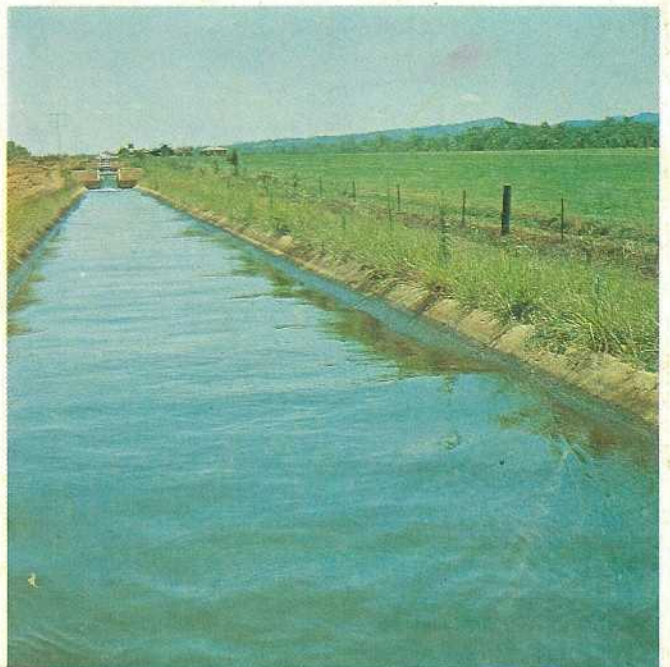
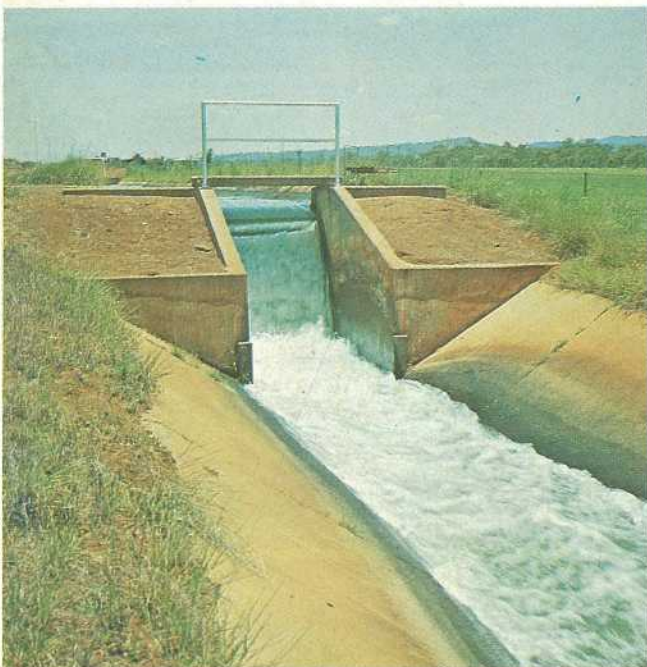
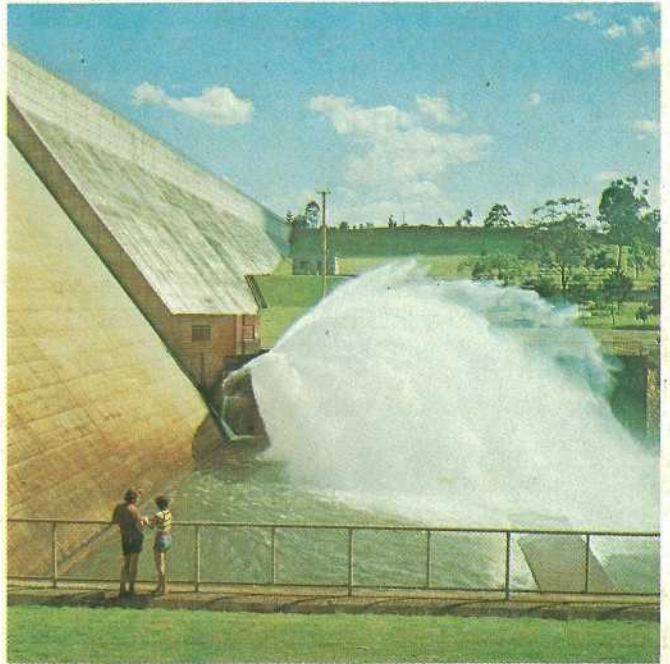
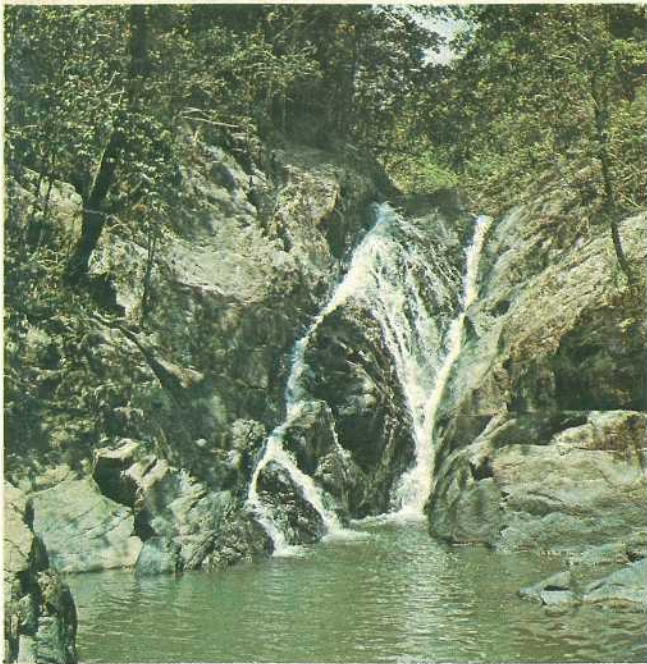


Queensland **AGRICULTURAL JOURNAL**

SEPTEMBER 1976 Vol. 102 No. 5



IRRIGATION AND WATER CONSERVATION

The important primary industries of Queensland are subject to relatively frequent and serious losses by drought and also to extensive flooding. There is therefore a definite need for the provision of works for water conservation for irrigation and stock watering and for flood mitigation.

The average annual flow of all streams in Queensland, equivalent to approximately 40 per cent of that for all Australian streams, gives ample scope for such works.

The right to the use and flow and to the control of water in watercourses, lakes, springs, and artesian wells in Queensland vests in the Crown, and the Commissioner of Irrigation and Water Supply is authorised to take measures to conserve water and provide for its more equal distribution and beneficial use.

Irrigation areas

About 9.5 per cent of the area under irrigation in the State is concentrated in five established irrigation areas.

Dawson Valley Irrigation Area. This area situated around the town of Theodore is supplied by four weirs on the Dawson River. Pumping stations deliver water through channel systems to 61 farms. Cotton and grain crops account for the major part of production from irrigated farms. In addition the towns of Theodore and Moura and the Thiess Peabody Mitsui Mining Group obtain supplies from the storages.

Burdekin River Irrigation Area and Water Supply Scheme. This scheme is a complex system of water conservation, irrigation, industria, urban, and stock water supply. Storages are Eungella Dam on the Broken River, and Gorge and Blue Valley Weirs on the Burdekin River.

