, known as the growing points.

The growing point is usually at the apex of the shoot, but in grasses increase in the length of stems does not take place by growth at the apex, but is due to the activity of growing points which are situated at the base of the internodes, and which by their increase in length lift up the portions above them. Such growing points are said to be intercalary, and the result of such method of growth is, as is well known, that the tip of the grass is the oldest part, the younger and more succulent parts being lower down.

A similar method of growth occurs in the long leaves of some monocotyledonous plants, such as rushes, the actively growing part being at the base of the leaf, the tip being the oldest part and often quite dead and withered, while the base is still soft and succulent. The actively growing part of peduncles and pedicels of flowers is also often at the base. Intercalary growing points, however, are the exception, terminal growth being the rule.

The question often arises whether blazes and marks on trees, such as flood marks, are after a lapse of years practically at the same height from the ground as when first made, and a good deal of controversy has centred round the subject; all careful, accurate observations, however, go to show that there is not any, or practically speaking any, alteration in the height of such marks, thus going to prove that actual growth in length is confined to the terminal parts.

There is a considerable variation during each twenty-four hours, height growth at night being more rapid than during the day, this being due to the retarding influence of light on growth and to the fact that during the daytime the plant is engaged on the fixation of carbon and the formation of carbohydrates. At night-time the free utilisation of the manufactured food results in increased height growth.

Growth in Thickness.—The embryonic tissue which is responsible for the growth in thickness of the stem of a plant is the cambium or layer of thin-walled parenchymatous tissue encircling the stem and separating the phloem or bast from the xylem or wood. The cambium cells subdivide, producing new tissues on both sides, the inner forming new xylem, and the outer new phloem; thus the cambium is being continually pushed outwards by the new wood formed. Additional growth in thickness of the bark is due largely to the new tissues formed by the cork cambium, though the latter in many cases is compensated for in due course by the shedding of the outer layers of dead bark.

Growth Movements.—Inherent in the vital characteristics of protoplasm and plants is the power of movement in response to the influence of stimuli, such movements being a direct manifestation of the property of protoplasm known as irritability. The chief causes which produce movement in plant members are physical contact, changes in temperature, the force of gravitation, lateral illumination, and variation in moisture.

Contact.—Perhaps the most familiar example of movement induced by contact is that of the Sensitive Plants (*Mimosa* and *Neptunia*), whose bipinnate leaves immediately fold up when touched, the stimulus given by contact being transmitted through the pinnæ to the primary and secondary peticoles which accomplish the folding action.

Other examples are to be found in the tendrils of climbing plants, which on making contact with a foreign body are so stimulated that they curve towards and around the object, completely encircling it. Continued contact causes the tendril to become more turgid on the side not irritated, with the result that growth on the outside is more rapid, and the necessary curvature produced.

On the other hand, a very restricted area near the tips of growing roots is so affected by contact with stones and other impenetrable bodies that the roots curve away from the object, and thus enable themselves to continue growth in the direction in which food supplies can be obtained.

Changes in Temperature and Light.—In the well-known sleep movements of the leaves in trees—as in the pinnate-leaved Leguminosæ (*Albizzia, Acacia, Poinciana* spp., &c.)—during night the leaflets fold over one another so that only the edge of each leaflet remains exposed, and the same position may be assumed during the daytime, due to great heat or intense light; the folding in these cases accomplishes a twofold object—viz., to prevent the loss of heat by radiation during the night-time and loss of water vapour by transpiration during the hotter part of the day. In the case of floral leaves, these may open with bright, dry sunshine and close at night, this being particularly noticeable in some Compositæ such as Everlastings, Sunflowers, Gerberas, &c., or bright sunlight may cause the closure of the floral envelop, the parts opening out to their fullest during the night, as in the Moon Flower (*Ipomœa bona-nox*) and certain Cacti; in other cases flowers may be only open for a limited period during the day, as in the Morning Glory (*Ipomœa purpurea*), Fringed Violet (*Thysanotus*), *Sida retusa*, &c.

Lateral Illumination.—A plant allowed to grow in a room before a window, plants growing alongside a fence, a wall, &c., or the leading shoot of a tree growing close under the shelter of an overhanging tree, will be found to curve towards the side from which most light is received.

Moisture Variation.—Movements due to the influence of moisture are especially characteristic of roots of land plants, which always bend away from dry to moist soil. This property is so marked in roots that it may overcome their tendency to grow downwards, and by a suitable arrangement of moisture conditions they may be induced to grow upwards away from the centre of the earth.

The trunks of trees growing on the banks of watercourses or along the edges of fresh-water pools often have a marked tendency to lean over towards the water, due to the greater root growth in the side nearer the water and the consequent pull exerted.

CHAPTER XVIII.

Reproduction.

In the previous five chapters the physiological processes described have been concerned with the maintenance of the life of the individual, and attention is now directed to the process of reproduction or the power of giving rise to new individuals. Among plants two distinct types of reproduction are recognised—(*a*) the vegetative or asexual, and (*b*) the sexual.

(*a*) *Vegetative Reproduction.*—In the lowest forms of plant life, such as the bacteria and unicellular Algæ, reproduction may merely consist of cell division, the parent plant dividing, the division being perhaps repeated several times, and the parts so divided separating off and starting life as new individuals, nothing being left of the parent as an individual plant. It is the higher plants, however, with which we are mainly concerned, reproduction in these implying the separation, either naturally or artificially, of vegetative portions of the parent plant and their subsequent development into new and complete individuals.

In a natural state vegetative reproduction is more or less restricted to herbaceous plants. It may occur by means of *rhizomes,* as in several grasses (*e.g.,* Couch Grass, Johnson Grass, &c.), stolons or runners, as in the Strawberry, bulbs or bulbils, as in the Lily, corms, as in Gladiolus, tubers, as in the Potato, by aerial tubers, as in the Yams (*Dioscorea* spp.), simply by leaves dropping on the ground, as in *Bryophyllum,* or by the cladodes, as in Prickly-pear (*Opuntia* spp.), by buds or young plantlets, as in many ferns (*e.g., Asplenium attenuatum, A. bulbiferum*), &c.

Vegetative reproduction enters very largely into horticultural practice, all the above means being taken advantage of. In addition, plants are extensively propagated by means of cuttings and layers and by the well-known processes of budding and grafting so extensively used by gardeners and nurserymen.

(*b*) *Sexual Reproduction.*—Vegetative reproduction is a comparatively simple process in the higher plants mainly depending on the formation of adventitious roots; in contradistinction to this, sexual reproduction is a complicated process.

The characteristic feature of reproduction of new individuals by sexual means in either plants or animals consists of the union of two special kinds of cells known respectively as the male gamete and female gamete. In the flowering plants the fusion of the male and female gametes results in the formation of seed; so it can easily be seen that in the natural state reproduction by the sexual method is easily the more important among the higher plants.

The process which results in the union of the male and female gametes is spoken of as the process of fertilisation. The sexual organs of the plant are contained in the flower, and their external features and general characters have already been dealt with ("Morphology," Chapter VI.).

We will now follow the process which results in the fertilisation of the ovule and the consequent formation of the seed containing the embryo or young plant.

Pollination.—In order that the ovule may become fertilised, the pollen grains must be transferred from the anthers to the stigma, the surface of which is generally moist with a slight sticky secretion which serves the obvious purpose of retaining the pollen grains when they fall on it. The transference of the pollen grains to the stigma is called pollination.

Flowers are said to be self-pollinated when the stigma receives pollen from the anthers of the same flower, or cross-polinated when the stigma receives pollen from the anther of another flower either growing on the same or on a distinct plant. Similarly, when the act of pollination is followed by the fertilization of the pistil, the flower is said to be self- or cross-fertilized, as the case may be.

Cross-fertilization.—Cross-fertilization, however, even in plants possessing hermaphrodite flowers, would seem to be the rule, and many obvious devices can be noticed for the effective carrying-out of cross and the prevention of self-fertilization.

It has also been proved by careful experiment that, as a general rule, seeds developed as the result of cross-fertilization give rise to plants which are more virile and vigorous in growth than do seeds developed as the result of self-fertilization.

In trees such as the Pines and She-oaks, in which the individual flowers bear either only male or female reproductive organs respectively, cross-fertilization is obviously ensured. On the other hand, looking at an ordinary hermaphrodite flower, it would seem that self-fertilization must be the rule, as the anthers and stigma lie in such close proximity. On going further into the matter, however, we find that self-fertilization is either completely prevented or more or less retarded by one or two simple methods.

Plants may produce hermaphrodite flowers of which the male and female organs of each individual flower do not ripen together; either the anthers mature and shed their pollen before the stigma is receptive, or the stigma is receptive or fit to receive pollen before the anthers dehisce. Self-fertilization may also be more or less prevented by the relative positions of the anthers and stigma in the same flower or by the anthers shedding their pollen outwards.

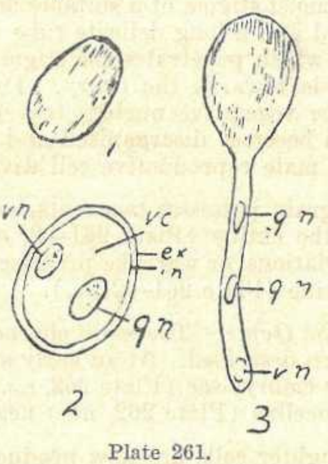


Plate 261.

1. Pollen-grain. 2. Section through a pollen-grain. 3. Germinating pollen-grain (diagrammatic).

Transference of Pollen.—In cross-pollination the pollen must be carried from one flower to another by some external agency, and the principal agencies employed by plants in this work are the wind, insects, and birds. Wind-pollinated flowers are usually inconspicuous, scentless, and produce no sweet nectar for the purpose of attracting insect or bird visitors. The pollen is usually dry and produced in great abundance, as in the Pines, and the stigmas may be relatively large and feathery, as in grasses, and thus especially adapted to catch the floating pollen grains. Plants with wind-pollinated flowers are often gregarious in their distribution, as in many Conifers (*e.g.*, the Hoop and Bunya Pines, &c.), the *Casuarinaceæ* (She-oaks), grasses, &c.

Sometimes the flowers may be pollinated by almost any visitor—insect or bird—but there are many flowers which are especially adapted for pollination by a particular group of insects or birds, or even by one particular species of either. These flowers possess, as a rule, brightly coloured floral leaves, are often scented, and secrete nectar by means of their nectaries or honey glands. To what extent insect and bird visitors are attracted by the two first-mentioned properties is a matter of some doubt, but there is no doubt whatever that the pollen and nectar are the principal attraction for pollen-eating insects and nectar-feeding insects and birds.

Fertilization.—Though flowers are spoken of as either cross-pollinated or cross-fertilized, it must be clearly understood that pollination and fertilization are two very distinct processes. Pollination is merely the dusting of the stigmatic surface with pollen. Fertilization is the actual fusion of the male and female cells.

In its younger stage the pollen grain is unicellular, but later the cytoplasm and nucleus divide and a small cell is produced lying in the general protoplasm; this is the generative cell or male reproductive cell (Plate 261—2, *g.n.*), and the larger one in which it lies is now differentiated as the vegetative cell (Plate 261—2, *v.c.*), and its nucleus as the vegetative nucleus (Plate 261—2, *v.n.*). The pollen grain now really appears as a large cell with two nuclei lying in it. When a ripe pollen grain is placed on the moist stigma of a suitable flower, it germinates; its outer crust is ruptured and a long delicate tube is sent out—the pollen tube (Plate 261—3)—which penetrates the stigmatic surface and grows down through the style towards the ovary. During this process the generative cell and the vegetative nucleus travel into the pollen tube, the vegetative nucleus becomes disorganised and eventually disappears, but the generative or male reproductive cell divides into two.

A typical pollen grain possesses two coats—an outer, comparatively stout one, known as the extine (Plate 261—2, *ex.*) (this is commonly marked with veins, striations, or wartlike processes), and a thinner inner coat, known as the intine (Plate 261—2, *in.*).

Development of the Ovule.—The main characteristic features of the ovule have already been described. At an early stage in its development a large cell termed the embryo-sac (Plate 262, *e.s.*) makes its appearance in the tissue of the nucellus (Plate 262, *nu.*) near the micropyle.

A number of daughter cells are now produced within the embryo-sac, the process being somewhat as follows:—

At first the embryo-sac has the appearance of an ordinary cell with a single nucleus lying somewhere about the centre of the cytoplasm, but before fertilisation takes place the nucleus divides into two, the two daughter-nuclei passing to the opposite ends of the cell; here each by further division gives rise to four separate nuclei, so that at this stage there are eight free nuclei in the embryo-sac. After this one nucleus from each group travels back to the centre, where they fuse with each other to form what is known as the secondary (or definite) nucleus (Plate 262, *n.*) of the embryo-sac.

The other nuclei now receive differential names. The three situated near the chalaza develop cell-walls and are known as the antipodal cells (Plate 262, *a.*). The three situated near the micropyle do not become surrounded by cell-walls and constitute the so-called egg-apparatus; two of the cells of the egg-apparatus are termed synergidæ (Plate 262, *s.*), the third being variously known as the ovum, egg-cell, or oosphere (Plate 262, *o.*). The ovum is the actual female reproductive cell, and its consequent fusion with the generative or male reproductive cell from the pollen grain is the act of fertilisation which results in the formation of the seed and eventually a new plant. How this fusion is brought about will now be described.

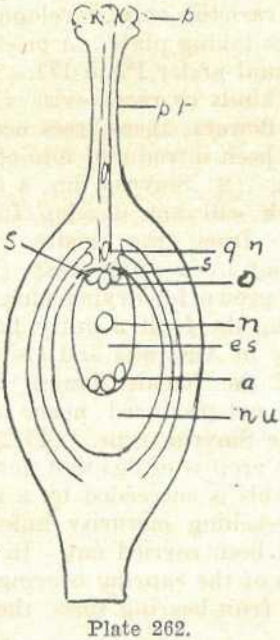


Plate 262.

Longitudinal section (diagrammatic) through a carpel containing a single orthotropous ovule.

After the germination of the pollen grain the pollen tube advances through the tissues of the style and ovary, and at length reaches an ovule, which it penetrates through the micropyle and comes into contact with the egg-apparatus. At this stage its tip becomes disorganised, and one of the generative cells escapes and unites with the ovum or egg-cell; this fusion is the essential feature of the act of fertilization. The fertilized ovum forms a cell-wall and is now termed an oospore. A cell resulting from the fusion of two gametes, as the fertilized egg-cell of the ovule, is termed a zygote. In flowering plants the zygote or oospore develops into an embryo and thence finally into a new individual plant.

Effects of Fertilization.—Fertilization not only results in the development of the embryo and seed, but the growth of the whole ovary is stimulated, resulting in the formation of the fruit, and in most cases, unless fertilization takes place, fruits either do not develop at all or fall off long before they reach anything like normal size. Sometimes, in addition to the ovary, other parts of the flower are stimulated into increased growth, as the perianth tube in *Eugenia* and *Cryptocaraya*, the pedicel in *Exocarpus*, the torus in the Apple, &c.

Though, as a general rule, non-fertilization is followed either by the more or less immediate withering and shedding of the whole flower or later of the immature fruit, some notable exceptions to this rule are known among cultivated plants, such as the Banana, Pineapple, Navel Orange, the seedless Currant and Sultana Grapes, &c., all of which almost invariably produce seedless fruits. The cause of seedlessness in all cases is not known.

The common edible Fig (*Ficus carica*) is an example of a cultivated fruit in which, in some varieties only, development is continued without fertilization of the ovules taking place. A brief account of the structure of a fig fruit will be found under Plate 171. Of the common edible fig there are four distinct kinds or races—viz., (1) Caprifigs, which bear male, female, and gall flowers; these trees occur wild in the Mediterranean region and have been introduced into other fig-growing countries as Australia, California. (2) Smyrna figs, a race that develops female flowers only, but which will not develop fully formed fruit unless pollinated by pollen from the males, borne on a caprifig; pollination is carried out by a small wasp (*Blastophaga grossorum*). Smyrna figs are largely grown for drying purposes, the ripened achenes or nutlets (seeds) giving the fruit a nutty flavour. (3) The common edible fig, grown largely in Australia and elsewhere; the fruit does not require fertilization of the female flowers to become fully formed. Ripe seeds, however, are not produced; hence the fruit when dried lacks the nutty flavour of the Smyrna type. (4) A race known as the San Pedro figs, in which one crop is of figs that develop without fertilization of the female flowers; this is succeeded by a second crop in which the fruits fall off before reaching maturity unless fertilization from the oollen of a caprifig has been carried out. In countries where Smyrna figs are grown branches of the caprifig bearing receptacles are hung up in the branches of the fruit-bearing sorts, the process being known as *caprification*.

Though unfertilized flowers soon drop off the plant, it does not follow that all fertilized ones persist and that their ovaries develop into mature fruit; this is especially true of plants that produce a great wealth of blossom, and it is doubtful in such cases if the plant could support the weight of fruit and withstand the drain on its system consequent upon all the flowers developing mature fruits; on the other hand, in plants which produce only a few flowers nearly every fertilised flower may result in a fully developed fruit.

Every ovule requires a pollen grain to effect fertilization if it is to develop into a seed, so that in fruits closely packed with numerous seeds, such as the watermelon, papaw, passion fruit, &c., a great number of pollen grains must be placed on the stigma. In the case of the watermelon, which may produce several hundred fully developed seeds in a single fruit, it has been estimated that over a thousand pollen grains must fall on the receptive stigma.

[TO BE CONTINUED.]

The Babcock Test.

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HISTORICAL.

VERY early in the organisation of the dairying industry it was decided that milk and cream should be paid for on the percentage of fat which it contained.

For this purpose a method which was cheap, quick and accurate was required, and the first method fulfilling these conditions was that of Gustaf De Laval, who, in 1885, took out a patent in Sweden for the use of a mixture of twenty parts of acetic acid and one part of sulphuric acid. This mixture coagulates and then dissolves the proteins and destroys the emulsion, and a brief whirling in a centrifugal causes the fat to collect in a clear, sharply defined layer.

This method was followed in 1889 by the Leffman and Beam method. The bottles used are very similar to the familiar Babcock bottles but smaller, and the basis of graduation is different and the zero mark is at the top of the bottle. The method is as follows:—

> Measure 15 ml. of milk into the test bottle. Add 3 ml. of a mixture of equal volume of amyl alchohol and hydrochloric acid and mix. Add 9 ml. of sulphuric acid and mix. Fill the bottle to the zero mark (top of the graduations) with dilute sulphuric acid (one part of acid plus two parts of water) and place in the centrifuge and whirl for one minute.
>
> The percentage of fat is read from the bottom of the lower meniscus to the bottom of the upper meniscus.

About the same time as Leffmann and Beam introduced their method, Dr. S. M. Babcock, of the Wisconsin Agricultural Experiment Station, was working out the method now known as the Babcock method. This was introduced in 1890 in a pamphlet entitled "A New Method for the Estimation of Fat in Milk especially adapted to Creameries and Cheese Factories." This method immediately became popular, as the only chemical required is sulphuric acid.

Later still, Gerber modified the Leffmann and Beam method by eliminating the hydrochloric acid and adapting it to yet another method known as the Marchand method, and the resulting method known as the Gerber method is almost universally used in European countries. This method utilises a special form of bottle known as an "acido-butyrometer" as well as a specially designed centrifugal machine holding a large number of bottles.

The method is carried out as follows:—

> Measure ten ml. of sulphuric acid into the empty bottles, then add eleven ml. of milk and one ml. of amyl alcohol. A rubber cork is then inserted and the contents shaken until the curd is dissolved. The bottle is then inserted in the holes of the centrifuge, whirled for two or three minutes, and the percentage of fat read off from the bottom of the bottom meniscus to the bottom of the upper maniscus.

Of all these methods the Babcock method is probably the most widely used, although it is not quite so fast as the Gerber or Leffman and Beam methods.

THEORETICAL DISCUSSION OF THE BABCOCK METHOD.

Milk and cream are composed of fat and serum. The serum consists of water in which is dissolved lactose, mineral salts, and albumin, and this aqueous solution is intimately mixed with casein, forming an excellent emulsion in which the fat is distributed in the form of very minute globules. If this emulsion is destroyed these fat globules may be collected in a mass, and the volume occupied by the fat may then be measured.

The means employed for the destruction of the emulsion and for the collection of the fat globules are:—

1. Sulphuric acid, which dissolves the casein, thus destroying the emulsion.
2. Heat generated by the action of the sulphuric acid on the water of the milk serum. This generated heat melts all the fat and keeps it in a fluid and mobile condition.
3. Centrifugal force, which assists the accumulation of the fat. The effect of centrifugal force may be illustrated by placing two bodies of the same shape and size, but of differing weights, such as a cork and a piece of lead, near the centre of a revolving platform. Each of these bodies is flung outwards and each of them will be travelling at the same speed when they reach the edge of the platform. The heavier body, however, will have the greater momentum and will be flung further than the lighter body.

In the Babcock test the two bodies are:—

1. The fat, which is much the lighter body,
2. The acid serum mixture, which is very much heavier.

As the cups of the centrifuge limit the distance to which these two bodies may be flung, the heavier acid serum accumulates as far as possible from the centre of rotation, and forces the much lighter fat nearer the centre. The water which is added during the test serves the dual purposes of:—

1. Washing the fat layer free from acid serum.
2. Forcing the fat nearer and nearer to the centre of rotation until the final whirling brings the washed fat into the graduated neck of the test bottle, where the volume of fat may be measured.

The graduations on the neck of the test bottles bear a definite relationship to the volume and weight of the fat, and to the volume and weight of the milk originally introduced into the bottle. This relationship is based on the average specific gravity of milk fat at 140 degrees Fahr. being 0·900. The volume of the graduated neck between 0 and the 8 per cent. mark is 1·6 Ml., each 1 per cent. graduation therefore representing 0·2 ml. Now 1·6 ml. of butter fat at 140 degrees Fahr. having the specific gravity of 0·900 (*i.e.*, a known volume of fat weighs only 0·900 times as much as the same volume of water) weighs only

$$1{\cdot}6 \times 0{\cdot}900 = 1.44 \text{ gram.}$$

This 1·44 gram of fat represents 8 per cent. by weight of fat, the weight of milk for which the bottle is graduated is therefore

$$1{\cdot}44 \times \frac{100}{8} = 18{\cdot}00 \text{ grams.}$$

Now 18 grams of milk at 70 degrees Fahr. (milk having a specific gravity of 1·03, *i.e.*, a known volume weighs 1·03 times as much as the same volume of water) occupies a volume of

$$\frac{18}{1\cdot03} = 17.48 \text{ ml. or very nearly } 17.5 \text{ ml.}$$

A pipette with a total volume of 17·6 ml. will deliver only 17·5 ml. under ordinary conditions of usage, the remaining 0·1 ml. clinging to the inside walls of the pipette.

The whole calculation can be reversed by starting from the pipette having a total volume of 17·6 ml. as follows:—

A 17·6 ml. pipette delivers 17·5 ml. of milk.

17·5 ml. of milk weighs 17·5 x 1·03 = 18 grams.

$$8 \text{ per cent. of } 18 \text{ grams} = \frac{8 \times 18}{100} = 1\cdot44 \text{ grams.}$$

$$1\cdot44 \text{ gram. of fat occupies } \frac{1\cdot44}{\cdot900} = 1\cdot6 \text{ ml.}$$

The 0 to 8 per cent. graduations of the bottle therefore show a volume of 1·6 ml.

On the cream test bottles the graduations are based on only 9 grams of cream being used, the volume represented by each 1 per cent. graduation being therefore only half that of the milk bottle graduations. Each 1 per cent. graduation therefore represents 0·1 ml., and the whole of the 50 per cent. graduations represent a volume of 5·0 ml.

As cream has a variable specific gravity varying from about 0·950 for a 50 per cent. cream to 1·002 for a 25 per cent. cream, the 8·8 ml. of cream used in the testing of cream does not represent 9 grams. With the two cases mentioned the weights of cream taken are—

8·8 x ·950 = 8·36 grams for the 50 per cent. cream,

and 8·8 x 1·002 = 8·82 grams for the 25 per cent. cream.

The percentage of fat obtained by the cream test is therefore lower than the true percentage.

O'Callaghan gives figures showing that a 48·5 per cent. test = 50·9 per cent. true fat and 38 per cent. test = 39·4 per cent. true fat.

Accurate results when testing cream are therefore only obtainable by weighing 9 grams of cream into the test bottle.

The commercial butter tables used in Queensland, however, are based on the readings obtaining by using 8·8 ml. of cream, allowance having been made for the inherent inaccuracy of the method.

TAKING THE SAMPLE.

(*a*) *Sampling of Bulk Supplies.*

When testing a sample of a bulk supply, the small sample taken must represent the average quality of the whole. The bulk must, therefore, be as well mixed as possible prior to drawing the sample for analysis, by stirring well with a long paddle or a specially constructed stirring rod with a shallow dish attached to the end. When the bulk is as homogenous as it is possible to make it by these means the sample should be immediately drawn and placed in a separate small receptacle which must bear some distinguishing mark, such as a number, so that the various patrons' samples will not be hopelessly mixed.

