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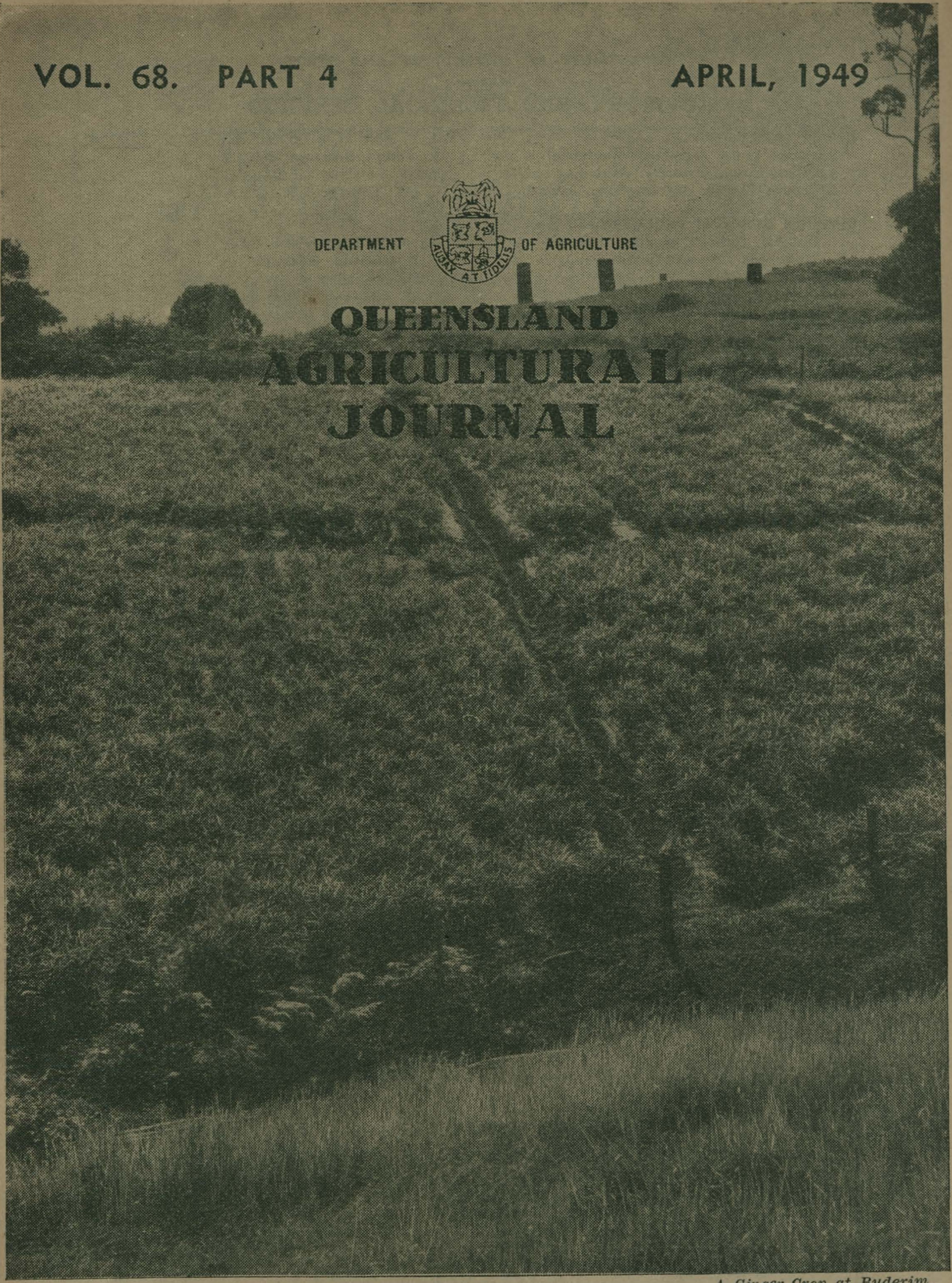

A Ginger Crop at Buderim, Southern Queensland.

LEADING FEATURES

Agriculture in the United States

Restoring Worn-out Tobacco Soils

The Mango

Heliothis in Linseed

Cheese Starters

Hand Feeding Sheep

Poultry Farming

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Contents

Notes on Agriculture in the United States.*

C. J. McKEON, Director of Agriculture.

Grain Sorghum.

DURING the war years the dwarf grain sorghums, which can be mechanically harvested, came into prominence in the United States, and this crop is now of considerable importance in Texas, Kansas, Oklahoma, California, Colorado, New Mexico, Arizona and other States.

As late as 1941 only 10 per cent. of the total grain sorghum acreage was planted to types which could be harvested with a combine, or header, as it is known in Australia, but this had increased to 90 per cent. in 1946, in which year the production of grain sorghum in Texas alone was 74,000,000 bushels.

The leading varieties now being grown are Martin (a selection from Wheatland), which matures in 95 days; Plainsman (a milo x kafir cross), which matures in 100 to 105 days; and Caprock (another milo x kafir cross), which matures in 105 to 115 days. Caprock is somewhat similar to Plainsman, the main difference being the period of maturity. Martin and Plainsman are under test in Queensland.

The original Kalo and Wheatland types, which have been so widely grown here, are now only grown to a limited extent in the United States, where the main Kalo selection is known as Midland.

Hegari, another variety which has done very well in parts of Queensland, is still grown fairly extensively in southern Texas, where a new strain called Early Hegari has given very good results. It is two weeks earlier than Hegari, and like the original Hegari is more palatable to stock as a green fodder than most other grain varieties.

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* These notes on various crops have been taken from a report prepared by Mr. McKeon following a visit to the United States as a member of a committee investigating the soy bean industry.

At Lubbock Experiment Station, Texas, sorghum breeding work is conducted on a most extensive scale and some particularly fine kafir x shallu hybrids are under observation (Plates 104–106). One of these, which is a dwarf type but has a characteristic shallu type of head (Plates 105 and 106), has been released for general cultivation. It still is lacking somewhat in uniformity, but having such an open type of head should ultimately prove an ideal type to withstand grub attack.

Work is also in progress at Lubbock on Cody, a variety with a grain which has a waxy endosperm. Large quantities of waxy endosperm grains have been used in the United States for the manufacture of a tapioca substitute in recent years.

Sweet Sudan Grass.

This variety was evolved at the Texas Agricultural Experiment Station, in co-operation with the Bureau of Plant Industry, United States Department of Agriculture, after several years' work. The variety is the result of a cross between a sweet sorghum, Leoti, and Sudan grass, the desire being to incorporate the sweet, juicy stalk and the sienna-coloured glumes of Leoti into the grass and at the same time retain the grassy characteristics of the latter. Because of the very close resemblance of Sudan grass seed to Johnson grass seed, it is often not possible for farmers to be sure they are not introducing Johnson grass to their properties when buying Sudan grass seed. The distinctive glume colour of the new variety renders it readily distinguishable from Johnson grass or common Sudan grass.

It was claimed that in feeding trials conducted in Texas stock not only showed a marked preference for Sweet Sudan grass but grazed it to the ground, while the common Sudan grass was grazed only to a height of one foot from the ground.

Leoti, the sweet sorghum parent, is resistant to several leaf diseases which attack Sudan grass in coastal areas. Sudan grass has proved very susceptible to leaf diseases in coastal districts of Queensland, also, and for that reason is rarely grown in those districts. It is claimed that most of the resistance possessed by Leoti has been transmitted to Sweet Sudan grass. The new variety, however, is not wholly resistant to leaf diseases and work is in progress to endeavour to correct that deficiency.

Rice.

Rice production was seen in several States. Though the most modern methods are used for the production of the crop, yields, even in the States which have the highest yields per acre, are much below Australian figures. Surprise was expressed, even on research stations, when those associated with the industry were informed of the high yields that were obtained in Australia.

At the University of Arkansas Rice Branch Experiment Station, breeding work is concentrated largely on the production of types which are resistant to stem rot and 80 different selections were undergoing trials at the time of my visit. This disease is responsible at times for losses of up to 50 per cent.

At the Arkansas station, it was stated, 31 inches are required to bring a crop to maturity—10 inches from natural rainfall and 21 inches supplied by irrigation. The cost of applying the water is from 10 to 12 dollars per acre.

Approximately half of the rice produced in Arkansas is of a medium grain variety, Zenith. A new long grain variety named Prelude is now gaining popularity. The average yield in Arkansas is 50 bushels per acre.

In some of the large rice producing districts, aeroplanes are used for sowing the seed, and this is being done with remarkable accuracy. Aircraft are capable of sowing from 300 to 500 acres a day and each machine earns up to 500 dollars a day. The rice seed is distributed through a chute at the bottom of the plane (Plate 107) and it is claimed that it is distributed as evenly as if sown with a seed drill. Apart from the speed with which sowing is carried out, an added advantage is that the seed is sown directly on to the flooded land. With the normal method of sowing, the land would of necessity have to be dry on the surface to carry the seed drills and flooding would have to be carried out after seeding had been completed.

On one property which was visited in California, 600 acres were under rice, all of which had been sown by aeroplane. Costs of production on this property were approximately 80 dollars per acre. A yield of 30 to 35 cwt. per acre would be considered a good one.

Harvesting is carried out before the grain is quite dry, as it has been found that the high moisture content reduces cracking of the grain during harvesting (Plates 108 and 109). The grain is taken from the headers to drying plants, where the moisture content is reduced to 14 per cent. Two types of driers were seen in operation, one in which the loose grain is passed through blasts of hot air and the other in which the bagged grain is laid on small openings and hot air is forced up through the bags from underground chambers (Plate 110).

Maize.

Practically all maize grown for grain in the chief maize producing States is now hybrid maize, only a very small percentage being the open pollinated varieties.

The average annual acreage sown to maize in the United States is 90,000,000, and as the bulk of this is sown with hybrid seed the production of hybrids is now carried out on a very extensive scale. Several private concerns produce the seed on a large scale, each having its own farms on which the seed is produced. The firms concerned also have their own highly trained plant breeders to carry out the breeding work.

Maize yields for the whole of the Corn Belt are high, and this applies particularly to some of the chief producing States, such as Illinois, where the average yield has not been below 40 bushels per acre for the past 10 years. This is a remarkably high yield when it is considered that the average acreage sown each year is over 8,000,000.

Rainfall during the growing period is very reliable and is particularly well distributed, and it is only in a very exceptional season that high yields per acre are not obtained.

Since the use of hybrid seed has increased, yields have shown a consistent improvement.

Although there are quite a number of different hybrids offered for sale in Illinois, most of the leading hybrids are very closely related, as will be noted from the following pedigrees:—

U.S. 13	(Hy x L317) (WF9 x 38-11)
Illinois 21	(WF9 x 38-11) (Hy x 187-2)
Illinois 200	(WF9 x 38-11) (K4 x L317)
Illinois 201	(WF9 x 38-11) (187-2 x L317)

It will be noted that there is only one inbred line difference in the pedigrees of nearly all of these.

The cost of hybrid seed is approximately 10 dollars per bushel.

Although there are different makes of pickers on the market, the bulk of the United States maize crop is still hand-harvested. The crops in the Corn Belt were not sufficiently mature to witness any of the pickers operating in those States, but one was seen operating on a light crop in California (Plates 111 and 112). This machine performed fairly well under very favourable conditions.

Kudzu.

After travelling through most of the agricultural States, the opinion was formed that this plant is not nearly as extensively grown in the United States as many press articles would indicate. It has been found in that country that the plant only thrives in areas in which there is a moderate rainfall and where extremes of temperatures do not occur. It has also been found that the plant does not thrive in tropical high-rainfall areas. This has been the experience at South Johnstone in this State, where the plant has been under trial for a number of years. At no time has it made the prolific growth under tropical conditions that has been made by its relative, tropical kudzu.

Plate 113, which shows kudzu in Louisiana, will give an indication of how this plant thrives under suitable climatic conditions.

Plate 104.
GRAIN SORGHUM.—At right, a shallu variety, height 88 inches. At left, a shallu hybrid, height 58 inches.

Plate 105.
GRAIN SORGHUM.—A dwarf shallu hybrid.

Plate 106.
GRAIN SORGHUM.—A close view of a dwarf shallu hybrid.

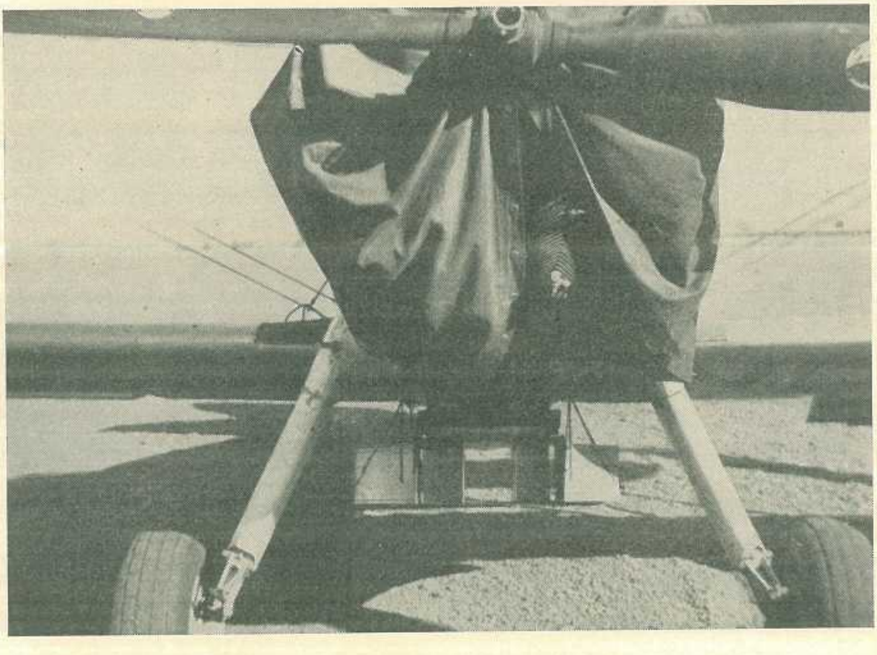

Plate 107.
RICE SOWING.—A view of the chute through which aerial sowing is carried out.

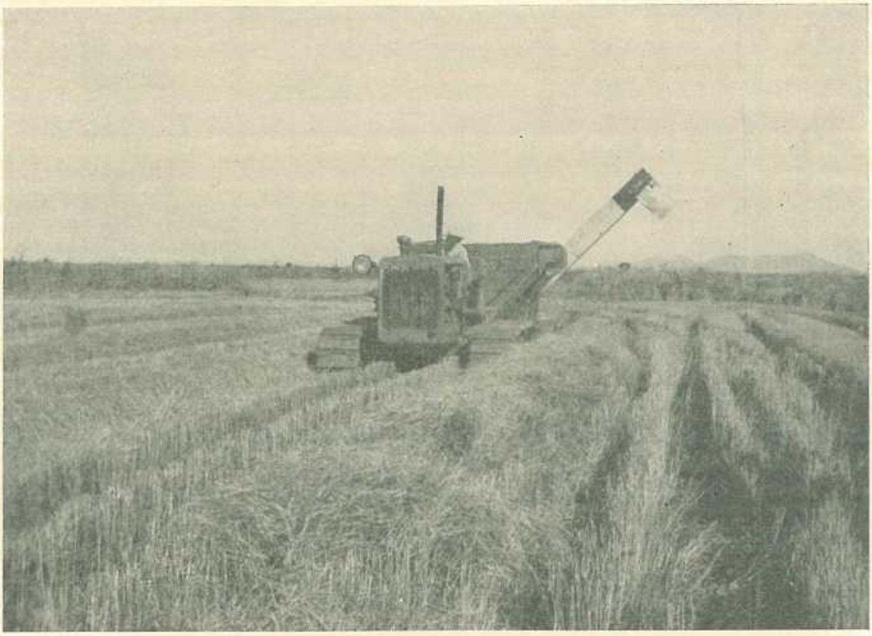

Plate 108.
A RICE HARVESTER IN OPERATION.

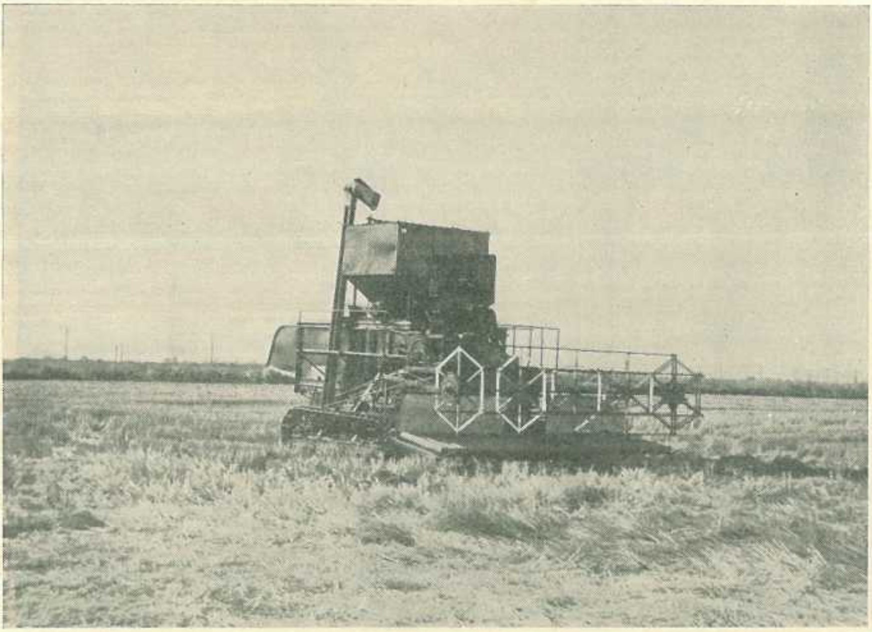

Plate 109.
A NEW TYPE OF RICE HARVESTER.