From Eungella Dam water is diverted directly by a privately owned 120-kilometre piped supply system to coal mining operations at Goonyella and Peak Downs and the town of Moranbah.

Supplies for other purposes are maintained along the Bowen River and lower 114 kilometres of the Burdekin River by release of water from the storage as required. These

purposes and the arrangements for supply comprise: (i) a pumping station on the Bowen River delivering supply through 34 kilometres of pipeline to the Collinsville Power Station, Collinsville Town, and nine grazing holdings along the pipeline: (ii) six pumping stations delivering water through channel systems to 141 individual irrigated holdings in Clare, Millaroo, and Dalbeg sections of the Burdekin River Irrigation Area, the principal crops from irrigated farms being sugar cane, rice, and (iii) private diversion by pumping for irrigation on holdings along the Bowen and Lower Burdekin Rivers.

Mareeba-Dimbulah Irrigation Area. This area is supplied by Tinaroo Falls Dam and weirs on the Barron and Walsh River systems. Water is delivered through channel systems and regulated streams to 563 farms on which the principal crop is tobacco. In addition, water is supplied to the towns of Mareeba, Dimbulah, Walkamin, Mutchilba, and Tinaroo Falls, and to the hydro-electric generating station at Barron Falls.

St. George Irrigation Area. The principal storages of this area, located near the town of St. George, are Beardmore Dam and Jack Taylor Weir on the Balonne River and 2 weirs on Thuraggi Watercourse. Water is supplied to 25 farms, on which the principal crops are cotton and soybeans, and to the town of St. George. The construction of works to extend the area by some 16 farms is in progress, four of these farms being opened at 30 June 1974.

Emerald Irrigation Area. This scheme, a joint Australian Government and State Government undertaking involved the construction of Fairbairn Dam on the Nogoa River, some 19 kilometres upstream from Emerald. Water from this dam and associated irrigation, drainage, and roadworks could ultimately serve 110 irrigation farms on which 20 000 hectares could be irrigated annually. In addition, supplies will be provided for coal mining and urban water supply in the Black-water area. The area commenced operations during 1972-73 when 13 farms were connected to the channel system. An area of 1 691 hectares of crops (1 485 hectares on channel supplied farms and 206 hectares from regulated streams) was irrigated during 1973-74 with the principal production being sorghum.

Text from the Queensland Year Book 1975.

Our cover features scenes of the Barron River and Tinaroo Dam in northern Queensland. Pictures by George Cripps.

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Contents

New Director-General of Primary Industries 418	Tuberculosis-free cattle herds 451
Feral pig control trials 419 <i>by W. D. Hamilton and J. Wright and R. Kirby</i>	Looking back—items from 1901 issues .. 452
Comparative breed studies—Hereford and Belmont Red 422 <i>by S. J. Wood</i>	Breeding wheat for overseas markets .. 453 <i>items from Wheat Research</i>
Ensuring long storage life for pasteurised milk 424 <i>by T. W. Dommett</i>	Symptoms of 2,4-D injury to horticultural crops 456 <i>by J. F. Gage</i>
Of particular interest 427 <i>Statements by the Minister for Primary Industries</i>	First U.K. pure-bred Romagnola calf heads for Texas 463
Whittet kikuyu in the Gympie district .. 429 <i>by L. E. Brands and B. G. Cook</i>	Burning fire breaks 465 <i>by N. Scott</i>
Biological control of green turkey bush 433 <i>by P. G. Allsopp</i>	Good traprock pastures need proper grazing management 468 <i>by E. J. H. Glavimans</i>
How economic dairy farming was achieved at Cushnie 435 <i>by W. B. Oliver</i>	Trigger Plants 473 <i>by Beryl A. Lebler</i>
Mung Bean—an important new grain legume 438 <i>by W. Bott and R. W. Kingston</i>	Products of the Hive 478 <i>by C. Roff</i>
A predacious mite—possibilities for two-spotted mite control 443 <i>by Leonie E. Markwell</i>	Brucellosis-tested swine herds 488
Identifying Insects—Stick Insects 445 <i>by I. D. Galloway</i>	Guide to soils and plant nutrition 489 <i>by N. G. Cassidy</i>
Improving environment for the farm worker 447 <i>by G. Archer</i>	The Farm Family 503 <i>with Ann Cook</i>
	Gardening notes—growing carrots, beet-root and parsnips in the home garden 506
	Cookery—consider the sweet biscuit .. 509

QUEENSLAND DEPARTMENT OF PRIMARY INDUSTRIES

New Director-General of Primary Industries

(Statement by
The Hon. V. B. Sullivan, M.L.A., Minister
for Primary Industries).

MR. A. A. (Alan) Ross has been appointed the new Director-General and Under-Secretary of the Queensland Department of Primary Industries.

The appointment takes effect officially from October 18, with the end of retirement leave of the former Director-General, Dr. J. M. Harvey.

Mr. Ross, the deputy Director-General since December, 1965, has served the Department with dedication and distinction for 37 years.

He brings to this top executive position in my Department a wealth of experience in horticultural research and extension work, in marketing and in the administrative field.

As the deputy Director-General and chairman of both the Research Stations and Extension Services Boards, Mr. Ross has travelled extensively, and regularly, throughout Queensland and is well known to Departmental officers and primary industry leaders in every corner of the State.

He played an active role in the development of the Department's regional extension services and studied extension organisation in major primary-producing countries during a world tour in 1970.

The new Director-General graduated from the Queensland Agricultural College in 1934 with a Diploma in Agriculture and, four years later, with a Bachelor of Agricultural Science degree from Queensland University (both with first class honours).

He secured his Master's degree from the same University in 1945.

In 1960, Mr. Ross gained the advanced certificate at the Australian Administrative Staff College at Mt. Eliza, Victoria.

In his 37 years spent with the Department, 18 of them based in country areas, Mr.



Mr. A. A. Ross.

Ross has served at Nambour, Brisbane, Stanthorpe, Gayndah and Maryborough.

His career began in the horticultural research field at Nambour in 1939, investigating sub-tropical tree crops, such as macadamia nuts and avocados and citrus.

At Stanthorpe, the accent was on deciduous fruits but, while there, Mr. Ross made the initial selections of Q varieties for the Tomato Seed Certification Scheme.