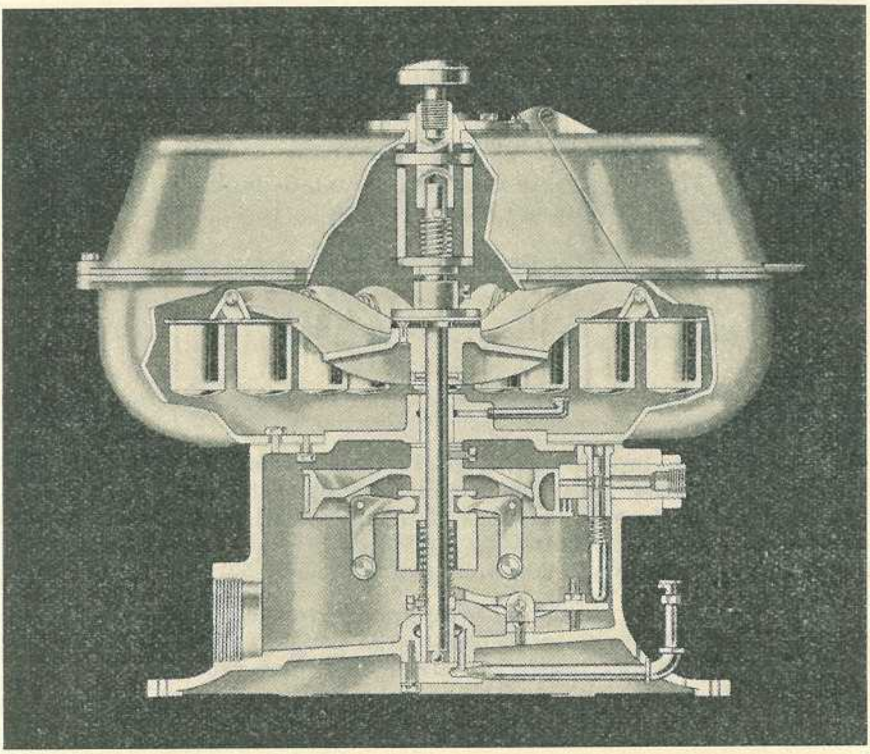


Plate 263.

Cross-section of a modern steam turbine Babcock "tester" with a built-in governor.

The practice in butter factories is to place the samples of cream in small cups or mugs, and these are taken to the testing room and tested almost immediately. When a sample is to be kept for any length of time it should be placed in a jar or bottle with a well-fitting stopper to prevent evaporation.

(b) Composite Samples.

In cheese factories composite samples of each patrons' supply are kept and analysed periodically, generally weekly. To do this the sample must be preserved.

The preservatives used are:—

1. Formalin or formaldehyde.
2. Corrosive sublimate or mercuric chloride.
3. Potassium dichromate.

Formalin is the most commonly used preservative in Queensland, and has proved very satisfactory for the purpose.

The composite samples are obtained by taking a small amount of each day's supply and storing in a bottle containing the preservative. Mixing the contents of the bottle after each day's sample has been added is essential.

THERE IS ONLY ONE BABCOCK TEST.

Regulations 157 and 161 under "*The Dairy Produce Acts,* 1920 *to* 1935," provide that milk and cream shall be tested by the Babcock method or other method approved by the Minister.

It is very important, therefore, that the standard technique of the Babcock method be faithfully followed. Any modification introduced to hasten the testing automatically makes the method illegal, as none of the modifications usually practised are approved.

THE TESTING OF MILK.

Reagent.

Commercial Sulphuric acid—Specific gravity, 1·82 to 1·83 at 70 deg. Fahr.

Apparatus.

(*a*) *Test Bottle.*—The 8 per cent., 18-gram milk test bottle specifications for which are given in Regulation 190 under the Dairy Produce Acts.

(*b*) *Pipette.*—The 17·6 ml. pipette specified in Regulation 192 under the Dairy Produce Acts.

(*c*) *Acid Measure.*—Any suitable device to measure 17·5 ml. of sulphuric acid.

(*d*) *Centrifuge or "Tester."*—The standard centrifuge, however driven, shall be constructed throughout and so mounted as to be capable, when filled to capacity, of rotating at the necessary speed with a minimum of vibration and without liability of causing injury or accident. The proper rate of rotation may be ascertained by reference to the table below. By "diameter of wheel" is meant the distance between the inside bottoms of opposite cups measured through the centre of rotation of the centrifuge wheel while the cups are horizontally extended.

Diameter of wheel in inches ..	12,	14,	16,	18,	20,	22,	24
Revolutions per minute ..	980,	909,	848,	800,	759,	724,	693

It shall be heated, electrically or otherwise, to a temperature of at least 130 deg. Fahr. during the whirling.

(*e*) *Dividers or Callipers.*—For measuring the fat column.

(*f*) *Water Bath.*—Provided with a thermometer and a device for maintaining a temperature of 130 deg. to 140 deg. Fahr. The bath shall be of such depth that the test bottles may be immersed to the top of the graduations.

Preparation of the Sample for Analysis.

If the sample is fresh or in a good homogeneous condition, the only preparation required is to bring the sample to a temperature of between 60 deg. and 70 deg. Fahr., and mixing well just prior to testing.

If the sample is partly churned, the sample bottle should be placed in warm water until the churned fat is well softened, then well mixed and cooled to 60 deg. to 70 deg. Fahr. with frequent gentle mixing. The fat should never be melted to an oil as it is then difficult to again incorporate into the sample.

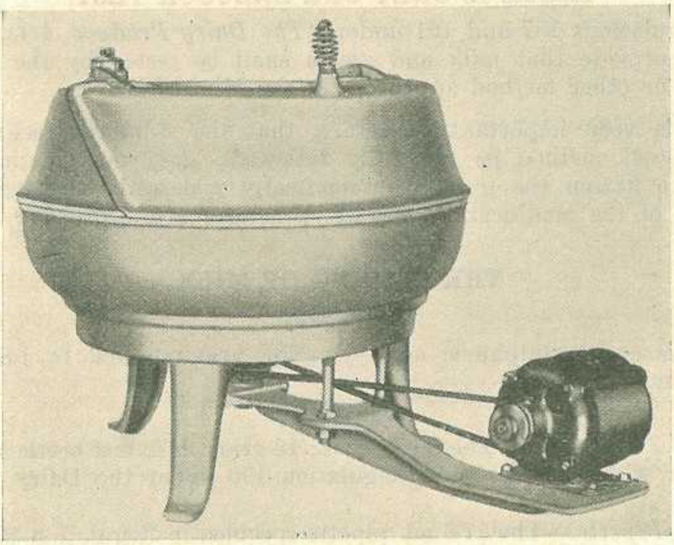


Plate 264.
Belt-driven electric Babcock "tester."

If the sample is curdled, a small amount of powdered caustic soda may be added (about 1 gram for a ½-pint sample) and the sample well mixed until the curd has redissolved. When a sample is so treated, greater care must be used when mixing acid with the milk, as much greater heat is generated.

One of the best methods of mixing samples is to pour from one vessel to another, allowing the milk to run down the walls of the vessels. In this way solid lumps can be easily seen, churning is practically prevented, and no air is mixed with the sample.

Determination.

Insert the lower end of the 17·6 ml. pipette into the prepared sample and fill to some distance above the mark by applying suction to the upper end. Quickly cover the top of the pipette with the tip of the finger, and *adjust the bottom of the meniscus to the graduation mark* by lessening the pressure of the finger sufficiently to allow air to slowly enter the top of the pipette. To do this with the required accuracy, the pipette must be held vertically with the graduation mark at eye level. A pipette should never be used in any other manner.

Drain the milk in the pipette into the test bottle and blow out the last drop. The test bottle should be marked to correspond with the mark on the sample container.

Add 17·5 ml. of the sulphuric acid. The temperature of the acid should be between 60 deg. and 70 deg. Fahr., and should be added in such a manner that it flows down the walls of the neck and the bulb forming a layer beneath the milk, and, incidentally, washing down any drops of milk from the neck.

Immediately mix the acid and milk by shaking with a rotary motion. This rotary motion prevents splashing into the neck of the bottle. The mixing should be continued until all traces of curd have been dissolved and the mixture turns a dark chocolate colour. With preserved samples, the curd is much harder to dissolve, and, with very obstinate cases, the bottles may have to be placed in water kept at 130 deg. to 140 deg. Fahr. with constant shaking until the curd has dissolved.

Place the bottles in the cups of the tester, seeing that the wheel is evenly balanced. If an odd number of samples are being tested, test one sample in duplicate, as this will make an even number of bottles and will also indicate whether the technique gives constant results.

Whirl for five minutes after the correct speed has been attained.

Add hot soft water to the bottles until the bulb is completely filled. The temperature of the water should be between 140 deg. and 160 deg. Fahr. If soft water is not available, it is advisable to add a few drops of sulphuric acid to each pint of cold water and heat the very slightly acid water to the required temperature.

Whirl again for two minutes.

Add hot water until the level of the liquid approximately reaches the top graduation mark.

Whirl again for one minute.

Place the bottles in the water bath which should previously have been heated to 130 deg. to 140 deg. Fahr., and allow them to remain with the whole of the fat column immersed for five minutes so that the fat will attain this temperature before measuring.

Reading the Percentage of Fat.

By means of the dividers, which should have fine, sharp points, measure the entire length of the fat column. This is best done by placing one point of the dividers on the lowest point of the lower meniscus and then adjusting the other point to the top of the upper meniscus of the fat column. Without altering the adjustment of the dividers, place one point on the zero mark and the mark which the other point reaches is recorded as the percentage of fat by weight.

The fat column at the time of reading the percentage should be translucent, of a golden yellow or amber colour, and free from visible suspended matter, gas bubbles, or charred matter.

THE TESTING OF CREAM.

Reagent.

Commercial Sulphuric Acid—Specific gravity, 1·82 to 1·83 at 70 deg. Fahr.

Apparatus.

(*a*) *Test Bottle.*—The 50 per cent., 9-gram cream test bottle specified in Regulation 191 under the Dairy Produce Acts.

(*b*) *Pipette.*—The 8·8 ml. pipette specified in Regulation 193 under the Dairy Produce Acts.

The other apparatus required is the same as that described for the testing of milk.

Preparation of the Sample for Analysis.

As cream is much more difficult to mix than milk owing to its greater viscosity, the samples of cream are warmed gently until they are liquid enough to be thoroughly mixed and to be easily drawn into the pipette. The sample shall not, however, be heated to a higher temperature than 80 deg. Fahr. The other remarks made about milk samples also apply to cream.

Determination.

Insert the lower end of the 8·8 ml. pipette into the prepared sample and fill to some distance above the graduation mark by applying suction to the upper end. Quickly cover the top of the pipette with the finger, hold the pipette in a vertical position at eye level, and *adjust the bottom of the meniscus to the graduation mark.*

Drain the remaining contents of the pipette into the test bottle

Insert the lower end of the used pipette into warm water (110 to 120 deg. Fahr.) and fill to approximately the position of the graduation mark.

Wash down the walls of the neck of the test bottle by means of about one-half of the contents of the pipette.

Now close the lower end of the pipette with the finger and shake the pipette until all the cream has been loosened from the sides.

Drain the remaining contents of the pipette into the test bottle and blow out the last drop.

Add from 12·5 ml. to 17·5 ml. of sulphuric acid, the actual amount to use being best judged by the colour which develops in the bottle, the desirable colour being chocolate darkening more slowly than is the case with milk. If the cream is very rich in fat, less acid will be required than if the cream is poor in fat.

Place the bottles in the cups of the tester, seeing that the wheel is evenly balanced. If an odd number of samples are being tested, test one sample in duplicate, as this will make an even number of bottles and will also indicate whether the technique gives constant results.

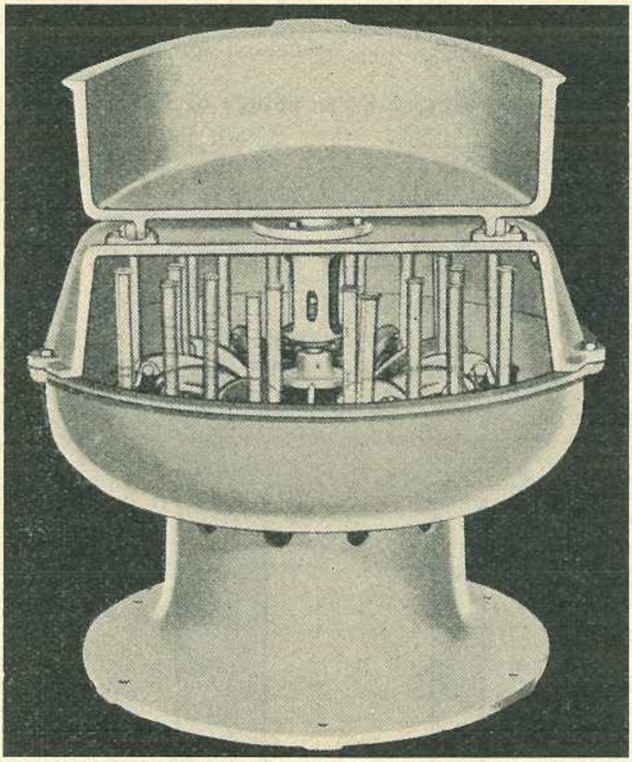
Whirl for five minutes after the correct speed has been attained.

Add hot soft water to the bottles until the bulb is completely filled. The temperature of the water should be between 140 deg and 160 deg Fahr. If soft water is not available, it is advisable to add a few drops of sulphuric acid to each pint of cold water and heat the very slightly acid water to the required temperature.

Whirl again for two minutes.

Add hot water until the level of the liquid approximately reaches the top graduation mark.

Whirl again for one minute.



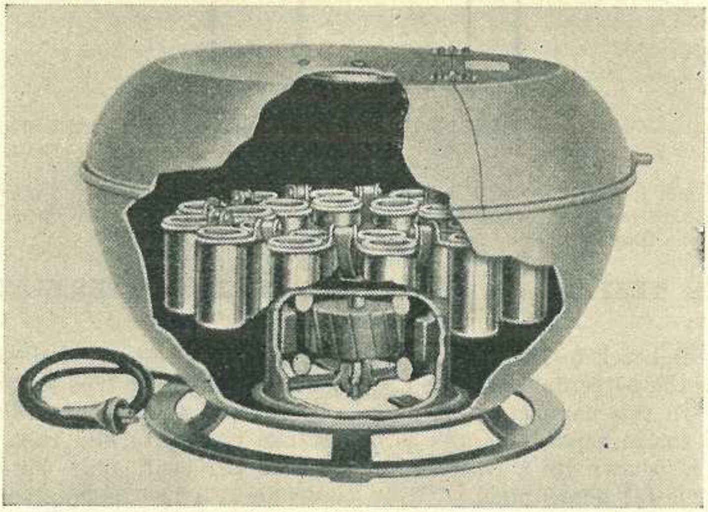


Plate 26b.
Direct drive electric Babcock "testers.'

Place the bottles in the water bath, which should previously have been heated to 130 deg. to 140 deg. Fahr., and allow them to remain with the whole of the fat column immersed for five minutes.

Reading the Percentage of Fat.

By means of the dividers, which should have fine, sharp points, measure the entire length of the fat column. This is best done by placing one point of the dividers on the *extreme lower end* of the fat column and then adjusting the other point to the *extreme upper end* of the fat column. Without altering the adjustment of the dividers, place one point on the zero mark and the mark which the other point reaches is recorded as the percentage of fat.

This method of reading the fat column is given in Regulation 157 under the Dairy Produce Acts, and is the only method allowed.

The fat column at the time of reading the percentage should be translucent, of a golden yellow or amber colour and free from visible suspended matter, gas bubbles, or charred matter.

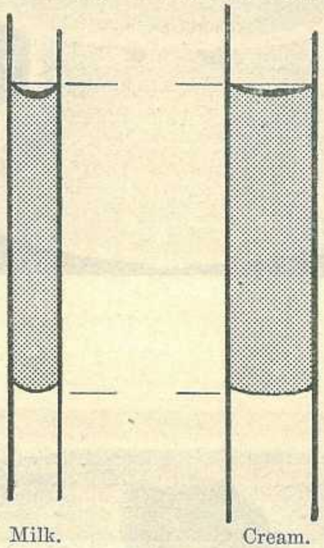


Plate 266.

HOW THE PERCENTAGE OF FAT MUST BE MEASURED.—In reading the percentage of fat in both milk and cream the whole of the fat column must be measured as shown in the illustration.

THE TESTING OF SEPARATED MILK, BUTTERMILK, AND WHEY.

The Babcock test is not allowed to be used for testing of these products, as the percentage obtained is much lower than the true percentage of fat. In this connection, it may be mentioned that the average per cent. of fat in separated milk is about 0.08 per cent., and this would usually be shown by a Babcock test of 0.01 per cent., only one-eighth of the true fat percentage.

Regulation 164 provides that the method used for these products shall be the normal butyl alcohol modification of the Babcock test.

THE NORMAL BUTYL ALCOHOL MODIFICATION OF THE BABCOCK TEST.

Reagents.

(*a*) Commercial Sulphuric Acid—Specific gravity, 1·82 to 1·83 at 70 deg. Fahr.

(*b*) Normal Butyl Alcohol.

Apparatus.

(*a*) *Test bottle.*—The special double-neck bottle designed for these products. These bottles have a graduated neck of very small bore, the graduations being from 0 to 0.5 per cent., each small division representing 0.01 per cent. A second tube of much larger bore is attached directly to the bulb for filling purposes.

(*b*) *Pipette.*—The 9 ml. pipette specified in Regulation 194 and which is usually used for the acidity test. As the pipette used in the factory for acidity tests usually contains remnants of cream, it is advisable to have a 9 ml. pipette used only for this test.

The other equipment required is the same as that described for the testing of milk.

Preparation of the Sample.

Proceed as directed for milk-testing.

Determination.

Add to the test bottle in the order shown below:—

(1) 2 ml. of normal butyl alcohol.

(2) 9 ml. of separated milk, buttermilk, or whey.

(3) Sulphuric acid.

10 to 12 ml. for separated milk.
7 to 9 ml. for buttermilk.
4 to 6 ml. for whey.

Mix well after each addition

When all the casein or non fatty milk solids have dissolved, place in the centrifuge, which should have been heated to at least 130 deg. Fahr., preferably higher.

Whirl for six minutes at the normal speed.

Add hot water until the bulb of the bottle is filled.

Whirl again for two minutes.

Add hot water until the fat column is well up in the graduated neck.

Whirl again for two minutes.

Place in the hot water bath at 130 to 140 degrees Fahr. for five minutes.

Measure the entire length of the fat column by means of the dividers.

***Double the reading* to obtain the percentage of fat.**

DEFECTS IN THE FAT COLUMN AND THEIR CAUSES.

1. Dark specks or particules of charred matter, or the whole column of fat dark in colour—

Causes:—1. Too much acid.

2. Temperature of acid and (or) milk is too high.

3. Allowing the acid to drop directly into the milk or cream, instead of down the walls of the bottle.

4. The acid and milk being allowed to stand for some time before mixing.

5. Acid too strong.

2. Particles of the white undissolved matter may appear in, above, or below the fat column.

Causes:—1. Not enough acid.

2. Temperature of acid and (or) milk is too low.

3. Acid too weak.

4. Acid and milk not shaken long enough for all curd to dissolve.

5. Curd may have been splashed into the graduated neck during shaking.

3. Foam or gas bubbles in the fat column.

Causes:—1. Using hard water containing carbonates.

2. Centrifuge not whirled fast enough.

SOURCES OF ERROR.

Particular attention should be paid to the following details, which though small in themselves have a cumulative effect and cause appreciable errors.

(1) The "tester" must be heated to not less than 130 deg. Fahr. during the whirling. If the tester is cold, the fat loses its mobility and may not rise into the neck of the bottle and lower tests result.

(2) The hot water added must have a temperature of at least 140 deg. Fahr. when introduced into the bottle. Cold water has the same effect as a cold "tester," i.e., lower tests.

(3) The "tester" must be whirled at the correct speed. A lower speed results in an incomplete accumulation of the fat and lower tests, while a higher speed causes breakages.

(4) The "tester" must be whirled for the times stated in the methods, shorter whirlings having the same effect as slower speeds, i.e., lower tests.

(5) Two additions of water must be made to wash the fat free from acid and serum. One addition of water is not sufficient to completely wash the fat and higher tests result.

(6) The sample must be at the correct temperature, when measured in the pipette. A cold sample gives a higher test and a warm sample gives a lower test.

(7) The sample must be measured in the pipette by adjusting the bottom of the meniscus to the graduation mark. This is only possible by holding the pipette vertically with the graduation mark at eye level. Remember a pipette is never intended to be used in any other manner. If the top of the meniscus is adjusted to the mark it means that less milk or cream is introduced into the bottle and lower tests result.

(8) The temperature of the fat must be between 130 deg. and 140 deg. Fahr. when the column is measured. If the temperature is higher than this the tests are high, while lower tests are obtained if the fat is allowed to cool before reading.

(9) The whole length of the fat column must be measured. Reading to the bottom of the upper meniscus is not allowed as lower tests are so obtained.

(10) Above all remember that the Babcock method is a standard method which will only give accurate results when the standard technique is followed.

STRAINING WIRES—A HANDY HINT.

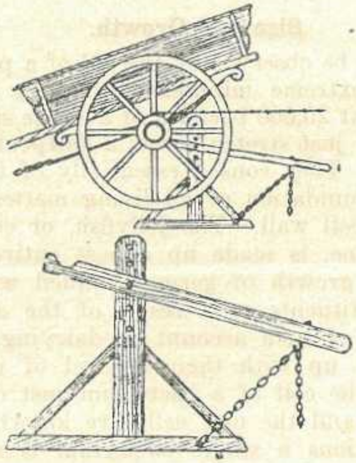


Plate 267.

The idea is a fencing hint. Sometimes when a farmer wants to strain his barbed wire, he might not have a wire-strainer handy, so my suggestion is to use a spring cart (writes a farmer in the "Western Mail"). If the horse is reasonably quiet, there is no need to take him out of the shafts. First tie a chain from the axle to the post in front to act as a brace, next jack up the wheel a few inches off the ground (will put in a sketch for a very handy light jack). Tie the wire to a spoke where it joins the hub, then turn the wheel by hand. When you have the wire tight enough push a piece of timber through the spokes then under the cart to act as brake. You can then put in a few staples to hold the wire whilst it is being tied to the strainer.

Microbes in the Dairy.

E. B. RICE, Dairy Research Laboratory (Dairy Branch), Queensland.

THE spoilage of milk and cream, because of their special value as a food, is very rapid unless every care is exercised in their production and handling and the most frequent cause of their deterioration is from the activities of the most lowly of living organisms, popularly called microbes or germs.

Application to Industry.

At the outset it is advisable to correct the erroneous impression, so frequently held, that all microbes are harmful. Because a few species are well known as the cause of certain diseases which take a heavy toll of human life, microbes have gained a reputation which is wholly undeserved. Of the numerous species those which are detrimental to animal and plant life, or are objectionable in industrial processes, are relatively few indeed, and were it not for the activities of some types several important industries might not be in existence to-day. The fermentation industries, such as brewing, winemaking and vinegar manufacture, depend upon the specific functions of certain microbes. The dairy industry itself must be regarded as one of the major fermentation industries; cheese especially could not be made without the aid of microbes. Another instance of their application to agriculture is in the making of silage, where the acid developed by bacteria prevents putrefaction. If this acid were not produced decay would result, rendering the fodder unfit for use.

Size and Growth.

Microbes can only be observed by the aid of a powerful microscope. Some idea of their extreme minuteness may be gathered from the popular illustration that 25,000 bacteria of average size when placed end to end in a row would just stretch across a halfpenny, which is exactly one inch in diameter. They consist essentially of the substance protoplasm, which is the foundation of all living matter, surrounded by a membrane called the cell wall. The jellyfish, or common sea blubber, well known to everyone, is made up almost entirely of protoplasmic material. The rapid growth of germs, coupled with the undesirable changes in milk constituents as a result of the activities of certain species, renders them of such account in dairying. This rapidity of development is bound up with their method of reproduction, which is extremely simple; the cell of a bacterium just divides into two by the process of fission and the new cells are known as daughter cells. Under suitable conditions a single bacterium is able to divide into two within a period of thirty minutes; in the succeeding thirty minutes there would be four, which would increase to eight after the next interval of thirty minutes. Such growth in geometrical progression is so rapid that in less than twenty-four hours the progeny of the original single microbe would number millions. Fortunately, under natural conditions, the by-products resulting from the activities of the germs on the nutrive substance upon which they are subsisting exert a retarding influence on their rate of growth, so that the actual numbers fall short of what they would be were ideal conditions possible.

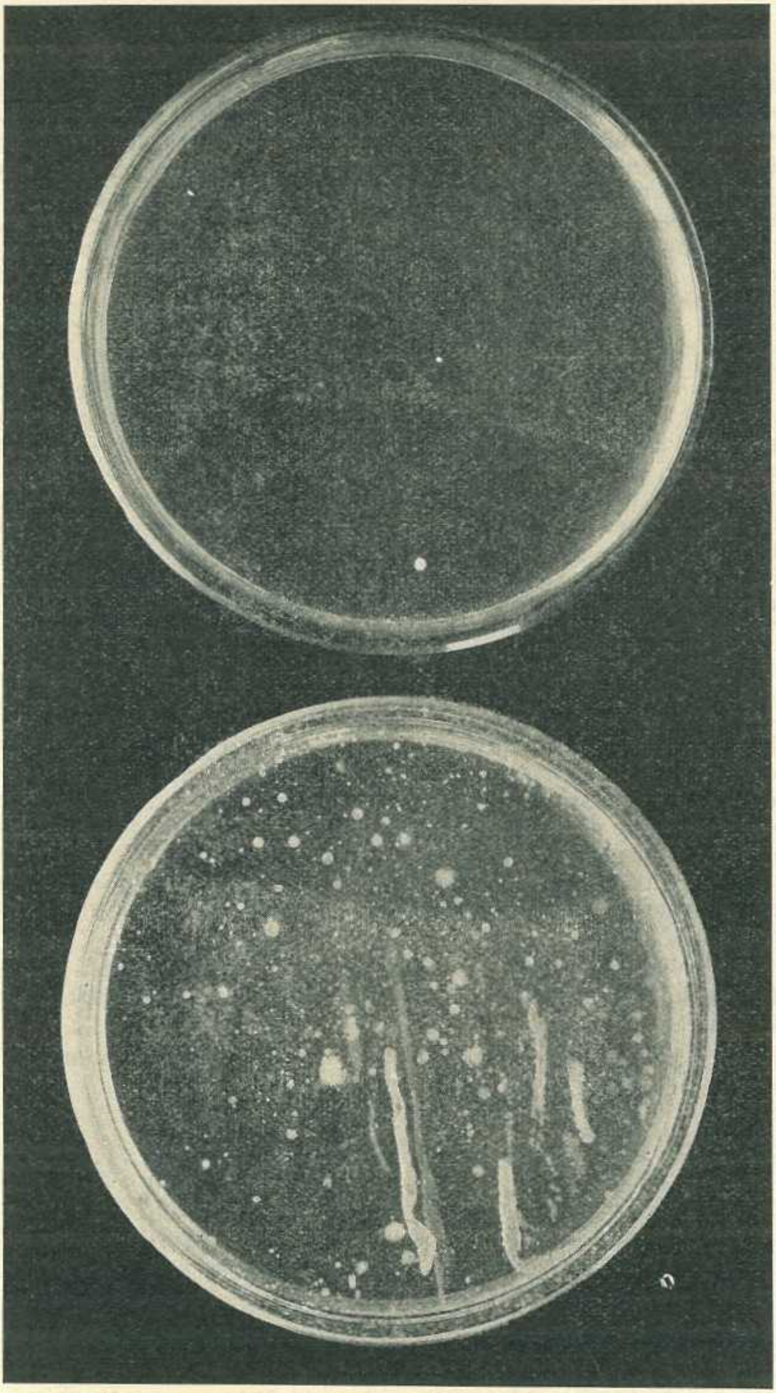


Plate 268.