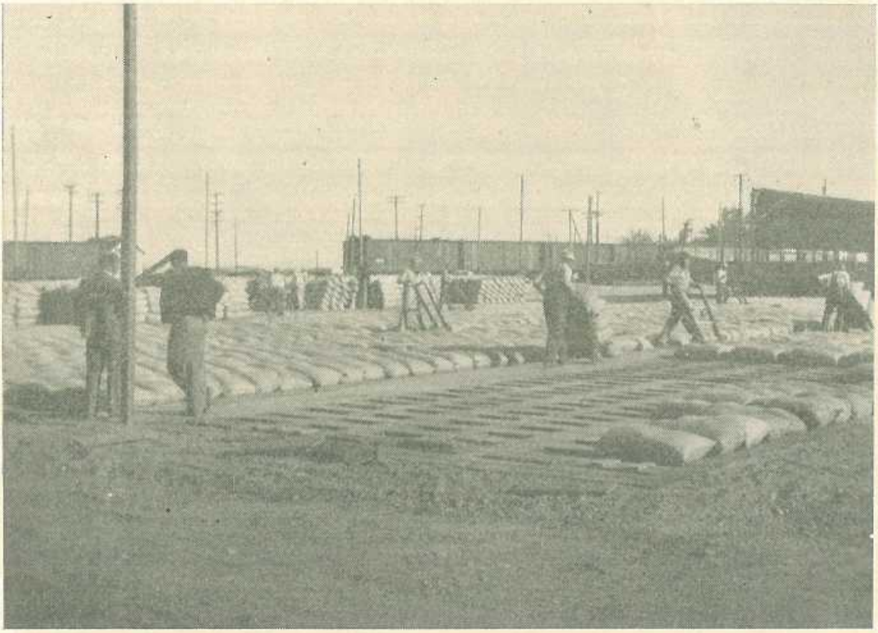

Plate 110.
RICE DRYING.—Hot air is being forced through the bags from underground chambers.

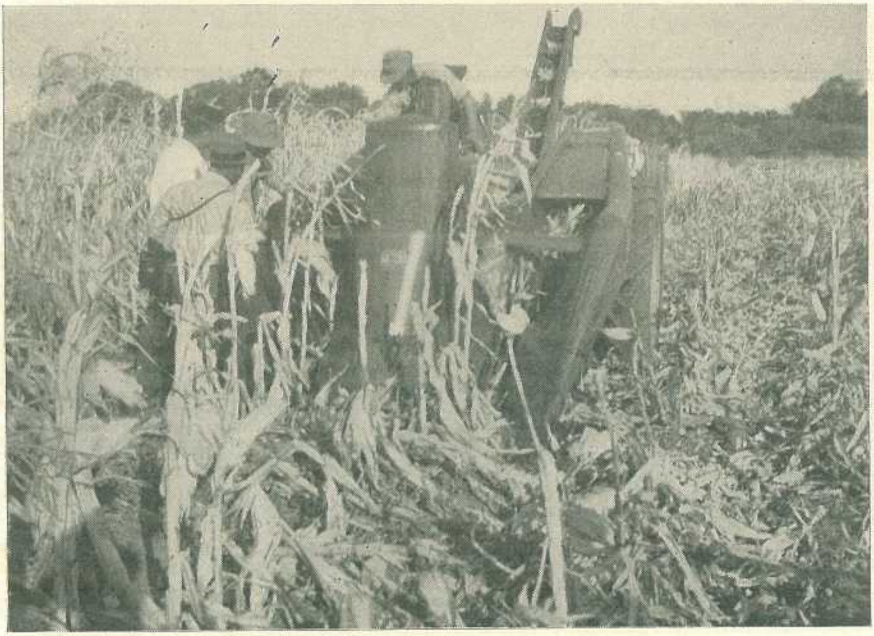

Plate 111.
MAIZE HARVESTING.—A front view of a machine in operation.

Plate 112.
Maize Harvesting.—A rear view of the machine shown in Plate 111.

Plate 113.
Kudzu Growing over Treetops.

Restoring the Productivity of Worn-out Tobacco Soils in the Miriam Vale District.

W. J. CARTMILL, Senior Soils Technologist, and R. A. TARRANT, Senior Adviser in Agriculture.

TOBACCO is grown in the Miriam Vale district under rainfall on light sandy and sandy loam soils derived from granite. As is frequently the case with soils of this nature, they are naturally of low fertility; but they are well suited to the production of bright flue-cured tobacco since the plant food status can be adjusted to the proportions required for this purpose by proper fertilization. Satisfactory yields are to a large extent dependent upon a steady supply of available soil moisture during the growing period and, since the water-holding capacity of the top-soil is low, it is desirable that the subsoil should be of heavier texture so that it will retain a greater quantity of water from which the plant can obtain its water requirements after the top soil has dried out.

Though the characteristics of the Miriam Vale soils class them as suitable for tobacco growing, it has been the experience of most growers that the soils will produce only one satisfactory crop of tobacco after they have been broken up. Attempts to utilise land which had previously grown tobacco have not met with much success even in cases where the land has been rested for four or five years. The second crop makes a stunted and irregular growth and usually becomes severely infested with nematodes. As a consequence the general practice has been to grow the tobacco crop only on virgin soils. New land is cleared each year and often the old fences are removed and re-erected around the areas of newly-cleared land. This practice greatly adds to the cost of production and restricts the growing of the crop to the availability of virgin land. By 1945 the position in regard to the availability of new land had become acute and at the request of growers investigations were then commenced on the problem of restoring the productivity of the old soils.

CAUSES OF UNPRODUCTIVENESS.

Early investigations indicated that undoubtedly one of the principal causes of unproductiveness was nematode infestation of the old land. Past experience had shown that in nearly all cases where tobacco had been planted on old land the crop became heavily infested with this pest. Nevertheless, poor and irregular growth was known to occur amongst crops showing only slight nematode infestation and it was considered that the effects of the nematodes were made severe because the plants failed to make satisfactory early growth. It is probable, therefore, that a nutritional factor is involved in the first instance. Examinations of the soils in the field suggested that the organic matter content had been depleted by cultivation. The soils on the worn-out areas showed a greater degree of compaction than neighbouring virgin soils and sometimes a lightening in colour. There was also evidence that erosion had occurred on some paddocks and in places had removed all the top soil.

Inquiry into the treatment applied to the old land following the removal of the tobacco crop revealed that the general practice was to remove the fences and allow stock free access to the areas. As a consequence of this practice only a very scanty cover of weeds and grasses established itself, and the areas virtually remained bare. It is probable that stock selectively grazed these areas because of the greater palatability of the grass shoots as a consequence of the soil containing residual supplies of fertilizer which had been applied for the tobacco crop. At all events, the grass cover on these areas always seemed to be particularly poor, which led to the general belief that the soil had become too poor to grow grass or any other crop.

IMPORTANCE OF ORGANIC MATTER.

When organic matter thoroughly decomposes it forms humus. Humus is a highly colloidal substance and because of its porosity it raises the water capacity of a soil to a marked degree. It also has a high absorptive capacity for mineral plant foods and stores these in the soil against the effects of leaching. Small increases of humus in the soil have a marked effect upon the physical properties of the soil far in excess of their proportionate amounts. Its important role in light-textured soils growing crops under rainfall is therefore apparent. There is also evidence that the harmful effects of nematodes are often markedly reduced by the addition of organic matter to soils, a factor of considerable importance in the case of the soils in question. Large quantities of crop residues are required to build up the organic matter appreciably in soils, and since these are usually not readily available they must be produced on the spot over a period of time. It has been found that one of the best ways of doing this in a relatively short time is to grow a dense grass cover on the soil and allow it to remain there for a few years. The matted root system of the grass, by its simultaneous growth and decay, adds steadily to the soil an appreciable quantity of organic matter within a year or two.

ROTATIONS PRACTISED.

To restore the productivity of these soils it was clear that some form of rotational cropping would have to be adopted. As the principal aim was to build up depleted supplies of organic matter, it was decided that grasses and legumes should form the basis of the rotations. Although it was felt that a long-term rotation would probably be necessary to restore the productivity to a satisfactory level, it was decided to work on a two-year and a three-year rotation because of the urgency of the problem and because it was considered that some indication of the value of the rotations could be obtained in three years, if not in two. Nevertheless, it was decided that the emphasis should be on the longer rotation.

The grasses chosen for trial were the summer-growing perennial Rhodes grass and the annual Sudan grass, and the legumes were the perennial centro* and the annuals Gambia pea† and velvet beans. In addition, native grasses and weeds developed from volunteer growth were included as a treatment.

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* *Centrosema pubescens.*

† *Crotalaria goreensis.*

It was decided that the investigations should be conducted as demonstration plots and that each plot should be fairly large so that all operations could be conducted on a practical scale. It was arranged that the growers who co-operated in these trials would attend to all the cultural operations and the harvesting and curing of the leaf. A 5-acre area which growers agreed was a typical sample of the worn-out lands and which had not grown tobacco for five years was selected, fenced, and divided into 10 plots each one-half acre in extent. The following rotations were commenced on the 10 plots in November, 1945:—

Plot No.	First Season (1945–46.)	Second Season (1946–47).	Third Season (1947–48).
1	Native weeds and grasses	Tobacco	Tobacco
2	Native weeds and grasses	Native weeds and grasses	Tobacco
3	Centro	Rhodes grass	Tobacco
4	Centro	Centro	Tobacco
5	Gambia pea	Gambia pea	Tobacco
6	Rhodes grass	Rhodes grass	Tobacco
7	Sudan grass	Gambia pea	Tobacco
8	Gambia pea	Tobacco	Tobacco
9	Velvet beans	Tobacco	Tobacco
10	Tobacco	Rhodes grass	Tobacco

These rotations were planned after deciding to make the following the main features of the trials:—

(*a*) The principal rotations to be on the basis of a three-year period, with tobacco following two years under grass and/or legumes.

(*b*) Tobacco to be followed by tobacco in some of the short-term rotations to determine the extent of the decline in productivity.

(*c*) One plot to be planted to tobacco in the first season to determine if the land would not grow a satisfactory crop of tobacco in its existing state, as had been claimed.

(*d*) The whole area to be under tobacco in the third season.

As it was important to ensure that the various crops should be given every opportunity to establish themselves satisfactorily in the first season, the land was ploughed and harrowed and fertilized with a moderate dressing of a complete fertilizer mixture, excepting Plots Nos. 1 and 2, which were only topdressed with fertilizer.

TREATMENTS AND RESULTS.

Though all the treatments for the first season were established according to plan it soon became apparent that some were very promising and that others would not be successful. Rhodes grass flourished from the start and formed a dense stand. The native grasses were slow to close in but eventually a fairly dense stand of mixed species, but principally of bunch spear grass,* was developed. Sudan grass died out early and creeping summer grass† took possession of the plot. Gambia pea grew vigorously and formed a good cover where the stand

* *Heteropogon contortus.*

† *Digitaria* sp.

was satisfactory. Centro made slow growth and for a time native grasses dominated those plots. Velvet beans failed early and creeping summer grass took possession of that plot also. The tobacco on Plot No. 10 failed to make much headway, and though some individual plants made good growth the plot was written off as a failure. This result substantiated the claim made by growers regarding the low productivity of the land in relation to tobacco.

Details and results of the various rotations are as follows:—

Plot No. 1.

1945-46 *Season.*

Topdressed with 240 lb. of mixed fertilizer (4·5:12·0:4·5).

Native grasses and weeds, consisting mainly of bunch spear grass, with creeping summer grass, crowsfoot* and horse weed,† were permitted to grow. A good cover was established after a slow initial growth.

Plate 114.
TOBACCO FOLLOWING ONE YEAR OF NATIVE GRASSES (PLOT 1, 1946-47).

1946-47 *Season.*

Grasses ploughed under. Fertilized with a 4:12:6 mixture at the rate of 480 lb. per acre and planted to tobacco. Yield = 625 lb. of cured leaf per acre. (See Plate 114.)

1947-48 *Season.*

Fertilized as before and again planted to tobacco. Plants stunted and badly infested with nematode. Crop considered a failure.

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* *Eleusine indica.*
† *Erigeron* sp.

Plot No. 2.

1945-46 *Season.*

Same as for Plot No. 1.

1946-47 *Season.*

The grasses and weeds made good growth and formed a dense cover. (See Plate 115.)

1947-48 *Season.*

Grasses and weeds ploughed under. Area fertilized with 4:12:6 mixture at the rate of 480 lb. per acre, and planted to tobacco. The strike was poor, but subsequent growth good. Difficulty was experienced

Plate 115.

RIGHT.—NATIVE GRASSES AFTER TWO YEARS (PLOT 2, 1946-47).
LEFT.—RHODES GRASS FOLLOWING CENTRO AND SUMMER GRASS (PLOT 3, 1946-47).

in rotting the grass, which had grown tall and rank and did not plough under well. It was because of these conditions that the resultant strike was poor.

Yield = 325 lb. of cured leaf per acre. (See Plate 116.)

Plot No. 3.

1945-46 *Season.*

Fertilized with 240 lb. of a 2:15:4 mixture and sown to centro. A poor strike resulted and subsequent growth was slow. Eventually a dense growth of summer grass took possession though the centro plants persisted.

1946-47 *Season.*

The mixed stand of summer grass, centro and crowsfoot was ploughed in and the plot sown to Rhodes grass. A dense growth of Rhodes grass resulted. (Plate 115.)

1947-48 *Season.*

The Rhodes grass was ploughed in, and the plot fertilized with 4:12:6 mixture at the rate of 480 lb. per acre and planted to tobacco. The crop grew well and excellent quality leaf was produced. Yield of cured leaf = 632½ lb. per acre.

Plot No. 4.

1945-46 *Season.*

Fertilized and sown to centro, as for Plot No. 3. The strike was only fair and the growth of the legume slow, and summer grass invaded the plot.

Plate 116.
Tobacco Following Native Grasses for Two Years (Plot 2, 1947-48).

Plate 117.
Tobacco Following Gambia Pea for Two Years (Plot 5, 1947-48).

1946-47 *Season.*

The centro made further growth and eventually a thick cover of summer grass and centro was developed.

1947-48 *Season.*

The grass-legume mixture was ploughed under and the plot planted to tobacco after fertilizing with 4:12:6 mixture at the rate of 480 lb. per acre. A good crop of high quality leaf was produced, yielding 731½ lb. of cured leaf per acre.

Plot No. 5.

1945-46 *Season.*

Fertilized with 240 lb. of a 2:15:4 mixture and Gambia pea sown broadcast. An excellent crop resulted, which seeded freely.

1946-47 *Season.*

The plot was given no further treatment. A second crop of Gambia pea grew from the seed of the first crop as well as from the base of the old plants, and a dense growth resulted.

1947-48 *Season.*

The Gambia pea was ploughed under and decomposed readily. After fertilizing with a 4 : 12 : 6 mixture at 480 lb. per acre the plot was planted to tobacco. The crop grew well and yielded 924 lb. of cured leaf per acre. (See Plate 117.) The quality of the leaf was very good.

Plot No. 6.

1945-46 *Season.*

Fertilized with 240 lb. of a 4·5 : 12·0 : 4·5 mixture and Rhodes grass sown broadcast. The grass became well established and a dense cover developed. It seeded freely.

Plate 118.
RHODES GRASS AFTER TWO YEARS (PLOT 6, 1946-47).

1946-47 *Season.*

A dense cover of Rhodes grass was maintained without further treatment. (See Plate 118.)

1947-48 *Season.*

The grass was ploughed under and the area prepared for tobacco. It was fertilized with 4:12:6 mixture at the rate of 480 lb. per acre. The grass was somewhat slow to decompose, with the result that only a fair strike of tobacco was obtained. The subsequent growth was very good and the resultant yield of 742½ lb. per acre of cured leaf must be considered very good under the circumstances. (See Plate 119.)

Plot No. 7.

1945-46 *Season.*

Fertilized with 240 lb. of a 4·5 : 12·0 : 4·5 mixture, and Sudan grass sown broadcast. The crop did not thrive and eventually died out. Late in the season the plot was reploughed and sown to Rhodes grass, but because of dry conditions the germination was poor.

Plate 119.

TOBACCO FOLLOWING RHODES GRASS FOR TWO YEARS (PLOT 6, 1947-48).

Plate 120.

TOBACCO FOLLOWING TOBACCO (PLOTS 8, RIGHT, AND 9, LEFT, 1947-48).

1946-47 *Season.*

The plot was sown to Gambia pea without any further preparation and a good strike and excellent growth resulted.

1947-48 *Season.*

The Gambia pea was turned under and the area prepared for tobacco. It was fertilized with 4:12:6 mixture at the rate of 480 lb. per acre. The tobacco crop yielded 847 lb. per acre of good quality leaf.

Plot No. 8.

1945-46 *Season.*

Fertilized with 240 lb. of a 2:15:4 mixture, and sown to Gambia pea. Only a fair strike resulted and, because of the fairly thin stand of legume, summer grass invaded the plot and was choking out the legume when the mixture of legume and grass was ploughed in late in the season and the plot sown to Rhodes grass. Because of drought the germination of Rhodes grass was very poor.

1946-47 *Season.*

The plot was ploughed, and prepared for tobacco. It was fertilized with 4:12:6 mixture at the rate of 480 lb. per acre before planting. A very satisfactory yield of 742½ lb. of cured leaf per acre was harvested. (See Plate 121.)

1947-48 *Season.*

The plot was again planted to tobacco after fertilizing with 4:12:6 mixture at the rate of 640 lb. per acre. The growth was very poor and the yield of cured leaf was only 165 lb. per acre. Nematode infestation was severe. (See Plate 120.)

Plate 121.

TOBACCO FOLLOWING GAMBIA PEA AND SUMMER GRASS FOR ONE YEAR (PLOT 8, 1946-47).

Plot No. 9.

1945-46 *Season.*

Fertilized with 240 lb. of 2:15:4 mixture and velvet beans sown in drills 4 feet apart. Shortly after germinating the plants gradually died off and eventually the plot became a mass of creeping summer grass.

1946-47 *Season.*

The grass was ploughed in and the plot prepared for tobacco. It was fertilized with 4:12:6 mixture at 480 lb. per acre. From the tobacco crop a satisfactory yield of 660 lb. of cured leaf was harvested. (See Plate 122.)

1947-48 *Season.*

Tobacco was again planted after fertilizing with 4:12:6 mixture at the rate of 640 lb. per acre. The growth was very poor and the plants became infested with nematodes. The resultant yield of leaf was only 143 lb. per acre. (See Plate 120.)

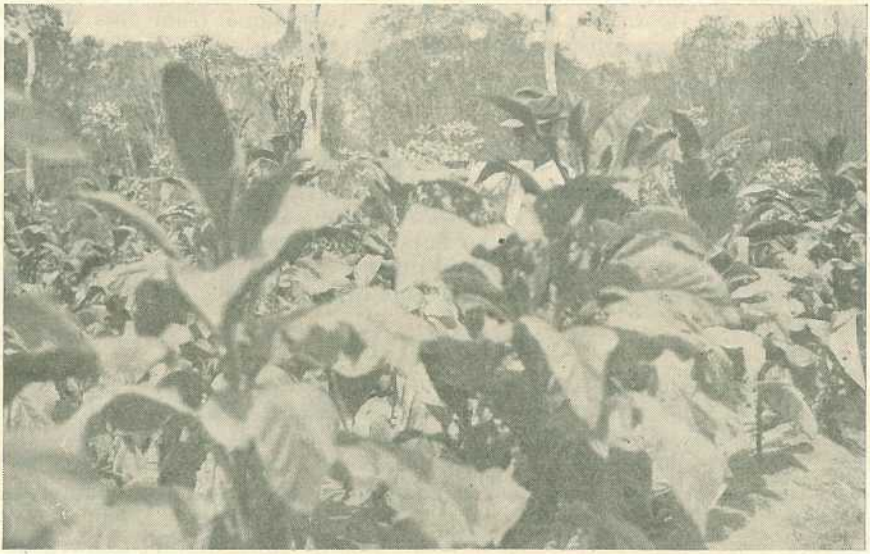

Plate 122.