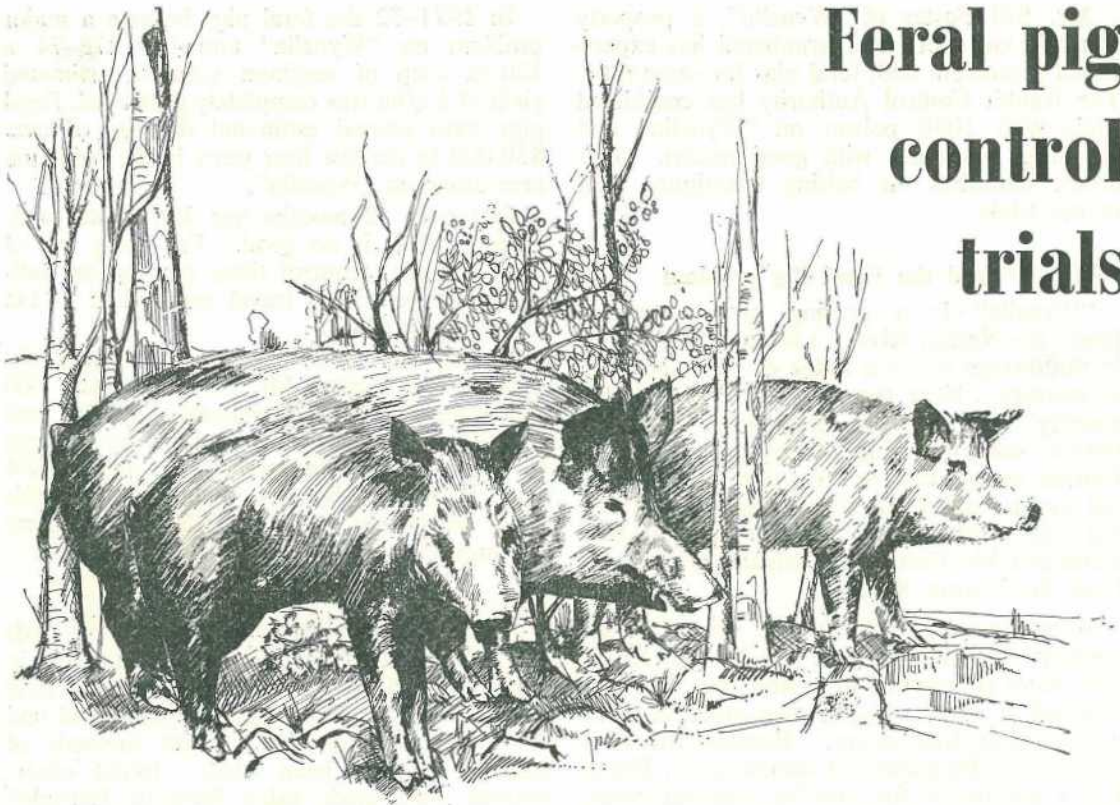
His next postings were to Gayndah (citrus fruits) and Maryborough (sub-tropical crops and tomatoes in a region stretching down the coast from Mackay to Gympie).

Mr. Ross was transferred to Brisbane in 1956 as Officer-in-Charge of the Standards Branch and, in 1962, appointed Director of Marketing. He has been Chairman of the Brisbane Milk Board since 1964.

Mr. Ross deputised on several occasions for Dr. Harvey at meetings of the Australian Agricultural Council's Standing Committee on Agriculture.

The Committee was an advisory body to the Council, which comprised Federal and State Agriculture Ministers and was the top policy-making body in Australia for primary industry.

Feral pig control trials



on “Wynella”, Dirranbandi

by W. D. HAMILTON, Department of Primary Industries, and
J. WRIGHT and R. KIRBY, Rabbit Control Authority.

FERAL pigs are a serious problem in many areas of Queensland. They damage fencing and watering facilities and cause serious losses in crops and livestock. They pose a serious threat in the spread of various livestock diseases such as foot and mouth disease, should any of these diseases be introduced into Australia. Control of feral pigs has now become an important part of property management on many Queensland properties.

Mr. Bill Foster of "Wynella", a property some 40 km south of Dirranbandi has experienced a problem with feral pigs for some time. The Rabbit Control Authority has conducted trials with 1080 poison on "Wynella" and adjoining properties with good results. This article describes the baiting techniques used in the trials.

"Wynella" and the Feral Pig problem

"Wynella" is a grazing property which fronts the Narran River. Like most properties in the district it has a range of different types of country. Near the river there is "flooded country" composed of deep grey and grey-brown self mulching cracking clay soils. Further away from the river there are lateritic red earths and hard-setting loamy soils with red clayey subsoils. The property runs beef cattle and Mr. Foster also irrigates grain crops from the Narran River.

Approximately 200 ha of the "flooded country" is irrigated from the Narran River. The water is supplied by a weir that was constructed in 1965. Use is also made of flood waters when they occur. Because the river floods most frequently in summer, Mr. Foster has a preference for growing summer crops. Grain sorghum has been successfully grown but in the past these have been devoured by feral pigs. Crops of barley, oats and sunflower have also been grown.

In 1971-72 the feral pigs became a major problem on "Wynella" and in 1973-74 a 120 ha crop of sorghum with an estimated yield of 5 t/ha was completely destroyed. Feral pigs have caused estimated damage of over \$30,000 in the last four years in the irrigation area alone on "Wynella".

Just over 12 months ago Mr. Foster concluded, "This is no good. I'm going out of grain. I can't control these pigs on an individual basis. They travel more than 14 km to eat my crops."

During this time when the feral pigs did most of the damage Mr. Foster claims 1 000 pigs were shot, with 20 gallons of S.A.P.* and 4 gallons of Luci-Jet† used in an attempt to poison them. In one five-day period 294 pigs were shot by five men. All of this effort made no apparent difference to feral pig numbers.

The 1080 Trials

The Rabbit Control Authority started trials on "Wynella" and adjoining properties in January 1975. It had been observed that feral pigs were poisoned by baits prepared and laid for rabbit control but different methods of baiting had not been tried. Initial observations were made using Barastoc Extruded Rabbit pellets. The baits were laid on an 8.8 km trail. Several free feeds were followed by a poison feed. The results and observations are tabulated below:—

Date	Quantity of pellets used/km	Estimate of quantity of bait taken	Comments
29-1-75	20 kg	..	Baits laid on banks and dry areas in the irrigation area
30-1-75 a.m. ..	..	60%	All bait taken in 60% of the trail length
30-1-75 p.m. ..	20 kg	..	Trail re-laid on parts consumed
31-1-75 a.m. ..	..	90%	All bait taken in area re-laid with an additional 30% of trail taken
31-1-75 p.m. ..	20 kg	..	Trail re-laid on parts consumed
2-2-75 .. ..	..	100%	All baits were taken along 8.8 km trail
3-2-75	25 kg of poison baits	..	Complete trail re-laid
4-2-75 .. ..	..	60%	Bait on the original 60% was taken, 70 pigs were found dead
5-2-75 .. ..	..	..	No more bait appeared to be taken but a further 15 pigs were found dead
6-2-75 .. ..	..	..	No more bait appeared to be taken but a further 6 dead pigs were found

*S.A.P. Rabbit, Pig and Crow Poison is the registered trade name for yellow phosphorus—sold as a pest destroyer.

†Luci-Jet is the registered trade name for fenthion-ethyl, a sheep dip concentrate.

These trials were conducted on "Wynella" and two adjoining properties "Booligar" and "Boorumbirra". A similar trial was conducted on "Weeallah", a property some 56 km north-west of St. George. Comparable results were achieved on each property where Barastoc Extruded Pellets were laid.

Rabbit pellets have several advantages as pig bait, but they are expensive and cannot be distributed in paddocks where stock graze. When choosing an alternative bait, consideration was also given to the need that—

- it must be more attractive to the feral pig than ripening grain crops, and
- it must be inexpensive and readily available.

Meat baits cut from unsaleable cattle filled these criteria.