PHOTO. SHOWING CONTAMINATION OF MILK.—Top: Colonies from cleanly-produced milk. Bottom: Colonies from milk produced under insanitary conditions.

Parasites and Saprophytes.

Bacteria, not having the power of independent existence, are always found in association with other forms of matter. According to whether their host is living tissue—either animal or vegetable—or inert material, they are designated as parasites or saprophytes, respectively, but there is no strict line of demarcation between these groups. Again, the parasites are divided into disease-producing (pathogenic), or non-disease producing (non-pathogenic), germs. An organism may be pathogenic for, say, animals, yet non-pathogenic for man. For instance, the causal organisms of lumpy jaw and mammitis of dairy cattle are reputed to be harmless to man.

Food.

As with all other forms of life, moisture is essential for bacterial development. Similarly, food is required, but, obviously, in exceedingly small quantity. If a teaspoonful of milky solution be left in a cream can or other utensil after cleaning, it is capable of sustaining the growth of millions of microbes which would seed any fresh milk or cream introduced into the vessel. The reason why it is always stressed to clean scrupulously and thoroughly dry afterwards any dairy utensil is thus apparent, because so long as there is a complete absence of moisture any few bacteria which remain behind after washing the vessel will be prevented from increasing in numbers.

Influence of Temperature.

The warm temperatures in the summer in Queensland prove almost ideal for the development of most microbes. Their growth is practically suspended at cold temperatures, like those of our winter nights, hence the desirability of cooling cream and keeping it cool. At temperatures of 50 deg. Fahr. or lower, growth is almost checked, although much lower temperatures are required for their destruction. Freezing water will only slowly kill most species. They are also able to adapt themselves to withstand temperatures which would be excessive for other forms of life.

The following table, abstracted from Orla Jensen's "Dairy Bacteriology," illustrates nicely the influence of temperature on rate of growth.

Milk immediately after milking .. 1,480 bacteria per ml.

Same milk, after standing eighteen hours—

At deg. Fahr.	Bacteria per ml.
48	2,100
54	5,600
59	156,000
64	550,000
70	6,750,000

Temperature also has an important bearing upon the types of microbes found in milk. If cream be maintained at 70 deg. Fahr., which corresponds roughly with spring conditions in this State, the lactic acid bacteria, which cause the familiar souring of milk, will gain almost complete control of the fermentation. These bacteria may be regarded as friends of the dairying industry, for the acid produced by them, combined with the rapid growth at their optimum temperature, will prevent other species which bring about injurious fermentations from developing in sufficient numbers to impart any taint. At temperatures in the neighbourhood of 90 deg. Fahr., which approximates with summer conditions, many microbes which are very objectionable in dairy produce become dominant. Although it is recognised that in the summer in many of the dairying districts of this State there are difficulties in the way of cooling cream or milk to an extent sufficient to prevent any increase in the microbial flora, yet if farmers were able to cool and to keep their cream at 60 deg. Fahr. to 70 deg. Fahr. they would be going a long way towards reducing considerably the high proportion of inferior cream which is delivered to the factories at this time of the year.

Darkness and Sunlight.

Microbes prefer darkness, and strong sunlight kills them. Well-lighted and ventilated bails and dairy buildings will assist to keep them in control. To obtain the maximum benefit from the natural light, the bails should face north. Dairy farmers should bear in mind that sunlight is the cheapest germicide.

Where Microbes Exist.

The question might naturally be asked, "Where do microbes exist?" They are found in the soil, in water, in the air, and in the digestive tract of man and animals; in fact, almost everywhere. The air over high mountain peaks and the sea, some miles from the shore, is often sterile; that is, free from microbes. Their numbers are relatively few in the open air, especially in rural districts, but the air of a city street may be heavily contaminated. Dust in the stables and flies are potential sources of contamination of milk, because they always transport numbers of germs, some of which are the cause of serious defects of milk. Flies may also be the carriers of disease germs. Impure water from stagnant waterholes, dams, &c., sometimes is the means of contaminating milk. The udders, flanks, and tails of the cows wading in such places pick up germs, which, during milking, fall into the pail.

Bactericidal Action of Blood.

It may be of interest to refer to the absence of microbes in the blood-stream of a healthy person or animal. This is attributed to the ability of certain cells in the blood to digest bacteria which invade the blood-stream. Not until this natural resistance is broken down, through ill-health or other cause, are microbes able to survive and bring about disease.

Resistance to Unfavourable Environment.

A factor which renders the control of microbes a difficult problem is their resistance to unfavourable conditions, such as lack of food, unsuitable temperatures, dryness, chemical action, &c. Mention has already been made of their ability to withstand better than other forms of life unusual degrees of cold and heat. Certain microbes, usually those whose natural habitat is the soil, are able to form what is known as a spore, which may be compared with the seed of a plant. Like the seed, which is hardier than the plant itself, the microbial spore is able to withstand adverse circumstances much better than the living cell. The hardihood of a spore may be indicated by pointing out that boiling water is unable to destroy it, unless allowed to remain in contact for some time, and spores of the anthrax bacillus which had been kept in a dried state for ten years germinated when transferred to a suitable environment. Fortunately, few of the microbes encountered in dairy products, unless they are produced and handled under conditions which can only be regarded as hygienically unsatisfactory, belong to the spore-forming group.

Control of Microbial Contamination.

Care in all stages of production and treatment on the farm and in conveyance to the factory is essential to produce milk and cream free from excessive bacterial contamination. Strict observance of the few points enumerated hereunder would go far towards checking the activities of undesirable germs, and, incidentally, deriving the monetary reward which is now provided by the Regulations under the Dairy Produce Act for cream of choice quality:—

1. Clean flanks and udders with a cloth moistened in weak condy's fluid.
2. Wash the hands before milking each animal.
3. Thoroughly clean and dry utensils after use, in the following manner:
   (*a*) Rinse in lukewarm water.
   (*b*) Immerse in boiling water.
   (*c*) Allow to drain and dry in the sun on a dust-free rack.
4. Cool cream immediately and keep it cool.
5. Exercise additional care in the summer months, when conditions are ideal for bacterial multiplication.

PULLING OUT BOGGED TRACTOR.

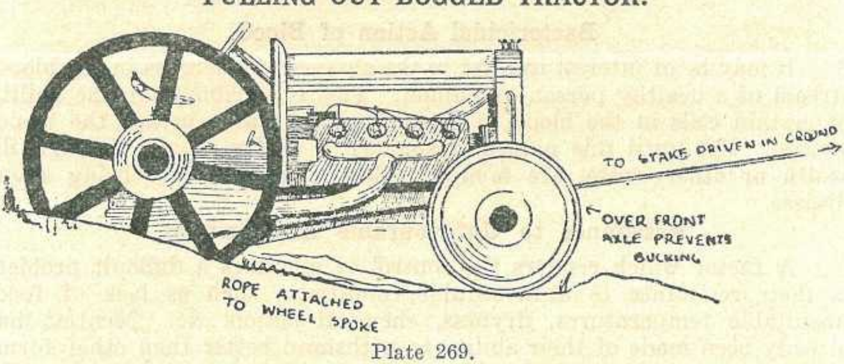


Plate 269.

The sketch illustrates a sure, safe and simple way of pulling a tractor out of a bog. Two wires or wire ropes are tied to the two rear wheels of the tractor and led forward over the front axle to an anchor of some kind in front. As the tractor is driven forward, the wheels wind the wires around themselves, and so pull the tractor forward. The wires are led over the front axle as a precaution against "bucking." This method can be used for backing also. Lorries can be pulled out of bogs in the same way.

Tobacco Culture in Southern Rhodesia.

R. A. TARRANT, Instructor in Agriculture.

The subjoined notes contain the substance of a short series of radio talks to tobacco growers, and are illustrated with snapshots taken by Mr. Tarrant in the course of a recent tour through the tobacco producing regions of South Africa.—Ed.

Soils.

THE soils on which I found most of the tobacco being grown are of granitic origin, and more or less identical with our Mareeba soils in appearance, but generally they are much richer in fertility. These soils are of varying depths of from 8 to 14 inches of surface soil, being light grey to reddish in colour. According to the geological map, Southern Rhodesia contains 49·5 per cent. of granite soil, all of which is suitable for tobacco growing, but unfortunately nearly half of the area is situated in what is considered a very uncertain and dry belt which only averages from 10 to 15 inches of rain annually, and then this rainfall is interspersed with long dry spells.

Plate 270.

LARGE TOBACCO PLANTATION, SOUTHERN RHODESIA.—This crop yielded over 700 lb. of cured leaf to the acre. Some plantations grow 250 to 500 acres and a living area is 60 acres.

In Southern Rhodesia tobacco is grown mostly on three classes of soil—viz., sandy loams, contact soils, and clay loams.

The ideal soil for flue-cured tobacco leaf (always called Virginian tobacco in South Africa), is a granite sandy loam, light grey in colour, of a depth of from 8 to 12 inches, merging into a reddish subsoil containing a percentage of clay with sand and granite mixed in suitable proportions. This allows for good drainage in a wet season and the retention of moisture in a dry or uncertain season.

The "contact" soils are mostly located on the fringe of the granitic and basement schists. Intrusions, however, may occur right in the granite belts, and any of the estates with these intrusions are considered fortunate, as the value of the land is increased. These soils are well drained, and grow good crops of tobacco and maize, requiring less fertilizer for the production of commercial crops. These contact soils, which are classed as sandy loams, are very friable and fine in texture, and are usually very deep and reddish in colour. The contact soils recommended for tobacco growing are granite diorite, granite dolorite, granite schist, and granite banded ironstone. Besides growing Virginian leaf I have also seen fire-cured and air-cured varieties growing on these soils, but there is a very limited demand for air-cured leaf. The soils classed as clay loams, and which are entirely derived from diorite, dolorite, schist, and banded ironstone, are red in colour, and for the first year will produce leaf of a bright colour which can be flue-cured, but the leaf grows heavier and cures darker as the soil is cropped, and therefore are most unsuitable for growing Virginian leaf. Most maize crops are grown on these soils.

Plate 271.

A FARM ROAD.—Headlands are used in Southern Rhodesia as motor roads for transporting the leaf to the barns.

Rainfall.

Tobacco crops grow best and make uniform growth of leaf, which cures easily, when the average rainfall is between 22 to 26 inches spread evenly over the growing period.

The monthly mean rainfall for Salisbury and district spread over a period of thirty-five years:—

	Inches.
July to September	0·36
October	0·92
November	3·23
December	5·72
January	7·07
February	5·60
March	4·11
April	0·99
May to June	0·46

These statistics make an average of 28·46 inches. It will be noticed that the storms commence in October, heaviest precipitations being in

Plate 272.

BREAKWINDS.—Australian gums are grown on the headlands as a shelter break for tobacco crops in parts of Southern Rhodesia.

December, January, and February. From March to September the rainfall is very light.

These conditions compare favourably with those of Mareeba, where, however, the precipitations are slightly heavier and the general storms and seasonal rains are later. In Southern Rhodesia November and December are the usual planting-out months, the month of January being considered too late.

Plate 273.

BREAKWINDS.—Another view of gums sheltering a growing crop.

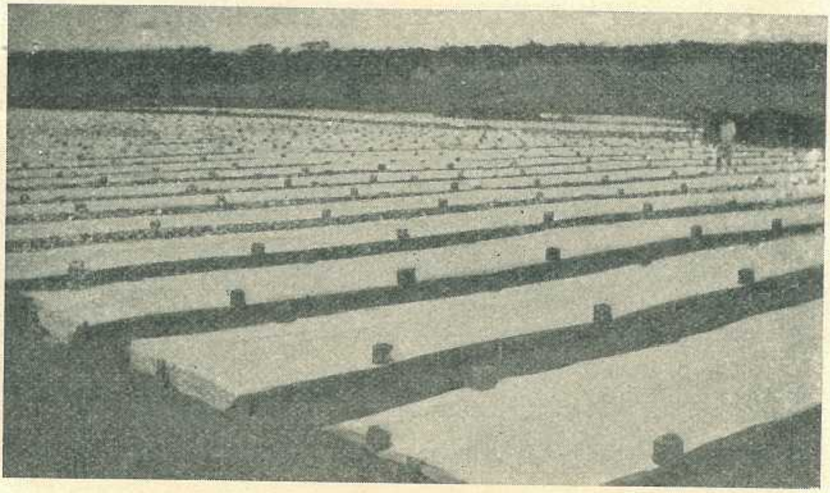


Plate 274.

A SEED BED LAYOUT.—All seed beds are built up, formed, and enclosed with bricks. The bricks are sterilized during the burning of the beds.

Altitude and Climatic Conditions.

It will be interesting to note that the capital of Southern Rhodesia is situated in the same latitude as Mareeba—18 deg. S.—and most of the tobacco is grown within a 70-mile radius of Salisbury.

Over 24 per cent. of Southern Rhodesia is 4,000 feet above sea level. Salisbury itself is 4,885 feet, and Sinoia, another large tobacco-growing area, is 3,793 feet. These altitudes naturally give this colony a very temperate climate.

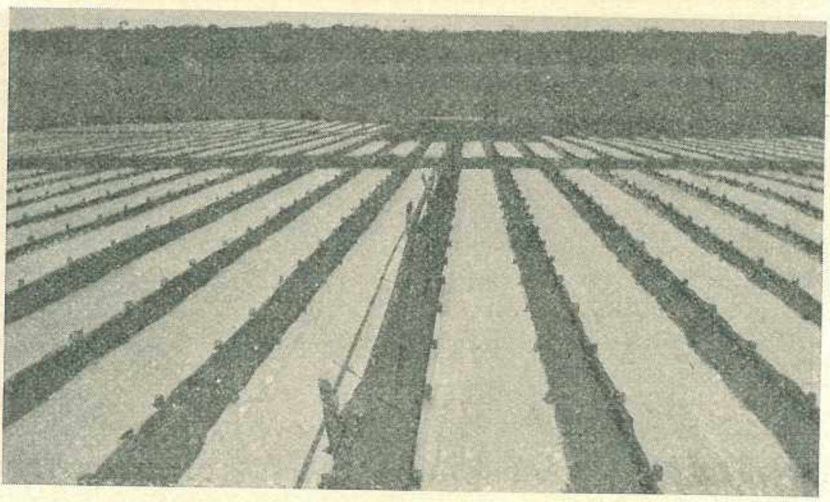


Plate 275.

SEED BEDS IN SOUTHERN RHODESIA.—They are covered in most instances with cheese cloths, but no storm curtains are used.

During October and November the days are hot, the mean temperature being 91 degrees, but the nights are cool, when temperatures range from 46 degrees to 54 degrees.

During December, January, February, and March the mean maximum temperatures are approximately 84 degrees, while the mean minimum temperatures 52 degrees.

The relative humidity ranges about 70 per cent. from November to March, and this is not regarded as excessive.

Salisbury is 300 miles inland, and is, therefore, uninfluenced by sea breezes.

Plate 276.

In Preparation for Transplanting.—Seedlings ready for the field being hardened off.

Rotational Cropping.

The most favoured rotation in Southern Rhodesia on the flue-cured tobacco soil is as follows:—

First year—Tobacco, with fertilizer.

Second year—Tobacco, with fertilizer.

Third year—Maize, no fertilizer.

Fourth year—Sunn hemp (*Crotaleria juncea*), ploughed under.

Fifth year—Maize, no fertilizer.

Sixth year—Tobacco, with fertilizer.

With this rotation tobacco is grown two years with fertilizer, then followed with a crop of maize, there being sufficient fertilizer residue left in the soil to produce this crop. The following year a heavy smothering crop, usually Sunn hemp, is grown and ploughed under as a green manure. This green crop ploughed under makes the soils rich in nitrogen and humus, so much so that it is not advisable to follow immediately with a crop of tobacco, so to tone the soil down the fifth year is planted with a crop of maize and then the sixth year tobacco again.

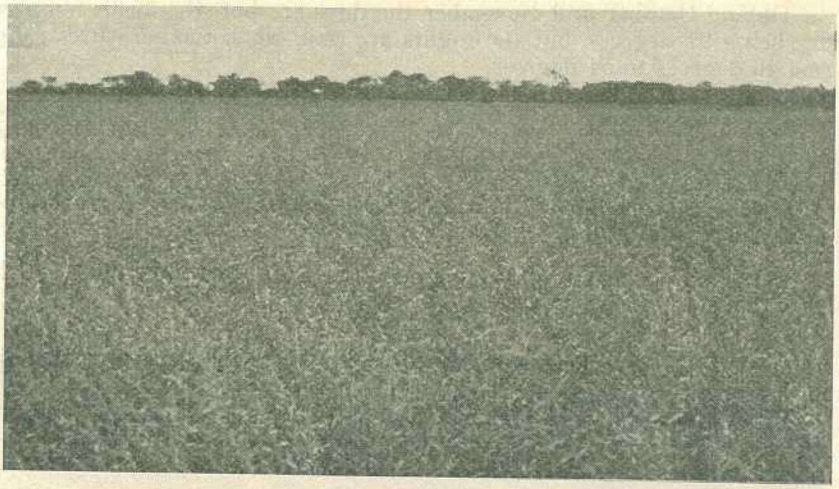


Plate 277.

Crop of Sunn Hemp (*Crotalaria juncea*) in Flower and Ready for Ploughing Under.—This crop is sown broadcast, rate of 40 lb. to the acre, and is used in most tobacco rotations.

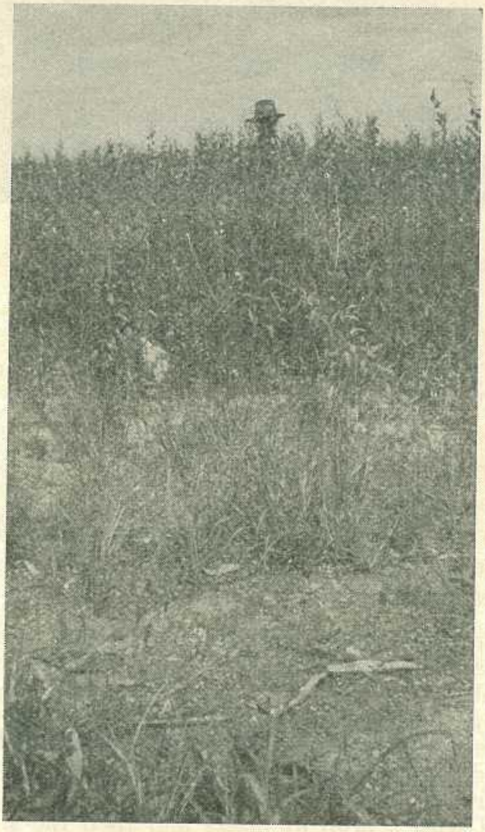


Plate 278.
Showing ordinary height of a crop of Sunn hemp.

It has been found that tobacco leaf following a crop of Sunn hemp grows very coarse and thick in texture; the leaf also crinkles and is most difficult to cure.

Another rotation recommended is:—

First year—Tobacco, with fertilizer.
Second year—Velvet beans.
Third year—Cotton.
Fourth year—Maize.
Fifth year—Tobacco, with fertilizer.

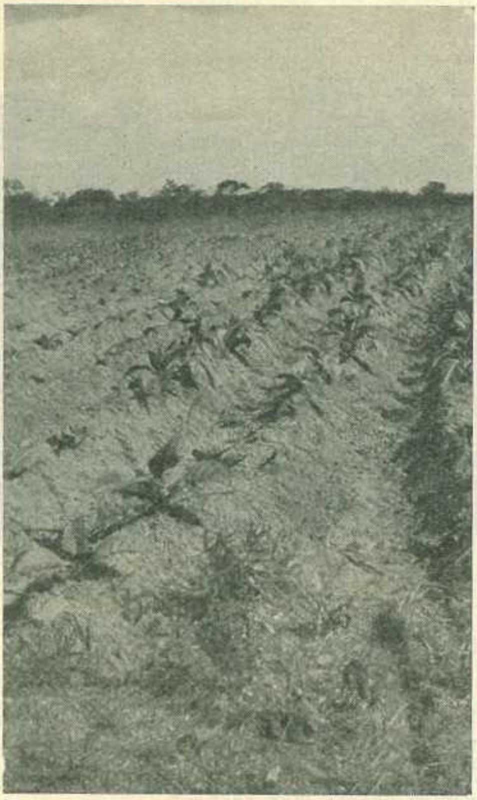


Plate 279.

A FIELD IN SOUTHERN RHODESIA.—Showing height of ridges; the crop is obviously suffering from the effects of dry weather.

This appears to be a very good rotation, but I would be inclined to substitute Sunn hemp in place of velvet beans, as the former is such an easy crop to grow and readily ploughed under if handled at the right stage of maturity, whereas velvet beans are very difficult to handle.

Preparation of Land.

The land into which the tobacco seedlings are to be transplanted should be thoroughly worked and brought into a fine tilth so that the seedlings will be given every chance to grow without receiving any setbacks.

Most of the tobacco soils in Southern Rhodesia, especially the granites, are shallow, and shallow ploughings are advocated. If the subsoil is brought to the surface it will have very detrimental effects on the yield and quality of the leaf. The clearing of the land is attended to during the wet season; the timber is never burnt, but is drawn to the headlands and cut into lengths as fuel for flue-curing purposes. The veld generally is sparsely timbered, and there is a shortage of timber throughout the populated areas. Land, by the way, can be cleared for £1 per acre in some districts, and even where the trees are denser rarely costs over £2 per acre.

Plate 280.

A FARM SCENE IN SOUTHERN RHODESIA.—Showing a field "hillocked" ready for planting. The fertilizer is at the bottom of each hillock.

In Queensland we also save the timber for flue-curing fuel, but incidentally burn a tremendous amount of timber on the land. This is not recommended in Rhodesia, as the ash residues cause the growing of uneven and sometimes coarse leaf crops.

Usually the tobacco-grower ploughs his land as soon as the crop is taken off, or, with virgin land, about March or April. This early ploughing allows for the rotting of any vegetation that has been ploughed under, while there is still moisture in the soil, and also assists in sweetening the soil by letting it fallow during the winter months. The land is also worked during the winter months to keep down weed growth, and to keep the soil loose and friable and in a moistened condition.

Ploughing is done generally with a three-furrow disc plough (shave) and seven span of oxen. Horses are subject to sickness, and are never used; in fact, I did not see a horse team during my travels throughout Southern Rhodesia.

Ridging.

The light soils used for producing bright leaf are sometimes ridged, and these ridges are run east and west wherever possible to allow the plants to receive the maximum amount of sunlight. Naturally, the contour of the field is the deciding factor with regard to ridging, and is so aligned as to follow the natural drainage of the slope. They are usually made or formed 3 to 4 feet apart.

The Irrigation Department, when I was in Southern Rhodesia, was handling contour ridging and soil erosion, and officers were making visits to all farmers who were desirous of having their fields properly laid out in contour drains. Growers generally were taking advantage of this service.

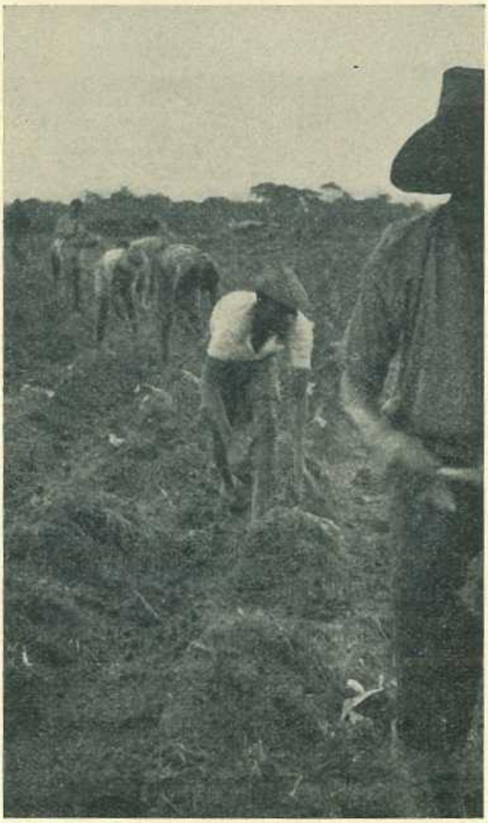


Plate 281.

FIELD PRACTICE IN SOUTHERN RHODESIA.—Planting in hillocks. Some farm workers use dibbling sticks, others use their hands.

On most of the tobacco plantations visited I found that very few tobacco ridges were being put up with plough teams, the majority of the growers preferring hillocks, which were pulled up with badzas or hoes. All this work was done by hand, the hillocks being marked out with wire tapes and formed on the check system 3 feet apart. The advantages, according to the growers, in favour of the hillocking system are, firstly, the crop receives an equal dressing of fertilizer (measured cup system is practised), each hillock receiving a measured quantity; secondly, they are better able to keep the crop free from weeds; and thirdly, the crop receives an equal amount of sunlight.