Tobacco Following Velvet Bean and Summer Grass for One Year (Plot 9, 1946-47).

Plot No. 10.

1945-46 *Season.*

Planted to tobacco. One half of the plot was fertilized with 4·5:12·0:4·5 mixture and the other half with 3:9:7 mixture, both at the rate of 960 lb. per acre. The plants mostly made a stunted and irregular growth and became heavily infested with nematode. Odd plants grew well, but the crop as a whole was a failure and was not harvested.

1946-47 *Season.*

The plot was ploughed and sown to Rhodes grass. No fertilizer was applied. The grass grew well during the season and a dense cover was established.

1947-48 *Season.*

The Rhodes grass was ploughed under and the plot prepared for tobacco. The tobacco was planted after fertilizing with 4:12:6 at 480 lb. per acre. A fairly satisfactory yield of 583 lb. per acre of cured leaf was harvested.

FIELD OBSERVATIONS.

An interesting observation of the effect of the various rotations on the soil was made when the whole area had been ploughed and prepared for tobacco at the commencement of the third season. The different plots exhibited various shades of colour from light grey to a much darker grey, the darker shades corresponding with plots on which a heavy cover crop had just been turned under. The darkening in colour was regarded as evidence of a substantial increase in organic matter in the soil.

During a hot dry spell in January-February of the third season the tobacco crops which followed a cover crop in these rotations showed no sign of stress, whereas those which followed tobacco wilted and scorched badly. Many crops throughout the district also wilted and scorched during this heat wave. It is reasonable to assume from this observation that the organic matter added to the soil had improved its moisture holding capacity, which stood to the plants during the dry period.

Nematode infestation observations made at the end of the third season revealed that few of the plants were attacked on plots where tobacco followed a cover crop. On an average the affected plants represented less than 1 per cent. of the crop, and on these the infestation was so slight that it had no important physiological effect on the plants. On the other hand, a heavy infestation occurred where tobacco had been followed by tobacco and the plants were severely affected thereby.

DISCUSSION.

The trials demonstrated that a dense cover of native grasses and certain sown grasses and legumes can be readily established on these worn-out soils if the soils contain a reasonable amount of plant nutrients and provided stock are not allowed access to the areas. Normally, sufficient plant food to establish a good cover crop would probably be contained in the soil as residual fertilizer following the removal of the tobacco crop. This contention is borne out by the splendid growth of Rhodes grass following tobacco obtained in Plot No. 10.

After turning under a good cover crop the productivity of the soils for tobacco is as good as, or even better than, that of virgin soil, based on yields of cured leaf. Yields above 600 lb. of cured leaf per acre are rarely obtained in the district, whereas in these trials several yields were above that figure.

Although the two-year rotation gave surprisingly satisfactory results it is considered that the longer rotation is preferable and definitely safer.

Legumes appeared to have a pronounced effect on yield. The highest yields followed the ploughing in of a dense stand of Gambia pea, while following a legume-grass mixture the yields were high and better than after grass alone. However, it is thought that this result was largely brought about by the greater rapidity of decomposition of the legume. In the case of the grasses, insufficient time had elapsed between ploughing under and planting to tobacco for complete decomposition of the organic matter to occur, and the strike was adversely affected as a consequence.

The failure of the tobacco crop in the first season paralleled the experience of growers that a bare fallow does not restore the productivity of the soil. Neither is it maintained for more than one season, as illustrated by the failure of the second plantings in Plots Nos. 1, 8 and 9. This also had been the experience of growers.

From the practical aspect an important feature of these trials was the virtual absence of nematode infestation on the tobacco crops following a good cover crop. Nematodes have always been considered a major obstacle to tobacco growing in these soils, but in the light of these investigations it appears that if the soil organic matter content is satisfactory the effects of the pest are negligible.

CONCLUSIONS AND RECOMMENDATIONS.

To maintain the productivity of the Miriam Vale tobacco soils it is evident that some form of rotational cropping must be adopted. As the maintenance of productivity seems to be dependent on the maintenance of the soil organic matter at a satisfactory level it is desirable, if not essential, that the rotation should include a cover crop. The cover crop should be established as soon as possible after the removal of the tobacco to take advantage of the residual supplies of fertilizer in the soil and to ensure its satisfactory growth while avoiding the necessity of applying more fertilizer. It is important that stock be kept off the area, at least until the cover crop is well established. Judicious grazing so that the cover crop is not destroyed is not likely to have any detrimental effect on the value of the crop for soil renovation purposes and the land need not therefore be entirely unproductive during the renovation period.

The cover crop should be maintained for at least two years and preferably longer. The minimum time required for a satisfactory restoration of soil productivity would depend to some extent on the condition of the cover crop. A dense stand, for example, would effect a considerable improvement after only one year.

The cover crop should be ploughed in about two months before planting to tobacco if weather conditions permit. If it is ploughed in too early, decomposition and loss of humus would proceed fairly rapidly through exposure and leaching and much of the benefit of the crop would be lost by the time the tobacco is planted. On the other hand, sufficient time should elapse for the decomposition of the organic matter to be almost complete when the tobacco is planted, otherwise the establishment and early growth of the tobacco might be adversely affected.

With regard to the choice of crops, it is probable that there are a number of different crops that would form good covers and be efficient renovators on these soils; but it can be confidently stated from the results of these trials that the legume Gambia pea is eminently satisfactory for this purpose. Rhodes grass can also be relied upon to give good results, while in addition it could fill the role of a useful pasture grass. There is no doubt that a Gambia pea–Rhodes grass mixture would also give good results, and the mixed crop would probably decompose in the soil more rapidly than the grass alone. Native grasses and weeds are useful soil renovators if they form a dense cover, but on land which has been recently cultivated they would probably be slow to close in.

While Gambia pea makes a useful cover crop it would be of no value for grazing purposes; in the first place it is regarded as being unpalatable to stock, and in the second it is suspected of having poisonous properties, in common with other plants of this species (rattlepods).

Summing up, from the results of these trials the following procedure can be recommended for restoring the productivity of the Miriam Vale tobacco soils:—

1. Plough or harrow the area in the early summer following the harvest of the tobacco crop.
2. Sow to Gambia pea (10 lb. per acre) or Rhodes grass (10-15 lb. per acre), or a mixture of the two (5 lb. Gambia pea and 7 lb. Rhodes grass).
3. If the area is to be used for grazing, keep stock off until the crop is well established and then avoid overgrazing.
4. Allow the cover crop to remain for at least two years. For this purpose annual crops (e.g. Gambia pea) should be permitted to seed.
5. Turn under about two months before planting to tobacco.

The Mango.

S. E. STEPHENS, Horticulturist, Horticulture Branch.

(*Continued from page* 153 *of the March Issue.*)

CULTURAL PRACTICES.

Tree Spacing.

AS this fruit tree grows to an immense size on suitable soil and as any interlacing of branches of adjoining trees causes a great reduction in cropping it is essential to allow plenty of room between the trees. A reasonable distance for planting is 40 by 40 feet, but on very good land the spacing could be well increased to 50 by 50 feet. As indicated earlier, a mango tree with a measured branch spread of 125 feet has been recorded, but of course this is abnormally large and such large trees need not be catered for in planning an orchard. However, a 50-feet spread may be considered quite normal in Queensland for mature trees grown under favourable conditions, so such a tree size should be kept in mind when considering the layout. At 40 by 40 feet spacing, 27 trees per acre may be planted and at 50 by 50 feet, 18 can be accommodated.

On poor soils, and under adverse climatic conditions such as cold winter temperatures, tree growth will be much less vigorous, so planting distances of 35 by 35 feet, allowing 35 trees per acre, may be quite safely employed.

Setting out the Trees.

If young seedlings, raised as already explained, are to be used the planting of the orchard entails little difficulty. The plants should have the foliage reduced by about two-thirds, which is accomplished by cutting off two-thirds of each leaf, and the young tree is then set in a hole prepared in the usual manner for tree planting. A hole of ample size to accommodate the roots without bending them must be dug. The young tree must be set the same depth in the soil as it was in the seed-bed, and the soil should be firmly trodden in round the roots when refilling the hole. A bucket of water is poured into the hole before it is completely filled and, when this has soaked away, the hole is topped off with dry soil. Shade from a small leafy branch pushed into the soil beside it gives the young plant a chance to establish itself if weather conditions should be adverse.

If budded trees or large seedling plants are to be used in establishing the orchard the preparation for planting is rather more involved, as preliminary conditioning of the young trees is necessary. This should be carried out about six weeks before it is desired to plant the orchard and consists of digging down beside each tree to a depth of about 12 inches and severing the tap root. Sometimes mangoes have a forked tap root. In such cases, both branches of the root must be cut. The cutting is best accomplished with secateurs, so that a clean cut without bruising of the bark is obtained. The hole is then refilled and the trees given a good watering.

The object of this root-cutting operation is to induce the formation of many vigorous surface roots. The root cutting must not be done too long before transplanting as the tree commences to grow a new tap root from the severed end within a short time after the operation and the development of this defeats the objective.

When the root forming period has elapsed, the young tree should be carefully dug to retain a ball of earth on the roots and then set in the prepared hole in the orchard, with the usual planting practices of firming the soil and watering in. Shortening back of the foliage to about half is sufficient to allow the establishment of a well-balled tree.

If bare root planting is necessary, as may be the case when the young trees have to be transported some distance, then the roots should be well puddled immediately the plants are dug and a good three-quarters of the foliage cut away. The digging of the trees should, of course, have been preceded by the customary severing of the tap root. Such trees are then planted in the same way as any other tree received from a nursery. They will require care in the provision of shade and water until they become established. Even so, the mortality in bare root planted trees is much higher than that in balled trees.

The best time for transplanting mangoes is in the summer during the monsoonal wet season. At this period there is not only ample soil moisture to ensure growth but the atmospheric moisture is also high, so the tops are not subjected to desiccating air influences during the difficult period of establishment.

Balled or potted trees are less affected by adverse weather than are bare root plants since their rooting system is not subjected to such disruption. Such plants may therefore be set out quite successfully at other times of the year, provided facilities are available for watering regularly. In all cases the plants should be moved only when they are in a dormant condition, which is indicated by the normal dark-green colour of the terminal shoots.

Cultivation.

The usual methods of orchard cultivation are recommended. During the early years of the establishment of a mango orchard, use can be made of the wide inter-row spaces to grow small crops. The cultivation required by these will maintain the land in good condition for the mangoes, and the crops produced will assist to cover the costs of establishing and tending the orchard.

After the trees have reached an age and size that render further intercropping inadvisable, and also during the earlier years at times when cropping is not being practised, it is desirable to have the soil protected by a cover crop. Such cover crops as cowpeas—Black, Poona, Groit, Clay, Giant, or other variety—are suitable for short term covers, and the perennials such as dolichos,* calopo,† and Madagascar bean‡ for long term covers. Centro§ is not as suitable on account of its pronounced tendency to climb trees. Even those listed as suitable must be watched and cut back from young trees from time to time to prevent smothering.

Pruning.

The whipstick seedling should have its terminal bud pinched out when it reaches a height of about 3 feet in order to start the main frame of the tree. Failure to do this often results in a single straight sapling 15 to 18 feet high. If pinching back has been neglected at the correct period, then it will be necessary to cut back the top to a point just above a growth ring at the appropriate height. A number of shoots will grow from the head at the next flush. They should be reduced to two or three to form the main branches. These in turn can be pinched back when they have made 18 inches to 2 feet of growth to induce further branching. The only pruning needed subsequently is the removal of weak shoots that grow in the centre of the tree, the cutting out of branches that cause overcrowding and the shortening back of limbs that droop too close to the ground.

The season for pruning is immediately following fruit harvesting when the trees are dormant for a short period.

Fertilizing.

The manurial requirements of the mango are not fully known. No experimental work has yet been undertaken in Queensland on the subject and the present recommendations from overseas countries do not appear to have been based on any extensive experimentation. However, research on the subject now in progress in several countries should lead to the laying down of a manurial programme based on accurate knowledge of the requirements of the tree.

The opinions of overseas authorities seem to agree that the trees require fairly large applications of nitrogenous manure during the early years of growth and that once fruiting commences the emphasis should be on phosphate and potash. The balance of opinion regarding the nitrogen applications is that farmyard manure, dried blood, or some other form of organic nitrogen is preferable, but that its application after fruiting commences is inadvisable. Much stress is placed on the importance of phosphate and potash in ensuring regular cropping. Recommendations for bearing trees favour complete fertilizer mixtures of formulae such as 4:8:8, 5:8:10, 5:8:15, and 5:15:12. It will be seen there is fairly general agreement regarding the percentage of nitrogen, but the proportions of phosphate and potash recommended vary. However, for the purpose of fertilizing mango trees in Queensland these formulae may be adopted as a general basis. The one to be selected should be that containing the higher proportion of the element known to be most deficient in the particular orchard or district.

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* *Dolichos hosei.*

† *Calopogonium mucunoides.*

‡ *Phaseolus lunatus.*

§ *Centrosema pubescens.*

Regarding the amount of fertilizer per tree, opinions are just as varied as they are concerning the best source of manurial constituents and their proportions. On the basis of the percentages of N, P and K contained in the standard fertilizers available in Queensland, the overseas recommendations vary from 1 lb. to 7 lb. of complete mixture for young trees and 8 lb. to 40 lb. for mature bearing trees. It may therefore be concluded that at present the amount of fertilizer to apply must be governed very largely by the general fertility level of the soil. Thus, trees planted on soils known to be fairly well provided with available plant foods could receive amounts in the lower range of applications, while those on the poorer soils should be given the larger amounts. The condition of the individual trees should, however, also be taken into consideration when deciding on the amount of fertilizer needed.

As to time of application of fertilizer, there is fairly general agreement that applications immediately before and immediately after the summer wet season give best results, the total annual dressing being split fairly evenly between the two periods.

FRUITING.

In coastal North Queensland, the flowering season is very long. In some years the first blossoms may appear late in April and at times the flowering has continued as late as mid-October. Flowers may be noted on the trees throughout the whole of this period, but two seasons of heavy flowering occur. These vary by a few weeks in different parts but occur approximately during part of the June-July and part of the August-September periods.

In sub-tropical Queensland and on the northern highlands, the flowering period is restricted to the spring months of August to October.

With such extended flowering as occurs in North Queensland, the fruiting period may be expected to be similarly extended. However, except in the case of the Townsville district, this is rarely the case, for, as has been noted above in connection with climate, early flowers are destroyed by fungal infection. Except for Townsville, where fruit from the early flowering is harvested during August and September, the main fruit ripening season extends from November to the end of January. With increase of south latitude and also with increased altitude in the tropical area, the maturity season becomes later, extending to late March at the extreme Queensland range. The age of a mango tree at first fruiting is variable but the general rule is five to seven years. Some varieties commence at an earlier age. The variety Kensington is extremely precocious when grown under good conditions, as its first fruits are borne at three years of age.

Four to five months usually elapse between flowering and maturity of fruit. During the early stages of growth the fruit is normally of a dark green colour, but as it approaches full size the skin commences to assume a blush characteristic of the particular variety on the cheek exposed to the light. However, colouration is environmental as well as varietal and may vary in the one variety grown under different environmental conditions. This is particularly apparent in the case of soil factors influencing density of tree growth. Under conditions that produce a dense head the dominant colour in the fruit is yellow, the red blush being lacking.

During the short period of about 10 days before full maturity is reached, the fruit fills out, increasing considerably in minor diameter and appreciably in major diameter. When this occurs the fruit is mature and will ripen satisfactorily if picked. It will be found, too, that at this stage the fruit stem snaps readily when the fruit is bent back sharply on it. At earlier stages of development the stem attachment is very secure. A strong pull is necessary to dislodge the fruit and often the full length of stem comes away attached to the fruit. Abscission cells in the stem, which permit the easy breaking, apparently develop only when the mango is very near to maturity.

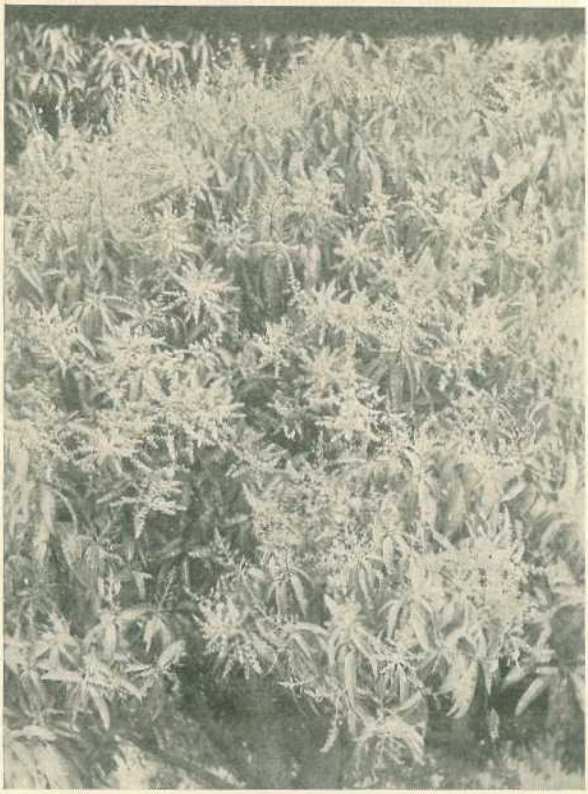

Plate 123.
MANGO FLOWERS ILLUSTRATING THE TIP FLOWERING HABIT AND PANICULATE INFLORESCENCE.

HARVESTING.

Fruit harvesting from a large tree such as the mango is not an easy operation. It is, of course, essential that the fruit be picked carefully from the tree by hand and placed carefully into the picking boxes. Gathering the fruit from the ground after it has been dislodged by rough shaking of the tree should not be tolerated. Fruit on the lower branches can be harvested easily from a cart or truck but the higher fruit, which is often the best fruit on the tree, is difficult to secure. A proportion of such fruit can be picked from the inside by climbing into the branches, but most of it is on the outermost tips of the branches and so beyond reach from inside. Three methods can be used successfully to harvest this fruit.

The first involves a long, light rod fitted with a hook and a bag at one end. The bag is arranged under the hook with its mouth held open so that the fruit, when hooked and pulled, falls into it. The bag should

Plate 124.

VIEW OF MANGO-HARVESTING LADDER ILLUSTRATING DETAILS OF CONSTRUCTION.

be only shallow and of small capacity as it is not possible to support the weight of more than four or five fruit on the end of the long rod and still operate it with ease. Though fairly satisfactory, this method is slow.