A further observation trial was planned. This time a "cancer-eye" cow was slaughtered and boned out and 150 pieces of beef each about 1 kg were cut from the carcass. A little over 100 ml of 1:30 1080 solution was poured over 7 to 10 kg of meat bait. These baits were then distributed along a bulldozed track where pigs were known to cross. About 50 metres separated each bait.

Observations showed that feral pigs readily took the bait but only 3 pigs were found dead the following day. It was also decided that pouring a 1080 solution over the baits was not a satisfactory method of impregnating them. The baits would be injected with poison in future.

To follow this up a further bait laying program was organised on "Booligar", on the opposite side of the Narran River.

An unsaleable beast was slaughtered and boned out the following day. Into each bait

was injected 5 ml of 1080 solution (concentrated at 454 g/8 l of water). The baits were from 150 to 200 g in size and were distributed along a scent trail made by dragging the skin of the slaughtered beast behind a utility. Each bait contained enough 1080 to kill two adult pigs of 100 kg body weight. The dose rate was based on the lethal dose of 1 mg of 1080 per kilogram of body weight.

Over a period of 10 days, 2 100 baits were laid. Sixty pigs and 13 foxes were found dead during that time. Almost all the baits laid were eaten over the 10 day period. One pig was seen to eat eight baits, enough to kill 22 average size pigs.

Following this success on "Booligar" a group poisoning program using the same techniques was started on twelve adjoining properties. Although no careful counts of dead pigs were made, it was considered that the baiting with 1080 greatly reduced feral pig numbers.

The success of the pig control program on "Wynella" is demonstrated by the crop of sorghum harvested in 1975. It was planted in January and little pig damage was experienced. Of the 150 ha crop only 2 or 3 ha were lost to pigs. A yield in excess of 2½ t/ha was harvested—a worthwhile result for the effort put in to controlling the feral pig problem.

The results of the 1975 campaign and an outline of the 1976 programme of the Co-ordinating Board will be announced in a later issue of the Queensland Agricultural Journal.

GOT A FARMING PROBLEM?

Advice from the D.P.I. is free. Contact your Local D.P.I. office if you think we can help you—it is listed under "PRIMARY INDUSTRIES" in your telephone directory.

Comparative Breed Studies

Hereford and Belmont Red

Brigalow Research Station

by S. J. Wood, Beef Cattle
Husbandry Branch

A RECENT research programme started at Brigalow Research Station aims to further evaluate the performance of the relatively new Belmont Red beef breed.

At the time of the inception of Brigalow Research Station in 1965 Herefords were the predominant breed in the region. Initial cattle husbandry experiments were developed using a purebred base Hereford herd. A proportion of these breeders were used to generate halfbred Simmental progeny over the three years, 1972-74 for the studies outlined. (See *Queensland Agricultural Journal*, July-August 1976). The inherent high fertility of the Hereford breed has been shown by an average calving rate of 87% for all Hereford breeders associated with the research programme over the past three mating seasons.

More recently the trend in the tropical regions has been away from the purebred British breeds towards the tropical adapted breeds. These are able to cope better with the harsh environmental factors in the tropics such as the cattle tick, worms, high summer temperatures and humidity, and poor nutritional conditions during the winter dry season.

Typical mating groups of Hereford breeders (40 cows) involved in the project. They are standing in buffel grass improved pastures. This group has been mated to an Africander sire.



The Brahman derived breeds have shown better adaptation and growth rates than the Africander derived Belmont Red on the coast at the C.S.I.R.O. National Cattle Breeding Station "Belmont".

However, higher reproductive rates in later generations and better temperament of the Belmont Red relative to the Brahman derived breeds makes up for these disadvantages.

Because of this difference in fertility, a greater selection intensity can be used with the Belmont Red cattle for beef production attributes relative to the Brahman derived cattle.

For these reasons the Department of Primary Industries decided to establish an experimental Belmont Red herd by mating half the base Hereford breeders to Africander bulls to produce halfbred progeny. These offspring

will be mated for two generations to Belmont Red Bulls. The remaining half of the base Hereford breeders are being bred to Hereford bulls.

All breeders will be kept together outside the mating season and be given the same management and grazing conditions. Progeny performance will be evaluated on common improved pastures by regular weighings. The herd will continue to be performance recorded to evaluate selection on economically important production characteristics.

This will provide a direct comparison between the purebred Hereford and Belmont Red breeds under the same conditions on improved pastures in the Brigalow region.

These studies will provide a further assessment of the breeds to assist graziers in making their own value judgements.

KEEPING A BULL HAS ITS UPS AND DOWNS



A.B. MAKES LIFE SO MUCH EASIER

For further information contact your nearest D.P.I. office or write to the Officer-in-Charge; Wacol A.B. Centre, Grindle Road, Wacol - Phone 372 2522. Telegrams - ARTINSEM.

Ensuring long storage life for pasteurised milk

by T. W. DOMMETT,
Otto Madsen Dairy Research Laboratory,
Dairy Research Branch.

MILK has always been one of mankind's most nutritious foods. Normally, it contains certain bacterial types which can be present in low or high numbers. These micro-organisms are able to use the milk to satisfy their food requirements.

In so doing, they rob the milk of its food value and leave waste products which make the milk unpalatable for humans. For example, they may cause souring or rancidity as they develop in the milk. Chemical changes such as of the constituents of milk may also occur if long storage is involved.

Milk spoilage caused by micro-organisms will be minimised when (a) numbers of bacteria are as low as possible (b) storage temperatures are as low as possible and (c) storage times are as short as possible. Storage temperature and time will also influence the rate of chemical changes. To prevent milk spoilage, careful attention should be paid to each of these factors.

What precautions are taken in the dairy industry to prevent spoilage?

Milk is pasteurised by heating to 73°C for 15 seconds to reduce the numbers of bacteria to acceptable levels. This process serves two purposes. It removes from the milk any bacteria which may be a health risk and reduces the chances of subsequent spoilage. Processing and handling of the milk is carried out hygienically using sterilised equipment to prevent entry of large numbers of bacteria into the product.

Homogenisation is a process designed to give an even distribution of the fat content of the milk. This is achieved by breaking down the fat globules so that smaller droplets can be dispersed in a more stable form. This

process should have no effect on the potential storage life of the product.

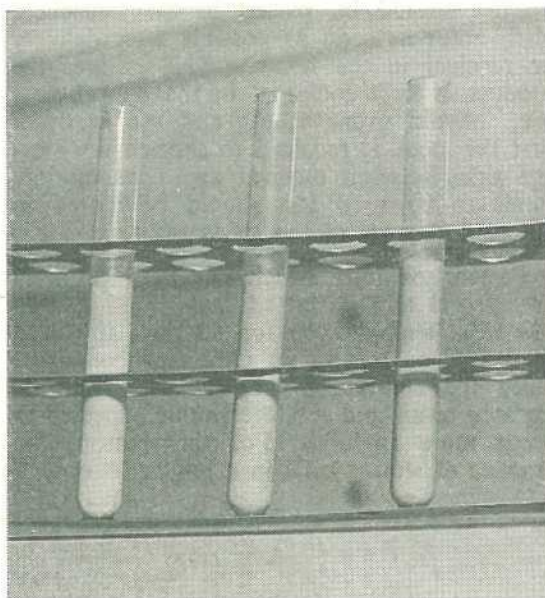


Dairy Research Branch officer testing a dairy product for keeping quality.