Growers who oppose hillocking maintain that it exposes too much surface soil, causing loss of moisture and rapid erosion by which the roots of the plants are laid bare during heavy rain.

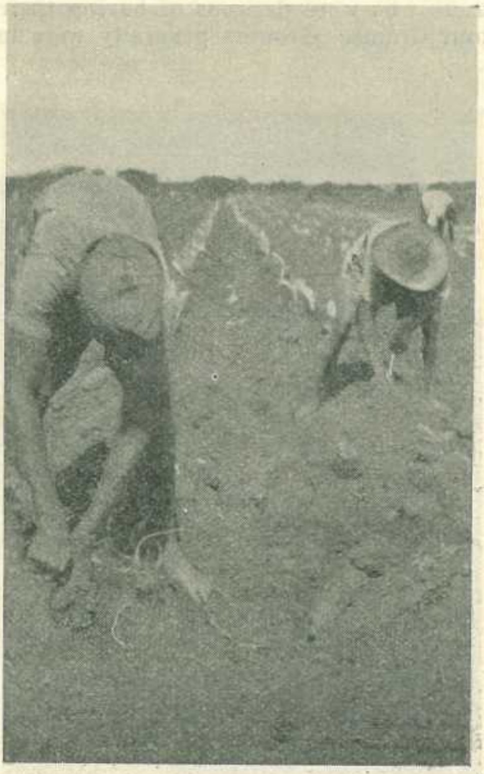


Plate 282.

PLANTING IN HILLOCKS.—Another view.

Fertilizing.

Fertilizer is applied to the soil shortly before planting and the hillock pulled over it. Some growers, however, prefer to broadcast and harrow it in, while I have seen others hoeing out a hole in the ridge and applying the required quantity to each hole, and when transplanting placing the seedlings in these depressions.

The fertilizer used is double complete, and contains the following water-soluble components:—Phosphoric acid (P_2O_5), 20 per cent.; nitrogen (N), 7 per cent.; potash (K_2O), 10 per cent. This formula appears to be the most popular amongst growers in the poorer sandy soils, and is used at the rate of 200 to 250 lb. per acre.

On light sandy soils of greater natural fertility the following formula is suggested:—Phosphoric acid (P_2O_5), 18 per cent.; nitrogen (N), 6 per cent.; potash (K_2O), 8 per cent. It is applied at the rate of 175 to 200 lb. to the acre at a cost of approximately £2 per acre.

In this mixture the nitrogen is derived from a combination of organic and inorganic nitrogenous components.

On the dark fire-cured soil the formula recommended is phosphoric acid, 12 per cent.; nitrogen, 6 per cent.; potash, 8 per cent. This mixture is applied at the rate of 400 to 500 lb. to the acre.

Transplanting.

Tobacco seedlings are considered ready for transplanting when they are 6 inches in height, but if the seasonal rains are early they are planted out when only half this height. Growers prefer to wait for an overcast day, but if seedlings have become accustomed to plenty of sun they will withstand adverse conditions much better than plants that have been shaded. The seedlings are never covered during transplanting operations, but are left exposed to all weather conditions.

In Queensland seedlings are covered with paper tents if conditions are dry and hot, and in some instances they are watered in. In Southern Rhodesia, where the living acreage is considered to be 60 acres, it would be an impossible task to cover the young seedlings in the field. In transplanting two Kaffirs will plant 1 acre per day. These men receive in actual wages 12s. per month. This works out at approximately 6d. per day, and so it costs actually 1s. per acre to plant seedlings in Rhodesia.

The main plantings are made in November and December. This means the leaf ripens evenly, the crops reaching maturity while the weather is warm and before the rains cease. With January and February planted crops they seldom produce leaf of high quality and the yields are very disappointing. The Kaffirs sometimes use dibbling sticks when transplanting, but in most instances use their hands, especially when the soil is soft. Long tap roots are cut back close to the plant, for on no account should these roots be allowed to bend up. Plants with bent tap roots seldom make satisfactory growth.

The heart of the seedling should always be kept above the surface of the soil. If they are planted too deeply they become sanded up and die, thereby causing a very uneven strike in the field. This entails extra work in replacing plants that have failed.

According to results obtained from tobacco curing experiments in the United States of America, tobacco which reaches maturity and is harvested while the weather is still warm generally will be decidedly better in quality, particularly in respect of colour, than later harvestings.

Cultivation.

As soon as the plants have become established in the field inter-row cultivation work commences. The Kaffirs begin to work around the plants with their badzas or hoes, also along the ridges or hillocks, and the oxen teams begin to scuffle between the rows, and the plantations generally are certainly kept free from any weed growth. I noticed that all light scufflers were being discarded and very heavy ones with three or four long tines taking their place, and these are pulled by two oxen. These tines penetrate into the soil very deeply—at least 6 inches—thereby stirring the soil up and giving it a good aeration, but at the same time no subsoil is brought to the surface during the operation. I was informed that with heavy tine cultivation better crops are grown, as with deeper cultivation the plants develop a better rooting system, and make a more even and rapid growth.

Plate 283.

IN SOUTHERN RHODESIA.—Field workers dropping plants on the hillocks while others are planting.

Priming.

The removal of the lower leaves from the plants is called priming, and is done when the crop is averaging 12 inches in height. Generally, these leaves are never left on the field, but are carried to the headlands and burnt. The final priming of tobacco is made when the plants have reached the correct topping stage.

Topping and Suckering.

During the growing of the crop the Kaffirs are kept constantly in the field, especially during the topping and suckering stages.

It has been found in Southern Rhodesia that plants that have been topped too low are very prone to disease, more especially wilt, angular spot, and wildfire.

The terminal bud or flower head is taken out when the requisite number of leaves have developed and while the stem of the plant is still soft and supple. Delayed topping, or when the plants are in full flower, is not recommended, and is considered to be a waste of plant food and energy, as the stalks become hard as the flower head develops, and the operation of topping becomes more difficult.

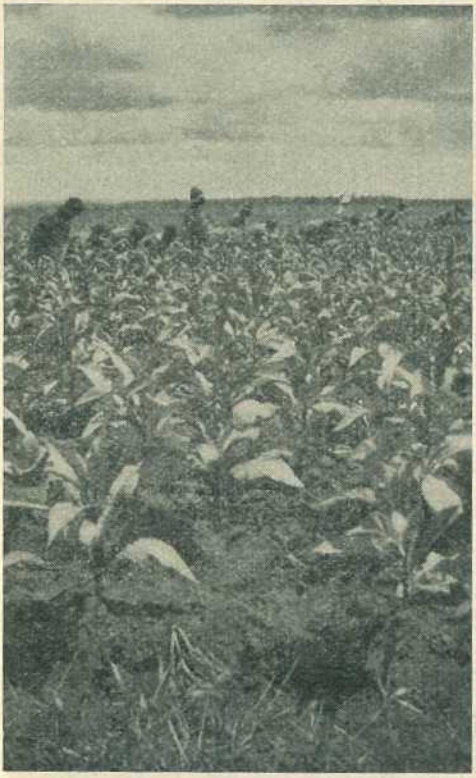


Plate 284.
BUSY FARM WORKERS.—Topping and suckering a tobacco crop.

All sucker growth is carried off the field and burnt as is the case with primed leaves.

Harvesting.

With large areas under tobacco it is a very simple matter to harvest leaf all at one stage of ripeness. In Southern Rhodesia 60 acres is considered a living acreage, but I saw plantations with 150 to 500 acres under tobacco, and in one instance 1,000 acres. On these bigger plantations a European section manager attends to 150 acres. His work is to supervise and keep the natives moving and attending to their allotted tasks in a proper manner, and it is not unusual to see 100 boys harvesting and working in a field. All Virginian leaf is harvested and cured by the single leaf method; the same applies to fire cured.

In harvesting the leaf is carried in the curve of the arm, but in a few instances I saw baskets in use. Each boy carries the leaf he has harvested to the headland, where big crates are placed and special

Plate 285.

PRIMING AND SUCKERING.—Kaffirs working in a tobacco crop priming and suckering in Southern Rhodesia.

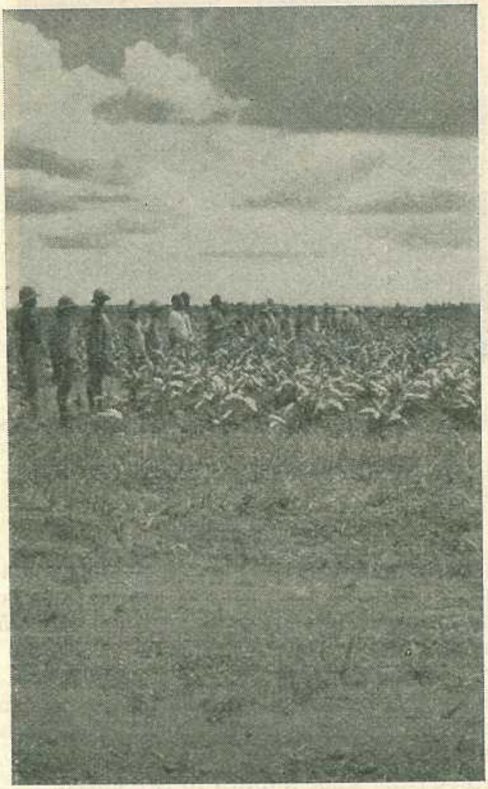


Plate 286.

WAITING FOR THE WHISTLE.—Eighty odd native workers ready to commence harvesting in a tobacco crop in Southern Rhodesia.

Plate 287.

A TOBACCO TRANSPORT WAGGON.—Method of transporting leaf to the curing barns. In some places leaf is carried four and five miles from field to barn.

Plate 288.

READY FOR THE BARN.—Special "boys" pack the leaf into crates on the headlands or motor roads.

Plate 289.
This illustration shows leaf packed in crates and being transported by motor lorry to the curing barns.

Plate 290.
A plant of White Stem Orinoco Tobacco.

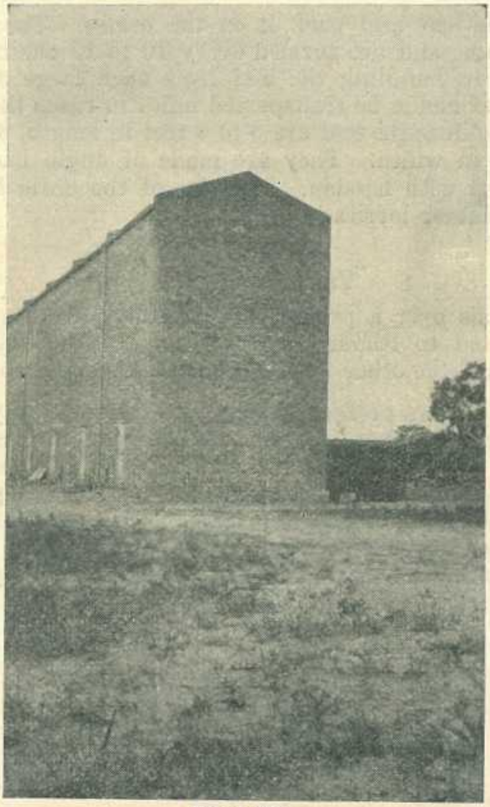


Plate 291.

A Brick Barn.—In Southern Rhodesia all barns are built of brick, and the work is done by natives, even to the moulding and burning. Bricks cost 12s. 6d. per 1,000.

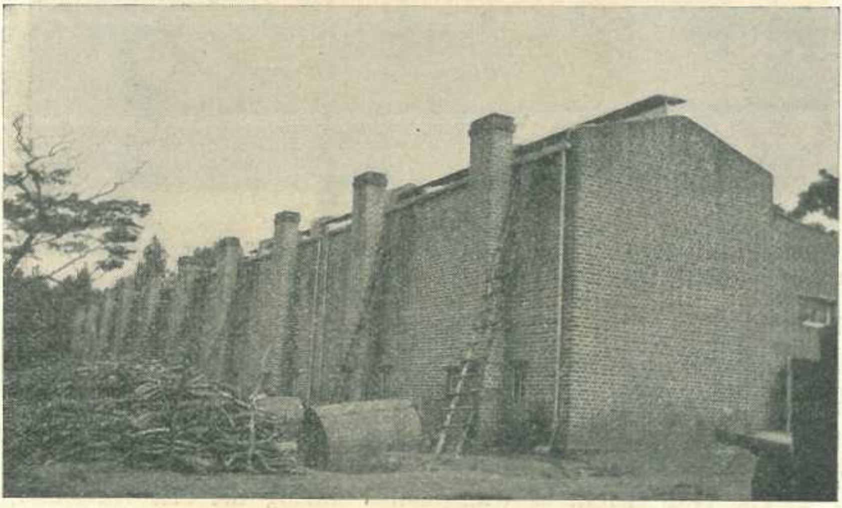


Plate 292.

With a battery of barns this size it is necessary to have thermometer inspection windows on the furnace side for the stoker, as well as the door or filling side for the supervisor or curer.

boys receive this leaf and pack it in the crates. The headlands are really motor roads, and are formed every 10 to 15 chains. This allows for convenience in handling the leaf from such large areas. In some instances, the leaf has to be transported miles to reach the curing barns. The crates for holding the leaf are 5 to 6 feet in length, 3 feet in height, and 2 to 3 feet in width. They are made of angle iron, braced each way, and covered with hessian. The size of the crate is made to suit the type of the motor lorries in use.

Varieties Grown.

Varietal trials over a period of years have demonstrated that the best variety suited to Rhodesian conditions for flue curing is White Stem Orinoco. All the other varieties have more or less been discarded.

The manufacturers prefer White Stem Orinoco to any other variety, as it goes through the "proctoring" or re-drying process without any damage to the leaf tissues, and this is one of the reasons why the variety is most popular. The leaf is subjected to a high temperature, which drives out all the moisture. It is cooled immediately afterwards and placed in a chamber in which it is reconditioned with a correct quantity of moisture and made fit for baling or bulking down without any fear of heating or bulk moulds.

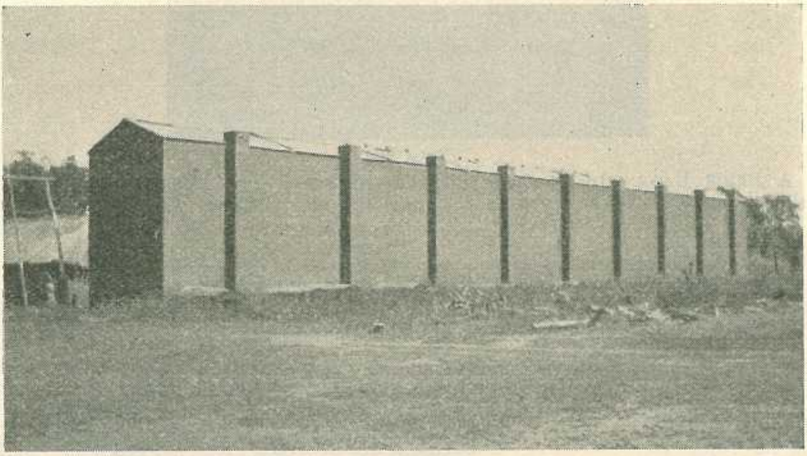


Plate 293.

Curing barns are built usually 20 feet by 20 feet by 20 feet, and this nest of barns is capable of handling between 70 to 80 acres of leaf.

SUMMARY.

The following summary contains some very useful hints by the Southern Rhodesian Chief Tobacco Officer, and are well worth quoting:—

1. The land should be properly prepared in advance of planting operations.

2. The crop should be transplanted during the most favourable portion of the planting season.

3. Early planted tobacco generally produces the best tobacco.

4. Late planted tobacco costs as much to produce, but is of little or no value.

5. A full and even stand secures a uniform and good yielding crop.

6. The acreage is governed by barn and housing accommodation and available labour supply.

7. Correct field work reduces the difficulty in curing and handling operations.

8. Aim for quality rather than quantity.

SUPPLEMENTARY FEEDING OF STOCK.

Good foundations and framework are essential prerequisites to an elaborate building, and the same is true of a living organism. The skeleton or bony material must be well formed if it is to support the intricate mechanism of an active body. The skeleton is largely mineral matter, and of this material over 90 per cent. is composed of lime phosphate. During the intra-uterine period of its life and in the early suckling period, the young derives the whole of its mineral requirements from the mother. She in turn derives her supplies from the food she eats. When this is deficient in the required elements, nature enables her to draw upon her own reserves. Such is the overpowering force of maternity that a cow has been known to deplete her own body stores by 20 per cent. of their lime and phosphate content for the sake of the calf.

The growing animal and the producing mother require relatively large amounts of lime and phosphate to meet development on the one hand, and lactation or the needs of the unborn young, on the other. The mature male or the unproductive female require much less.

As the mineral content of good pasture closely resembles that of animals themselves there is rarely any need to feed supplementary minerals when green grass is available. When the grass dies much of the inorganic (mineral) matter returns to the soil, and is unavailable to the animal. At this time the palatability of the grasses is affected, and stock are less inclined to eat all they require for maximum production. This reduced intake means a reduced mineral intake, and may lead to a temporary mineral deficiency. On certain types of country the soil, and consequently the vegetation it supports, is deficient in some minerals, and stock grazed thereon are in a constant state of malnutrition.

Under these conditions supplementary feeding becomes an economic necessity.

This has long been understood by the producer, but there has always existed some uncertainty as to the minerals required and the amount to be fed. On farm lands where the animals are under constant observation, and where the composition and palatability of the feed is known, the question presents little difficulty. On open grazing country complications arise. Apart from the requirements of the stock the difficulty of administration must be considered. The grazier cannot afford the individual attention to animals that farm stock get. He must aim at a mineral composition which corrects the deficiencies, and at the same time automatically limits the intake to the required amount. The problem is different for each locality, and results must largely depend upon the intelligent observation of the owner. In general, a mixture of well-graded steamed bone meal and coarse salt makes an efficient and palatable lick. The salt content should not exceed one-third of the composition, and where water analyses indicate it, the salt may even be excluded. A little appetiser must then be added to the bone meal. Price will govern which is to be used. The attraction which it holds for stock will determine the amount to be added. The quantity consumed will determine how often the material is exposed. When very fibrous food is being used it may become necessary to incorporate a purgative—5 per cent. sodium sulphate (Glaubers salt) is recommended.

Steamed bone meal should be fine, uniformly graded, and of good analysis. The Department of Agriculture and Stock will report on samples submitted. Salt should be clean butcher's quality. On no account use second-hand material.

Silos and Silage.

A. E. GIBSON, Instructor in Agriculture.

IN a recent letter directed to the Department of Agriculture and Stock, on the subject of silos and silage, the correspondent mentioned that he had taken considerable interest for some time past on subjects likely to benefit the man on the land, and incidentally matters relating to silage; but mentioned that certain items which have occurred to him have either been insufficiently dealt with or totally ignored. Consequently, with a view of clearing up the several matters in connection with silos and silage on which he desires information, the following questions submitted by him are dealt with seriatim:—

Question 1.—What is the best form of silo?

Answer.—A properly roofed and watertight cylindrical structure of reinforced concrete built overground and having an internal chute for emptying purposes in preference to doors.

Question 2.—Which is the better plan? Having the height greater than the diameter or *vice versâ*?

Answer.—Silage rapidly depreciates when exposed to the atmosphere; consequently in order to reduce surface exposure to a minimum the diameters of silos are reduced as much as possible, whilst the height is increased in order to give a greater pressure to the silage for the purpose of compaction and consequent exclusion of air from the silage. Usually the proportion of height to diameter is 2 to 1 respectively, and is found to be economically preferable to those in which the height compared to the diameter is at a higher ratio, say, 2½ or 3 to 1.

Silos which are excessively high require greater strength in foundations and walls, apart from which higher power and more expensive machinery is necessary for the filling.

Question 3.—Or is there any specific proportion between diameter and height?

Answer.—This question is really answered under Answer 2, but, whilst there is no distinct or specific proportion between diameter and height, it must be clearly understood that as the diameter increases to the ratio of the height so is the density of the silage decreased unless some form of artificial pressure is used.

Question 4.—Which is the best silo? Above ground level, below ground level, or half and half?

Answer.—Although it is admitted that the filling of a pit or underground silo is extremely economical and can be effected with a minimum amount of machinery and labour, the process of emptying the silage therefrom is the most costly and strenuous of all forms of silos. The overhead silo, whilst requiring a little more power and machinery for the filling, is the most economical of all when it comes to the operation of emptying. The silo which is half above and half below ground level has all the drawbacks of the pit and overhead silo, whilst only possessed of half the benefits of the latter.

Briefly, the merits of the three silos may be summed up as follows:—

Pit Silo.—Economical in filling, expensive in emptying (it requires the services of two operatives to empty a pit silo).

Overhead.—Slightly more expensive, due to increased power and machinery in the process of filling, but is decidedly economical in the process of emptying.

Half aboveground.—Costs practically the same to fill as an ordinary overhead silo, and is as cheap to empty down to ground level. From that on the cost of emptying becomes greater with the depth below surface.

Question 5.—Give dimensions for building a 50-ton silo.

Answer.—Silo internal diameter 11 ft. 6 in.; height, 23 ft. 3 in.

Question 6.—Give quantities for making same.

Answer.—For a 50-ton silo, using a 4-2-1 mixture—*i.e.*, four parts of broken stone, two of sharp sand, and one of cement—you would require:—Cement, 70 bags; stone aggregate ($\frac{3}{4}$-in. gauge), $14\frac{3}{5}$ cubic yards; sharp sand, 8 cubic yards; reinforcement, 2 coils 36-in. K-Wire netting, 10 gauge; rendering, 1 in. inside and out, $2\frac{1}{2}$ cubic yards sand; 36 bags cement. Roof specifications depend on style adopted (gable or octagon).

Question 7.—How would you work out the necessary information from Answers 5 and 6 to enable one to build (*a*) larger silo, (*b*) a smaller silo?

Answer.—Diameter $2 \times .7854 \times$ height $\div 48 =$ tons capacity. Diameter $\times 3\frac{1}{7} \times$ height $\times$ thickness of wall in feet $\div 27 =$ cubic yards contents of wall.

Based on the proportions of 4-2-1—*i.e.*, four of stone, two of sand, one of cement. To each cubic yard of concrete 540 lb. of cement are required ($4\frac{1}{3}$ bags). Of aggregate (stone) broken to gauge (in this instance $\frac{3}{4}$ in.) nine-tenths of one cubic yard are required and $\frac{1}{2}$ cubic yard of sharp sand.

The cement and sand together do not appreciably increase the bulk of the concrete, as they fill up the interstices in the aggregate.

Rendering (inside and out) is calculated at 2 to 1 (2 of sand and 1 of cement). This will give a sufficiently watertight job without the addition of water-proofing material.

Question 8.—What acreage of maize will fill a 50-ton silo?

Answer.—This, of course, depends on the crop; also the manner in which it was sown—*i.e.*, broadcast or drilled. Under ordinary circumstances the quantity required should be easily obtained by the cultivation of 5 acres of maize sown in drills—which method is recommended at all times in preference to sowing broadcast.

Question 9.—How is a silo filled?

Answer.—By a power-driven elevator of a similar pattern to that used on chaff or grain elevators, slats of timber being substituted for cups, or by blower—the latter being simply a fan blast-driven at a high rate of speed with delivery pipes of 6 in. and upwards led directly into the silo at the top. More power is required to a "blower" than an elevator. Whatever system is adopted for the purpose of conveying the chaffed green material from the chaff or silage cutter to the silo must make provision for its equal distribution. Where chaffed maize is indiscriminately fed into a silo, the tendency will be found for the heavier (stalk) portions to lodge in the centre, whilst the lighter (leafy) class of material accumulates around the walls.

Unless this is thoroughly incorporated with the heavier class of fodder in the subsequent fermentation which takes place, uneven settlement results. The centre, by reason of its greater solidity, does not settle to the same extent as the outside or lighter material; consequently a shrinkage from the walls occurs, admitting air, which, once fermentation has lessened, brings about a gradual decay of all the exposed surfaces of the silage.

To overcome this, all material fed into silos must be evenly incorporated and tramped tightly along the walls, and around all doors of internal chutes. To do this thoroughly necessitates the presence of a competent and reliable operative in the silo during entire filling operations. Note that all doors that come in contact with the silage must be rendered airtight. This can be effected by covering them with tarred brown paper.

Although the question was not asked by the correspondent, it is thought that a few points on emptying will not be amiss.

When emptying use a strong-toothed rake, and rake evenly from the top the amount of silage required for the daily ration. At all times avoid digging into the bulk of the silage. Remember that the more even and level the surface of the silage is left after each daily ration is obtained, the less decomposition and consequent waste will occur. If your silo has doors fitted to it, keep them closed; there is then less strain on the hinges and the doors (which are weighty) would fit more snugly when refilling, apart from which there will be no chance of rain destroying the silage, for nothing tends to bring about the decomposition of silage quicker than the admission of either air or water.

THE BLENDING OF CREAM.

The great importance of the operation of blending cream is evidently not well understood by many farmers, judging by the condition in which much cream reaches the butter factories. Lack of proper attention to this vital matter is often the cause of undesirable fermentations, which detact from the bright, aromatic flavour desired in choice cream, and results in the consignment being graded down.

The practice of holding the cream from each separation in a separate utensil encourages the development of faults like staleness and overripeness in the portions which are kept longest on the farm, and the mixing of these portions with the other separations just before despatching to the factory gives a bulk cream of inferior flavour. Adding the cream straight from the separator, without in any way reducing the animal heat, to a partly-filled can of cream from a previous separation is another practice which merits the severest condemnation.

The correct procedure to follow is to mix each batch with the bulk after the heat has been reduced, which usually takes about an hour, unless cooling devices are used, when the different portions can be mixed immediately. It is much easier to prevent off flavours from developing by keeping the cream in larger quantities than by retaining each separation in a separate container.