For the second method a long light ladder to lean against the tree is required. As a ladder of the length required to reach the highest parts of a tree would be cumbersome to handle and also rather insecure if stood on its own narrow base, a good plan is to fit it on a pair of wheels with a wide axle, such as a pair of old hay rake or sulky wheels. Plate 124 illustrates such an arrangement as used by a mango grower on Magnetic Island. The ladder is easily wheeled from place to place as required and when the top is leaned against a tree and the feet dropped on the ground it is quite rigid.

An elevated platform, which is the third method, is probably the most effective arrangement but is more elaborate and more expensive to construct. It is actually a small tower of light construction equipped with an extending platform on top and hinged platforms at intervals as required up its side. The tower is mounted on the back of a truck, the picker or pickers working from the platforms and moving the truck round the trees as required. The arrangement is on exactly the same principle as the tower used by electric authorities for attending overhead tramway wires or lights, with the addition of one or more drop platforms at different heights.

Handling of fruit at all stages, whether in the orchard or in the packing shed, must be carried out with care. Mango fruit bruises very readily and then breaks down rapidly.

Information on the grading and packing of fruit does not come within the scope of this article but may be obtained from the Department of Agriculture and Stock, Brisbane.

YIELD.

Fruit yield is very variable from variety to variety quite apart from the annual variation due to seasons and climate. The Queensland Common variety is consistently a heavy cropper and in the Bowen district is estimated to give an average harvested yield of eight bushels per tree. This, however, is only a portion of the yield as the Commons are seldom fully harvested. The Kensington variety crop, which is harvested in its entirety, averages four bushels from trees in early maturity, that is, at 10 to 15 years of age.

Aged trees over 25 or 30 years produce yields up to double those quoted above but accurate figures for these are not available.

PESTS AND DISEASES.

In common with most other cultivated fruits, the mango is frequently subjected to attack by fruit fly, and in addition there are at least two pests peculiar to this particular fruit.

The mango weevil* causes some loss of crop by burrowing into the seed. Only one larva of the weevil usually enters a fruit. Its entry is made while the fruit is very young and the injury is so slight that it often heals over completely during the growth of the fruit. Sometimes it causes fruit deformity but often there is no external evidence of its presence. Its feeding in the seed often causes premature ripening and shedding of the fruit. In some seasons the pest is responsible for the fall of much of the crop on individual trees.

The tip borer† is the larva of a moth which lays its eggs on or near the tip growth of mango shoots. The larvae enter the immature shoots and tunnel them out back to the hard wood. This results in the death of the tip growth and the development at the subsequent growth flush of a number of shoots from the injured terminal. If these in turn are attacked, as frequently happens, and further fresh growths from the same point similarly destroyed, a deformed condition develops. In

* *Cryptorhynchus mangiferae.*

† *Peperita euthysticta.*

addition to causing more or less permanent disfigurement to the tree, the destruction of the young shoots affects cropping. Plate 125 illustrates the type of injury caused by the tip borer.

Parrots during daylight hours and fruit bats or flying foxes at night cause much destruction at times. In taking steps to combat them it is essential to destroy the first marauders as soon as they discover the fruit because on each occasion on which they return to the tree they bring more of their companions with them.

Plate 125.
Typical Injury Caused by the Mango Tip Borer.

Mention has been made previously of the injury and loss caused by a fungus. This is commonly known as anthracnose. It is responsible for the destruction of flowers and young fruit and for the tear streaking of fruit in the more advanced stages of development.

Detailed information regarding the pests and diseases of the mango and methods for their control may be obtained from the Department of Agriculture and Stock, Brisbane.

PLANT PROTECTION

The Control of Heliothis in Linseed.

A. W. S. MAY, Entomologist, Science Branch.

DURING the past two years, considerable progress has been made in establishing linseed as a commercial crop on the Darling Downs and adjacent inland districts. Although the acreage sown to this crop should expand considerably in future years, certain problems must be solved before linseed growing can become firmly established. The part played by pests threatens to become a major issue in the successful cultivation of this crop and growers are well advised to make themselves familiar with this problem so that crop losses can be avoided.

The corn ear worm, or Heliothis*, has long been recognised as an important pest of maize, cotton, lucerne, tomatoes and other crops in this State, while it had also been recorded elsewhere as a pest of linseed. Although it caused little damage to small experimental sowings of linseed in Queensland in 1947, it attained major importance during the following year and may have greatly reduced yields had not the likelihood of pest attack been anticipated and the necessary measures taken to counteract it.

DESCRIPTION OF HELIOTHIS.

The moth has a wing expanse of about one-and-a-half inches and varies in colour, the average having grey-brown forewings marked with dark-grey irregular lines and smoky-grey hind wings which darken towards the edges. They are stout bodied and fly very rapidly, particularly when disturbed in a crop. On cloudy days in early spring they may be seen flying among the linseed, but more usually they fly at dusk and on warm evenings deposit their small whitish eggs singly on the buds, flowers and tips of plants. On the average, a moth can lay over 1,000 eggs during the two weeks of its life.

The young larvae hatch within a week of egg-laying and at first feed on the flower parts or unopened buds close to where the eggs were deposited. As they develop they favour the seed capsules, eating out the developing seed. When fully grown, the larvae measure approximately 1½ inches long and vary considerably in colour, individuals in a crop ranging through shades of green and brown to black, each being additionally marked with longitudinal stripes.

The larval stage lasts from two or four weeks, during which time one larva may destroy a large proportion of the seed capsules on a plant, showing little tendency to migrate far from the site where the

* *Heliothis armigera* Hbn.

egg was deposited. When fully grown, the larva descends the plant and enters the soil, where it changes into the resting stage known as the pupa, from which a moth subsequently emerges.

FACTORS INFLUENCING PEST ATTACK.

Linseed crops planted in late autumn rarely suffer damage from the pest until the seed capsules are forming in the following spring. By this time some Heliothis moths will have emerged from the over-wintering pupae in the soil and having matured their eggs will be eagerly seeking a suitable host on which to deposit them. Flowering linseed is very attractive to these moths. It is therefore evident that the amount of damage done to a linseed crop will depend on three factors:—(1) the number of moths present in the spring; (2) the time that they are ready for egg-laying; and (3) the time that the linseed flowers and becomes attractive.

The number of moths emerging in the spring is governed by the pest population in the preceding autumn and the survival rate of the overwintering pupae. Apart from attacking many cultivated crops, this pest can breed on numerous weeds, and these latter hosts are often responsible for some of the more serious outbreaks that occur from time to time. Good growing conditions in the preceding summer and autumn will ensure many hosts for a large-scale breeding of this pest and may give rise to a large pest population by late autumn. In addition, high soil moisture during winter favours survival of the hibernating pupae in the soil and also ensures early moth emergence.

The time of moth emergence in the spring is a reflection of soil temperature and soil moisture during winter. Some moths may be present in early September, but a certain time must elapse between moth emergence from the soil and egg-laying; thus crops flowering early in September may escape attack, while crops flowering later in the month would experience greater damage. Thus from early September onwards, with the number of moths increasing as emergence proceeds, the time of flowering of the linseed will govern the extent of pest attack.

Investigations in the 1948 season supported these conclusions. Ideal conditions for breeding in the preceding summer and autumn were followed by a winter favourable for pupal survival. Crop damage increased very appreciably as the date of flowering of individual crops was delayed through September and into October. These conditions will not be repeated every year but will fluctuate considerably insofar as the many factors governing the pest build-up and crop development vary. It is sufficient to state that the likelihood of pest attack can only be gauged with certainty by an actual observation of the moth population in the crop at flowering time. The weather conditions of summer, autumn and winter may suggest conditions for or against a pest outbreak, but farmers are advised to be prepared for any eventuality in the spring.

CONTROL MEASURES.

The Value of Certain Cultural Measures.

Though control of this pest may be achieved by the application of DDT, the likelihood of pest damage in the spring can be offset to a considerable degree by the proper use of cultural measures. There are many factors governing the probability of Heliothis attack in the spring, and it is extremely difficult to forecast what may eventuate. In years when winter rains are light, the pest position may not be serious and satisfactory control may be possible by these measures alone.

Experience has shown that even in years when moths are prevalent in the spring early-planted crops largely escape Heliothis damage. In such instances, early crops have completed flowering before many moths have emerged and cease to be attractive for egg-laying. Planting in early May gave the best results in the 1948 season, although it is possible that April sowings may have an added advantage. Admittedly, weather conditions, adequate soil moisture and seed-bed preparation all govern the time of seed sowing, but where possible farmers should aim to plant their crops as early as practicable and so promote flowering in the early spring. When a dry autumn delays operations, planting should proceed at the first opportunity.

The rate of seed sowing is another important consideration, for it may govern the rate of crop development and the period of flower formation. Any tendency to prolong flower production will serve to increase the period that the crop is attractive for egg-laying. Although often conducive to heavy yields under certain growing conditions, the late flowers tend to prolong moth activity, and in the case of early-planted crops attract moths after the greater part of the crop has formed. These late-formed buds and seed capsules will be destroyed should egg-laying occur, the larvae in time attacking the earlier formed capsules, which would have escaped damage had these late flowers not developed to any great extent.

It is difficult to prevent some late flowers developing in a crop, but where possible measures should be adopted to offset this tendency. A relatively dense stand of plants, apart from suppressing unwanted weed growth and ensuring an even rate of seed development, will reduce the likelihood of prolonged flowering. Thin stands, on the other hand, in addition to reducing the possible yield per acre, may allow secondary branching and late flowerings should spring rains eventuate and will most certainly take longer to mature.

A seeding rate of from 23 to 25 lb. per acre seems best under the circumstances. It produces a relatively dense stand of plants that flowers evenly and matures its crop more quickly than thinner stands.

Chemical Control.

Although the use of sound cultural measures, particularly those mentioned above, can offset the possibility of serious pest damage and may even obviate the necessity for insecticidal treatment, the farmer should always watch for moth activity in linseed at flowering time. Where a heavy yield is assured, every precaution should be taken to safeguard against crop loss, particularly where planting has been delayed. Any signs of moth activity at flowering time should be viewed with apprehension and treatment applied promptly. Egg-laying will continue as long as moths are present in a crop and flowers are being formed. Crops that have not reached the flowering stage may become infested should moth activity be exceptionally heavy.

Power Dusting.

Where suitable power-operated equipment is available, the application of DDT dust has proved a quick method of treating large areas of crop. A 5 per cent. DDT dust applied at the rate of 15 lb. per acre will give efficient control of Heliothis larvae. Treatment should be commenced immediately after the bulk of the flowering has ceased and before the newly hatched larvae have had time to damage the crop. Efficient dust application requires a still atmosphere, and so early morning or late afternoon dusting is preferable.

An efficient power-operated machine should be capable of covering approximately 8 acres of crop per hour. Dust application by aeroplane, where possible, has proved an ideal method of treating large areas.

Power Spraying.

The application of DDT in spray form has also proved very satisfactory for Heliothis control in linseed, the DDT being applied at 0·2 per cent. concentration at a dosage rate of up to 100 gallons per acre. DDT in either the dispersible powder or the emulsion form may be used for spray preparation. Power spraying machines especially adapted for mounting on to motor trucks or tractors have been developed for spraying field crops and these are ideally suited for spraying linseed for pest control. A boom of 30 to 40 feet evenly distributes the spray material as a vehicle is driven slowly through the crop.

Although a dosage rate of 100 gallons per acre is recommended, certain types of machines are incapable of putting out this quantity of material per acre, the amount actually delivered being nearer half the recommended rate of application. A dosage as low as 40 gallons per acre, using 0.2 per cent. DDT, has been used successfully. A greatly reduced rate of application, using higher concentrations of DDT, is an important consideration in treating large areas of crop as it overcomes the necessity for carting water to recharge the spray tank at frequent intervals. The need for carting large quantities of water, apart from delaying operations, tends to increase the likelihood of damage to the crop by vehicles. Spray machines combining a low dosage rate with increased insecticidal concentration are being developed, and should revolutionise pest control where crops are grown in large acreages.

In contrast to dust application, spraying can be carried out under much less exacting weather conditions and may proceed despite slight winds. Although power syraying equipment varies a great deal in design and output per hour, a machine carrying a 30-feet boom and driven at approximately 4 miles per hour should cover roughly 15 acres per hour. However, the need for refilling the spray tank may cut the acreage per hour by as much as one-half.

Damage to Crops by Vehicles.

When properly operated, little material damage to the crop is caused by the trucks or other vehicles used to carry the power operated spraying or dusting equipment. Furthermore, if treatment is applied soon after flowering the plants should show little evidence of vehicular traffic by harvest time. Generally, the wheels can be made to track in the spaces between adjacent drills, while the crop between the wheels rises again soon after the vehicle has passed. Most damage occurs where the vehicle turns, but again a good proportion of the plants will rise again before harvesting. At a conservative estimate, less than 2 per cent. of the crop would be destroyed by a truck fitted for spraying and carrying a 30-feet boom, though more damage may be associated with the use of a power duster treating only half this width at each run through the crop.

CONCLUSIONS.

The adoption of cultural measures to ensure flowering in the early spring will go a long way towards reducing the likelihood of pest attack and will eliminate this possibility altogether in some years. In view of two important considerations—namely, cost of treatment and shortage of suitable machines for applying the insecticide—this method of control has much to commend it and will play an important part in establishing the crop on a sound cultural basis. As a safeguard, a farmer who hopes to rely on cultural measures should keep a close watch on moth activity at flowering time so that chemical control measures can be taken if and when required.

While not a difficult problem in itself, the successful control of Heliothis in linseed by spraying or dusting may be dependent on the availability of equipment and, with the possibility of a further increase in acreage in future years, the need for large numbers of spraying and dusting machines becomes obvious. The routine application of DDT soon after flowering has much to commend it where equipment and materials are available.

QUEENSLAND SHOW DATES.

Barcaldine	May 13-14
Beaudesert	May 6-7
Beenleigh	September 16-17
Blackbutt	June 3-4
Boonah	June 3-4
Bowen	July 6-7
Brisbane R.N.A.	August 6-13
Bundaberg	June 9-11
Cairns	July 19-21
Charleville	May 18-19
Childers	June 6-7
Crow's Nest	May 27-28
Dirranbandi	May 27-28
Esk	July 1-2
Gatton	July 21-23
Gin Gin	June 13-14
Goombungee	May 21
Goomeri	May 24-25
Gympie	May 26-28
Home Hill	July 1-2
Ingham	July 15-16
Ipswich	May 17-19
Kalbar	May 28
Kilcoy	June 24-25
Kilkivan	June 10-11
Kingaroy	May 5-7
Laidley	July 8-9
Lawnton	July 29-30
Longreach	May 3-5
Lowood	June 10-13
Mackay	June 28-30
Maleny	May 12-13
Marburg	May 13-14
Maryborough	June 2-4
Mitchell	May 11-12
Mount Morgan Show	June 2-3
Mt. Morgan Camp Draft	June 4
Mundubbera	May 6-7
Murgon	May 19-21
Nambour	July 7-9
Proserpine	July 1-2
Redlands	July 15-16
Rockhampton	June 22-25
Roma	May 4-5
Rosewood	July 15-16
Toogoolawah	June 17-18
Townsville	July 12-14
Warrill View	May 21
Wondai	May 12-14
Woodford	July 15-16

Cheese Starter: Its Preparation and Control.

E. B. RICE, Director of Dairying, and L. E. NICHOLS, Assistant Director of Dairying.

A CHEESE starter is a culture of living microorganisms used for the purpose of bringing about certain changes during the manufacture and/or ripening of cheese. Different species of organisms are used in the manufacture of the many varieties of cheese; for example, lactic acid bacteria for producing acid in cheddar cheesemaking, propionic acid bacteria for ensuring eye formation in Gruyere cheese, and moulds for the blue-veined cheeses.

This paper deals only with starters for cheddar cheesemaking.

Starters are prepared by various Government and proprietary laboratories and supplied to cheese factories in powder or liquid form. Separated or whole milk is the usual medium for the propagation of the starter in a factory.

Some commercial laboratories include certain aroma-producing bacteria in starters for cheddar cheese. However, they are not essential in these cultures. The particular species of bacterium contained in the starters which are now supplied by the Queensland Dairy Research Laboratory is known as *Streptococcus cremoris*, strains of which are used in starters produced by all the leading dairying institutes. The organisms are cultured daily in the laboratory in sterilized separated milk and transferred to a bottle of sterilized chalk litmus milk prior to despatch to a factory. This procedure ensures that the starter will be in a vigorous condition and ready for inoculating the mother starter immediately upon arrival at the factory. Some powder cultures need subculturing for several days before being used as mother starter, as the organisms take a few days to regain full vigour.

Advantages of Single-strain Cultures.

There are two types of commercial starter culture: (1) *Single-strain*, containing one strain only of starter bacteria; (2) *Mixed cultures*, containing more than one strain of starter bacteria.

Single-strain cultures usually have better vitality, produce acid more uniformly and give a closer-textured cheese, but are susceptible to the effects of bacteriophage, which may slow down or completely stop acid production in the starter or cheesemaking vat. Mixed strain cultures are less susceptible to the effects of bacteriophage, but they are also less vigorous, and tend to produce a more open-textured cheese.

Functions of the Starter.

In the manufacture of cheddar cheese the starter produces acid in the milk prior to and after adding the rennet. In making cheddar cheese from pasteurised milk, it is necessary to add starter to inoculate the pasteurised milk with the desired acid-forming bacteria. Even if milk of comparatively high acidity is received and manufactured without pasteurisation, a small quantity of good starter tends to suppress the undesirable bacteria in the raw milk.

The acidity developed by the starter has several effects:—

1. It ripens the milk and produces acid during manufacture. Ripening the milk favours the coagulation with rennet. Milk of too low acidity curdles slowly with rennet and the manufacturing period would be prolonged.

2. It causes the expulsion of the whey. The bacteria which are trapped in the curd produce acid, the curd shrinks and the whey is expelled.

3. It assists the fusing of the curd particles (matting). This gives a mellow body and texture to the cheese.

4. It has a protective action against putrefaction. The putrefactive bacteria, being susceptible to acidity, are restrained in the acid medium, but would quickly spoil the cheese if insufficient acid was present.

5. It stimulates the action of the enzymes in the rennet. Rennet not only coagulates milk due to the enzyme rennin, but other enzymes which it contains have a digestive effect in the presence of acid. They act on the curd in the vat and throughout the ripening of the cheese.

Notes on Plate 126.—

Windows to be 4 ft. × 2 ft., fixed sashes.

Doors to be 2 ft. 6 in. wide.

Sills to doors, studs and heads to be rebated and packed with sponge rubber, saddler's felt, or other suitable material.