At all stages of production except pasteurisation, milk is held under refrigeration or insulated cold storage to minimise any increase in microbial numbers. This cooling of milk applies from when it leaves the cow until final delivery to the customer.

After bottling, milk is marketed as soon as possible to shorten the storage time before consumption.

To ensure the pasteurised milk available to consumers will keep as long as possible, regular testing of selected samples is carried out in Dairy Research laboratories throughout the State. A series of microbiological and chemical tests is used to determine various aspects of milk quality, and one of these is specifically designed to assess the storage life of the product. This particular test is called the "keeping quality" test, as it measures how long the milk will keep without spoilage occurring.



Rack of completed keeping quality test samples.

What is involved in the keeping quality test?

In the keeping quality test, the milk sample is subjected to adverse storage conditions to speed up the development of defects which are then measured by a colour change in a simple dye test.

Bottles, cartons or plastic sachets of pasteurised milk are taken from dairy factories on the day of packaging and transported to the laboratory. These samples are then stored at 20°C for 21–24 hours to allow microbial development to occur much faster than it could under the normal marketing arrangements.

A small sample (10 ml) is then placed in a test tube to which is added 1 ml of methylene blue dye. The sample, now coloured pale blue, is then incubated at body heat, 37°C for two hours.

At this temperature the microbes present will continue to grow and in so doing gradually use up any oxygen dissolved in the milk. Eventually, when all the dissolved oxygen has been exhausted, the blue dye will become colourless and the liquid in the tube will assume the white colour of the original milk. When the colour change occurs, the time is recorded.

The better the milk, the fewer the bacteria that will be present in the sample and the slower the rate at which oxygen will be used.

Therefore the better the milk, the longer the dye will remain blue. Satisfactory quality is assured when the time exceeds 2 hours. Times in excess of 4 hours are not uncommon.

What can the customer do to assist keeping quality?

Milk delivered to the home should be received in a cool shaded part of the property. If the milk is left for some hours in direct sunlight or in some other heated area the quality may deteriorate from bacterial development and chemical change.

Milk is subject to flavour changes and loss of vitamin content when exposed to strong sunlight. If no naturally shaded positions are available, it is possible to arrange for milk to be left in an insulated box, such as a portable ice box, provided by the householder.

Shop purchases should be made from stores with efficiently operating refrigerated cabinets where the temperature is never allowed to approach room temperature. The products should be taken home as soon as possible and kept cool between the store and the home.

Milk should be placed in the household refrigerator as soon as possible after delivery or receipt in the home. This ensures the product is kept cool and in the dark before use. Avoid over-stocking and use in order that the stock is received to shorten the storage time between receipt and consumption. Items to be used last should be stored in the coldest parts of the refrigerator.

Pasteurised milk which has been properly pasteurised and packaged from good quality raw milk should keep for 10 days if stored at 4.5°C or less in an unopened container. Once the container is opened, the milk is exposed to air and spoilage can be expected to occur more rapidly. For this reason, the practice of storing milk in a jug and "topping

up" milk from the previous day with fresh milk should be avoided.

The recommended temperature range for liquid milk products is 1–3°C with consumption within 5–7 days. However, the temperature in the different sections of the refrigerator varies from below freezing point (0°C) in the freezer compartment to over 7°C in some of the other sections. The higher the storage temperature, the sooner the product should be used.

A great deal of care and attention has gone into the production of pasteurised milk before it finally reaches the customer. With careful handling and storage of milk in the home, we can gain maximum benefit from one of our best foods.

Brand Directories

NEW editions of the Horse and Cattle Brands Directory and Sheep Brands and Earmarks Directory are now available.

The price for the Horse and Cattle Brands Directory, compiled to 30th June 1971, is \$45. Due to steep increases in labour, printing and paper costs, it has not been possible to approve the sale of this directory at a lower price—this price is set almost at cost.

The Sheep Brands and Earmarks Directory, compiled to 31st December 1974 is priced at \$5.00.

All prices include postage.

Any person who wants to buy any of these Directories should forward the required amount and advise the relevant details to the Registrar of Brands, Department of Primary Industries, William Street, Brisbane, 4000.

Of particular interest

Items of news recently released by the Minister for Primary Industries, the Hon. V. B. Sullivan, M.L.A.



NEW CONCEPT FOR CROP ESTABLISHMENT

A problem which often arises in Queensland soils is poor establishment in direct-seeded vegetable crops, due to unsatisfactory emergence because of soil crusting or other faulty seedbed conditions.

A new concept, called plug-mix seeding, has been developed overseas to overcome this difficulty.

The crop seed is pre-mixed with special media and planted in the field as a small plug.

My Department has imported from the United States a machine designed to carry out plug-mix seeding on a commercial scale.

Mr. N. S. Kruger, the assistant Director of Horticulture, has studied the machine in operation during a recent tour.

The success, or otherwise, of a crop depends upon good germination and an even stand of healthy plants.

From overseas experience, the advantages claimed for plug-mix seeding are that crops emerge faster with more uniform growth and maturity, less early weed competition and fewer disease problems.

The acquisition of the plug-mix seeder will enable preliminary testing to be carried out at my Department's Redlands Horticultural Research Station, near Brisbane, aimed at improving crop establishment by mechanical means.

It then is proposed to test and demonstrate the equipment in each of the major vegetable-producing districts of the State.

OFFAL BOILING POTS TO BE COVERED BY LID

POTS, or vats, used by slaughterhouses to boil-down offal for use as pig feed now must be covered by a close-fitting steel lid.

Originally, it was proposed that this practice be prohibited.

However, the State Government has decided to allow it to continue, with the provision that lids be fitted to make the cooking of offal more efficient and effective.

It has been found that containers with lids cooked the offal more rapidly and thoroughly and, as a side benefit, required less fuel in operation.

INLAND WOOL PROCESSING PLANT PROPOSAL

A PROPOSAL to establish a wool top-making plant at Charleville is being examined jointly by my Department and the Department of Commercial and Industrial Development.

Consultant firms which specialise in carrying-out feasibility studies now are being approached.