Some farmers consider that by keeping each separation apart the risk of getting second-grade cream is minimised, or, at any rate, that only part of the supply is likely to be graded low. However, modern methods have demonstrated very definitely that correct blending of cream, by ensuring an even souring, helps to achieve choice quality.

Stirring of the cream at regular intervals throughout the day may be regarded as an essential point in the correct blending of cream. It assists to obtain even ripening and even consistency. Finally, it should always be the rule to deliver to the factory as frequently as transport arrangements will permit, for the longer that cream is kept on the farm the more difficult control of ripening becomes.

THE prolonged dry weather is now causing serious concern to farmers and dairymen throughout the South Coast and Downs areas. Scattered storms occurred early in October, but few districts received over an inch, while subsequent storms produced only light falls. Pastures are now very dry. The diminishing water supply has also become a problem with many farmers. It is noteworthy that in spite of the conditions briefly outlined, the demand for good farm land persists.

Wheat.

Harvesting commenced during October under favourable conditions, ripening being hastened by the dry spring. Reports indicate that a large area has been utilised for grazing purposes owing to the shortage of natural feed, a factor that will considerably reduce the prospective yield. Some excellent crops have been harvested in the Evanslea, Bongeen, Oakey, and Pittsworth districts, illustrating the possibilities of modern cultural methods, even during unfavourable seasons. However, the average yield will be below the normal figure for the State, and many farmers will need to purchase their seed supplies for 1937 sowings.

The rise in wheat prices is an encouraging feature, recent sales having been effected by the State Wheat Board on a basis of 5s. 6d. per bushel f.o.r.

Peanuts.

At a recent meeting held at Wooroolin, Mr. C. F. Adermann, chairman of the Peanut Pool Board, stated that a surplus of Red Spanish peanuts from the 1935-36 crop was held at the silos, owing to the unusually heavy deliveries amounting to approximately 4,100 tons. Further plantings of this variety are therefore not desired at present, growers being advised to give preference to the Virginia Bunch. The Board received a total of 7,000 tons during the 1935-36 season, which, with outside railings, would indicate a total crop of approximately 9,000 tons. For the coming season it is estimated that 4,500 tons of Virginia Bunch will be required, which, at an average of ½ ton per acre, will necessitate over 9,000 acres being planted to ensure a safe crop.

Cotton.

The harvesting of the 1935-36 cotton has finally been completed with a total production of 19,187,634 lb. of seed cotton, or 13,504 bales of lint. The total, while lower than the 14,515 bales of last year, is very satisfactory, considering the adverse conditions the crops encountered, and is considerably greater than was anticipated at one period. Had the severe and unusual jassid attack not been experienced in the Callide Valley the total would undoubtedly have been considerably greater. Many crops gave promise of good crops at mid-season, but were so badly attacked by this pest during the extraordinary period of cloudy weather in March, that only a first picking was obtained.

Seed distribution for the coming crop still continues, the total to the 22nd October being sufficient to plant at least 52,000 acres, as compared to 58,300 acres at this time last season. The continued outstandingly dry conditions have undoubtedly influenced some growers to withhold their orders for planting seed, but following on the receipt of good rains it is anticipated an acreage equivalent to that of the previous season will be planted, as many farmers who have already ordered seed either have not grown cotton previously or have not grown it for many years.

Several light general storms have been experienced during the month, but in only a few fortunate localities has sufficient rain occurred to enable a strike to be obtained. Some dry plantings have been lost through just enough rain falling to start germination and spoil the seed. Ample time still exists, however, to obtain highly profitable yields, based on the results realised in previous seasons; so it is to be hoped that good soaking rains are experienced in the near future.

Sugar.

All mills report excellent progress in dealing with the 1936 crop, which is of record proportions in many cane areas. The crop is now at its peak of sugar content, which is rather abnormal. This is to be expected with heavy tonnage yields.

The prospects for 1937 are very good in the areas north of Townsville, though storm rains would be welcomed. In the areas south of Townsville acute drought conditions prevail; this is particularly the case in the southern areas, where the prolonged dry spell will definitely be reflected in the 1937 harvest. Any substantial prolongation of drought conditions will be serious.

General.

Local reserves of stored grain and fodder have become depleted, resulting in steadily increasing prices and increased importations from New South Wales. Some recent prices realised are as follows:—Lucerne hay, £10 per ton; oaten chaff, £6 10s.; Wheaten chaff, £6 5s.; mixed chaff, £8 1s.; pumpkins, £9 10s.; potatoes, £14; onions, £21 10s.; maize, 4s. 7d. per bushel.

The present seasonal conditions indicate the necessity for increased attention being devoted to fodder conservation on every farm every year, both for normal winter and spring feeding, and as provision for the inevitable dry spells. As good rains may be anticipated during November and December, successive plantings of crops, such as maize, sorghum, millet, and cowpea, can be made for green feed and silage purposes. Coastal climatic conditions do not always favour the making of good quality hay, but silage and maize grain should be held in reserve on every farm where suitable soils exist. Such action is preferable to purchasing supplies at the high prices indicated.

HARVESTING AND PACKING OF PEACHES AND NECTARINES.

IN comparison with other fruits, the marketing of stone fruits presents greater problems to growers in the placing on the market of a first grade article, and growers will obtain satisfactory results only by the exercise of great care. It must be remembered that, in order to ensure quick sales and prompt clearances from the market, it is necessary to present the fruit in its most attractive manner. Peaches left stored in the markets for even short periods stand a great risk of becoming affected with diseases such as Brown Rot. It is therefore necessary that fruit be allowed to ripen as much as possible before being harvested.

Maturity.

It must be remembered that stone fruits are different in their manner of ripening from other fruits. Whereas apples and pears can be harvested before they reach the fully ripe stage and yet attain perfection of quality and flavour, this is not the case with stone fruits such as peaches, apricots, and plums. In order to attain perfection these should be allowed to ripen on the trees. This, of course, would raise unsurmountable difficulties in the marketing of these fruits, so it is necessary to remove the fruit from the trees prior to the ripening stage. In this respect experience is the best teacher, and growers soon learn to ascertain the correct stage of maturity at which to pick the fruit. The fruit should be fully matured before harvesting, as is shown by a change in the coloured portions of the peach from dull to rich tints. If intended to be transported for long distances, fruit at this stage of development is ready to be removed from the tree. When it has to be transported for only short distances, however, it is advisable to allow the fruit to develop to a further stage until a tendency to softening at the point and bottom end of the lips is noticed. Peaches removed from the trees in this latter condition ripen almost perfectly. Fruit picked too green is always unsatisfactory, being unattractive in colour, deficient in flavour, and usually shrivelled in appearance when so-called ripe; as dessert fruit it is of poor quality, being only suitable for stewing.

Transit Troubles.

One of the greatest difficulties in the way of successful marketing is the fungus disease of Brown Rot (*Sclerotinia cinerea*). This disease attacks the fruit, generally during the ripening stage, both on the tree and during transport to the market. As any injury or break in the skin of the fruit will facilitate the attack of the disease, it can readily be seen that care in handling is very necessary.

Ordinary transit rots, of course, also play their part in causing loss in transit over long distances.

To assist in overcoming these troubles, in addition to adopting the usual methods of control in the plantations and packing-sheds, growers should use only new cases. Second-hand cases are often infected with the spores of these diseases, which will readily infect the fruit during transit to market.

Containers.

The most satisfactory case to use is the Dump Half-Bushel, 18 inches long by 7½ inches wide by 8⅝ inches deep. When properly packed, this case will carry the fruit in satisfactory condition over quite long distances.

A very satisfactory method of marketing peaches would be with the use of cartons. The cartons could be made with veneer wood or cardboard, and would contain a single layer of fruit. If made 9 inches long by 7 inches wide by 2¾ inches deep, an ordinary half-bushel box would hold six cartons. This method of marketing peaches has been tried with success in many parts of the world. It must be remembered, of course, that this type of package should be used only for high-class types of fruit.

Harvesting.

As previously mentioned, the fruit should be allowed to develop to a satisfactory degree of maturity before being removed from the trees. Baskets or specially made picking containers should be used for receiving the fruit from the trees. A satisfactory picking bucket can be made from a kerosene tin cut lengthways and fitted with a handle or with a strap to hang over the shoulder. The fruit should be carefully placed in the picking container, and the same care taken when transferring it to the orchard boxes. The boxes should be placed on the shady side of the trees in order to protect the fruit from heat and sun. The orchard boxes should be transported to the packing shed as soon as possible after being filled, and there stacked in a cool place with spaces left for cool air to flow between the boxes. When the fruit is cool, packing can be commenced. If these precautions, however, are not taken and the fruit is packed whilst it is still warm, it will sweat and tend to generate its own heat, which will cause premature ripening and a high humidity favourable to the growth of fungus diseases, thus greatly lessening the life and transportable distance of the fruit. This necessity for adequately cooling the fruit, before packing and during all handling and transporting, cannot be stressed too strongly.

Packing Shed.

The equipment of an up-to-date packing shed for handling peaches is not costly, most of the accessories for a well-equipped shed being easily made. These should consist of:—

Case-making bench (Plate 297);

Packing bench (Plate 294);

Packing stand and spring board (Plate 295);
Nailing-down rack (Plate 299);
Sizing gauge made of 3-ply (Plate 300);
Nail boxes;
Stencils and inking pad.

All of these necessities can be made by the handy man during wet or quiet periods. The total cost would not exceed £4 for materials.

The case-making bench should be solidly made with slots to hold the case ends in position while the side boards are being nailed on to them. The legs should be placed beneath the slots in order to make the structure as solid as possible when driving nails. The slots should be at least an inch deep and long enough to hold the case ends, and should be placed eighteen inches apart.

The packing bench should be 5 feet long by 3 feet wide, and tilted to have a height of 30 inches in front and from 34 to 36 inches at the back. Where a mechanical sizer is used, there would be no need for this bench to be built.

The packing stand is built to hold three half-bushel cases, measuring 21 inches in width and 18 inches from front to back, and is tilted so that it is 24 inches high in front and 28 inches at the back. A stand of this size will enable three different sizes of fruit to be packed at the same time.

A spring board for packers to stand upon whilst packing consists of three pieces of 6-inch flooring timber 2 feet long, joined across the ends by two pieces of 2 inches by 2 inches. The board rests upon the pieces of 2 inches by 2 inches, thus giving the packer a springy surface to stand upon whilst working, and assisting greatly in saving the operator's feet and back from getting tired.

The nailing-down rack is made of two pieces of 3 inches by 2 inches placed 16 inches apart and mounted on legs. The packed cases are placed across the rack so that the lengths of 3 inches by 2 inches rest underneath the ends. This will enable the bottom of the case to bulge slightly when the lid is applied to the packed case, thus assisting to keep the pack tight.

A piece of 3-ply 20 inches long by 6 inches wide in which are cut five circular holes 2 inches, $2\frac{1}{4}$ inches, $2\frac{1}{2}$ inches, $2\frac{3}{4}$ inches, and 3 inches in diameter, respectively, is an extremely useful accessory. The names of the packs for the respective sizes can be written alongside the holes.

Stencils can easily be cut from thin sheet zinc by using a heavy pocket knife or a hammer and chisel. It is useful to always keep a sheet of light-gauge zinc in the shed from which stencils may be cut at a moment's notice when required. No up-to-date grower need use pencil or crayon.

When laying out the shed, the equipment should be so placed that the work is permitted to run smoothly from one end of the shed to the other; that is to say, the fruit is received at the door at one end, then packed and the cases nailed up, and the completed cases despatched from the other end of the shed. A little thought given to the organisation of the shed in this way will save much time and labour. After all, harvesting and packing during the height of the season is usually more than a full-time job, so it is certainly worth while to reduce time and labour wherever possible.

Packing Material.

The use of sheets of corrugated cardboard for lining the cases is recommended, so that the packed fruit is protected on the top, sides, and bottom. The corrugated side of the cardboard should be placed to the wood of the box so that the fruit will rest against the smooth side; otherwise the fruit will become marked. The amount of cardboard required for each case is:—

2 sheets 18 inches long by 7 inches wide; and

2 sheets 18 inches long by 8 inches wide.

The cost per case would be approximately one penny. Where this method of lining is used, there will be no need to line the case with lining paper. However, if the cardboard is not used, the cases should be lined with a plain, white, or coloured paper. A layer of wood-wool on the top and bottom of the case is an added protection; the wood-wool is placed outside the lining paper. The procedure is, when packing, to place a layer of wood-wool on the bottom of the case and the lining paper placed on the wood-wool; the fruit is then packed, the lining paper folded over, and a layer of wood-wool placed on top of the paper before placing the lid in position. Care should be taken that the wood-wool does not come into contact with the fruit, as if it does, it will cause pressure marks. Pieces of lining paper 18 inches by 20 inches in size should be used, two pieces to each case.

Grading.

Grading the fruit for quality is always worth while. Modern marketing conditions show an outlet with the retail trade for two qualities. The high-class shops do not desire to buy a mixture of quality, as they have no demand for a second-quality article, and to foster this trade, which always commands the top prices, it is advisable to definitely keep the high-class fruit separate. This can be easily achieved by placing all poorly-coloured, blemished, and badly-shaped fruit on one side to be packed separately as a second-grade. The first-quality would be branded "Extra Fancy," and the second-quality "Fancy." These terms are now in general use in the fruit trade as trade designations.

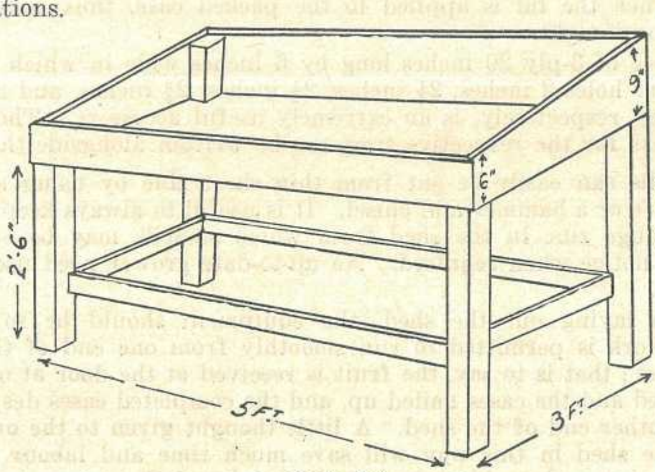


Plate 294.

FRUIT BENCH TO HOLD FRUIT WHILST PACKING.—Where there is no mechanical sizer this type of bench is very useful. Greatest efficiency is obtained when only one case at a time is tipped for packing. Please note that the bench is higher at the back than at the front, allowing the fruit to always be close at the packer's hand.

Wrapping.

It is always advisable to wrap peaches for long distance transit to market. The wrapping of peaches isolates each individual fruit from the possibility of disease infection from its neighbour, so that in the event of one fruit becoming affected the wrapping paper is a means of preventing infection to the fruit next to it. Wrapping also assists in making a better pack, as there is not the tendency for the layer of fruit to buckle and slip about as when fruit is packed unwrapped. When wrapping, the fruit should be placed in the wrapping paper and the ends of the paper folded under and on to the cheek of the fruit, forming a pad on which the fruit is placed, giving a very finished and neat appearance to the wrapped and packed layer. The dull side of the paper is always placed to the fruit, each fruit when wrapped having the shiny side of the paper to the outside.

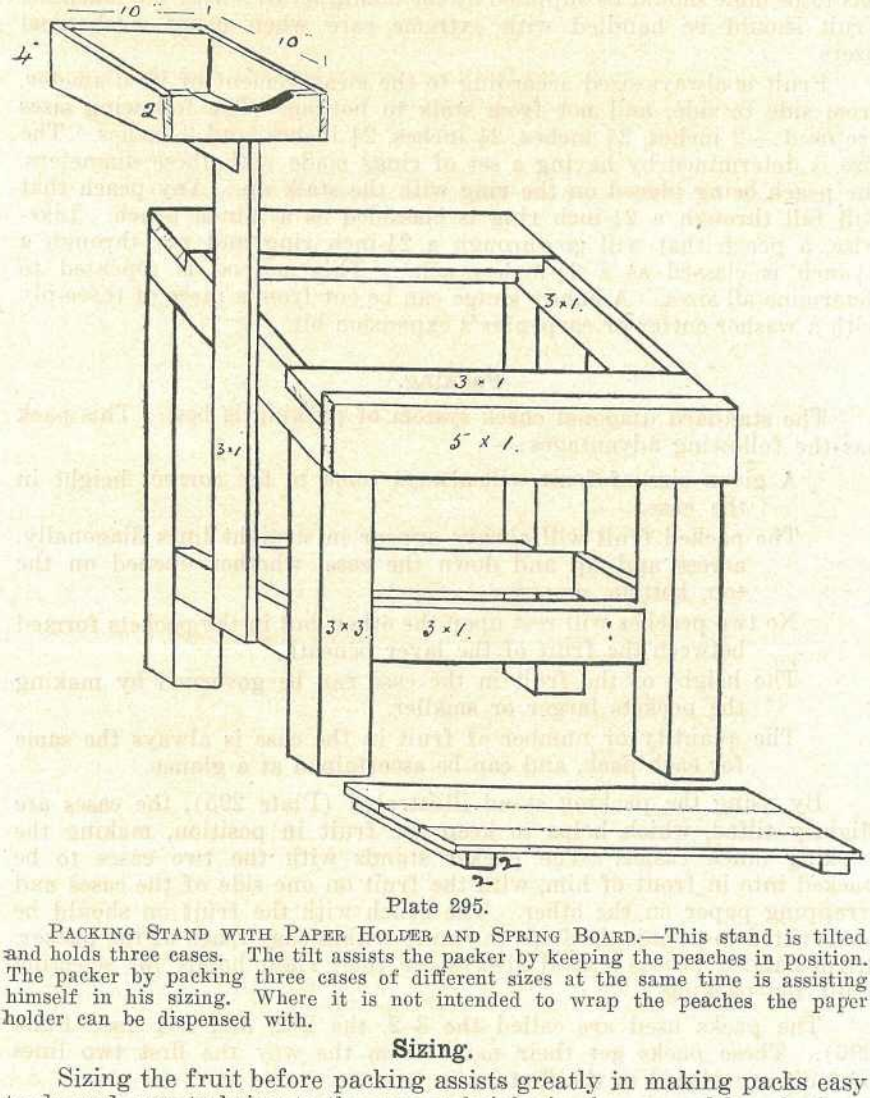


Plate 295.

Packing Stand with Paper Holder and Spring Board.—This stand is tilted and holds three cases. The tilt assists the packer by keeping the peaches in position. The packer by packing three cases of different sizes at the same time is assisting himself in his sizing. Where it is not intended to wrap the peaches the paper holder can be dispensed with.

Sizing.

Sizing the fruit before packing assists greatly in making packs easy to do and easy to bring to the correct height in the case, although there are packers who find no difficulty in packing unsized fruit by using a roomy bench (see Plate 294) to hold the fruit, tipping one case only on the bench at a time. The packer then packs two different sizes at the same time, and, while packing, sorts the remaining sizes into separate heaps on the bench. Growers who are fortunate enough to have a mechanical sizer will find the operation of packing made easier, provided care is taken to avoid the pitfalls associated with mechanical sizers. Firstly, it should be remembered that in practically all mechanical sizing machines two different counts of fruit can be packed from each bin. Packing is made very easy if this rule is observed. To enable this to be done, it is well to have packing stands of the type illustrated (Plate 295). Another point well worth remembering with the roller and belt type of sizing machine is to have the correct gear ratio between the carrying belt and the sizing roller. The gear wheels necessary for this to be done should be supplied by the manufacturer with the machine. Fruit should be handled with extreme care when using mechanical sizers.

Fruit is always sized according to the measurement of its diameter, from side to side, and not from stalk to bottom. The following sizes are used:—2 inches, $2\frac{1}{4}$ inches, $2\frac{1}{2}$ inches, $2\frac{3}{4}$ inches, and 3 inches. The size is determined by having a set of rings made with these diameters, the peach being placed on the ring with the stalk up. Any peach that will fall through a $2\frac{1}{4}$-inch ring is classified as a 2-inch peach. Likewise, a peach that will go through a $2\frac{1}{2}$-inch ring and not through a $2\frac{1}{4}$-inch is classed as a $2\frac{1}{4}$-inch peach. This method is repeated to determine all sizes. A handy gauge can be cut from a piece of three-ply with a washer-cutter or carpenter's expansion bit.

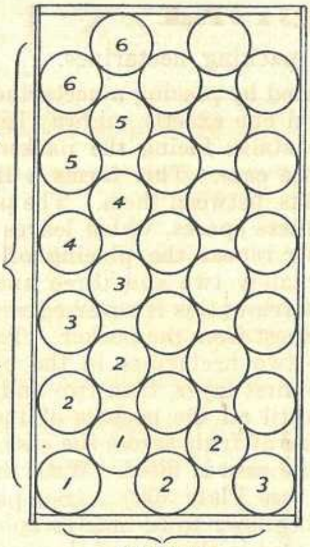
Packing.

The standard diagonal cheek system of packing is best. This pack has the following advantages:—

- A given size of fruit will always come to the correct height in the case.
- The packed fruit will always appear in straight lines diagonally, across and up and down the case, whether opened on the top, bottom, or sides.
- No two peaches will rest upon the other, but in the pockets formed between the fruit of the layer beneath.
- The height of the fruit in the case can be governed by making the pockets larger or smaller.
- The quantity or number of fruit in the case is always the same for each pack, and can be ascertained at a glance.

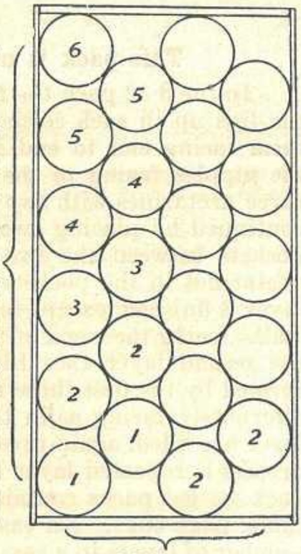
By using the packing stand illustrated (Plate 295), the cases are slightly tilted, which helps to keep the fruit in position, making the packing much easier. The packer stands with the two cases to be packed into in front of him, with the fruit on one side of the cases and wrapping paper on the other. The bench with the fruit on should be made tilted to permit the fruit to run to within easy reach of the packer. Right-handed people should always use their right hands for selecting fruit for packing.

The packs used are called the 3–2, the 2–2, and 2–1 (see Plate 296). These packs get their name from the way the first two lines of fruit are placed in the first layer.



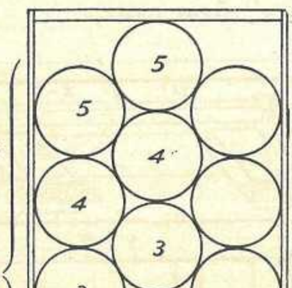
3-2 PACK.

The Pack gets its name from the way the first five fruit are placed in the layer. The Count is made of the first two lines of fruit across the case.



2-2 PACK.

The Pack gets its name from the way the first four fruit are placed in the layer. The Count is made of the first two lines of fruit across the case.



2-1 PACK.

The Pack gets its name from the way the first three fruit are placed in the layer. The Count is made of the first two lines of fruit across the case.

Plate 296.

How to read and use the packing table. Explanation of the name of the packs.

3 x 2 Pack.

This pack is used mostly for packing nectarines.

In the 3 - 2 pack the first layer is started by placing a nectarine with the lips up in each corner of the case and one exactly midway between them facing end to end in the case, the stalks facing the packer, and the nipples facing to the other end of the case. This forms a line of three nectarines with two spaces, or pockets, between them. The pack is continued by placing two nectarines in these spaces, which leaves three pockets between the two nectarines. We repeat the placing of three nectarines in the pockets and then alternately two and three until the layer is finished, except for the last line of fruit; this is reversed with the stalks facing the wood of the case end furthest from the packer. To start the second layer (see Plate 309), place two nectarines in the pockets formed by the first three nectarines of the first layer, then two and three alternately facing as in the first layer, until all the pockets of the first layer are filled, again reversing the last line of fruit across the case. This process is repeated layer by layer until the case is filled. With the 3–2 pack we get packs containing six layers (see Plate 309). (See packing table, page 684). An easy way for the beginner to be able to know the number of layers in a case is to remember that in the case of the 3 - 2 pack the first, third, and fifth layers will start with three at the end nearest the packer, and the second, fourth, and sixth layers start with two at the end of the layer. The reason for the need of knowing this is explained in the paragraph on bringing the pack to the correct height in the case. Very few varieties of peaches are small enough to be packed with the 3 - 2 pack, but many nectarines have to be packed 3 - 2.

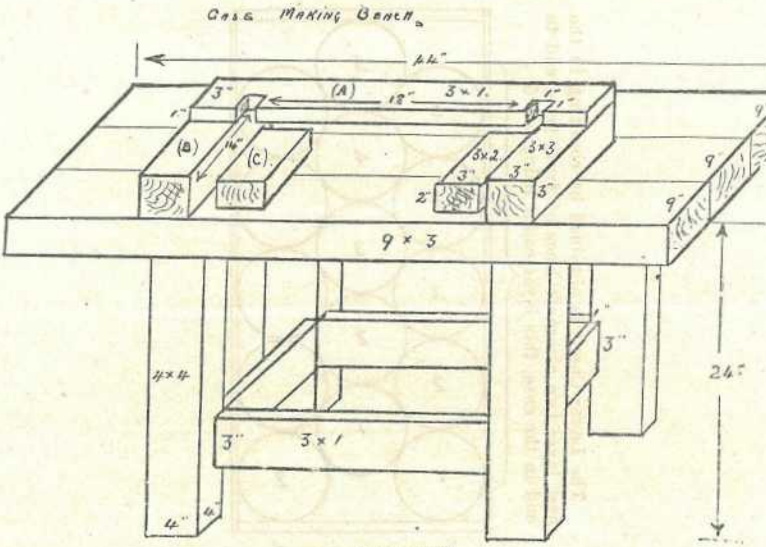


Plate 297.

CASEMAKING BENCH.—For making Australian Dump, Canadian Standard, Bushel and Half-Bushel Cases, and other Fruit Cases, 18 inches in length, inside dimensions.