Concrete topping to floors of three rooms to be 1½ in. thick, reinforced with chicken wire netting; each floor to have a fall towards an outlet discharging through the floor, complete with trap, &c.

Cover strips to ceiling to be 2 in. × ⅝ in. pine and those to walls 1 in. × ⅜ in. pine.

Hood connected to ceiling to be provided over "steamer."

Ventilating fan to be multivane centrifugal (size 0, Richardson or other approved type). Fan to be connected to oil filter with canvas connectors.

Movable box protecting fan and motor, &c., to have air inlet opening.

Drainage to be provided to suit site.

Building to be painted internally with mould-resistant paint.

Building to be at least 50 ft. from factory, and site to be selected according to position of whey tanks and prevailing winds.

Vitality of Starters.

A starter must be capable of producing acidity at the desired rate throughout the making operations. A starter may develop acid when it is first introduced into the vat of milk, but fail to maintain its vitality in the "cooking" and cheddaring stages. During the "cooking" the milk is raised to between 100 and 102 deg. F., and in extreme cases to 104 deg. F., temperatures which are higher than the optimum for the starter bacteria; while the comparatively dry curd at cheddaring is not conducive to their best development. There is thus a possibility of a starter failing to give a steady increase in acidity during these stages unless its vitality is good.

Contamination of Starters.

The necessity for the utmost care and cleanliness in all operations connected with starter making cannot be over-emphasised. A

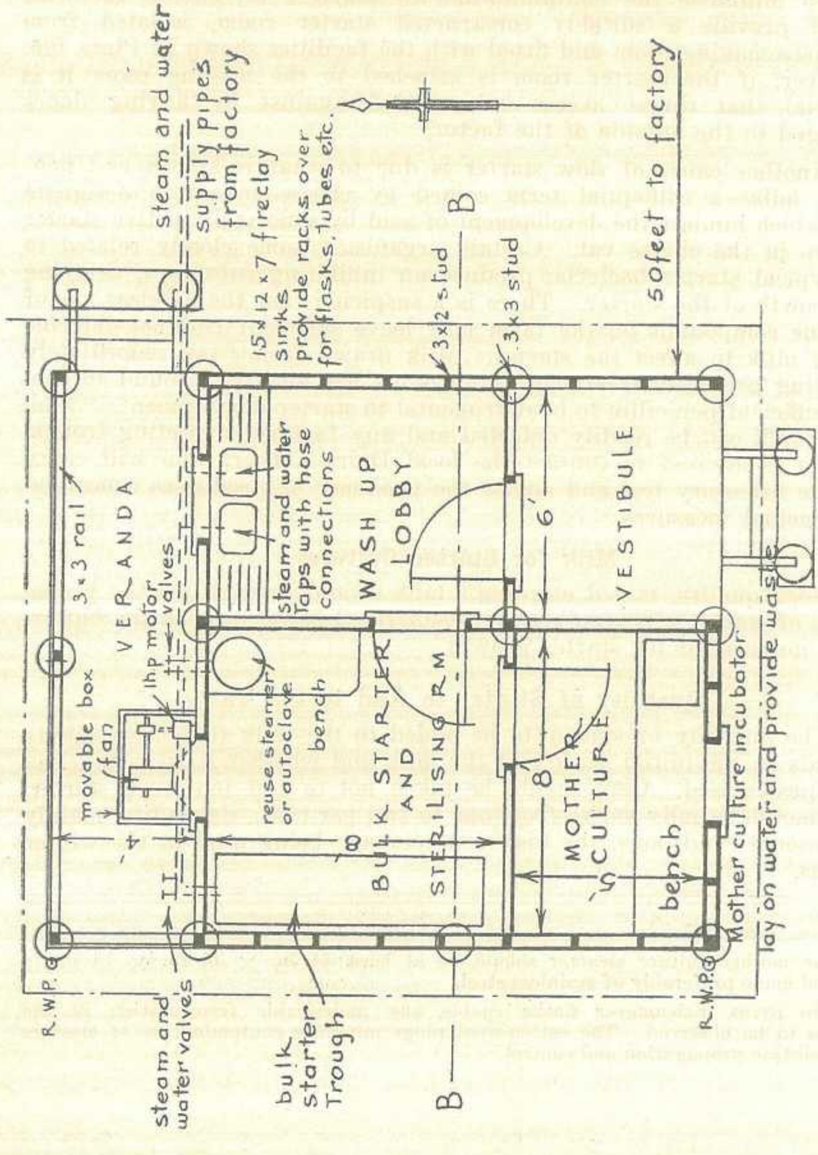

Plate 126.
FLOOR PLAN OF AN ISOLATED STARTER ROOM.
(For further details see notes at foot of opposite page.)

contaminated starter may show no abnormality in flavour or aroma and be quite active in the vat, but it will adversely affect the quality of cheese.

The examination of mother starters at factories frequently shows them to be contaminated with the gas-forming coliform bacteria, and yeasts and moulds, which grow in an acid medium; the contamination thus becomes progressively greater.

The cheesemaking room is unsuitable for propagating starter on account of the high temperatures, the risk of contamination from splashes of water and other sources, and infection with bacteriophage.

The most serious type of starter contamination is bacteriophage, and the methods of starter propagation now recommended are based on measures for its control.

To minimise the contamination of starters all cheese factories should provide a suitably constructed starter room, isolated from the cheesemaking room and fitted with the facilities shown in Plate 126. However, if the starter room is attached to the making room it is essential that direct access be guarded against by having doors arranged to the outside of the factory.

Another cause of slow starter is due to what is known as "non-acid" milk—a colloquial term coined by cheese-makers to designate milk which hinders the development of acid by a normally active starter culture in the cheese vat. Certain organisms, some closely related to the typical starter bacteria, produce an inhibiting substance, delaying the growth of the starter. There is a suspicion that the careless use of chlorine compounds on the farm may leave sufficient residual chlorine in the milk to affect the starter. Milk drawn from cows immediately following penicillin treatment for mastitis has also been found to contain sufficient penicillin to be detrimental to starter development. "Non-acid" milk can be readily detected and any factory suspecting trouble from it is advised to contact the local Dairy Officer, who will carry out the necessary test and advise the producer or producers concerned on remedial measures.

Milk for Starter Cultures.

Good quality, mixed morning's milk should be used for the propagation of starter. The milk may be separated before use, as the butter-fat is not needed for starter growth.

Quantity of Starter to Add to the Vat.

The quantity of starter to be added to the milk for cheesemaking depends on the initial acidity of the milk and whether it is pasteurised or unpasteurised. Care should be taken not to add too much starter. The amount usually varies from one to two per cent., depending mainly on seasonal conditions, the higher percentage being used in the winter months.

Notes on Plate 127.—

The mother culture steamer should be at least 15 in. × 15 in. × 15 in. in size, and made preferably of stainless steel.

The pyrex Erlenmeyer flasks enable any undesirable fermentation in the cultures to be observed. The cotton-wool plugs minimise contamination of starters and facilitate propagation and control.

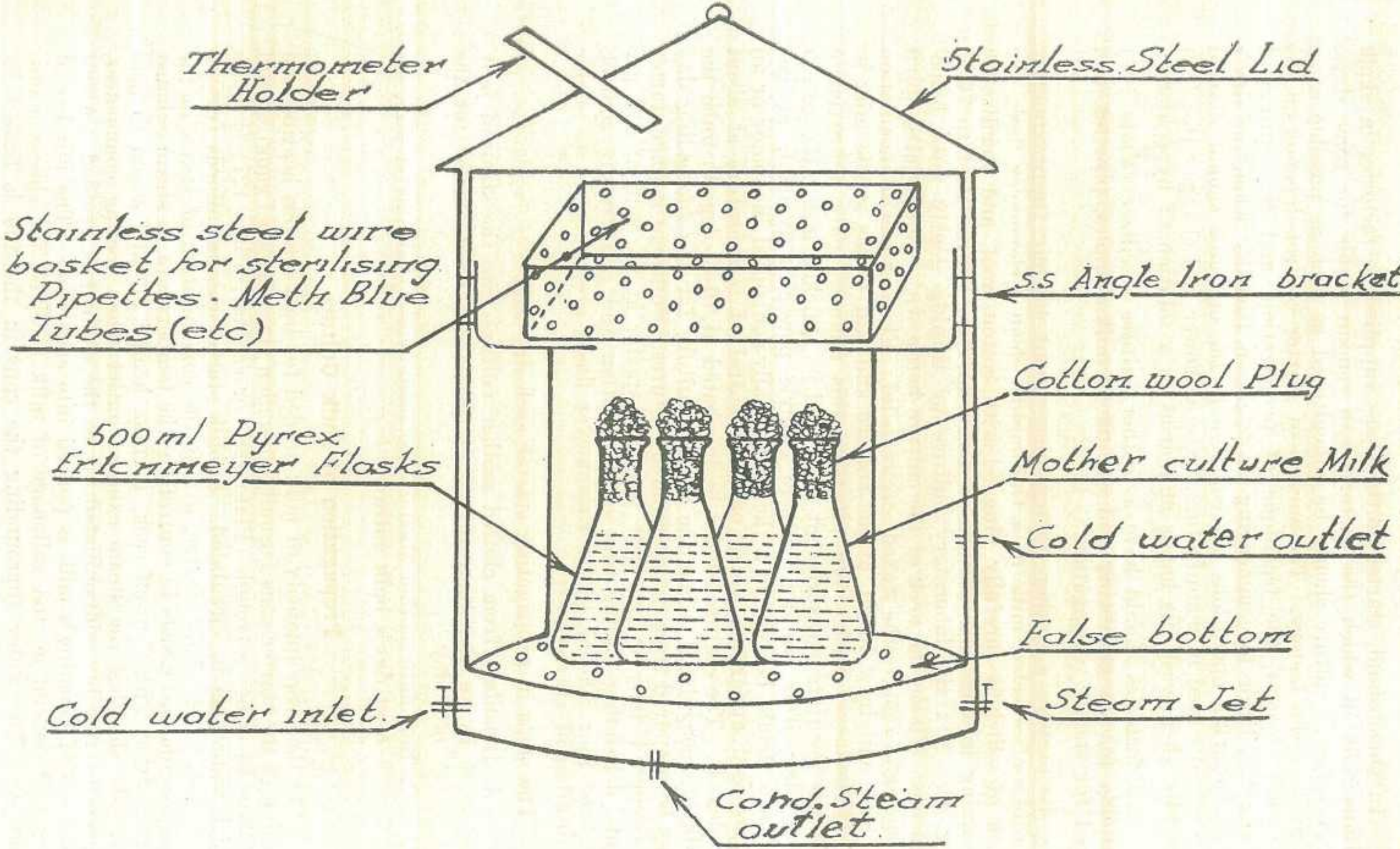

Plate 127.

DIAGRAM OF MOTHER CULTURE STEAMER.
(For further details see notes at foot of opposite page.)

Propagation of Mother Culture.

In Queensland, starter cultures are supplied to factories in chalk litmus milk in which the bacteria can remain viable for some days. However, the culture should be subcultured as soon as possible after arrival at the factory. The success of starter control depends on the personal element, the technique of propagation, and the equipment available. Prior to commencing propagation (usually when the day's manufacturing operations are completed) the operator should discard the overalls used in manufacture, have a shower and change into clean overalls, then wash his hands and arms in a solution of hypochlorite.

All factories should have a mother culture sterilizer (Plate 127) suitable for the sterilizing and cooling of milk samples, pipettes, &c., used for starter propagation.

To prepare a mother starter, place about 400 ml. (approximately ¾ pint) of selected milk in a thoroughly clean Erlenmeyer flask, the neck of which is carefully plugged with cotton wool, and sterilize by steaming in a mother culture sterilizer for two hours. Cool to 70-75 deg. F. Mix the laboratory culture by tipping gently until homogeneous. Flame the neck of the culture bottle with a methylated spirit burner and remove the waxed screwcap lid. Flame a sterile inoculation pipette, withdraw 10 ml. of the culture and add to the sterile milk in the Erlenmeyer flask. (In pipetting this quantity only approximate and not accurate measurement is needed.) Quickly insert the cotton wool plug after flaming. Where electric power is available mother cultures should be kept in a thermostatically-controlled incubator or an improvised apparatus which permits control of temperature at about 70 deg. F. The culture should be incubated at 70-75 deg. F. until the milk has coagulated, when the mother culture for the succeeding day may be prepared from the coagulated cultures. Sufficient mother starter is prepared daily to inoculate the bulk starter at the rate of 1–2 per cent., depending on the time of inoculation and temperature control. At least four 500 ml. pyrex Erlenmeyer flasks are necessary to enable a rotation of starters.

The steps in propagating starter each day are:—

1. Inoculate from clotted mother culture into the steamed milk in an Erlenmeyer flask to prepare mother starter for the next day.
2. Inoculate mother starter into pasteurised bulk-starter milk for next day's bulk culture.

Propagation of Bulk Culture.

For the large quantity of milk needed for bulk starter, heating and cooling of the starter cans (usually 10-gallon stainless steel cans) should be done in either a trough (Plate 128) or cabinet (Plate 127) through which water can be circulated. A bulk starter cabinet affords further protection of the bulk starter, avoids the condensation of steam in the starter-room and assists in controlling the temperature. A steam exhaust outlet, fitted with shut-off cock, permits heated air and steam to pass out. By shutting the steam exhaust outlet when cooling commences, ingress of possibly contaminated air to the cabinet is avoided. About 8 gallons of morning's milk is poured into each can. (The number of cans will depend on the gallonage of milk received for cheese manufacture.) The water surrounding the cans in the tub is heated by turning on the steam. The temperature of the milk is raised to approximately 200 deg. F., maintained for one hour, the steam-valve closed and cold water passed through the cabinet, entering at the bottom, until the milk is cooled to 70-75 deg. F. The milk is then

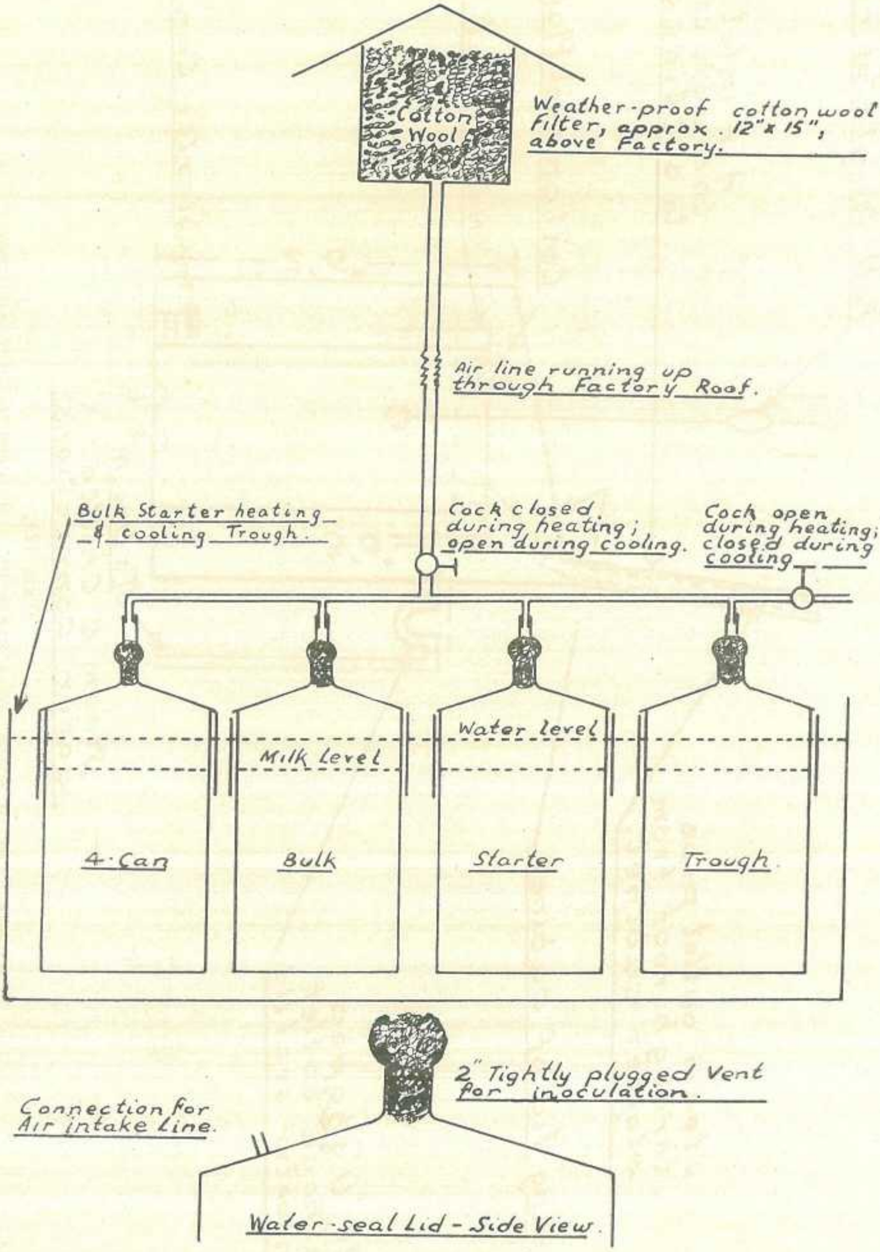

Plate 128.
DIAGRAM OF WATER-SEAL LIDS WITH FILTERED AIR INTAKE FOR BULK STARTER CANS.