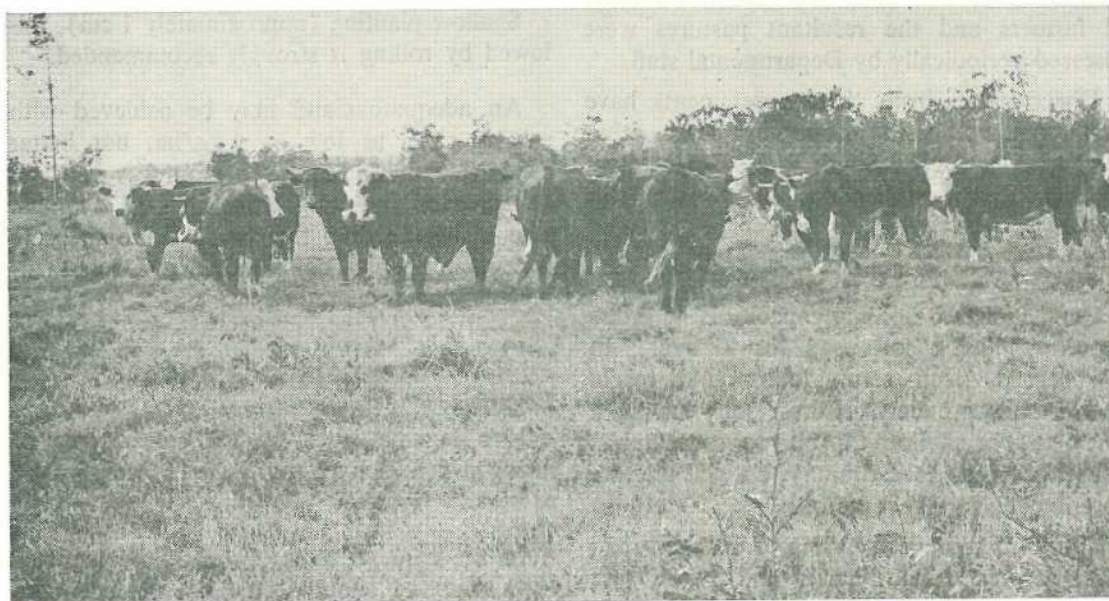
When advice is received on the cost involved in conducting such a study, it will be placed before State Cabinet for consideration.

The consultant employed will consider such suitability factors for location of the plant as:—

- Supply of suitable types of wool, freight costs, water supply and labour availability.
- A comparison of the capital costs of a plant in what was considered to be the best location with those of other suitable inland centres.
- The profitability of a newly-established wool-processing plant in both the short and long term.

Strong representations have been made to myself and to the Premier, Mr. J. Bjelke-Petersen, for the setting-up of such a plant at Charleville by Mr. Neil Turner, the Member for Warrego.

Mr. Turner made the approach on behalf of the Charleville Chamber of Commerce.



Beef cattle on nitrogen-fertilized Whittet kikuyu.

Whittet Kikuyu in the Gympie district

by L. E. BRANDS and B. G. COOK,
Agriculture Branch.

KIKUYU (*Pennisetum clandestinum*) has long been an important pasture grass in the higher rainfall areas of Queensland. Its use, however, has been restricted by the need to establish it vegetatively.

In 1972 seed of the new cultivar, Whittet, became available. This was the first commercial seed of kikuyu and resulted in a major upsurge of interest in the grass.

Whittet kikuyu is a taller, coarser, broader leaved and more vigorous cultivar than common kikuyu. It was introduced from Kenya by the New South Wales Department of Agriculture in 1960.

Following the success of Whittet in New South Wales, the Nestle Company and the Queensland Department of Primary Industries launched a co-operative project in the Gympie district. Seed was made available to a number of farmers and the resultant pastures were assessed periodically by Departmental staff.

Observations from these assessments have been combined with information from other local trials and New South Wales Department of Agriculture publications to prepare this article.

Where is it planted?

Good moisture holding capacity is of prime importance in a soil used for kikuyu. In this regard, deep scrub loams and recent alluvial soils are best. Forest soils having a sandy and/or shallow topsoil are not suitable. The grass needs good drainage but will tolerate waterlogging for short periods.

Kikuyu is more demanding of nitrogen than other grasses. Phosphorus and potash are also important for good growth.

When is it planted?

The best planting period is in late February or March. Whittet kikuyu can, however, be planted at any time between October and April. In the early part of this period, moisture availability is often a problem; in mid-summer, temperature and weed-competition may slow growth; April plantings in lower situations can be adversely affected by early frosts.

Planting procedures

As with all small seeds, a properly prepared seedbed gives the best chance of successful establishment. Success has also been achieved with minimal seedbed preparation, but some complete failures have been recorded with this practice.

The natural grasses in most areas where Whittet may be planted are mat grass (*Axonopus affinis*) and paspalum (*Paspalum dilatatum*). Unless eradicated during the seedbed

preparation, these will respond strongly to subsequent nitrogen applications, and offer strong competition to the developing kikuyu plants.

Shallow planting (approximately 1 cm), followed by rolling is strongly recommended.

An adequate stand may be achieved with sowing rates as low as 1 kg/ha, but better establishment and quicker ground cover will be achieved by using from 2 kg to 4 kg/ha. The higher seeding rate tends to compensate for greater weed competition and less-than-perfect land preparation.

Companion species

Legumes

If a legume is to be the sole source of nitrogen for kikuyu, that legume needs to be extremely vigorous.

In the trial pastures, none of the legumes used supplied enough nitrogen for adequate kikuyu growth during the first two years. In view of this and from other experimental results, a legume based kikuyu pasture is not recommended on forest soils.

On scrub and alluvial soils, where the level of soil nitrogen is much higher, legumes can provide a worthwhile supplement. White clovers (cultivars of *Trifolium repens*) are the best legumes for alluvial soils. On scrub soils Greenleaf desmodium (*Desmodium intortum*) and glycines (cultivars of *Glycine wightii*) can also be used.

Whittet seed can be added to a tussock grass/legume seed mixture as an extra component. This allows the gradual development of the kikuyu over a number of years with the normal build up of soil nitrogen from the sown pasture.

General experience in this district is that as kikuyu vigour increases, legume vigour declines.

Grasses

District farmers commonly tried to establish Whittet kikuyu under a rye grass and/or oat cover crop, usually with irrigation. These attempts were largely successful; however, if an early dense stand of kikuyu is required, seeding rates of rye grass and oats must be low enough to give an open stand of these species. No more than 15 to 20 kg/ha of oats seed or 4 to 6 kg/ha to rye grass seed, in each case depending on seed size, is recommended.

Fertilizing

The actual amounts of fertilizer needed, either for establishment or maintenance, depend largely on the soil type involved, the cropping history and the yield of kikuyu the farmer wants.

If soil analyses indicate marginal levels of phosphorus (P) and potassium (K), a dressing of about 20 kg P/ha and 25 kg K/ha is strongly recommended.

In recently cleared scrub soils, enough planting nitrogen is available from ash and soil organic matter. On old cultivation land, nitrogen fertilizer to supply at least 50 kg N/ha is needed. This fertilizer should not be mixed with the seed; in two observed cases this practice caused weak straw-coloured seedlings. These did recover eventually but during the recovery period strong weed growth developed. The problem does not occur if the nitrogen is broadcast on established seedlings or incorporated in the soil before sowing.