Specifications.

Length ..	44 inches	Timber.—	Legs	4″ x 4″
Height ..	24 inches from floor		Stops—Outside	3″ x 3″ (B)
Width ..	27 inches		Inside ..	3″ x 2″ (C)
			Back ..	3″ x 1″ (A)
			Top	9″ x 3″
			Stays	3″ x 1″

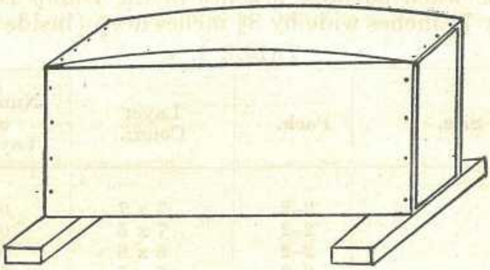


Plate 298.

NAILING-DOWN ON BATTENS.—Where a grower does not have a nailing-down bench, two pieces of 3 x 2 placed under the ends whilst nailing make a good substitute.

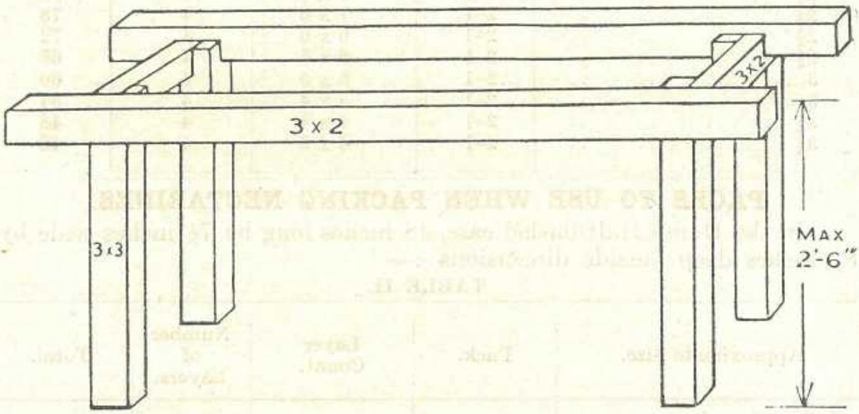


Plate 299.

NAILING-DOWN BENCH.—This enables the bottom of the case to bulge slightly with the pressure of the fruit. This keeps the pack tight in transit preventing the fruit from rubbing or becoming damaged.

2 x 2 Pack.

This pack is started by placing a peach with the lips up in the bottom left-hand corner of the case, and midway between the peach and the right side of the box a second peach, leaving two pockets between the two, in which the next two peaches are placed, forming the two-two from which the pack derives its name (Plates 296 and 301.) This is then repeated, the peaches being placed facing the same way until the layer is finished with all but the last line of fruit. This is reversed, with the stalks facing the wood of the case end furthest from the packer. The second layer is started by placing two peaches with the lips down on the pockets formed by the first two of the first layer (see Plate 307), the layer being finally finished by placing peaches on all the pockets of the first layer and reversing the last line of fruit as in the first layer. By repeating this layer by layer the case is finished. It will be noticed by referring to the table that the 2 - 2 packs contain five layers. If close attention to the rule of starting the first layer in the left-hand corner is observed, the number of layers in the case can be easily counted, the first, third, and fifth layers starting in the left-hand corner, and the second and fourth starting in the right-hand corner.

Packs to use when packing peaches in the Dump Half-bushel case, 18 inches long by 7⅛ inches wide by 8⅔ inches deep (inside dimensions) :—

TABLE I.

Approximate Size.	Pack.	Layer Count.	Number of Layers.	Total.
Inches.				
2	2–2	7 x 7	6	168
2	2–2	7 x 6	6	156
2	2–2	6 x 6	6	144
2	2–2	7 x 7	5	140
2⅛	2–2	7 x 6	5	130
2⅛	2–2	6 x 6	5	120
2¼	2–2	6 x 5	5	110
2½	2–2	5 x 5	5	100
2½	2–2	5 x 4	5	90
2½	2–1	7 x 7	4	84
2¾	2–1	7 x 6	4	78
2¾	2–1	6 x 6	4	72
2¾	2–1	6 x 5	4	66
3	2–1	5 x 5	4	60
3	2–1	5 x 4	4	54
3¼	2–1	4 x 4	4	48
3¼	2–1	4 x 3	4	42

PACKS TO USE WHEN PACKING NECTARINES.

In the Dump Half-bushel case, 18 inches long by 7⅛ inches wide by 8⅔ inches deep (inside dimensions) :—

TABLE II.

Approximate Size.	Pack.	Layer Count.	Number of Layers.	Total.
Inches.				
1¾	3–2	8 x 8	6	240
1¾	3–2	8 x 7	6	225
1¾	3–2	7 x 7	6	210
1¾	3–2	7 x 6	6	195
2	3–2	6 x 6	6	180
2	3–2	6 x 5	6	165
2	2–2	7 x 7	6	168
2	2–2	7 x 6	6	156
2	2–2	6 x 6	6	144

Larger nectarines can be packed by using the counts as for peaches.

PACKING PEACHES IN TRAYS FOR EXPORT.

Inside dimensions of tray—18 inches long by 14¼ inches wide by 3 inches deep.

TABLE III.

Approximate Size.	Pack.	Layer Count.	Number of Layers.	Total.
Inches.				
2½	5–4	4 x 4	1	36
2½	5–4	4 x 3	1	32
2¾	4–4	4 x 3	1	28
2¾	4–4	3 x 3	1	24
*3	4–3	3 x 3	1	21
*3	3–3	3 x 3	1	18

* These sizes are packed on the flat side of the fruit so that no pressure will take place when the trays are placed together.

2-1 Pack.

This pack is started by placing two peaches, lips up, one in each corner of the case. This leaves a pocket in which the next peach is placed, forming the 2–1 from which the pack gets its name. The layer is then finished by placing the fruit in lines of two and one until filled. The second layer is started by placing one peach in the first pocket of the first layer (Plate 307) with the lips down. The second layer is finished by placing two and one alternately in the pockets of the first layer until it is finished. The same system of placing in the pockets of the previous layer is adopted for the other layers until the case is filled. 2–1 packs have four layers to the completed case.

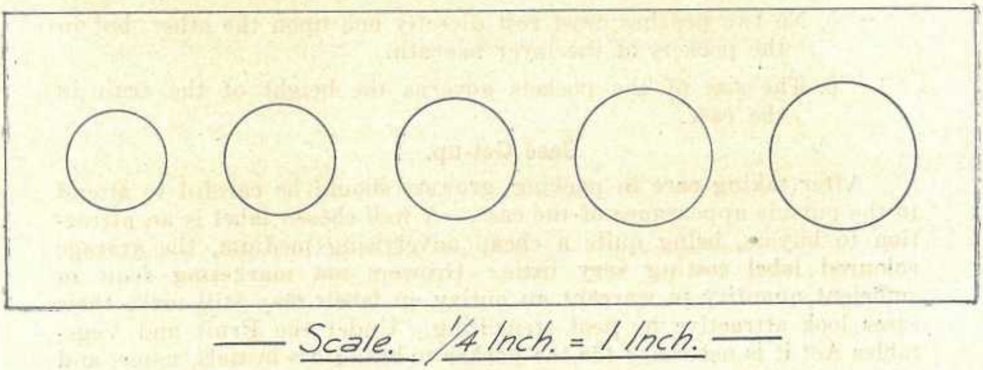


Plate 300.

GAUGE FOR MEASURING FRUIT.—Holes are cut in a piece of three-ply 2, 2¼, 2½, 2¾, and 3 inches in diameter.

Bringing the Pack to the Correct Height in the Case.

Peaches should be packed ½ inch to 1 inch above the top of the case, and be gently eased into position before applying the lid. After nailing, both the lid and bottom of the case should show a slight bulge. Care should be taken that the bottom of the case, while nailing, is kept clear of the floor or nailing-down stand. This, if a nailing-down rack is not used, can be done by placing a block under one end of the case while easing the fruit into position and nailing.

Knowing the number of layers in a case at any stage of packing is a good guide to a packer. By calculating the height the fruit will come to in the case two or three layers before the top is reached, the packer, by applying the rule, "The size of the pockets governs the height of the fruit in the case," can bring the fruit either higher or lower, as necessary. This is done by making the pockets smaller by slightly increasing the size of the fruit, and bringing the fruit higher in the box to correct a pack which will come too low, or, in the case of a pack that is coming high, to open the pockets by reducing slightly the size of the fruit. Usually these faults are caused by a variation in sizing the fruit in the subsequent layers after placing the first layer in position. Cases not of the correct width are often the cause of trouble in bringing fruit to the correct height, but by following the rule governing the size of the pockets this difficulty may be overcome. It should be remembered that it is an offence against the Fruit and Vegetables Act to market fruit in undersized cases.

Packers observing the following rules should have no difficulty in obtaining good results with their packing:—

1. All fruit should be placed with the lips in the pockets and facing end to end in the case.
2. In the first layer the lips are placed facing up, whilst in the second and subsequent layers the lips face downwards.
3. Reverse the last last two or three peaches, as the case may be, in each layer.
4. See that all fruit appears in straight lines from end to end in the case, across and diagonally.
5. No two peaches must rest directly one upon the other, but in the pockets of the layer beneath.
6. The size of the pockets governs the height of the fruit in the case.

Case Get-up.

After taking care in packing, growers should be careful to attend to the outside appearance of the case. A well-chosen label is an attraction to buyers, being quite a cheap advertising medium, the average coloured label costing very little. Growers not marketing fruit in sufficient quantity to warrant an outlay on labels may still make their cases look attractive by neat stencilling. Under the Fruit and Vegetables Act it is necessary for the packer to brand his initials, name, and address legibly and durably within a space measuring not less than 5 inches long by 2 inches wide. The name of the variety of fruit and the size or count should also be branded in letters of not less than ½ inch in length. Pencil or crayon markings on the ends of cases are unsightly, and not to be recommended.

Wiring.

A machine for this purpose is obtainable commercially. Wiring is recommended in all cases. Many country-order buyers pay extra to obtain cases wired, as it saves them time and money when they can procure the cases ready wired for long-distance transport. Two wires should be used being placed around the ends of the case just inside the inside edge. A single wire around the middle of the case is not recommended, as when it is tightened around the bulge of the top and bottom it will cause damage to the fruit through pressure.

Transport.

As the whole basis of successful marketing is care, growers should follow this principle right to the finish of their share of the handling. Remember, good packing, fancy labels, wiring, or stencilling will not sell bad fruit. All the care taken in putting up a first-grade, attractive package will be of no avail if growers, while carting the fruit to the station and loading into the trucks, do not handle it carefully. Too often we see carters sitting in the middle of packed cases of fruit while on the road. Keeping the fruit covered and protected from the hot sun when on lorries and in railway trucks is necessary. Coolness at all stages is essential. Even good packing will not stand abuse, so in closing I would urge every grower to handle his fruit from the tree to the rail or market as carefully as he would handle a basket of eggs.

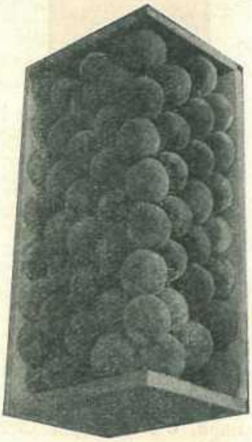
HOW TO PACK THE DUMP HALF-BUSHEL CASE.

2-2 Pack.

First Layer.

2-2 Pack, 7 x 7 Layer Count.
5 Layers. 140 Count.

Finished Case.
Side Top

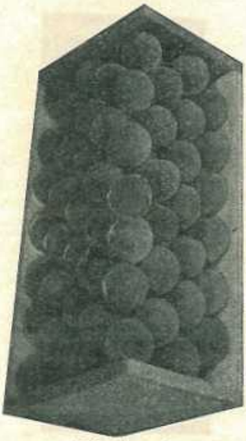


140 Count.

First Layer.

2-2 Pack, 7 x 6 Layer Count.
5 Layers. 130 Count.

Finished Case.
Side Top



130 Count.

Observe the alignment of the fruit, from end to end, across, and diagonally in the case.

Plate 301.

PACKING THE DUMP HALF-BUSHEL CASE.

2-2 Pack.

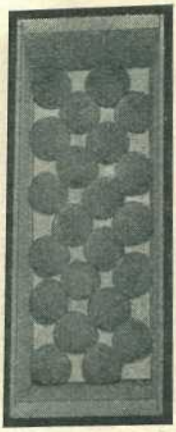
First Layer.

2-2 Pack, 6 x 6 Layer Count.
5 Layers. 120 Count.

Finished Case.
Top Side

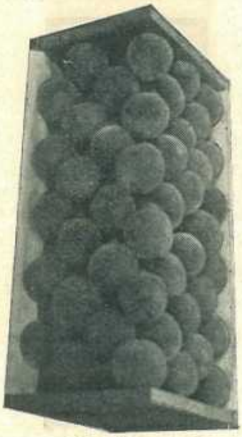
120 Count.

First Layer.



2-2 Pack, 6 x 5 Layer Count.
5 Layers. 110 Count.

Finished Case.
Top Side



110 Count.

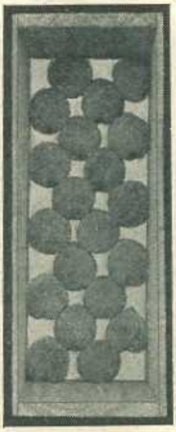
Observe the alignment of the fruit.

Plate 302.

PACKING THE DUMP HALF-BUSHEL CASE.

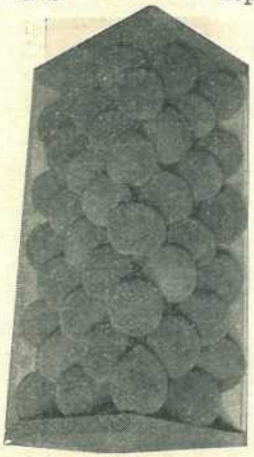
2-2 Pack.

First Layer.



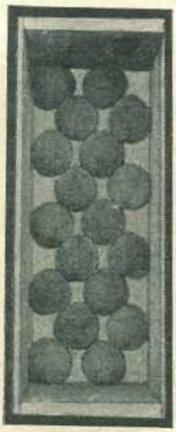
2-2 Pack, 5 x 5 Layer Count.
5 Layers. 100 Count.

Finished Case.
Side Top



100 Count.

First Layer.



2-2 Pack, 5 x 4 Layer Count.
5 Layers. 90 Count.

Finished Case.
Side Top

90 Count.

Observe the alignment of the fruit.

Plate 303.

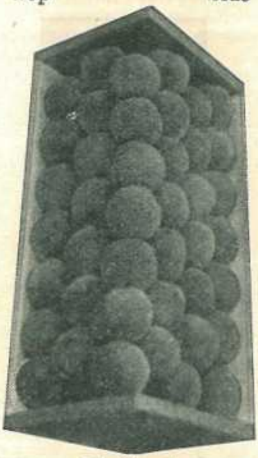
HOW TO PACK THE DUMP HALF-BUSHEL CASE.

2-1 Pack.

First Layer.

2-1 Pack, 7 x 7 Layer Count.
4 Layers. 84 Count.

Finished Case.
Top Side

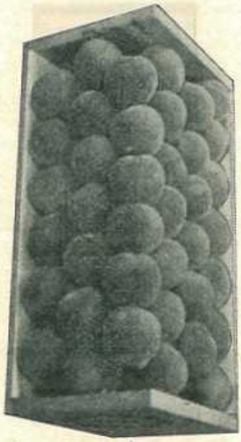


84 Count.

First Layer.

2-1 Pack, 7 x 6 Layer Count.
4 Layers. 78 Count.

Finished Case.
Top Side



78 Count.

Observe the alignment of the fruit, from end to end, across, and diagonally in the case.

Plate 304.

How to Pack the Dump Half-bushel Case.

2-1 Pack.

First Layer.

2-1 Pack, 6 x 6 Layer Count.
4 Layers. 72 Count.

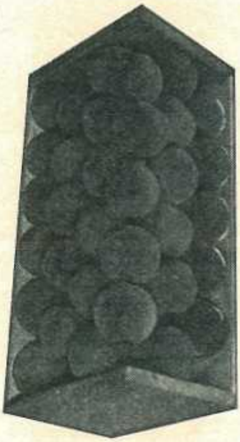
Finished Case.

72 Count.

First Layer.

2-1 Pack, 6 x 5 Layer Count.
4 Layers. 66 Count.

Finished Case.



66 Count.

Observe the alignment of the fruit, from end to end, across, and diagonally in the case.

Plate 305.

PACKING THE DUMP HALF-BUSHEL CASE.

First Layers, 2-1 Pack.

2-1 Pack, 5 x 5 Layer Count.
4 Layers. 60 Count.

2-1 Pack, 5 x 4 Layer Count
4 Layers. 54 Count.

2-1 Pack, 4 x 4 Layer Count.
4 Layers. 48 Count.

Plate 306.

How to Start the Second Layer of the Diagonal Check Pack.

2-2 Pack.

2-1 Pack.

Plate 307.

Packing Peaches for Export in Trays.

18 inches long x $14\frac{1}{4}$ inches wide x 3 inches deep.

5-4 Pack. Single Layer.
36 Peaches.

5-4 Pack. Single Layer.
32 Peaches.

4-4 Pack. Single Layer.
24 Peaches.

A pack containing 28 peaches can also be done with slightly smaller fruit.

**4-3 Pack. Single Layer.
21 Peaches.**

Note how the fruit is wrapped in sulphite wrappers and "nested" in pads of woodwool.

Plate 308.

3-3 Pack. Single Layer.
18 Pack.

Tray finished off by placing a layer of woodwool on the top of the packed case.

How to Pack the Dump Half-Bushel Case—3-2.

NECTARINES PACKED 3-2.

3-2 Pack—6 Layers.
7 x 6 Layer Count.
195 Count.

Finished Case.
195 Count.

Plate 309.

Acknowledgment.

Thanks are due to Mr. S. Smith, of Glen Aplin, for permitting the use of his fruit for packing and photographing the packed cases and trays illustrated.

FRUIT MARKETING NOTES.

JAS. H. GREGORY, Instructor in Fruit Culture.

AGAIN, unfortunately, we have to comment on the continued dry weather. The quality of fruit has fallen off, causing big discrepancies in prices, as with tomatoes, for instance, for which prices are ranging from 1s. 6d. to 10s. Prices on the various markets during the last week of October were:—

TROPICAL FRUIT SECTION.

Papaws.

Brisbane: Locals, 2s. 6d. to 4s. a bushel; Yarwun, 6s. 6d. to 8s. 6d. a tropical fruit case.

Melbourne: 9s. to 12s. per tropical case; special coloured higher.

Sydney: 6s. to 12s. per tropical case.

Only solid partly coloured fruit should be sent to southern markets.

I heard of a grower who has been picking his fruit green and leaving it in the heat, covered with bags, to push forward the ripening. This will only ruin the quality of the fruit so far as flavour, texture, and keeping are concerned. If difficulty is found in handling the crop, at least, keep the fruit cool if it is necessary to harvest fruit early.

Granadillas.

Few specimens of this fruit are being seen. The hot, dry weather renders it necessary to exercise extreme care when sending from the far north.

Mangoes.

These are coming on the market in increasing quantities. Prices have eased a 1s. per case. There is still room for a big improvement in harvesting and packing methods, in most cases no effort is made to protect the fruit. Growers considering sending mangoes to southern markets must remember that buyers there do not want the common type of fruit. Fruit removed from the trees with sticks, causing bruises is not popular. Prices will quickly decline if growers continue to send along green fruit.

Brisbane Prices: 6s. to 8s. a bushel.

Pineapples.

There is a great demand for good pines as supplies to market have been short.

Prices—

Brisbane Smooths: 7s. to 11s. 6d. per case; 2s. to 8s. per dozen. Ripleys, 10s. to 14s. per case; loose 3s. to 8s. per dozen.

Melbourne: 12s. to 16s. per case.

Sydney: 8s. to 12s. per case.

Selecting fruit a little less advanced in maturity than for the last few months when sending south is now necessary. Be sure to cool all fruit before packing. Woodwool instead of grass is more than ever necessary as a packing material.

Bananas.

The dry weather is affecting quality. Prices:—

Cavendish—

Brisbane: Nines and Eights 8s. to 12s. 6d. per case; Sevens 4s. 3d. to 11s. per case; Sixes 4s. 6d. to 9s. 6d. per case, 1¾d. to 6d. per dozen; Lady Fingers 2¾d. to 5¾d. per dozen.

Melbourne: Eights and Nines 14s. to 15s.; Sevens 12s. to 13s.; Sixes 10s. to 11s., a few lines higher.

Sydney: Nines and Eights 16s. to 19s.; Sevens 14s. to 16s.; Sixes 12s. to 14s.

Growers are recommended to take as many precautions as possible to keep the fruit covered and free from sunburn or bleaching. Cool thoroughly before packing, and now the hot weather has arrived tear the side papers to allow the fullest benefits from air circulation.

Passion Fruit.

High values are ruling on all markets up to 20s. per half bushel on the southern markets, and 18s. in Brisbane being realised during the month.

Brisbane: 6s. to 18s. per half bushel.

Sydney: 8s. to 20s. per half bushel.

Melbourne: 12s. to 18s. per half bushel.

Owing to the dry spell causing bad setting and dropping these prices should be maintained for some considerable period.

CITRUS FRUITS.

Oranges.

Queensland growers have now practically finished marketing this season's crop of oranges. Supplies are now coming in from New South Wales.

Prices, Small, 4s. to 6s., Choice, 7s. to 8s.

Lemons.

Lemons are not selling as freely as the weather would indicate. One is reluctantly compelled to conclude that the increase in Malted Milk consumption is having an effect on the sales output. Only cured lemons are wanted on the market. Local, 4s. to 8s. per bushel; Gayndah, 9s. to 11s. 6d.

Tomatoes.

Supplies of good lines are short. A wide discrepancy in the prices gives a good indication of actual market conditions and the struggle on the part of some growers to obtain a return for their labours.

Brisbane: Ripe, 1s. 6d. to 4s.; Coloured, 4s. to 9s.; Green, 3s. to 6s.

There is still, by far, too much green fruit coming on to the market.

Melbourne: Large supplies of Adelaide and West Australian fruit have dropped prices. Green, 6s. to 8s., repacked to 10s.

Sydney: Queensland fruit, 4s. to 9s.

Brisbane is well worthy of consideration as the best market at present as prices for good fruit compare more than favourably with other markets and the risk of damage, to any extent, in transit is not run.

Stone Fruits.

Cherries have made their appearance on the market and are selling at good prices, up to 16s. per case being realised for Stanthorpe and New England fruit. When packing these and other stone fruit every care must be taken to guard against Brown Rot infection. Cool the fruit in a clean place and use only new cases is sound advice.

Apples.

Southern apples are selling well on the Brisbane market:—Victorian Jon., 2½-2¾, 11s. to 12s.; Rokewoods, 7s. to 10s.; G. Smith, 12s. to 15s.; Democrat, 10s. to 12s.; Yates, 8s. to 12s. for 2½.

Southern growers would do well to discontinue the sending of Jonathans over 2½ inches to Queensland. Rome Beauty are also now a very risky variety to send. Many lines of fruit would arrive in better condition if corrugated cardboard liners were used on top, bottom, and sides of the cases.

Cucumbers.

Brisbane, 6s. to 9s. Sydney, 6s. to 10s. Melbourne, 12s. to 16s. a bushel.

Lettuce.

Five pence to 1s. 6d. per dozen. Greater use could be made of boxes for marketing.

Beans.

Brisbane, 10s. to 16s. per sugar bag. Sydney, 9s. to 11s. a bushel case.

There is a good demand in Brisbane for all green vegetables.

FRUIT TRAIN CHANGES.

The Committee of Direction of Fruit Marketing has announced that the fruit trains will commence running on 23rd November, both on the main line and the Amiens line, and the first Sunday train will commence on 29th November on both lines. Fast fruit trains will run each Tuesday from Roma Street to North Queensland until 29th December. Commencing in the New Year the Tuesday fast train to the North will be cancelled, and in place of it two fast trains weekly will leave Roma Street for Northern centres each Monday and Wednesday, commencing on 4th January. The Amiens branch line will have four trains a week.

The general manager of the Queensland Railways intends to use only CLF and Jumbo CLF wagons on the Northern fast fruit trains, which will start from Roma Street and will not be sent to the Granite Belt.

PRODUCTION RECORDING.

List of cows and heifers officially tested by officers of the Department of Agriculture and Stock which have qualified for entry into the Advance Register of the Herd Books of the Australian Illawarra Shorthorn Society and the Jersey Cattle Society, production charts for which were compiled during the month of September, 1936 (273 days unless otherwise stated).

Name of Cow.	Owner.	Milk Production.	Butter Fat.	Sire.
		Lb.	Lb.	
AUSTRALIAN ILLAWARRA SHORTHORN.				
MATURE COW (OVER 5 YEARS), STANDARD 350 LB.				
Springleigh Primrose	Moller Bros., Springleigh, Boonah	13,767·5	647·641	Kelston Warrior
JERSEY.				
MATURE COW (OVER 5 YEARS), STANDARD 350 LB.				
Kelvinside Roseleaf	P.J. McCantey, Neurum	6,032·95	370·057	Benedictine's Perfection of Kelvinside
SENIOR, 3 YEARS (OVER 3½ YEARS), STANDARD 290 LB.				
Kensington Fairy Queen	Miss. J. Nolan, Lindum	6,937·79	357·451	Trinity Recompense
JUNIOR, 2 YEARS (UNDER 2½ YEARS), STANDARD 230 LB.				
Blossom of Hillsdale	F. W. Hohman, Gowrie Junction	5,438·6	259·048	K.C. of Rosedale

Answers to Correspondents

BOTANY.

Replies selected from the outgoing mail of the Government Botanist, Mr. C. T. White, F.L.S.

Berrigan.