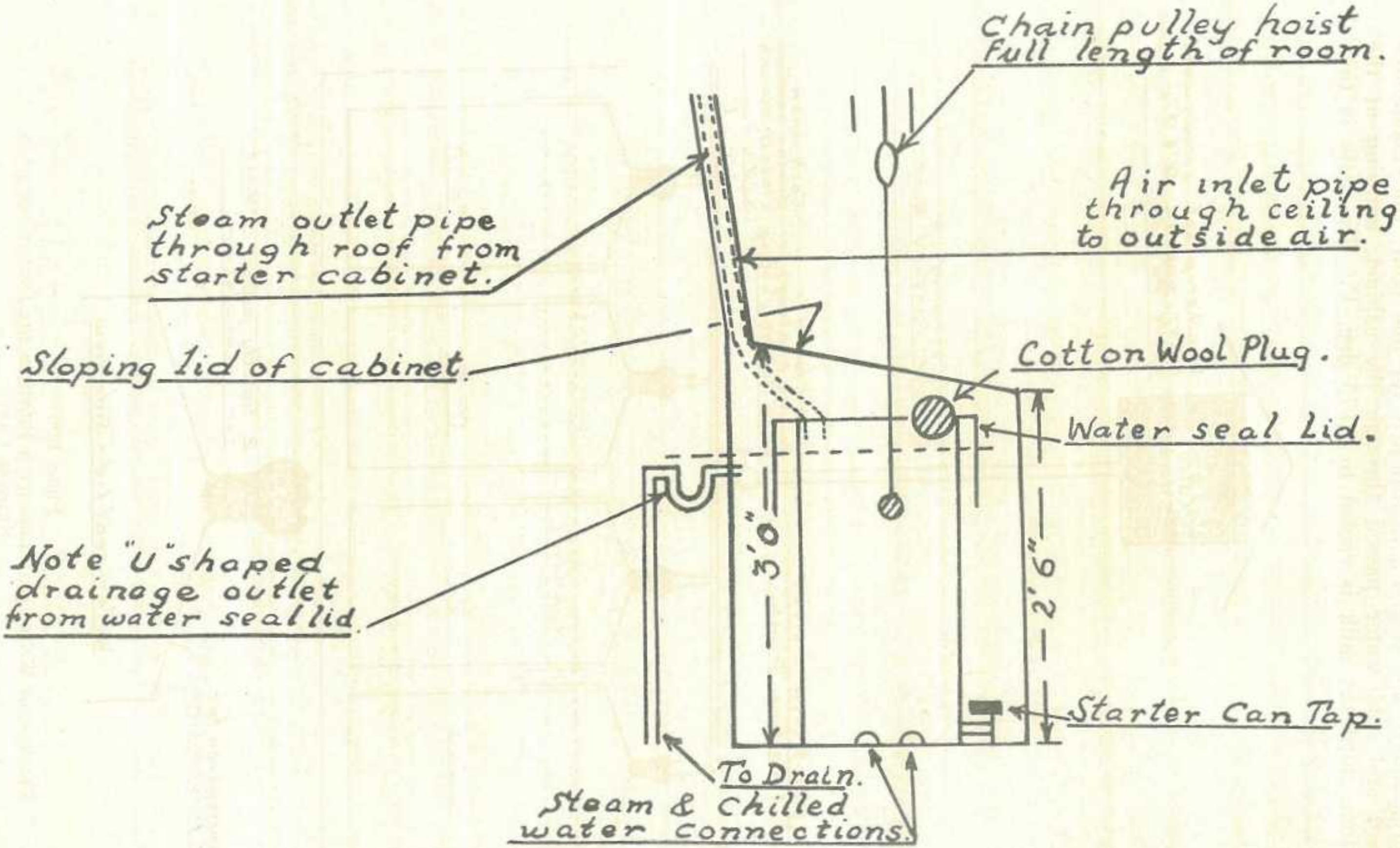

Plate 129.

DIAGRAM (NOT TO SCALE) OF A STEEL BULK STARTER CABINET, SHOWING A TYPE OF AIR INLET THROUGH WATER-SEAL LID TO BULK STARTER CAN.

inoculated by pouring the mother starter through the aperture in the water-seal lid of the bulk starter can, using about three-quarters of a pint (16 oz.) to each can in order to have the starter clotted and ready to use in the cheese vat next morning. The cotton wool closure of the pipe on the water-sealed lid should be immediately replaced after flaming. The bulk starter should be kept at 70-75 deg. F. during ripening.

Bacteriophage in Relation to Cheese Starters.

Single-strain starters produce acidity more uniformly during cheesemaking than mixed cultures. However, sudden failures of single-strain cultures both in the bulk starter and in the vat were puzzling until New Zealand research workers demonstrated the presence of bacteriophages which are able to destroy susceptible starter bacteria. Specific bacteriophages are usually associated with specific strains of starter bacteria. Bacteriophages are ultramicroscopic and until recently could be recognised only by their effects. When phage gains entrance to a starter culture it gradually develops and may bring about the complete destruction of the starter bacteria. Bacteriophage may survive the pasteurisation temperatures in cheese factory practice and progressively build up until the starter fails.

Research has shown that phage can be airborne or mistborne and that the greatest concentrations of phage are wherever there are concentrations of whey. Mist from whey separators and dust from the ground near whey tanks have proved to be carriers of phage.

As phage is airborne, great care must be taken to see that phage-laden air does not enter the starter culture, particularly the bulk starter which is more exposed to contamination. The following measures will assist in achieving this objective:—

1. The fitting of well-made cotton-wool plugs or rubber bungs to the mother culture flasks and the inoculating aperture in the water-seal lids of the bulk starter can.
2. Using water-seal lids with air inlets and air filters for minimising access of phage during cooling of the bulk starter (Plate 128). Alternatively, the fitting of a simplified bacteriophage filter to the individual bulk starter cans may be useful for small factories using only one or two cans of bulk starter (Plate 130).
3. The non-stirring of the milk during cooling and the culture after inoculation.
4. The checking of temperatures only in the water jackets and not putting the thermometer in the culture milk.
5. Maintaining a water seal throughout heating and cooling by arranging a water outlet in the starter cabinet at the level of the water seal.

Procedures for Controlling Bacteriophage in Factory Starters.

1. Isolated Starter Room.

The isolated starter room has proved successful in keeping phage-free starters, but too much stress cannot be placed on the fact that no system can succeed if the operator is careless. If the cheesemaker enters the starter room in clothes he has worn in the making room and which have been impregnated with whey mist, he must expect to infect the starter with bacteriophage. If the isolated starter room is to be used as the main control measure, it is *essential* that the operator chlorinate his hands and arms, and change into a clean pair of overalls before entering this room.

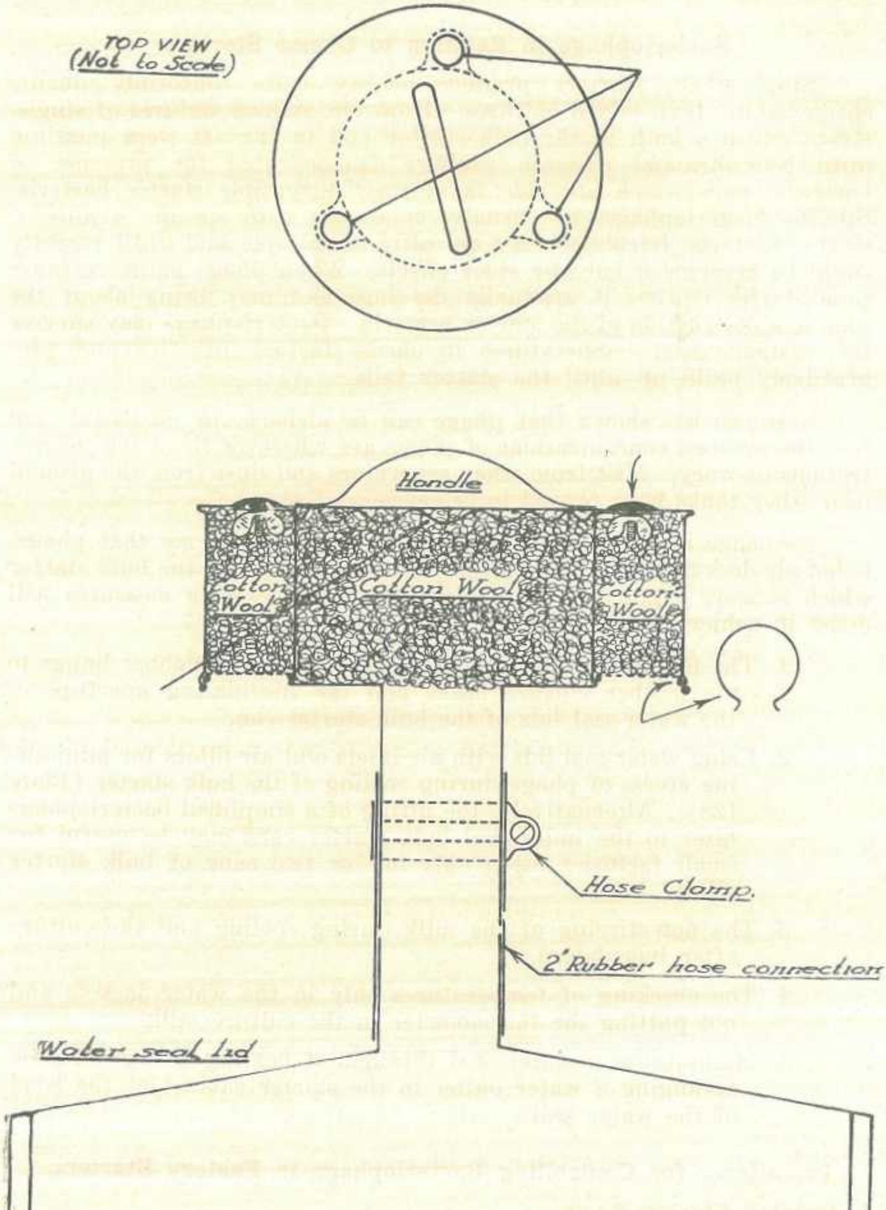

Plate 130.

DIAGRAMS OF A SIMPLIFIED BACTERIOPHAGE FILTER FOR SINGLE BULK STARTER CAN.

The starter room should be suitably aspected with respect to the prevailing wind and in the opposite direction to the whey tank and factory drainage (Plate 131).

Plate 126 shows details of the layout of an isolated starter room. An ante-room is provided for washing-up purposes. It adjoins the bulk starter room so that the only door to the mother-culture room is from the bulk starter room. The mother and bulk milk sterilizers are in the bulk starter room and all controls for steam heating and water cooling are outside the room. This means that once the milk is placed in the sterilizers there is no need to re-enter the starter room until the time for the afternoon sub-culturing. The bulk starter cabinet should be suitably insulated and provided with an external exhaust to which is fitted a tap, which should be closed from the commencement of cooling.

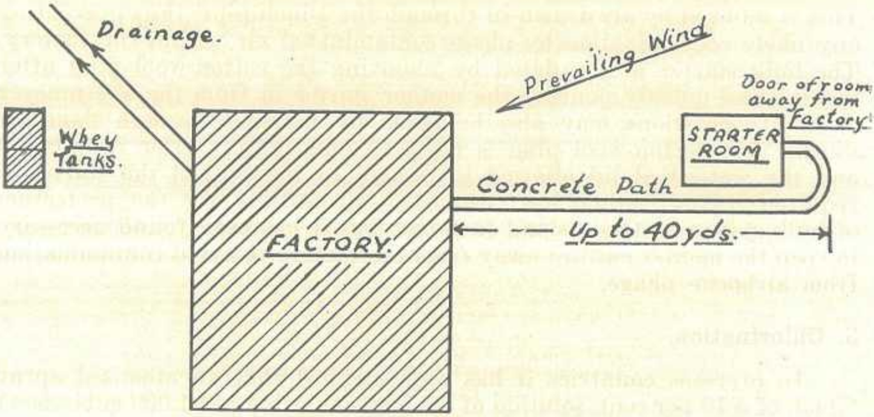

Plate 131.

Diagram Illustrating the Position of Starter Room in Relation to Factory.

All drainage is to an outside sump and all drainage, steam and water outlets are through U pipes, thus preventing the ingress of outside air.

The air should be drawn into the starter room through a suitable series of filters. The doors must be close fitting.

An alternative method (Plate 128) shows filtered air entering each of the bulk starter cans.

The milk for the mother culture should be heated by steam and that for the bulk starter with boiling water.

A hand-trolley and a concrete path make it easy to transfer the bulk starter from the starter room to the factory.

2. Water-seal Lids.

Research has shown that the inrush of phage-contaminated air into the can during cooling of the milk is one of the major causes of phage in the bulk starter. As a protection against this, water-seal lids are used in conjunction with the isolated starter room; or alternatively, in factories which have not built the isolated room, they may be used independently in a separate room from the making room. These lids completely cover the top of the bulk can and project down into the boiling water. A water-seal lid is a straight-sided can cover which rests on the shoulders of the can. It has an opening in the top which is plugged with cotton-wool and is sufficiently large (2 inches in diameter) for convenient inoculation of the bulk starter. To protect the cotton-wool from moisture, a metal cap is fitted over the pipe in which the cotton-wool is packed. The lid is also fitted with a ½-inch pipe which has a filter fitted to its extreme end through which outside air is drawn or alternatively the special filter (Plate 130) is fitted if air is drawn from inside the factory.

In actual operation the air above the milk in the can is driven out by steam during the boiling-up process. As soon as cooling starts the steam inside the water-seal lid condenses and a partial vacuum is formed. This is relieved by air drawn in through the ½-inch pipe, thus preventing any likely contamination by phage-contaminated air within the factory. The bulk starter is inoculated by removing the cotton-wool plug after flaming and quickly pouring the mother starter in from the Erlenmeyer flask. Inoculations may also be made by pouring through flame or steam. The cotton-wool plug is replaced immediately after inoculation and the water-seal lid allowed to remain in place until the starter is required. This method has been used successfully for the protection of bulk starter in Queensland factories, but it has been found necessary to keep the mother culture away from the factory to avoid contamination from airborne phage.

3. Chlorination.

In overseas countries it has been claimed that an atomised spray (5 ml. of a 10 per cent. solution of available chlorine per 1,000 cubic feet) will kill airborne phage in mother and bulk starter rooms in two minutes. This spraying must be carried out at least half an hour before cooling of the milk begins and again half an hour before subculturing. Care must always be taken to see that contamination is not carried into the room on clothes or hands.

This treatment could be used in conjunction with the isolated starter room or water-seal lids, although if good technique is used it should be unnecessary.

4. Oil-seal.

A layer of paraffin oil on the top of mother and bulk starters has been reported to prevent the ingress of phage provided condensate is not allowed to run through the oil into the culture. Trials in Queensland indicate that it is difficult to avoid condensate and thus the system cannot yet be recommended.

Further Precautions to Control Phage.

In addition to keeping the mother and bulk cultures free of phage it is essential to reduce the incidence of phage in the factory and surroundings. Routine factory control should include the following measures:—

1. All whey should be heated to at least 180 deg. F. before being returned to farmers.

2. Whey tanks, delivery lines and taps should be thoroughly cleaned and sterilized daily.

3. As pasteurising temperatures used for cheese milk (156-160 deg. F. for 10-15 seconds) do not kill phage, all cheesemaking plant and equipment should be thoroughly sterilized each morning. This can be done by circulating a chlorine solution containing at least 200 parts per million, for at least 2-3 minutes, through the weighing vat, chutes, pasteuriser, cooler, intake and making vats. Care should be taken to see that all parts of the making vats, agitators, curd knives, rakes, forks, &c., are adequately treated. Sterilization can be carried out by using boiling water or steam, but chlorination is convenient and less expensive for this type of equipment. Finally, the used chlorine solution should be circulated through the whey drains and sump or ejection lines.

4. Whey tanks should be away from the factory and whey separators installed in a separate room apart from the cheesemaking room. This reduces the risk of a "build-up" of phage from whey mist.

5. Four phage-specific starter strains should be used in daily rotation to prevent the build-up of strain-specific phages.

Defects of Starter.

1. *Contaminated Culture.* Faulty methods of propagation may cause contamination with the gas-forming coliform bacteria and yeasts and moulds, which can tolerate the acidity developed by starter. The effect on the mother culture may be observed through the Erlenmeyer flask before the flavour is affected. Careful propagation avoids this type of contamination.

2. *Loss of Vitality.* This may show by a gradual slowing of the rate of acid production in the vat, which delays manufacture, and leads to weak body and off flavours in the cheese. It is due to loss of vigour of the starter bacteria. Affected cultures should be renewed immediately.

3. *Malty Flavour.* Sometimes starters develop a malty flavour due to development of a malty-flavoured strain of *S. lactis*. Cultures showing this condition should be rejected.

4. *Ropiness.* A starter may develop ropiness. The condition usually first occurs on the surface of the starter. In such an event a few subsequent propagations made from inoculum obtained near the bottom of the Erlenmeyer flask may eliminate the defect.

5. *Curdy Starter.* This defect is due to oversetting or holding at too high a temperature. It may be avoided by reducing the quantity of inoculum or incubating the starter at the desired temperature of 70-75 deg. F.

6. *Bacteriophage and Non-Acid Milk.* When the starter fails or acid production is slow, samples of whey should be forwarded to the laboratory for examination and report. The laboratory will assist factories to effect control by determining phage specificity and recommending a suitable rotation of starters.

Hand-feeding Sheep in Drought Time.

G. R. MOULE, Officer-in-Charge, Sheep and Wool Branch.

INTRODUCTION.

IT is well known that drought occurs frequently, though somewhat irregularly, in pastoral Queensland and as a result heavy losses have been experienced by the sheep industry in this State.

Occasionally conditions warrant hand feeding of sheep in drought-stricken areas and this article has been written to assist sheep raisers in planning drought feeding. It is not suggested that hand feeding is the answer to drought in Queensland. There is no one answer to the problem, though one or more of several methods may be adopted to mitigate its effects.

However, where feeding is practised, care in the selection of the ration will save very considerable sums of money and accordingly it is important that woolgrowers should have the most recent information about the selection and feeding of drought rations.

INDICATIONS FOR DROUGHT FEEDING.

The woolgrower whose country is drought stricken may consider one of several methods of meeting the situation. These include:—

(i.) Moving of sheep to agistment;

(ii.) Feeding edible scrub;

(iii.) Hand feeding;

(iv.) Selling part or all of the flock; and

(v.) Allowing the sheep to take their chance in the paddock.

Naturally, economic factors will influence the final decision and either agistment or scrub feeding is usually the cheapest method. However, the more valuable edible trees and shrubs such as mulga are restricted in their distribution and there is a very large part of Queensland where scarcity of top feed makes scrub feeding impossible.

At the same time, suitable agistment areas are not always available and even if they do exist it is often impossible to move the sheep to relief pastures.

When this occurs the owner has to decide which of the other three methods he will adopt and to what extent he will use the one selected. Hand feeding can be most expensive and it is often the most disappointing because heavy losses of stock may occur after the rains fall. However, the efficiency with which the available food is utilised by the animals depends largely upon the management of the property. Accordingly, in making a decision about hand feeding consideration has to be given to:—

(i.) Which sheep will be fed?

(ii.) What is the market value of the sheep?

(iii.) What is likely to be the market value of the sheep at the end of the drought?

(iv.) For how long is it probable the feeding will have to be undertaken?

(v.) What is the availability of foodstuffs, and are supply, transport and labour assured?

(vi.) What will be the cost of feeding?

The answer to question (i.) is obvious; the young breeding ewes must get first preference. From them the flock can be rebuilt when the drought breaks. The answer to questions (ii.) and (iii.) depend on conditions at the time. If the prospect is for a well sustained wool market it is likely that the sheep will maintain their value. If, however, the wool market falls suddenly sheep would tend to lose value quickly.

No accurate forecast can be made about the time it may be necessary to feed sheep. It is seen from Table 1 that in the central-west and north the summer rains are more reliable than winter falls. However, because of the unreliable nature of the summer rains in that area the country between (and including) the Winton and Isisford districts has experienced more and longer periods of drought than any other. Isisford,

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COMMENTS ON TABLE 1.