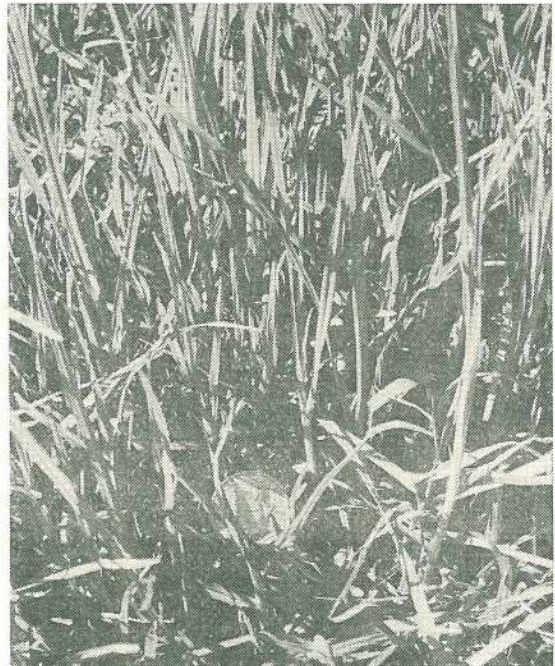
Once the sward has established, at least 150 kg N/ha is needed annually for maintenance. Because of the inadequacy of legumes this nitrogen will in most instances have to be applied as fertilizer. It is best applied as a split dressing in August/September and again in late March/early April. Strategic applications of larger quantities may be applied as needed.

Weed control

During establishment, excessive weed growth can inhibit tillering, compete for nutrients and light, and retard development of ground cover. Under such circumstances some control measures may be necessary.

If an associated legume component is to be encouraged, mowing or slashing are the only available practices; most chemicals seriously affect legume growth. With luxuriant growth of companion forage species e.g. rye grass or oats, grazing should be sufficiently heavy to reduce their competition.

One week's regrowth of Whittet kikuyu following an application of nitrogen fertilizer at 100 kg N/ha in mid-April. Note the 20 cent coin in lower centre.



If no legume or other forage is involved, post planting pre-emergence treatment with atrazine at 1.0 to 1.5 kg/ha will effectively reduce or eliminate competition from a wide variety of weed species such as crowfoot grass (*Eleusine indica*), summer grass (*Digitaria adscendens*), turnip weed (*Rapistrum rugosum*), wild radish (*Raphanus raphanistrum*) and bitter cress (*Coronopus didymus*). However, if the kikuyu is planted in conjunction with oats or rye grass, atrazine must not be used because of its detrimental effect on these species.

It is emphasized that if atrazine is applied at higher rates than recommended, adverse effects on the kikuyu will result.

Disease and pests

The only fungal disease of any consequence observed so far, is a leaf spot caused by *Pyricularia pennisetii*. Other leaf spots are common, but this one may be readily distinguished by the yellow halo around the central brown spot. The *Pyricularia* spots usually lead to leaf death; however, the disease is of consequence only under conditions of hampered growth such as moisture stress, or nitrogen deficiency.

Army worms, cutworms and grass caterpillar are all potential pests of kikuyu. However,

provided soil fertility is maintained, damage is not permanent. No damage was recorded during the observation period.

The most common cause of failure in the trial pastures has been nutrient deficiency, mainly nitrogen but in one case phosphorus. On shallow ridge soils kikuyu development was slow even where nitrogen was used, because of poor moisture retention qualities.

The other major factor contributing to failure (in some cases complete), was excessive competition from companion forages and weeds. Therefore, the main requirements for successful kikuyu establishment and growth are:

- deep, well drained soil,
- high fertility, especially with respect to nitrogen,
- clean, firm, shallow seedbed,
- proper planting depth and rolling,
- minimal competition in first few months of growth,
- adequate moisture at all times,
- maintenance of fertility.

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Biological control of green turkey bush

by P. G. ALLSOPP, Entomology Branch.

IN the mulga lands of semi-arid south-western Queensland, green turkey bush (*Eremophila gilesii*) is an important woody weed.

Up to 1.62 million hectares, particularly on the better watered slopes of the Warrego and Paroo River catchments, have been rendered useless for grazing because of dense stands of this weed. Although the bushes are lightly browsed during prolonged droughts, they compete strongly with grasses and other useful plants. Moreover, in recent years, the stands have increased rapidly in density where stocking rates were low and in sites completely protected from domestic stock.

Research by officers of the Charleville Pastoral Laboratory has shown that, although they are effective, mechanical and chemical treatments have only limited application because of high cost.

Spectacular control of small areas of dense, green turkey bush has occurred through the action of two species of grasshopper, *Monistria discrepans* (Walker) and *M. pustulifera* (Walker). Recommendations were made by Departmental officers and the United Graziers Association that the feasibility of a release programme of these grasshoppers be studied. With financial support from the Australian Wool Board, detailed studies were started in January, 1973.

These studies, which are now complete, were centred on *M. discrepans*, as initial surveys showed this insect to be the more common of the two. The conclusion arrived at is that this species has poor prospects as a bio-control agent. The reasons for taking this view involve an undertaking of many facets of the grasshopper's biology, the important ones being summarized below.

Disadvantages

In the Charleville area, *Monistria discrepans* has only one generation a year because eggs of the insect must undergo the cold temperatures of winter before they can hatch. Hatching occurs in late September or early October and the emergent nymphs develop to adults by early April at the latest. Adults are present in the field during February-March and egg laying commences in early March, but no hatching occurs until the following spring.

Owing to this restricted life cycle a large increase in numbers is not possible within a single year and the grasshopper is unable to take advantage of occasional seasonal conditions which might otherwise be ideal for the species.

Parasites Limit Usefulness of Grasshopper

Populations of the grasshopper are attacked by mites, flies and a fungus. The mites have little effect on their hosts but the two species of flies are important factors regulating population levels of the grasshopper. In the event of mass releases being made, parasitism by large populations of the flies could quickly reduce grasshopper numbers to the present low level. Both species of fly feed on the internal organs of the host, ultimately causing death or reduced egg production.

Infections of the fungus remain localized on the host during dry weather but spread rapidly after rain or under conditions of high humidity. Symptoms such as loss of function of limbs, surface colour changes and decreased food intake, appear three to four days before the death of the insect.

Difficulty in Rearing Large Numbers

One of the most important characteristics which a good biological control agent should possess is a potential for mass-rearing under laboratory conditions. This is necessary so that field releases of large numbers of the agent can be made at the most appropriate time. Under laboratory conditions, *M. discrepans* has a low reproductive rate which, coupled with a long period of development, would make it unsuitable for mass rearing.

A synthetic or at least semi-synthetic diet would be more useful in such a rearing programme than fresh leaf material. Two such diets have been tested for rearing *M. discrepans* and both have proved to be unsuitable.

Poor Dispersal

The term "wingless grasshopper" is often used to describe *M. discrepans*. This is not strictly correct since all adults have wings, although in most individuals these are reduced to small stubs and hence cannot be used. Even those individuals which have fully-developed wings are unable to fly. Thus the dispersal ability is poor and populations of the grasshopper remain localized.

Advantages

Points which favour the use of *M. Discrepans* as a bio-control agent in the Charleville area are few. The species is restricted to green turkey bush and other unloved relatives such as bastard sandalwood and Ellangowan poison bush. The species certainly does not eat grasses.

The life cycle of the grasshopper also fits in well with the period of best growth of green turkey bush. Nymphs and adults are present during summer and autumn, when most rain falls in the Charleville area, and prune new growth of the weed thus improving the chances for grass establishment and growth.