A. M. H. (Chinchilla)—

The specimen represents *Eremophila longifolia*, the Berrigan, quite a handsome shrub or small tree fairly widely distributed in New South Wales and Queensland. It is not known to possess any poisonous or harmful properties, and is generally looked upon as a useful fodder.

A Dangerous Plant—*Cestrum Parqui.*

INQUIRER (Booval).

The specimens you send from a paddock in Booval have been determined as from *Cestrum Parqui.* This plant is poisonous to stock. According to Steyn in "The Toxicology of Plants in South Africa," the leaves contain a toxic alkaloid parquin, which has a bitter taste. Steyn further states that the actions of parquin are similar to those of strychnine and atriphine, and that the course of the disease is rapid, with the result that treatment is impossible. Cases of apparent poisoning by this plant have been recorded in which the cows were normal at the night milking and were dead next morning.

Plants from the South-West Identified.

W. D. (Goondiwindi)—

The specimens have been determined as follows:—

(1) *Agropyron scabrum*, wheat grass.
(2) *Thellungia advenaa*, coolibah grass.
(3) *Thellungia advena.*
(4) No seed heads.
(5) *Daucus brachiatus*, native carrot.
(6) *Panicum prolutum*, coolah grass.
(7) *Dichanthium sericeum*, blue grass.
(8) *Astrebla lappacea*, curly mitchell grass.
(9) *Geranium dissectum*, wild geranium.
(10) *Eragrostis setifolia*, a love grass.
(11) *Oxalis corniculata*, sorrel.

Daucus brachiatus (5), is the true native carrot as it belongs to the same genus, Daucus, as the cultivated carrot. The name native carrot or wild carrot is applied to a number of weeds with finely divided leaves in Queensland.

Geranium dissectum (9), the wild geranium, is often called wild carrot. It possesses a large fleshy root much relished by sheep.

Eragrostis setifolia (10), love grass, is also called "never fail," a name, however, applied to several grasses in Queensland.

Oxalis corniculata (11), sorrel, is sometimes confused, particularly in its young stages with the trefoils. It possesses a very acidulous flavour, and we do not think it is of much value as a fodder.

Periwinkle.

H. P. L. (Toowoomba)—

The plant forwarded is *Vinca major*, the periwinkle. The name periwinkle is more often applied to this than it is to the pink or white variety that was mentioned in this Journal, namely *Vinca rosea*. *Vinca major*, as far as known, does not possess any of the properties of the other species. It—the blue species—is common in cooler climates, the pink in warm.

General Notes

Staff Changes and Appointments.

Mr. C. R. Mulhearn, B.V.Sc., Government Veterinary Surgeon, Department of Agriculture and Stock, has been appointed Acting Director, Animal Health Station, Townsville.

Mr. E. C. Olive, Dairy Instructor, has been transferred from Maryborough to Toowoomba, and Mr. C. L. Moran, Dairy Instructor, from Toowoomba to Maryborough.

Constables C. H. Coop, R. W. G. Lake, and L. McErlean, of Jondaryan, Gilliat, and Goodna, have been appointed also Inspectors under the Slaughtering Act.

Mr. R. W. Mungomery, Assistant Entomologist, Bureau of Sugar Experiment Stations, has been appointed Entomologist, Bureau of Sugar Experiment Stations, Department of Agriculture and Stock.

The following transfers of inspectors under the Stock, Dairy, and Slaughtering Acts, Department of Agriculture and Stock, have been approved:—Messrs. J. T. Smallhorn, from Miles to Coolangatta; H. B. Ford, from Ravensbourne to Miles; T. K. Kelly, from Toowoomba to Ravensbourne; J. W. Moy, from Brisbane to Toowoomba; C. C. Sewell, from Willowburn to Ayr; A. Dick, from Ayr to Willowburn.

Mr. T. Mee, Court House, Ayr, has been appointed Chairman of the Inkerman, Invicta, Kalamia, and Pioneer Local Sugar Cane Prices Board, vice Mr. A. M. Taylor, transferred.

Mr. D. J. Kearney, Mining Registrar, Cloncurry, has been appointed also an Acting Stock Inspector.

Messrs. H. G. Selby, J. H. Edgerton, O. Denaro, C. Oliveri, J R. Gill, P. Riordan, L Ballini, jun., and E. Beccaris, of Mourilyan, have been appointed Honorary Rangers under the Animals and Birds Acts

Mr. R. H. Allen, Innisfail, has been appointed Chairman of the Goondi, Mourilyan, South Johnstone, and Tully Local Sugar Cane Prices Boards, vice Mr. W. Rillie, transferred.

Constable T. W. O'Brien, Millaa Millaa, has been appointed also an Inspector under the Slaughtering Act.

Bureau of Sugar Experiment Stations Advisory Board.

Regulations have been issued under the Sugar Experiment Stations Acts fixing the remuneration payable to members of the Sugar Experiment Stations Advisory Board, other than the two Government representatives, at £8 6s. 8d. per month, and providing for the appointment of a successor when the office of a member of such Board becomes vacant.

Mr. N. H. Wellard (Mossman), representative of sugar-cane growers, has been appointed a member of the Sugar Experiment Stations Advisory Board, vice Mr. W. D. Davies, resigned.

Canary Seed Hail Insurance.

A regulation has been issued under the Primary Producers' Organisation and Marketing Acts providing that the Canary Seed Board Hail Insurance Regulations shall have no force or effect in respect of canary seed planted during the year 1936.

Plywood and Veneer Board.

Regulations have been issued under the Primary Producers' Organisation and Marketing Acts increasing the levy for the administrative expenses of the Plywood and Veneer Board from 2½d. to 3d. per hundred feet face measurement of plywood and veneer delivered between the 17th October, 1936, and the 2nd May, 1939.

Provisional Maize Board.

An Order in Council has been passed under the Primary Producers' Organisation and Marketing Acts further extending the term of the Provisional Maize Board for twelve months. The present term expired on the 14th October.

Rural Topics

The Living Future.

And she said: "I have heard it said that it was our duty to sacrifice ourselves for the men and women living in the world at the same time as ourselves; but I never before heard that we had to sacrifice ourselves for people that are not born. What are they to you? You will be dust, and lying in your grave, before that time comes." "If you believe in God," she said, "why cannot you leave it to Him to bring good out of all this evil? Does He need you to be made a martyr of? or will the world be lost without you?"

He said: "Wife, if my right hand be in a fire, shall I not pull it out? Shall I say, 'God may bring good out of this evil,' and let it burn? That Unknown that lies beyond us we know of no otherwise than through its manifestation in our hearts; it works no otherwise upon the sons of men than through man. And shall I feel no bond binding me to the men to come, and desire no good of beauty for them—I, who am what I am, and enjoy what I enjoy, because for countless ages in the past men have lived and laboured, who lived not for themselves alone, and counted no costs? Would the great statue, the great poem, the great reform ever be accomplished if men counted the cost, and created for their own lives alone? And no man liveth to himself, and no man dieth to himself. You cannot tell me not to love the men who shall be after me; a soft voice within me—I know not what—cries out ever, 'Live for them, as for your own children.' When in the circle of my own small life all is dark and I despair, hope springs up in me when I remember that something nobler and fairer may spring up in the spot where I now stand."—Schreiner, Olive, the South African novelist, in "Trooper Peter Halket of Mashonaland" (Boston, 1897), pp. 63-4.

Rural and Urban Philosophies.

Deeper, in my opinion, than the differences between individualistic or *laissez-faire* economics and socialism, deeper even than the differences between capitalism and communism, are those between rural and urban attitudes toward life. The farmer tends to think in terms of plants and animals, of birth and growth and death. The city man, on the other hand, tends to think in terms of wheels and levers and machines, or of buying or selling. Whereas agriculture is founded on life processes, particularly as influenced by soil and weather and the laws of inheritance, urban occupations are founded on manufacturing and commerce, and the activities are mostly carried on indoors. To the city child milk is associated with a bottle, not with a cow; an apple comes from a box, not from a tree; and these early impressions influence, I believe, the ideas of later life.

As a consequence the farmer's philosophy of life is primarily organic, whereas the city man's philosophy usually is mechanistic. The farmer lives in a natural world, the city man in an artificial world. Because of his occupation the farmer's thoughts are largely biological, whereas the city man's thoughts are largely physical or economic. In farming the family is the economic and social unit—it is difficult, almost impossible, to farm without a wife, and children can help with the work from about ten years of age onward. In the cities, on the other hand, the individual is the economic unit—a wife adds little, if anything, to the family income unless she works outside the home, in which case it is difficult to rear a family, and children involve expense, with little, if any, return, from birth till marriage. It costs generally two or three times as much to rear a child in the city as it does on the farm.

Perhaps because of the open air, and the contact with nature, perhaps because the farmer sees the stars at night and observes the progress of the seasons, perhaps also because of stronger family ties, farmers and farm women tend to think of the past and the future; city people, it seems to me, tend to think more about the present. Thrift has been called into question by many city people to-day; the workday, it is urged, should be shortened to six hours so that everyone will be employed, and children by some are considered a luxury to be indulged in only by people of ample means. Granting that parents should feel a keen sense of responsibility in bringing children into the world, the fact remains that the philosophy of life which is popular in the cities to-day leads to the disintegration of the family and to national and social decay.—From "Farming as a Life Work," U.S.D.A. Ext. Ser. Cir. 244, by Baker, O. E., October, 1935, p. 6.

Treatment for Milk Fever.

Since the discovery of udder inflation for the treatment of milk fever, this disease has had few terrors for the dairy farmer, but it is considered that a few notes on it, describing the precautions to be observed in udder inflation, some of the undesirable consequences that may follow, and recent advances in treatment, may be of interest.

Usually the condition has been present some time before treatment is applied, and the affected beast will be down and more or less unconscious.

The udder should be wiped clean with a clean damp rag, and then a clean towel should be placed under the udder to prevent contamination of the organ from the soil. The beast should then be propped up on its breast bone in as natural a position as possible, taking care that the hind legs are in a normal position and not causing undue pressure to be exerted on the udder. In very advanced cases, this may not always be possible but it should be attempted.

Strip the udder of any milk present and then commence inflation with a teat syphon. Each quarter is inflated firmly and the teats are tied off at the bottom with clean tapes to prevent the escape of air. The udder should then be gently massaged to fully distribute the air throughout the organ. The tapes should be removed about half-an-hour after their application. If no improvement is noted after three hours the inflation should be repeated. The most undesirable after effect that may follow treatment by udder inflation is mammitis. To avoid this the following precautions must be observed:—

(1) The teat syphon used should be thoroughly sterilized before use by boiling.

(2) Take every precaution during inflation that the teat syphon does not come in contact with any contamination; should it occur, immerse the syphon in boiling water before continuing its use.

The above precautions are against the possibility of introducing any infection into the healthy udder.

(3) If a quarter of a cow being treated with milk fever is affected with mammitis, or has been so affected at any time, that quarter should be the last inflated, and following use on that quarter, the teat syphon must be thoroughly sterilized by boiling before being used again.

The necessity for such a precaution is obvious.

Despite the fact that the majority of beasts treated by udder inflation record an uneventful recovery, it has been found that better results are obtained by the subcutaneous (under the skin) injections of a substance known as calcium boro gluconate. It is well known that in milk fever the calcium content of the blood drops considerably and the injection of calcium boro gluconate aims at restoring the lost calcium balance. In addition to being a more convenient treatment, other advantages it possesses over udder inflation are that there is no risk of introducing or spreading mammitis, recovery is more rapid, relapses are less likely to occur, and the method may also be used as a preventive. The drug is put up in convenient form commercially, and the local chemist will be able to advise where to get it.

The drug is usually issued in cartons containing 2½ oz., the contents are dissolved in 10 oz. of hot water recently boiled and then allowed to cool to body temperature before use.

The dose given is sufficient for one treatment, and should be injected under the skin at various parts of the body—do not inject all the solution in one place. The usual precautions are taken regarding sterilization of the syringe and needles, and antiseptic precautions at injection.

It has been found that repetition of the dose is rarely necessary.

Some cows are known to be more subject to milk fever than others, and in such cases it has been found advisable to give an injection immediately after calving, followed by a second injection about twenty hours later. For these injections, the dose should be half that used for curative treatment.

Whatever the method of treatment adopted, it is advisable to cover the animal with a rug, and in no circumstances should the beast be drenched, as, owing to the paralysis extending to the throat, the cow is unable to swallow, and any liquid forcibly given will find its way to the lungs and set up a penumonia that almost invariably proves fatal.

When the treated cow gets to her feet, it is advisable that some definite form of after treatment should be adopted. The udder should not be interfered with for at least twelve hours after the cow has risen, and milking "dry" must be avoided. Small quantities of milk should be drawn off at frequent intervals on the following day, and the diet should be restricted.

Sheep Nasal Fly.

During the spring and summer months, graziers in many parts of the State may be puzzled for an explanation as to why their sheep, for no accountable reason, suddenly gallop round the paddock or stand in bunches with their faces buried in each other's wool or held very closely to the ground. If such a group is closely watched the attitude of the animals will be seen to be due to the presence of a somewhat drab, stout, greyish fly, which is frequently to be observed during this time of the year resting on the fly screens and water tanks around the homestead. This is the sheep nasal fly, which lays its maggots on the edges of the nostrils of the sheep. The reason for the animal's endeavour to protect its nose by burying it in its neighbour's wool or in the soil is therefore readily understood.

These maggots, after they have been laid by the female, crawl up the sheep's nostrils and into the communicating cavities. Here they remain for several months. Being provided with a pair of stout hooks in the region of the mouth, they attach themselves to the lining of the nostrils and cause the secretion of much pus-charged mucous, on which they feed. The condition in sheep knows as "snotty nose" is due to the presence of these maggots, which may also be responsible for such a severe irritation that the infested animal loses condition.

Control of the sheep nasal fly is not at present very effective, but much good can be done by daubing the animals' noses at frequent intervals with stockholm tar. This procedure should be especially carried out during the period October to January, when the flies are most numerous.

Field Peas Sold as Peas for Human Consumption.

Following complaints made to the Department of Health and Home Affairs with respect to the fact that certain peas sold for human consumption turned black on cooking, investigational work was carried out and the following summarises the conclusions arrived at.

Eating peas, when boiled in water containing bicarbonate of soda—apparently a common practice—may be partially disintegrated if very young, but they do not change colour.

Field peas, when boiled in water containing bicarbonate of soda, turn black or nearly black in colour.

Pea growers are therefore warned not to forward to market, for human consumption, any peas picked from plants bearing coloured flowers (field peas). Only peas picked from plants bearing white flowers (eating peas) are likely to meet with approval for this purpose.

Control of White Louse of Citrus.

White louse of citrus occurs throughout the State, and although temperature does not appear to be an important factor determining its abundance, there seems to be reason for believing that it prefers dry climatic conditions. All portions of the tree are subject to attack, but infestation generally starts on the trunk near ground level and spreads upwards. The male scales are a very conspicuous white colour, and as they are much more numerous than the female scales, a colony of this species produces a white appearance on the infested surface which has led to its being given the quite appropriate name of white louse.

It is not a difficult insect to control, but growers should remember that vigorously growing trees are much less susceptible to attack than trees in poor health. The health of infested trees should, therefore, be attended to in order to reduce susceptibility, and whatever adverse factor is impairing their health should be eliminated so far as practicable.

Spraying with lime sulphur or resin-caustic soda-fish oil gives a very good control of white louse. Control is generally best accomplished by spraying in the late winter just before blossoming, using lime-sulphur at a strength of one to twelve. The preference for lime-sulphur is based very largely on the fact that its application is attended by other beneficial results in addition to establishing control of white louse.

When the correct time for spraying has arrived certain late-maturing varieties, e.g., the Valencia Late, may still be carrying fruit. This does not really matter very much because usually only the inside parts of the tree require spraying. However, should the harvesting of the crop have been completed, then it is desirable that the whole tree be sprayed.

Fumigation with hydrocyanic acid gas also gives a good control of the white louse, and can be employed against it when conditions render fumigation practicable.

The Brown Vegetable Weevil.

During the months of July, August, and September mainly, the plants in market and home gardens are liable to attack by a small insect known as the brown vegetable weevil. The plants principally affected are the vegetables, including beetroot, carrot, lettuce, mint, potato, radish, tomato, turnips, and watercress; tobacco seedlings and cineraria have also been recorded as hosts and among the weeds the insect feeds mainly on the cape weed. Both the larval or grub stage and also the adult weevil feed on the plant tissue, while the pupal stage occurs in the soil. The larva, when full grown, is pale green in colour with a brown head, soft bodied, and about half an inch in length. The adult is a small weevil about one third of an inch long, brownish in colour, usually with a paler oblique stripe on each wing cover, forming a wide V-shaped mark on the back. The head is produced into a trunk or snout typical of the weevils.

The adults feed mainly by night, sheltering in the soil during the day, but the grub stage remains on the foliage, usually on the under side of the leaves, or sheltered at the leaf bases. The insects injure plants such as potato, tomato, tobacco, and lettuce by chewing holes into the leaves, and in cases of extreme infestation cause complete defoliation. On the tuberous root crops, such as carrots, turnips, and radishes, as well as the ordinary foliage injury, the insects feed on the young centre growth, and also burrow into the tops of the fleshy roots. Where infestation is heavy the tuberous roots may be riddled.

Control of the insect on crops such as potatoes may be obtained by the use of arsenate of lead, applied either as a spray or as a dust. Similarly, young tuberous crops may be so treated *in the early stages*. Difficulty, however, arises with the tuberous crops as they grow, and likewise at any stage in the growth of plants such as lettuce, owing to the danger from any poisonous residue of the insecticide. A generall practice in these cases is to apply a bait, the attractant being the cut tops of plants such as tomatoes that have passed the productive stage, or cape weed. This plant tissue may be dipped in an arsenate of lead solution or dusted with arsenate of lead powder, and it is then distributed among the plants to be protected. Preferably, the cut tops should be partly buried at intervals between the crop rows, the distribution taking place in the late afternoon. Old plants or weed growth in which the insects are breeding or sheltering should be cleaned up and destroyed, and infested ground should be cultivated during the winter and spring at a time chosen so as to disturb and destroy as many pupæ as possible.

Farmers' Wool Scheme.

It is felt that the benefits to be derived by the owner of small flocks from the farmers' wool scheme are not sufficiently recognised and made use of. Briefly described, it is an endeavour to get full market values on behalf of the farmer for parcels of wool which, if sent straight to the brokers in bags, butts, and bales would be sold either as star lots, or, in the case of bags, by private treaty. The Department receives wool from farmers owning less than 1,500 sheep, and for a small charge classes it into lines of similar wool, thus getting the farmers' lines into the big catalogues and participating in the competition of all buyers.

At last February's sale in Brisbane the average price for 50,000 bales was 14.9 pence per lb., a consignment of farmers' wools numbering 107 bales, classed and sold by the Department, averaged 14.8 pence per lb. When it is understood that wool arrives in bags, butts, fadges, &c., the value of this scheme to the small grower should be readily realised. As it is sometimes necessary to hold wool for considerable periods, an advance of 60 per cent. of the estimated value of the wool is paid to farmers, without interest, on receipt into store. With the exception of removing wet stains and keeping locks and bellies separate, no treatment of the wool by the farmer is necessary. The whole of the skirting and classing is done by the Department.

Banana Marketing.

In the fruit market at present it is noticeable that immature bananas are being sent from many centres. The higher prices prevailing just now, no doubt, are an inducement to market immature fruit. Growers are advised during the cooler weather to allow their bunches to hang as long as possible before cutting, in order to give the fruit every chance of filling satisfactorily.

Persimmon Varieties.

Persimmons grow and fruit exceptionally well on the Upper Tableland of North Queensland. Care should, however, be exercised in selecting suitable varieties. Whilst "Tanenashi" is undoubtedly of outstanding quality in the district its early ripening renders it susceptible to fruit fly attack. "Dia dia maru," which ripens in May, is probably one of the most suitable varieties, as in normal seasons it is sufficiently late to escape the worst period of fly incidence.

Orchard Notes

DECEMBER.

THE COASTAL DISTRICTS.

THE planting of pineapples and bananas may be continued, taking care that the ground is properly prepared and suckers carefully selected, as advised previously in these Notes. Keep the plantations well worked and free from weeds of all kinds, especially if the season is dry. New plantations require constant attention, in order to give young plants every chance to get a good start; if checked when young they take a long time to pull up and the fruiting period is considerably retarded. Small areas well worked are more profitable than large areas indifferently looked after, as the fruit they produce is of very much better quality. This is a very important matter in the case of both of these fruits, as with the great increase in the area under crop there is not likely to be a profitable market for inferior fruit. Canners only want first-class pines of a size that will fill a can, and cannot utilise small or inferior fruit, except in very limited quantities, and even then at a very low price. Small, badly filled bananas are always hard to quit, and with a well-supplied market they become unsaleable. Pineapple growers, especially those who have a quantity of the Ripley Queen variety, are warned that the sending of very immature fruit to the Southern markets is most unwise, as there is no surer way of spoiling the market for the main crop. Immature pineapples are not fit for human consumption, and should be condemned by the health authorities of the States to which they are sent.

Citrus orchards require constant attention; the land must be kept well worked and all weed growth destroyed. Spraying for scale insects should be carried out where necessary. Spraying with fungicides should have already been carried out where necessary, and, except in the case of a heavy infestation with black spot or brown spot of the Emperor mandarin, no further applications of copper sprays should be required. A close lookout must be kept for the first indications of "maori," and as soon as it is discovered the trees should either be dusted with sulphur or sprayed with lime sulphur. Borer should be looked for and destroyed wherever seen.

Early grapes will be ready for cutting. Handle carefully, and get them on to the market in the best possible condition. A bunch with the bloom on and every berry perfect will always look and sell well, even on a full market, when crushed and ill-packed lines are hard to quit.

Peaches, plums, papaws, and lemons will be in season during the month. See that they are properly handled. Look out for fruit fly in all early-ripening stone fruit, and see that none is left to lie under the trees to rot and thus breed a big crop of flies to destroy the mango crop when it ripens.

Look out for Irish blight in potatoes and tomatoes, and downy and powdery mildew on melons and kindred plants. Use Bordeaux or Burgundy mixture for Irish blight and downy mildew, and sulphur dust or lime sulphur spray for powdery mildew.

THE GRANITE BELT, SOUTHERN AND CENTRAL TABLELANDS.

EARLY ripening apples, plums, apricots, peaches, and nectarines will be ready for marketing during the month. They are unsatisfactory lines to handle, as the old saw "Early ripe, early rotten" applies to all of them; in fact, the season of any particular variety is so short that it must be marketed and consumed as quickly as possible. All early ripening deciduous fruits are poor carriers and bad keepers, as their flesh is soft and watery, deficient in firmness and sugar, and cannot, therefore, be sent to any distant market. The available markets are quickly over-supplied with this class of fruit, and a glut takes place in consequence. Merchants frequently make the serious mistake of trying to hold such fruits, in the hope of the market improving, with the result that, instead of improving, the market frequently becomes more and more congested, and held-over lines have to be sent to the tip. There is only one way to deal with this class of fruit, and that is to clear the markets daily, no matter what the price, and get it distributed and into consumption as rapidily as possible by means of barrowmen and hawkers. Most early ripening fruits are useless for preserving in any way, their only value being what they will bring for consumption whilst fresh. This being so, it is only a waste of time and money to forward immature, undersize, and inferior fruit to market, as it is not wanted, and there is no sale for it. It should never have been grown, as it is frequently only an expense to the producer, besides which, unless the fallen or over-ripe fruit is regularly and systematically gathered and destroyed in the orchard, it becomes a breeding ground for fruit fly and codlin moth, as well as of fungi, such as those producing the brown and ripe rots. Early ripening fruits should, therefore, be carefully graded for size and quality, handled and packed with great care, and nothing but choice fruit sent to market. If this is done, a good price will be secured, but if the whole crop—good, bad, and indifferent—is rushed in to the local markets, a serious congestion is bound to take place and large quantities will go to waste.

Orchards and vineyards must be kept in a state of perfect tilth, especially if the weather is dry, so as to retain the moisture necessary for the development of the later ripening fruits. Where citrus fruits are grown, an irrigation should be given during the month if water is available for this purpose, excepting, of course, there is a good fall of rain sufficient to provide an ample supply of moisture.

Codlin moth and fruit fly must receive constant attention and be kept under control, otherwise the later-ripening fruits are likely to suffer severely from the depredations of these serious pests.

Grape vines must be carefully attended to and sprayed where necessary for black spot or downy mildew or sulphured for oidium.

WIDE GATES—MOVEABLE CENTRE POST.

On farms where implements of unusual width have to be moved from paddock to paddock the ordinary gate is not wide enough, to get them through. To provide extra wide gates everywhere would be inconvenient, owing to the trouble of handling such heavy gates at all times. The necessary width may be secured, however, by having two gates of ordinary width with a centre post between. This centre post, in place of being planted immovably in the ground, is so fitted that it can be taken away easily when required, and replaced in a few minutes after the implement has passed through.

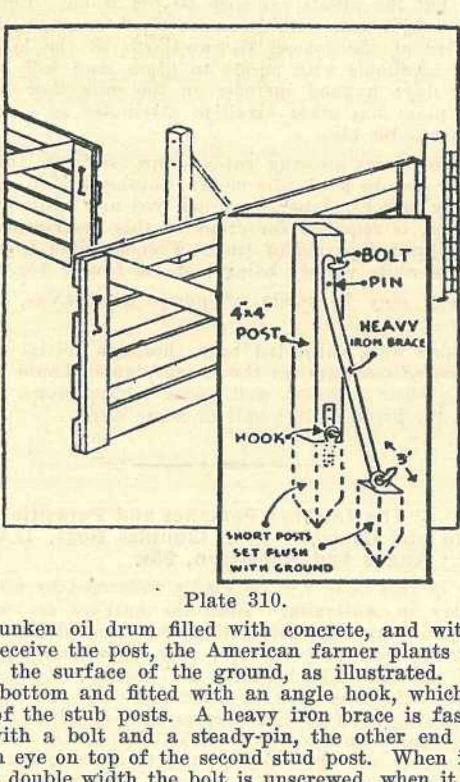


Plate 310.