This table shows, for a number of centres, the monthly average rainfall (Av.) in points for the centre, the "effective rainfall" (E.R.) in points for each month, the percentage reliability (P.R.) of the effective rainfall on a monthly basis, and the number of years on which records are based (in brackets).

The "effective rainfall" is the number of points which may be needed to stimulate plant growth. It is determined from studying the ratio of rainfall to evaporation. In interpreting these data for Queensland conditions due regard must be given to the reliability of the summer rains, as this is predominantly a summer rainfall country and in most districts the heaviest growth of grass occurs during normal summer seasons.

In some districts there is a plant community, commonly referred to as "herbage," which responds well to winter falls. In a light season herbage can bring useful but sometimes comparatively short-lived relief. Because of herbage comparatively light winter falls may be useful in the southern part of the State, though they would be useless in the north.

The "effective rainfall" for summer months can be regarded as being a close indication of the rainfall requirements to bring relief in any one month, though it would not assure "a season." Obviously, follow-up rains would be necessary, and after a long dry spell constant summer rains would probably be necessary to re-establish Mitchell grasses.

One other factor which has to be taken into consideration is the damage which can be done in the winter to a body of Mitchell grass, which is "standing over" from the summer, by light falls of from 20 to 30 points. It is well known that these may cause the feed to deteriorate rapidly and can produce a drought threat almost overnight.

TABLE 1.

Centre and No. Years' Record	Index.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
Camooweal ..	Av.	53	124	208	361	343	199	41	31	61	28	14	21
(57)	E.R.	300	256	250	224	182	240	236	211	154	168	211	236
	P.R.	3	12	37	49	75	35	3	3	17	7	2	2
Cloncurry ..	Av.	45	128	279	442	411	233	70	45	62	34	15	29
(64)	E.R.	308	259	256	234	208	248	248	226	173	168	225	244
	P.R.	2	17	34	62	64	39	11	6	14	9	3	2
Richmond ..	Av.	61	131	252	444	387	217	77	57	74	42	11	24
(59)	E.R.	284	243	237	198	170	212	204	178	134	149	197	220
	P.R.	5	19	47	68	75	41	15	14	20	10	0	3
Kynuna ..	Av.	63	124	237	332	309	191	62	54	79	46	15	31
(55)	E.R.	256	227	234	202	173	212	196	168	115	115	168	188
	P.R.	2	16	29	58	67	27	11	11	22	16	4	4
Winton ..	Av.	77	129	184	315	311	209	67	62	83	64	22	41
(64)	E.R.	268	243	250	230	196	224	200	173	125	125	173	204
	P.R.	5	17	23	47	58	34	14	19	22	25	3	6
Hughenden ..	Av.	86	126	263	454	366	212	105	60	88	48	30	41
(64)	E.R.	256	224	214	170	150	176	168	158	110	120	168	184
	P.R.	8	23	42	74	78	42	19	14	23	19	5	9
Longreach ..	Av.	97	115	181	212	338	239	95	85	87	80	28	57
(55)	E.R.	236	205	221	208	176	196	148	149	96	106	144	172
	P.R.	11	22	33	36	51	33	25	18	29	29	7	9
Isisford ..	Av.	103	133	189	240	278	263	134	99	109	92	54	63
(63)	E.R.	224	208	205	211	179	204	164	139	101	106	144	160
	P.R.	14	27	30	35	52	37	25	29	32	30	8	16
Barcaldine ..	Av.	140	134	224	322	280	258	142	115	114	100	55	68
(62)	E.R.	224	192	198	196	163	196	156	139	96	101	139	164
	P.R.	19	26	40	55	50	36	29	34	43	32	13	16
Alpha ..	Av.	125	175	264	364	302	236	139	102	151	102	74	88
(62)	E.R.	200	184	184	170	148	180	150	132	93	93	132	150
	P.R.	21	42	52	76	60	40	31	29	56	29	26	24
Blackall ..	Av.	139	151	241	285	320	267	134	136	125	112	66	77
(68)	E.R.	224	202	218	214	182	196	164	125	86	91	130	156
	P.R.	23	28	43	50	59	43	29	37	47	41	21	19
Tambo ..	Av.	135	181	251	283	297	260	139	135	129	120	74	86
(65)	E.R.	188	173	186	179	150	168	140	110	72	77	110	144
	P.R.	31	38	55	66	68	51	29	40	57	46	26	23
Augathella ..	Av.	141	187	258	299	280	292	142	119	158	124	77	96
(59)	E.R.	190	180	200	192	170	180	140	108	69	72	114	140
	P.R.	25	39	58	58	51	47	34	44	59	56	27	22
Charleville ..	Av.	125	164	236	247	264	227	135	122	135	123	77	84
(67)	E.R.	196	189	205	208	186	192	148	110	67	72	115	140
	P.R.	22	34	49	42	49	37	31	39	60	48	33	21
Clermont ..	Av.	131	207	374	505	415	306	158	129	168	107	68	97
(78)	E.R.	215	196	192	172	140	170	150	138	96	96	132	160
	P.R.	25	49	68	79	70	59	43	33	55	36	17	23
Emerald ..	Av.	146	208	333	418	326	289	139	107	167	113	86	112
(65)	E.R.	210	184	184	172	152	170	150	144	102	102	132	160
	P.R.	25	54	71	71	69	55	32	25	52	34	28	28
Springsure ..	Av.	165	232	320	420	375	294	152	123	175	121	101	126
(83)	E.R.	205	184	180	172	156	185	165	162	114	120	150	165
	P.R.	36	54	71	76	70	54	34	28	49	31	28	27

TABLE 1—*continued.*

Centre and No. Years' Record	Index.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
Mitchell ..	Av.	145	219	274	294	298	277	136	126	163	145	94	122
(64)	E.R.	189	180	191	191	169	166	122	97	59	65	103	130
	P.R.	34	56	62	52	52	59	44	47	72	66	37	30
Roma ..	Av.	173	216	250	311	283	268	128	143	153	145	89	138
(76)	E.R.	184	176	184	184	166	175	135	103	65	65	103	126
	P.R.	42	51	61	63	58	53	37	47	63	61	35	35
St. George ..	Av.	131	176	204	259	231	216	133	144	153	125	95	106
(67)	E.R.	180	173	184	220	180	180	162	113	70	65	103	122
	P.R.	30	37	46	48	48	45	27	40	63	57	33	33
Bollon ..	Av.	129	148	214	226	196	176	112	120	146	106	94	102
(63)	E.R.	180	176	191	205	180	180	126	103	65	59	92	122
	P.R.	24	36	49	49	38	32	38	36	67	62	43	31
Dirranbandi ..	Av.	120	161	217	226	196	188	124	134	157	111	86	102
(60)	E.R.	182	174	190	214	192	192	132	102	92	63	99	128
	P.R.	22	38	48	37	38	40	30	38	63	62	33	37
Talwood ..	Av.	153	215	250	230	221	184	121	159	163	137	89	101
(35)	E.R.	168	164	180	192	168	178	120	96	66	60	90	118
	P.R.	37	57	57	54	46	46	37	49	80	66	40	43
Miles	Av.	203	263	306	368	260	270	148	151	174	164	113	131
(63)	E.R.	162	148	155	151	130	144	112	97	65	70	97	122
	P.R.	56	70	76	79	71	63	52	54	75	68	43	43
Surat	Av.	174	182	269	273	291	257	122	127	175	173	101	123
(67)	E.R.	158	151	169	173	155	158	126	103	65	59	92	117
	P.R.	43	43	67	66	58	54	39	48	72	72	42	45
Goondiwindi ..	Av.	175	225	291	297	249	252	147	171	177	174	125	151
(69)	E.R.	158	155	176	169	151	162	117	92	59	59	86	112
	P.R.	46	59	69	67	61	51	49	61	74	75	52	58
Taroom ..	Av.	182	307	321	407	310	270	150	165	171	145	111	138
(78)	E.R.	174	155	158	156	124	156	120	104	70	75	155	174
	P.R.	46	70	74	74	71	59	44	45	60	50	26	33
Cunnamulla ..	Av.	88	105	153	131	208	138	106	115	118	88	70	82
(69)	E.R.	196	198	208	224	192	200	144	110	72	67	110	140
	P.R.	10	17	30	20	43	25	27	33	58	42	17	19
Wyandra ..	Av.	88	122	180	151	198	157	89	86	130	115	66	102
(50)	E.R.	190	194	212	222	194	200	150	114	69	72	114	140
	P.R.	14	16	38	26	38	24	26	30	68	48	20	26
Quilpie ..	Av.	59	93	141	122	119	73	119	82	105	61	35	53
(31)	E.R.	220	228	248	264	244	240	170	129	84	90	129	160
	P.R.	3	16	16	16	19	10	26	19	45	29	16	19
Eulo	Av.	76	98	132	127	151	127	78	80	117	83	68	61
(62)	E.R.	210	210	222	246	214	220	160	144	78	72	117	150
	P.R.	8	15	19	16	32	21	19	23	52	32	18	19
Adavale ..	Av.	102	125	178	229	201	181	96	104	124	93	52	64
(59)	E.R.	224	224	240	250	234	232	164	130	82	91	130	160
	P.R.	10	19	34	29	34	32	22	27	49	30	12	17
Boulia ..	Av.	49	95	122	163	193	147	56	43	54	32	20	31
(62)	E.R.	292	269	285	278	253	276	224	182	125	125	173	212
	P.R.	3	16	13	21	34	19	11	6	13	11	5	2

for instance, had 11 unfavourable years in succession, while Winton, on one occasion, experienced four consecutive years in which no useful rain fell. Hand feeding under these circumstances would have been impossible

Should summer rains fail, as they frequently do, the chances of relief during the winter are better in the southern part of the State than in the north, and it is interesting to note the difference between the reliability of the winter rains at Tambo and Blackall and Barcaldine and Longreach, but the possibilities of a prolonged dry period, with repeated failures of summer rain, should not be overlooked.

However, an owner who gets his flock through the earlier part of the year fairly well despite inadequate summer storms and failure of winter rains is often faced with a difficult decision by about August or September. He may feel that summer storms may commence during November and bring relief or, at the very worst, general summer rain should come by February or March. In these circumstances consideration might well be given to commencing hand feeding in the spring. Should this be done, property owners in the central and north-west would be well advised to discontinue feeding if relief rains do not fall by the late summer. The probability of winter rains in that area is low and it is inadvisable in most circumstances under pastoral conditions to attempt hand feeding for more than six or seven months.

The location of the property, with special reference to distance from the railway line, has to be considered. Haulage and transport costs can make drought feeding most expensive. Finally, it must be remembered that drought feeding calls for attention to an infinite amount of detail; failure to attend to details may mean failure of the whole project.

[TO BE CONTINUED.]

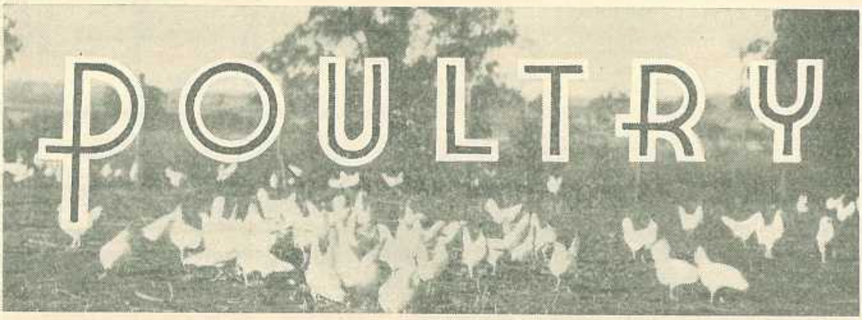
LONG-WOOL RAM SUBSIDY SCHEME.

The Minister for Agriculture and Stock (Hon. H. H. Collins) has announced that applications for assistance under the Long-Wool Ram Subsidy Scheme have now closed, since the maximum number of purchases to be subsidised during the current financial year has been reached.

The scheme was initiated to assist sheep raisers in the purchase of up to 400 long-wool rams suitable for crossing with Merino ewes for the production of fat lamb mothers. Mated with Dorset horn or Southdown rams, these crossbred ewes will produce fat lambs of high quality.

In the purchase of rams under the scheme, preference was given to Queensland studs, and 85 per cent. of the subsidised rams were bred in the 23 long-wool studs in this State. About two-thirds of the rams were Corriedales, one-quarter Border Leicesters, and the remainder Romney Marsh.

Mr. Collins said that consideration would be given to reintroducing the subsidy scheme in the next financial year.



Poultry Keeping on the General Farm.

P. RUMBALL, Officer-in-Charge, Poultry Branch.

POULTRY raising is now a very definite and important branch of primary industry. This is due largely, in the first instance, to the labours of the specialist breeder in the production of high producing strains; secondly, to modern methods of production and distribution of chickens; thirdly, to more efficient and organised marketing; and lastly, to the adoption by poultry raisers of scientific methods of feeding.

Although the specialist poultry breeder has an important influence on the maintenance of a highly organised and efficiently conducted industry, considerable quantities of eggs are produced on the general farm, and if the poultry industry is to expand, such expansion would be sounder as a part of general farming than as a specialised industry.

During recent years there has been a very definite increase in the production of eggs, as indicated by ever-increasing quantities exported overseas. Overseas export, however, can only be practised during a few months of the year. Fortunately for the industry, this period corresponds with the period of peak production, offering a ready means of dealing effectively with the surplus production which usually occurs over that particular period. There is, however, no definite break in production after the export season closes; consequently supplies are temporarily in excess of home requirements, and storage for winter use has to be provided.

The first cost of the egg with the added storage charge prevents eggs so treated being sold at prices that will encourage greater consumption; consequently there is a limit to the number of eggs that can be stored for winter use.

Expansion of the industry must march with increased local consumption, and this is only possible by establishing in the consumers' minds a greater appreciation of the food value of the egg than has been the case in the past.

The confidence of the consumer depends largely on the producer. The fowl produces an article of diet invariably in an almost perfect condition. It therefore remains for the producer, for his own protection, by the exercise of care and efficiency to maintain it in this condition.

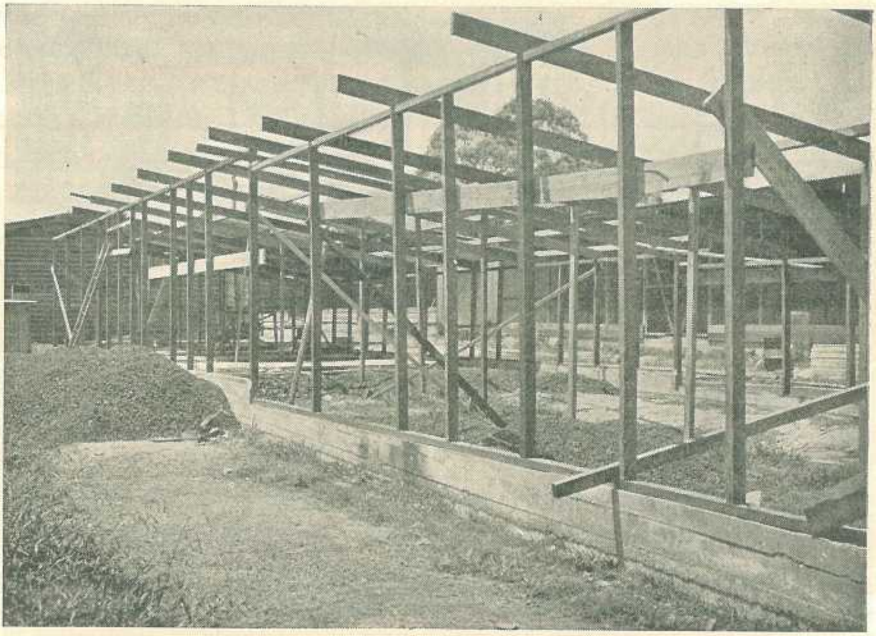


Plate 132.
INTENSIVE POULTRY HOUSE IN COURSE OF CONSTRUCTION.—Note concrete baffle wall to keep rats from under the floor.

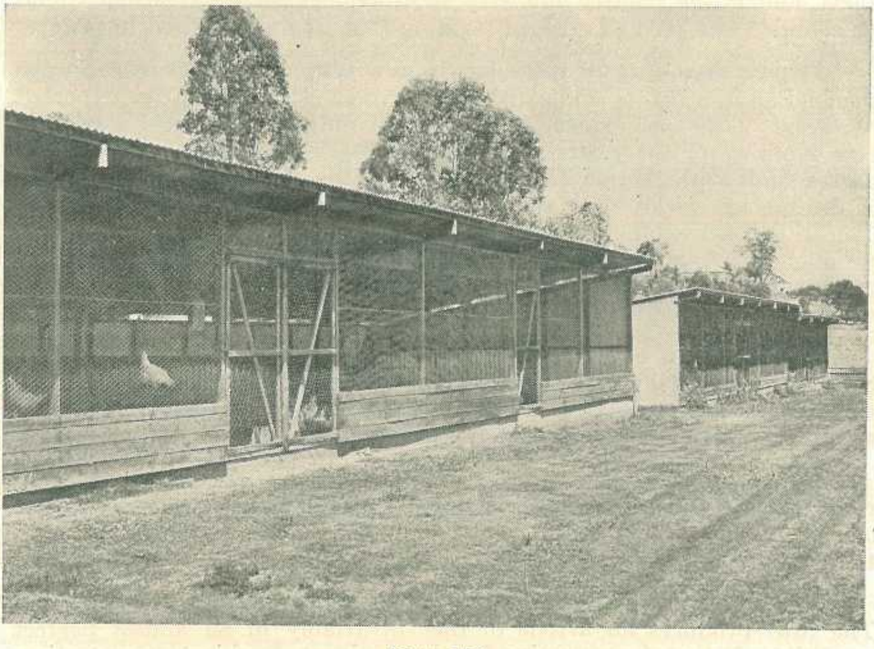


Plate 133.
INTENSIVE POULTRY HOUSE COMPLETED.

HOUSING.

To obtain the best results from poultry, good housing is as necessary as good stock, good feeding, and good management.

Elaborate housing is not necessary, but it must have correct ventilation, freedom from draughts, freedom from moisture, and sufficient room for the comfort of the birds.

Poultry houses may be built of a variety of materials and of many shapes, or old sheds or barns may be converted. If a new house is to be built, iron and sawn timber are recommended as being the most suitable materials (see Plates 132 and 133). The subject is dealt with separately in a Departmental pamphlet.

Systems of Housing.

Housing systems commonly adopted are:—

(1) Intensive, where the birds are kept entirely under cover;

(2) Free range, where a house is erected to provide sleeping accommodation and unrestricted liberty is permitted; and

(3) House and yard, where a house is provided for sleeping quarters, and liberty is restricted by a netted run.