Instead of a sunken oil drum filled with concrete, and with a socket moulded in the concrete to receive the post, the American farmer plants two stub posts with the tops flush with the surface of the ground, as illustrated. The centre post is squared off at the bottom and fitted with an angle hook, which hooks into an eye on the top of one of the stub posts. A heavy iron brace is fastened to the top of the movable post with a bolt and a steady-pin, the other end of the brace being curved to fit into an eye on top of the second stud post. When it is desired to open the gate to the full double width the bolt is unscrewed, when it is easy to bend the post over and unhook it from its supports. This idea was contributed by a correspondent to "The Prairie Farmer" (U.S.A.).

Farm Notes

DECEMBER.

ALTHOUGH November is regarded generally as the best period for planting the main maize crop, on account of the tasseling period harmonising later on with the summer rains, December planting may be carried out in districts where early frosts are not prevalent, provided a known quick maturing variety of maize is sown.

To ensure a supply of late autumn and winter feed, dairymen are advised to make successive sowings of maize and sorghums, to be ultimately used either as green feed or in the form of ensilage. The necessity for such provision cannot be too strongly urged. Farmers who have not had any experience in building an ensilage stack can rest assured that, if they produce a crop for this purpose, information and instruction on the matter will be given on application to the Under Secretary for Agriculture and Stock; also that, whenever possible, the services of an instructor will be made available for carrying out a demonstration in ensilage-making for the benefit of the farmer concerned and his immediate neighbours.

In districts and localities where supplies of lucerne are not available, sowings of cowpeas should be made, particularly by dairymen, as the lack of protein-yielding foods for milch cows is a common cause of diminished milk supplies and of unthriftiness of animals in dairy herds. Cowpeas and lucerne can be depended upon to supply the deficiency. The former crop is hardy and drought-resisting. When plants are to be used as a fodder, it is customary to commence to feed them to stock when the pods have formed. Animals are not fond of cowpeas in a fresh, green state; consequently the plants should be cut a day or two before use. Economy is effected by chaffing beforehand, but the plants can also be fed whole. Chaffed in the manner indicated, and fed in conjunction with green maize, or sorghum, when in head, in the proportion of one-third of the former to two-thirds of the latter, a well-balanced ration is obtainable. Animals with access to grass land will consume from 40 to 50 lb. per head per day; a good increase in the milk flow is promoted by this succulent diet. The plant has other excellent attributes as a soil renovator. Pig-raisers will find it invaluable also.

A great variety of quick-growing catch crops, suitable for green fodder and ensilage purposes, may also be sown this month, notably Sudan grass, white panicum, giant panicum (liberty millet), Japanese millet, red and white French millet. Well prepared land, however, is required for crops of this description, which make their growth within a very limited period of time. French millet is particularly valuable as a birdseed crop, the white variety being more in favour for this purpose.

Successive sowings may be made of pumpkins, melons, and plants of this description.

Cotton areas which were subjected to a thorough initial preparation, thereby conserving a sufficiency of moisture for the young plants, should now be making good headway and sending their taproots well down. Keep down all weed growth by scarifying as long as the growth will admit of horse work.

Publication Received—"The Internal Parasites and Parasitic Diseases of Sheep: Their Treatment and Control," by I. Clunnies Ross, D.V.Sc., and H. M. L. Gordon, B.V.Sc.; Angus and Robertson, 25s.

The appearance of this book will be gladly welcomed by all of those interested in the sheep industry in Australia. Both the authors are well known and are recognised as the two foremost authorities on worm diseases in sheep in this country. The matter is well put together, very up-to-date, and well printed and is chiefly concerned with the life histories and control of the various species of worms under such conditions as exist in Australia. The book is amply illustrated and the numerous photographs of the various species of worms, all natural size, greatly assist the authors' endeavour to make the matter understandable to the layman. Both the authors and the publisher are to be congratulated on the production of an excellent work which should prove a very valuable acquisition to the library of every veterinarian, stock inspector, and sheep owner.—F.H.S.R.

OUR BABIES.

Under this heading a series of short articles by the Medical and Nursing Staffs of the Queensland Baby Clinics, dealing with the care and general welfare of babies, has been planned in the hope of maintaining their health, increasing their happiness, and decreasing the number of avoidable deaths.

HANDLING BABIES AND "GOOD MOTHERCRAFT."

THE writer was travelling in a public carriage and could not help observing a young mother carrying a baby, and was distressed with what she observed. The mother was accompanied by an older woman, apparently a friend. During the journey I sat near the two, so was able to watch the way the mother handled the baby, and could not avoid overhearing some remarks passed between the mother and her friend.

The baby was obviously very young; it looked to be only two or three weeks of age, and it crossed my mind the mother and baby might just then have been discharged from the nursing home; otherwise I wondered why one so young was being taken about at that hour. Also, it was a little baby; by that I mean it appeared to be smaller than the infant of average size, and might have been about 6 lb. or so in weight. What caught my attention and distressed me on the baby's behalf was the fact that the mother evidently knew so little about holding the baby or allowing it to rest. She held it upright against her, and patted it vigorously without ceasing. After many futile attempts to close its eyes and sleep, the baby protested (rather feebly, I thought), so its position was changed, but the patting continued. Fortunately for the little one, it feel asleep in spite of the treatment, and was allowed at last to rest in a comfortable position reclining on its mother's arm, when I was relieved to see that at last the patting had ceased.

It is not my intention to be critical of the young mother. She no doubt loved the baby, and the patting and caressing she bestowed upon it were the means she used to express her feeling for her infant. But she was sadly in need of some teaching in mothercraft.

No woman is a natural-born mother; she must learn her profession just as any other individual must learn the profession which they intend to follow. And why should not a mother, whose profession is above all others, learn it perfectly, and not experiment on her first baby (probably at the expense of the child's welfare), when she can so easily obtain skilled help and advice from women who have made a study of the "care of baby"? How many little babies might be spared the unnecessary sufferings inflicted upon them through ignorance under the false name of love!

When the older woman was saying good-bye to the mother as she prepared to leave the tram, after discussing how long the delay had been in getting the baby to sleep during the afternoon, she advised the mother to "pop baby right into bed when she got home and allow her to have her sleep out.' As it was then after 5.30 p.m. I wondered when the tired-looking little mite would wake for her food, and if she would have to wait for it until she did wake up.

"Rest and sleep" are certainly included in baby's essential needs, and baby must have enough of both if he or she is to grow to adult life with a sound nervous system. Remember there are 11 other essentials as well. "Food" is one and "regularity" another, and "judicious handling" yet another.

Baby must have "food" if she is to grow, and if she is small, as this baby was, and does not get sufficient food she will become more and more sleepy, with consequent loss of vitality through lack of food. Now the importance of "regularity" is that baby is trained to sleep for a definite length of time at the same hours each day, and so a rhythm is established in the daily life. The same applies to "feeding times" and all other times for doing things. Baby either wakes or is wakened for feeding at the same time each day, and so a certain number of feeds are ensured each day and a regular space of time between to allow the digestive organs to do their work and rest a little before another meal has to be dealt with.

I cannot help hoping that this article may come under the eye of the mother for whose baby I have been moved to write it, and that her love is great enough to help her appreciate the few points I have tried to make clear.

IN THE FARM KITCHEN.

RHUBARB AS DESSERT.

Rhubarb Jellies.

Half-fill some large glasses with steamed or stewed rhubarb, well chilled. Cover with a layer of custard sauce. When set, decorate with sliced banana. Make a milk rhubarb jelly from a packet of lemon jelly crystals, mixed according to instructions on packet, but using half a pint of rhubarb juice and water and half a pint of custard sauce instead of a pint of water. Turn out. Fill centre with stewed or steamed rhubarb.

Rhubarb and Sago Mould.

Take ½ lb. rhubarb, 6 oz. sugar, ¼ lb. sago, 2 cupfuls water.

First simmer the rhubarb in one cupful of water for ten minutes. Then soak the sago in the remaining cupful of water for the same time. Add sago and sugar to rhubarb, and simmer ten minutes longer. Pour into wet moulds. Turn out when set, and serve with custard sauce or whipped cream.

Rhubarb Cream.

Take 1 lb. rhubarb, 3 cloves, 1-inch length stick cinnamon, 1¼ cupfuls sugar, I cupful whipped cream, grated rind and juice 1 lemon.

Wipe and chop rhubarb, then add lemon rind and juice, cloves, and cinnamon. Place in a pan and cook until tender. Remove cloves and cinnamon. Add sugar, and continue to simmer until reduced to a thick puree. Allow to cool, then fold in the whipped cream. Serve in glasses lined with sponge fingers and place a glace cherry and leaves of angelica on top for decoration.

Sussex Rhubarb Tart.

Take 3 cupfuls rhubarb, 1 teaspoonful butter, 1 cupful castor sugar, 1 oz. flour, ½ lb. plain pastry.

Wipe and chop rhubarb into equal-sized pieces. Sift sugar and flour into a basin. Line a low pie-dish with plain pastry, and spread it evenly with half the flour and sugar. All rhubarb. Pour over remainder of flour and sugar. Dab with butter. Brush edges of pastry with cold water, then place pastry cover on top. Decorate and bake from forty to forty-five minutes in a quick oven.

Rhubarb Flan.

Take 6 oz. short pastry, 3 cupfuls sliced rhubarb, 1 cupful castor sugar, ¼ oz. gelatine, 2 tablespoonfuls cornflour.

Roll pastry to one-eighth of an inch thickness, and line a greased pie plate, or sandwich tin, neatly. Ornament the edges and prick bottom with a fork. Mix the cornflour lightly with rhubarb, then stir in sugar. Cook in a double boiler till tender. Drain and arrange in pastry case. Bake in a hot oven for fifteen to twenty minutes, then reduce the heat and finish cooking. Dissolve gelatine in syrup. When beginning to set, pour over the fruit.

Rhubarb Meringue.

Take 1 lb. rhubarb, 8 oz. castor sugar, 4 eggs, 1 lemon.

Steam chopped rhubarb with half the castor sugar until tender. Strain off the juice into a bowl, and rub through a wire sieve. Return juice to pan and simmer down to a gill, then add to the rhubarb puree. Mix in the lightly-beaten egg-yolks, and add grated lemon rind. Pour the mixture into a fireproof dish, and bake for half an hour. Beat the egg-whites to a stiff froth, fold in remainder of castor sugar, and spread this evenly over the baked sweet. Return dish to the oven until the meringue is set.

Scalloped Rhubarb

Take 3 cupfuls rhubarb, 1 cupful castor sugar, 2 cupfuls soft breadcrumbs, 1 lemon, ¼ teaspoonful grated nutmeg, ¼ cupful water, 2 tablespoonfuls fresh butter, ¼ teaspoonful ground cinnamon, grated orange rind to taste.

Melt the butter and mix with the crumbs, mix sugar, spice, grated lemon rind, and orange to taste. Put quarter of a cupful of crumbs in the bottom of a fireproof dish, then add half the rhubarb. Sprinkle with half the spiced sugar, then cover with another quarter of crumbs. Put in remainder of rhubarb, sprinkle with remainder of spiced sugar, mix together lemon juice and water or half lemon juice and half orange juice and water, sprinkle over dish, put remainder of buttered crumbs on top, cover closely. Cook three-quarters of an hour in a moderately hot oven, then uncover and brown quickly.

Rhubarb Custard Pasty.

Take ½ lb. shortcrust, 2 level tablespoonfuls cornflour, ¼ teaspoonful salt, 2 tablespoonfuls cold water, 2 cupfuls rhubarb, 1 cupful boiling water, 1 egg, 1 cupful sugar.

Mix the cornflour to a smooth paste with the cold water. Add boiling water. Cook until mixture thickens. Stir in rhubarb, chopped very fine, and stir occasionally until mixture boils. Cover and allow to cool. Line a deep pie-dish with the short crust. Beat an egg until light, then beat in sugar and salt. Stir into rhubarb mixture. Pour mixture into prepared pie-dish. Bake until crust is done—in about half an hour. The lighter the egg is beaten the better. If liked, the rhubarb mixture can be flavoured with lemon juice or a little preserved ginger.

Rhubarb Betty

Take 1 pint rhubarb, 1 lemon, 1 orange, 7 oz. sugar, 2 tablespoonfuls dessicated cocoanut, 5 oz. breadcrumbs, 2 oz. butter.

Wipe some rhubarb and cut it in small pieces, then measure it. Melt the butter, and mix it with the breadcrumbs. Grate the rinds of the orange and lemon and squeeze out the juice and mix it with the cocoanut. Place about one-third of the breadcrumbs in a buttered dish, add half the rhubarb and sprinkle it with half the sugar. Add half the cocoanut with the fruit rind and juice. Add another portion of breadcrumbs, and remainder of fruit, sugar, and cocoanut, then cover it with remainder of the crumbs. Cover the pudding with a buttered paper and bake it in a moderately hot oven until the rhubarb is soft, then decorate it with pieces of lightly-cooked rhubarb.

Rhubarb Ginger Pudding.

Take ½ lb. self-raising flour, 2 level teaspoonfuls ground ginger, 4 oz. suet, water to mix, ½ bundle rhubarb (or sufficient to fill the basin), 2 tablespoonfuls brown sugar, 1 level teaspoonful ground ginger.

Wipe rhubarb sticks, remove the green leaves and tips, and cut the rhubarb into short lengths. Sift the flour with 2 level teaspoonfuls of ginger. Chop the suet finely and add it, then mix all to a pliable dough with cold water. Put barely one-third of this dough aside for the top of the pudding, the remainder roll to a round shape about one and a-half times as large as the top of the pudding basin. Grease this and line it with crust. Put in half the rhubarb, then add the sugar, mixed with 1 level teaspoonful of ginger. Fill up with rhubarb, and add a little water. Roll out the remaining piece of crust and cover the pudding, dampening the edge to make it adhere. Cover it with a greased paper and floured pudding cloth. Put it into a pan of boiling water and boil for about two and a-half hours.

HAVE YOU ANY SPARE TIME?

The day's work is done, dinner is over, and you're tired. There is still an hour or so before bedtime. What will you do? Switch on the radio maybe, but sometimes you're not just in that mood. You prefer a book or something, anything, to pass the time. You pick up a magazine—light fiction, but perhaps you throw it down, with "Umph! there's nothing in that." You want to read, but still you want something that isn't a sheer waste of time. Well now, here's just the very thing that you want. Here's a series of articles brightly written that will interest you, and at the same time give you some useful information. Now isn't that what you're looking for? "What sort of information?" you say. Well, about all sorts of things. What about some history? That can be very interesting, you know, or some articles about some of the things that farmers grow—wheat, cotton, sugar-cane, and so on—and not only the things that Queensland farmers grow, but those that are grown in other countries as well. Where they are grown, how they are grown, and how they are sent to market, and where they are used. That is to say, a series of talks on what one might call, say, economic geography. Or it maybe you might like to read all about the science of horticulture.

Then what about your boy and girl just growing up, thinking of looking for a job? They would get on so much better, you know, if they could express themselves well, no matter what job they are going to take on. It would be well worth their while reading up a series of papers on "How to Speak" or "How to Write."

On all these subjects, and many others, you can obtain sets of typewritten papers, 21 on each subject, which will be posted to you two each fortnight. Along with the papers, too, you can obtain books on the same subject, and all for the cost of only 8s. 6d. Seize this opportunity, and write to-night for further information to—The Director of Tutorial Classes, corner of Edward and Ann streets, Brisbane.

RAINFALL IN THE AGRICULTURAL DISTRICTS.

TABLE SHOWING THE AVERAGE RAINFALL FOR THE MONTH OF SEPTEMBER IN THE AGRICULTURAL DISTRICTS, TOGETHER WITH TOTAL RAINFALL DURING 1936 AND 1935, FOR COMPARISON.

Divisions and Stations.	Average Rainfall.		Total Rainfall.	
	Sept.,	No. of Years' Records.	Sept., 1936.	Sept., 1935.
North Coast.	In.		In.	In.
Atherton	0·69	35	1·89	Nil
Cairns	1·64	54	4·22	0·08
Cardwell	1·52	64	2·41	0·28
Cooktown	0·57	60	0·68	Nil
Herberton	0·55	50	0·85	0·03
Ingham	1·55	44	3·75	0·15
Innisfail	3·47	55	6·94	0·20
Mossman Mill	1·50	23	7·09	0·02
Townsville	0·78	65	0·21	0·03
Central Coast.				
Ayr	1·36	49	0·11	0·17
Bowen	0·82	65	0·06	0·68
Charters Towers	0·83	54	0·11	0·47
Mackay	1·58	65	1·08	2·70
Proserpine	2·10	33	2·28	0·79
St. Lawrence	1·29	65	0·08	1·00
South Coast.				
Biggenden	1·59	37	0·69	3·38
Bundaberg	1·61	53	1·24	2·49
Brisbane	2·04	85	0·84	3·49
Caboolture	1·89	49	0·73	3·07
Childers	1·86	41	0·48	2·93
Crohamhurst	2·72	43	1·09	3·81
Esk	2·15	49	1·09	4·18
Gayndah	1·60	65	0·55	2·01
Gympie	2·15	66	0·07	4·10
Kilkivan	1·73	57	1·13	2·64
Maryborough	1·98	65	0·18	3·33
Nambour	2·58	40	0·64	4·08
Nanango	1·85	54	0·99	2·64
Rockhampton	1·33	65	0·13	1·42
Woodford	2·22	49	0·43	2·88
Central Highlands.	In.		In.	In.
Clermont	1·03	65	0·06	0·61
Gindie	1·11	37	..	1·22
Springsure	1·33	67	0·26	3·00
Darling Downs.				
Dalby	1·70	66	1·07	3·06
Emu Vale	1·79	40	1·59	2·80
Hermitage	1·60	30	..	2·99
Jimbour	1·50	48	1·25	3·00
Miles	1·37	51	0·89	2·97
Stanthorpe	2·32	63	1·50	4·16
Toowoomba	2·15	64	1·70	3·36
Warwick	1·84	71	1·50	3·19
Maranoa.				
Roma	1·44	62	0·44	2·84
State Farms, &c.				
Bungeworgoral	0·97	22	0·25	..
Gatton College	1·59	37	1·27	2·99
Kairi	0·68	22	..	..
Mackay Sugar Experiment Station	1·51	39	0·94	3·94

A. S. RICHARDS, Divisional Meteorologist.

CLIMATOLOGICAL TABLE—SEPTEMBER, 1936.

COMPILED FROM TELEGRAPHIC REPORTS.

Districts and Stations.	Atmospheric Pressure Means at 9 a.m.	Shade Temperature. Means.		Shade Temperature. Extremes.				Rainfall.	
		Max.	Min.	Max.	Date.	Min.	Date.	Total.	Wet Days.
Coastal.	In.	Deg.	Deg.	Deg.		Deg.		Points.	
Cooktown	29·96	83	72	85	28	61	22	68	6
Herberton	..	76	57	86	26	44	27	85	9
Rockhampton	30·12	82	59	92	21, 24	50	10	13	6
Brisbane	30·16	76	54·1	87	12	50	4, 23	84	5
Darling Downs.									
Dalby	30·13	77	46	90	24	37	22	107	5
Stanthorpe	..	68	39	80	15	27	27	150	6
Toowoomba	..	72	46	85	15	36	27	170	6
Mid-Interior.									
Georgetown	29·99	91	64	97	25	57	26	76	1
Longreach	30·07	85	54	97	24	40	17	49	5
Mitchell	30·13	77	44	89	15, 23	30	27	49	4
Western.									
Burketown	29·98	90	66	95	11, 22	56	28	Nil	..
Boulia	30·09	85	54	99	14	45	1	28	1
Thargomindah	30·14	77	49	94	14	42	9, 17, 19, 26	31	3

ASTRONOMICAL DATA FOR QUEENSLAND.

TIMES COMPUTED BY D. EGLINTON AND A. C. EGLINTON.

TIMES OF SUNRISE, SUNSET, AND MOONRISE.

AT WARWICK.

MOONRISE.

	November. 1936.		December. 1936.		Nov., 1936.	Dec. 1936.
	Rises.	Sets.	Rises.	Sets.	Rises.	Rises.
					p.m.	p.m.
1	5.3	6.9	4·49	6·31	8.33	9·10
2	5.2	6.10	4·49	6·32	9.26	9·54
3	5.1	6.11	4·49	6·33	10.33	10·35
4	5.0	6.12	4·50	6·34	11.19	11·6
5	5.0	6.12	4·50	6·35	..	11·42
					a.m.	
6	4.59	6.13	4·50	6·36	12.1	..
						a.m.
7	4.58	6.14	4·50	6·37	12.39	12·15
8	4.57	6.15	4·50	6·38	1·11	12·46
9	4·57	6.15	4·51	6·38	1·43	1·17
10	4·56	6.16	4·51	6·39	2·16	1·49
11	4·56	6.17	4·51	6·39	2·45	2·29
12	4·55	6.18	4·51	6·40	3·16	3·8
13	4·55	6.18	4·52	6·40	3·52	3·53
14	4·54	6·19	4·52	6·41	4·29	4·43
15	4·54	6.20	4·52	6·41	5·11	5·37
16	4·53	6.21	4·52	6·42	5·58	6·32
17	4·53	6.22	4·53	6·42	6·49	7·32
18	4·52	6.23	4·53	6·43	7.41	8·30
19	4·52	6.23	4·53	6·43	8.36	9·30
20	4·52	6.24	4·54	6·44	9.37	10·29
21	4·51	6.25	4·54	6·44	10.35	11·26
						p.m.
22	4·51	6.26	4·55	6·45	11.34	12·28
					p.m.	
23	4·51	6.27	4·55	6·45	12.35	1·32
24	4·50	6·28	4·56	6·46	1·36	2·38
25	4·50	6.28	4·56	6·46	2.41	3·48
26	4.50	6.29	4·57	6·47	3.49	4.54
27	4·50	6.29	4·58	6·48	4·59	5·55
28	4·49	6.30	4·58	6·48	5.59	6·55
29	4.49	6.30	4·59	6·49	7.16	7·44
30	4.49	6.31	4·59	6·49	8.17	8·27
31			5·0	6·50		9.7

Phases of the Moon, Occultations, &c.

6 Nov.	☽ Last Quarter	11 28 p.m.	
14 ,,	● New Moon	2 42 p.m.	
22 ,,	☾ First Quarter	11 19 a.m.	
29 ,,	○ Full Moon	2 12 a.m.	

Apogee, 12th November, at 7.48 p.m.
Perigee, 28th November, at 12.24 a.m.

On the 17th it will be interesting to see the Moon in crescent shape near both planets during the evening hours, with the graceful curves of Scorpio nearby. At the time of conjunction—1 p.m.—Jupiter will be only one-tenth of a degree south of the Moon, while Venus will be separated from it by 2 degrees at 9 p.m., when the planet will be too near the horizon to be visible.

On the 18th Mercury will be in superior conjunction with the Sun, when it will be at a distance of more than 137,000,000 miles from the Earth. Its brilliance will be considerably less than it was about the middle of July.

Saturn, in the eastern part of Aquarius, after a period of apparently retrograde motion, will seem to become stationary on the 20th, after which it will again resume its eastward course. At 9 p.m. on the 23rd the Moon will be 8 degrees north of this comparatively lustreless planet.

Mercury rises at 4.35 a.m., 28 minutes before the Sun, and sets at 5.19 p.m., 50 minutes before it, on the 1st; on the 15th it rises at 4.47 a.m., 7 minutes before the Sun, and sets at 6.11 p.m., 9 minutes before it.

Venus rises at 6.56 a.m., 1 hour 53 minutes after the Sun, and sets at 8.40 p.m., 2 hours 31 minutes after it, on the 1st; on the 15th it rises at 7.10 a.m., 2 hours 16 minutes after the Sun, and sets at 9.4 p.m., 2 hours 44 minutes after it.

Mars rises at 2.53 a.m., 2 hours 10 minutes before the Sun, and sets at 2.35 p.m., 3 hours 34 minutes before it, on the 1st; on the 15th it rises at 2.20 a.m., 2 hours 34 minutes before the Sun, and sets at 2.20 p.m., 4 hours before it.

Jupiter rises at 7.52 a.m. and sets at 9.35 p.m. on the 1st; on the 15th it rises at 7.7 a.m. and sets at 8.55 p.m.

Saturn rises at 2.5 p.m. and sets at 2.43 a.m. on the 1st; on the 15th it rises at 1.8 p.m. and sets at 1.48 a.m.

The Southern Cross will be at position III., as on the clock-face, on 1st November, at 4 p.m. At 8 p.m., position V., it will be too near the horizon to be visible. It will reach its lowest position, VI., before midnight during November, and will therefore be absent from the evening sky.

6 Dec.	☽ Last Quarter	4 20 a.m.
14 ,,	● New Moon	9 25 a.m.
21 ,,	☾ First Quarter	9 30 p.m.
28 ,,	○ Full Moon	2 0 p.m.

Apogee, 10th December, at 6.6 a.m.
Perigee, 26th December, at 6.36 a.m.

For places west of Warwick and nearly in the same latitude, 28 degrees 12 minutes S. add 4 minutes for each degree of longitude. For example, at Inglewood, add 4 minutes to the times given above for Warwick; at Goondiwindi, add 8 minutes; at St. George, 14 minutes; at Cunnamulla, 25 minutes; at Thargomindah, 33 minutes; and at Oontoo, 43 minutes.

The moonlight nights for each month can best be ascertained by noticing the dates when the moon will be in the first quarter and when full. In the latter case the moon will rise somewhat about the time the sun sets, and the moonlight then extends all through the night; when at the first quarter the moon rises somewhat about six hours before the sun sets, and it is moonlight only till about midnight. After full moon it will be later each evening before it rises, and when in the last quarter it will not generally rise till after midnight.

It must be remembered that the times referred to are only roughly approximate, as the relative positions of the sun and moon vary considerably.