Under the intensive system, the birds are afforded the maximum protection from the weather, ensuring a greater stability in production. The health and condition of the birds are readily observed by the farmer. Further, it is possible to remove all excreta from the house at regular intervals.

Under the free range system some soil contamination from the excreta of the stock naturally takes place, but, because of the unrestricted range and the feeding on the soil by plant life, soil contamination does not become serious. The birds are, however, exposed to the vagaries of the weather, and egg production is not as stable as under the intensive system. There is, however, compensation in the reduced cost of feeding, as birds on range gather a good deal of food in the form of insect life, grass seeds, and other materials.

The house and yard system has the disadvantages and none of the advantages of both free range and intensive system. The birds are exposed to the weather as much as they are under free range, and cannot gather food as the netted run becomes bare in a very short time. The most serious disadvantage of this system, however, is the soil contamination of the pens.

Where a large flock is to be kept the intensive system of housing is recommended, but for the farmer keeping 50 to 100 birds the free range system offers many advantages.

The Site.

The intensive system requires a large and permanent structure, sc the site chosen should receive due consideration. As many poultry raisers start in a small way, provision should be made for extensions.

In addition, although concrete flooring is recommended, the position chosen should be well drained, and, if the building is to be erected on relatively flat ground, the floor should be raised several inches above the surrounding land surface and well rammed to provide a solid foundation.

The house should face north or north-east. A northerly aspect permits of the maximum penetration of the sun's rays into the house during the winter and the minimum during summer.

BREEDS.

Commercial poultry may be grouped in three classes, namely, light, heavy or dual purpose, and game.

Light Breeds.

Light breeds are usually developed especially for egg production with little or no regard to table qualities. This type of bird may also be classed as a non-sitter. Among many strains individuals will be found in which the broody trait has not been bred out, but taken collectively they may be classed as non-sitters. Another character of the light breeds is that they are layers of white-shelled eggs.

Among this group Leghorns predominate, with probably the Ancona next in favour, followed by the Minorca.

Heavy or Dual Purpose Breeds.

Heavy or dual purpose breeds have been developed for table and egg-producing qualities. As a group they are not as efficient egg producers as the light breeds, but individuals hold the record as egg producers in Queensland, namely, 354 eggs in 365 days. Without exception all heavy breeds are very docile, whereas light breeds are of a more or less nervous disposition. Breeds of this group may also be regarded as sitters. Every effort is being made to breed this characteristic out, and it has been done to some considerable extent, but in the best of flocks broody hens will be found. The eggs of this group should be brown in colour, although many pale eggs are laid by all breeds.

The most popular breed of this group is the Australorp. The Langshan is probably the next in favour, followed by the Wyandotte, Rhode Island Red, and Sussex.

Game Breeds.

Game breeds are essentially table birds. Although it may not be profitable to breed Game fowls for table purposes, if it is found commercially sound to breed birds exclusively for the table the crossing of any dual-purpose fowl with the Game will add remarkably to the table qualities of the progeny. This appears to be the most profitable use for Game fowls.

Among the Game group are the Old English, Indian, and Australian Game.

STANDARDS.

To maintain breed characteristics it is essential to have standards to which to breed. Thousands of fowls are bred yearly by producers with little or no regard to type. The departure from type may be attributed in some degree to the exaggerated specimens seen at times on the show bench, and to the greater consideration given by some judges to feather markings than to type and egg-producing qualities.

From the one breed there has often been developed two types, namely, the standard-bred fowl and the utility-bred fowl. In trying to perfect his bird from a show point of view the fancier sacrificed egg qualities, while the egg specialist in the race to produce eggs sacrificed type. The egg producer sacrificed type to such an extent that commercial breeders years ago drew up a utility poultry standard to be read in conjunction with the standard of perfection as laid down by the Poultry Club of England. This move has proved of great advantage to the industry, in as much as the improvement in type which has developed has materially assisted in maintaining the health and stamina of the flocks.

Utility Poultry Standard.

Type, colour (plumage and lobes), legs and feet (colour), condition (health, furnishing brightness and cleanliness of feather and legs), all in accordance with the accepted standard of the breed.

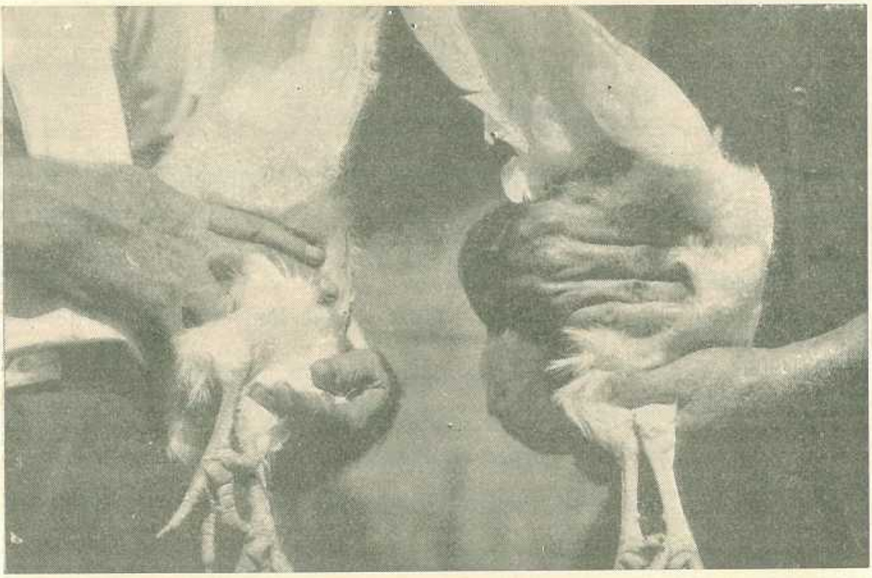


Plate 134.
MEASURING THE DISTANCE BETWEEN THE PELVIC BONES AND THE KEEL.

Laying Characteristics, any Breed.

Conformation—Length, depth and width proportionate to type of breed. Length is taken from base of the neck to base of the tail. Depth is determined by the vertical space between the back and the breast-bone and the pelvic bones. Width is measured across the saddle and immediately behind the wings and is indicated by the distance apart of the legs.

Freedom from Coarseness—

(*a*) Shanks strong, as differentiated from either extreme coarseness or fineness of bone.

(*b*) Pelvic bones strong at base, long, fine, and straight.

(*c*) Tissue—pelvic bones to be as free as possible from gristly covering.

Head.—Finely modelled; skull deep over eyes, full and round at back.

Eyes.—Full, bright, and expressive.

Face.—Bright, lean, free from feathering, and not sunken.

Comb and Wattles.—Neat, fine in texture, and medium size, without "beefiness."

Neck.—Fine and fairly long.

Skin and Abdomen.—Texture of skin to be of the thinnest and finest quality and pliable; abdomen to be elastic, avoiding sagging-in and/or fullness indicating excess of fat.

Plumage.—Feathers soft and silky, close, but not hard as in Game; fluff moderate.

Weights.—Light breeds, ½ lb. to 1 lb. above minimum, and heavy breeds 1 lb. to 1½lb. above, score maximum points; if in excess to be cut correspondingly.

Minimum Weights.

Light Breeds.

Leghorns, Minorca, Andalusians, Spanish, Campines, Buttercups, Anconas: cockerel, 5 lb.; pullet, 4 lb.

Hamburg: cockerel, 4 lb.; pullet, 3 lb.

Heavy Breeds.

Australorp, Plymouth Rock, Rhode Island Red, Sussex: cockerel, 7 lb.; pullet, 5 lb.

Langshans, Wyandottes: cockerel, 6 lb.; pullet, 4½ lb.

Any other variety: cockerel, 7 lb.; pullet, 5 lb.

Scale of Points.

Standard Points.—Type, maximum points, 20; colour (plumage and lobes), 7; legs and feet (colour), 3; condition, 5.

Laying Characteristics.—Conformation (indicating stamina and capacity), maximum points, 20; freedom from coarseness, 5; head, 7; eyes, 7; face, 6; comb and wattles, 5; skin and abdomen, 5; plumage, 5; weight, 5; total 100.

Disqualification.—Under-weight, wrytail, any indications of impurity of breed, dubbing, and faking.

CULLING.

Even with the best of stock unprofitable birds will be reproduced, and culling becomes necessary. By culling the cost of production is reduced, and greater accommodation is available for the stock retained.

In egg-laying competitions an average individual production of 200 or more eggs is usual. This average is not impossible for the poultry raiser to obtain from a flock of well-managed pullets. However, in the second year of a hen's life production is much lower than in her first. Some excellent first-year producers may be exceptionally poor in their second. A similar relationship exists between the production of the second and third year, but with the difference that third-year birds invariably do not lay enough eggs to warrant their retention in the flock.

Culling, therefore, in the first instance revolves around the disposal of old hens. This being so, it is essential that there should be some means of identification by banding birds or by toe-marking. With the latter system it is necessary to catch the bird and inspect its feet to determine its age.

In addition to culling for age, all obviously unfit birds, from chickens to the oldest hens, should be removed from week to week. The main culling should be practised in the summer.

Before culling, the conditions under which birds are housed and fed should be considered. Only well-treated birds can have the external features of a good layer. If the treatment has not been correct this should be remedied, and the birds given at least 6 weeks to respond.

Well managed and regularly culled flocks require little culling during the summer, apart from culling for age. In badly bred and poorly managed flocks considerable culling is necessary. Hens that have given two years' production should, with few exceptions, be culled for age.

Birds should be examined on the ground first. A good producer should be bright, alert, and active, and should have length, width, and depth of body. Birds without these characteristics should be rejected. All small, undersized birds, although of active appearance, should be removed. This work may be done best in the fowlhouse. The birds should be caught with a fish landing net. The other birds should be handled; the best way to catch them is to round them up in a corner, using a piece of 6-feet netting, enclosing 20 to 30 at a time. In the further examination it must be borne in mind that a moulting bird will not have the same measurements as a laying hen. On handling the bird, first its weight should be noted. A good producer will be lean, but not light. Exceptionally light birds should be rejected.

The examination procedure should be based on the following (see Plates 135-137) :—

GOOD LAYER.	POOR LAYER.
Comb (hen not moulting).	
Full, smooth, red, and waxy.	Limp, small, covered with white scale.
Head and Face.	
Lean, fine bone, inclined to length; smooth face.	Coarse-heavy bone; short, dull, and wrinkled face.
Eye.	
Full, bright, and prominent.	Dull, small and sunken.
Beak—Yellow-skinned Birds.	
White or bleached.	Yellow or yellow at base extending to tip.
Eye-ring—Yellow-skinned Birds.	
White or bleached.	Yellow.
Neck.	
Medium length, fine.	Coarse, short, bully.
Back.	
Flat, long, wide (width extending to tail).	Rounded, narrow, especially at tail.

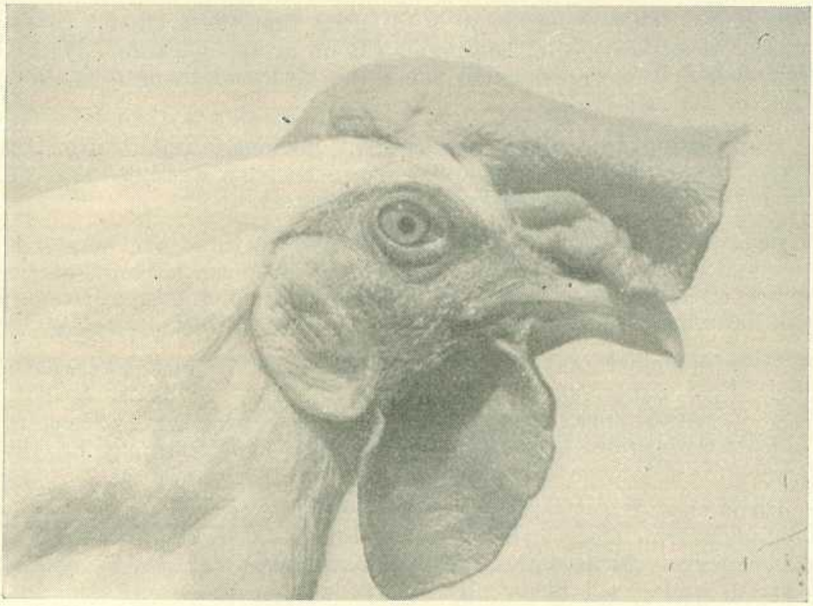


Plate 135.
HEAD OF A GOOD LAYER.—This is an alert, active bird from whom high egg production can be expected.

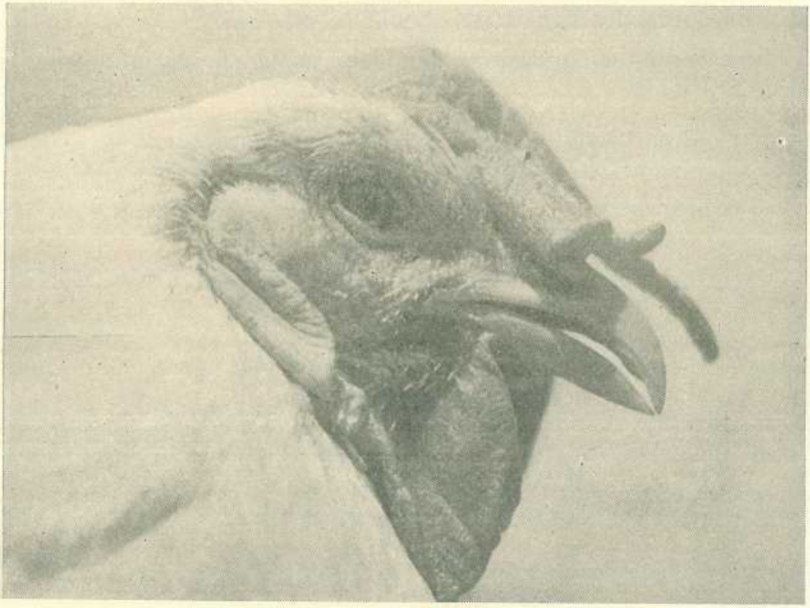


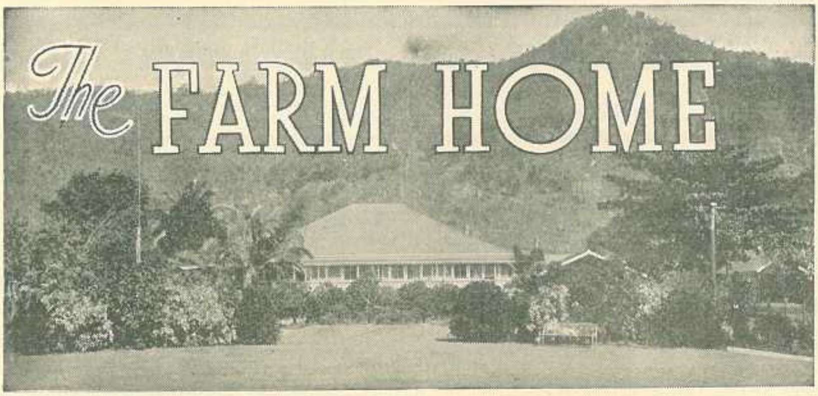
Plate 136.
A COARSE HEAD.—This type of head is not associated with high production.

GOOD LAYER.	POOR LAYER.
Body.	
Long, deep both front and rear.	Short, shallow, especially at rear of bird.
Legs.	
Medium length, fine bone, small close scales, toes well spread.	Short and excessively long; coarse round bone.
Feathering.	
Soft and close; when hand placed on bird it will not sink. Good layers frequently bald around head.	Loose, soft; excessive fluff.
Vent (Yellow-skinned Birds).	
White, large, soft, moist, oval, upper part overhanging.	Yellow, small, hard, dry, and round.
Pelvic Bones.	
Thin, pliable, and relatively wide.	Thick, blunt, and close.
Abdomen.	
Loose; skin pliable, soft; full when in lay and deep from pelvic bones to keel.	Tight, hard, tucked up; pelvic and keel bones close.
Moult.	
Late and rapid, many laying and moulting.	Early, slow.

Plate 137.

HEAD OF A GOOD LAYER.—Note the alertness and freedom from coarseness. Baldness is frequently associated with high production.

[TO BE CONTINUED.]



When Should Baby Start Talking?

Young mothers who have had little or no experience of children before their own babies arrive find themselves confronted with many problems. Feeding troubles are the most obvious ones. Other very usual ''worries'' centre round the ages at which baby should sit up, talk, walk and develop various other skills.

Speech is a mode of expression universal in man and by it the development of his intelligence is often judged, and so parents after carefully reading up the *average* age at which baby should commence to say words are worried because their baby is not doing so while perhaps the infant next door has been talking for some time.

The important thing which mothers and fathers must realise is that baby *understands* words long before he forms and uses them. He may show he does so by kicking and cooing when his feeding time is mentioned or pointing when asked where is his little brother or the puppy. Learning to associate words with things and situations will proceed slowly or quickly according to the opportunities provided by the mother or guardian who is with the child all day. A baby can only repeat what he hears, so a silent mother makes a silent baby while a mother who is a good commentator on life helps her baby to associate words with the articles to which they belong. In this connection it is well to remember that it is only by constant paintaking effort that faults of speech and pronunciation can be corrected once they have become fixed, so ''baby talk'' should not be encouraged however ''cute'' it sounds. If the baby hears from his parents and brothers and sisters badly formed and carelessly spoken words, slang or swearing, the day will come when, like a gramaphone record, he will reproduce these sounds.

Baby begins practising sounds very early in life. He finds it fun to make noises and a baby of 6 months experiments with many more sounds than he will ever use when he settles down to talking. Parents often become quite heated as to whether baby first said ''Ma-ma'' or ''Da-da'' but actually these are primary sounds common to all babies and he usually says these about 11 months of age. Other single words follow and by about 18 months he can usually say about six words. At 2 years of age he begins to put several words together to make sentences.

Some quite normal babies are slow in talking because they will ''not be bothered.'' They are usually strong-willed little people and sometimes spoilt as well. They get along quite well with gestures and signs—insisting on being understood. The more they are urged to talk the more silent they remain. There is no need to worry about these children. They will talk when it suits them and talk very well. They often live too much in adult company and it is a good plan to arrange for them to have the company of other children, when they will naturally copy what the others do.

If your child is not talking after he is well past the average age when he should do so it is a good plan to consult your doctor just to make sure that his hearing or natural development is not responsible. The earlier speech defects are taken in hand the sooner will they respond to treatment.

Any further information on this and other matters connected with children may be obtained by communicating personally with the Maternal and Child Welfare Information Bureau, 184 St. Paul's Terrace, Brisbane, or by addressing letters ''Baby Clinic, Brisbane.'' These letters need not be stamped.