Future

The conclusion derived from the study was that *M. discrepans* is basically of low potential as a mass-reared biological control agent. However, there could be limited potential in "seeding" uninfested sites with the grasshopper but this would depend on detailed surveys of the distribution of the weed coupled with either field collection or limited mass-rearing of the grasshoppers—practices which would be costly and which would yield rather uncertain results.



How economic dairyfarming was achieved at Cushnie

by W. B. OLIVER,
District Dairy Adviser,
Kingaroy.

PRODUCTION on this property increased by 160% between 1970-71 and the 1973 year and has been maintained at this level since. This success is mainly due to feeding cows properly over the whole year.

Cyril Schultz runs a 260 acre dry-land property at Cushnie near Wondai in the South Burnett. He has been farming there since 1960.

In 1971 the farm ran only 48 dairy cows whose production in that year was 7 400 pounds of butterfat. The per cow production according to Herd Recording figures was 164 lb. butterfat.

Although using A.I. and Herd Recording he did not seem to be making any real progress. The calving pattern was very erratic.

Only 35 acres of improved pasture were available for the cows. They got most of their feed from 40 acres of summer forage crops and 40 acres of oats. This was the usual cropping programme. Mineral blocks and urea-molasses drum lickers were also used. Only 400 bales of hay were conserved each year.

Pre-calving conditioning of cows was not practised.

Feeding strategy planned

Early in 1971, Cyril started to plan for increased production with the help of officers of the Department of Primary Industries. He became a member of the Wondai Dairy Farmers Discussion Group whose main object was to improve net income with emphasis on dairy cow nutrition.

An assessment of the situation showed that good pasture feed was available from November to March. Improved pastures did not make any real contribution however. The oats crop made up a good part of the winter feed supply.

Pre-conditioning of cows adopted

The overall strategy was to feed the existing number of cows well, all the time and to pre-condition them so that they calved in good condition.

The feed year plan revolved around providing adequate good quality pasture for as long as possible. More hay was to be conserved to offset expected feed gaps. Concentrate feeding, based on herd recording

results was to be used to boost production. The protein level was to be adjusted to balance any inadequacies in the paddock feed. Cropping was to be continued as before with less emphasis on forage sorghum and a large planting of Dolichos Lab Lab.

Long term farm development

The longer term development was to increase the area of improved pastures to 150 acres by planting a basic Green Panic with Siratro, or lucerne, mixture. Also cow numbers were to be increased and Friesian-Jersey cross cows would be reared to help boost production. The aim was to eventually average 300 pounds of butterfat per cow.

The progress to date has more than justified the effort.

There are now 130 acres of improved pasture including lucerne and 3 000 bales of hay

are conserved each year. A concentrate premix is bought as required. To help with an obvious autumn feed gap, the area of Dolichos Lab Lab has been increased to about 25 acres.

Herd increased

The herd has increased to 68 with the extra cows being mainly Friesian-Jersey cross heifers from the existing Jersey cows. Top A.I. Friesian bulls have been used.

Butterfat production has increased as shown:—

Year	Total lb. B.F.	Lb. B.F. per cow
1970-71	7 400	164
1971-72	15 083	289
1972-73	18 165	321
1973-74	19 526	322
1974-75	18 874	290



Cyril Schultz inspects a section of his herd on his property at Cushnie.

However this increased return has not been achieved without cost. Costs which increased most were those of hand feeding, fertilizer and electricity.

Because of the increased work load, especially with the hay making, Cyril has had to employ casual labour. This costs between \$1 000 and \$2 000 per year. He thinks that this is well worthwhile at the existing production level because it permits him to have more leisure time.

Even with these increased costs the net return for the property rose from \$3 236 in 1970-71 to \$8 286 in 1973-74.

Management changes

In 1974-75 the higher grain prices caused changes to be made in the management. Grain concentrate feeding was reduced and the cows were pre-conditioned on good quality pasture. Net returns were maintained and production dropped very slightly.

The future

In the coming years Cyril intends to clear the remaining unproductive land on the property and plant it with Green Panic and Siratro. Because of the excellent results from the Friesian-Jersey cross he will have to breed some Jersey heifers from pure bred Jersey cows so he can aim for the 50:50 animal.

Some of the production increase could be due to better seasons. However the district production per farm only increased by 16% from 1970-71 to 1973-74 compared with the 160% achieved by Cyril.

A further asset to Cyril has been the building of a new house made possible by his increased financial returns.

He has proved that feeding cows correctly during their dry period and maintaining a

balanced feed ration during lactation pays dividends. Cyril has used aids such as A.I., Herd Recording and the services available from the Department of Primary Industries to full advantage.

FOR THE FRUIT AND
VEGETABLE
GROWER

Queensland Agricultural and Pastoral Handbook (Volume 2)

Available from Queensland Department of
Primary Industries, William Street,
Brisbane, 4000

\$3.00—Posted \$3.49
(within Australia and Territories)

Although published in 1961, this book, which deals with all fruits and vegetables grown in Queensland contains information still of great value.

732 pages—425 illustrations

Mung Bean . . .

an important new grain legume

by W. BOTT and R. W. KINGSTON,
Agriculture Branch.

IN Queensland, new varieties of mung bean are coming into prominence in response to a growing market for this summer grain legume crop.

The seed is germinated to produce bean sprouts which are used as a green vegetable. Attractive and expanding export markets exist in Europe, the U.S.A., Canada, and Japan. There is also a small but growing market in Australia.

The crop has been grown on a small scale in Queensland for some time. Recently, the advent of the high-yielding, non-shattering varieties Celera and Berken has boosted the industry. An area of 240 ha around Dalby was sown to Celera on the Darling Downs in 1971-72, and this increased to 1 200 ha the next season.

Mr. C. Cousin checks a good crop of Berken mung bean growing on Messrs. K. D. Bassett and Partners' farm at Daandine near Dalby.



The area grown to both varieties has remained static at this level and the Dalby district is still the main production area. Yields averaged 0.6 t/ha although some crops have produced 1 and occasionally 2 t/ha. Yields of over 3 t/ha have been achieved with irrigation in N.S.W.

As the crop in Australia takes only 70 to 100 days to mature, depending on temperatures, and has modest water and fertility needs, mung bean fits well into the cropping sequence as a double or change-over crop.

Crop management is similar to that for grain cowpea, with which many Queensland grain-growers are already familiar.

The seed-bed need not be well worked as mung beans strike easily. In fact, mung beans would be ideal for sowing straight into stubble-mulched land, if the right equipment is used.

Botany

The botanical genus *Vigna* includes mung bean (*V. radiata*) and the very similar black gram (*V. radiata mungo*) and cowpea (*V. unguiculata*). Other commercial *Vigna* species include adzuki bean (*V. angularis*) which is grown in China, Japan and Korea, moth bean (*V. aconitifolia*) and rice bean (*V. umbellata*) which are cultivated in tropical regions.

The mung bean originated in southern and eastern Asia, where the crop has been grown for centuries.

In appearance, mung bean resembles the soybean with upright, branched plants 30 to 75 cm tall and trifoliate leaves of similar size and shape. However, the foliage is usually darker green than that of soybean and navy bean. It is less hairy than the soybean, though more so than the cowpea or navy bean.

The seed of mung bean develops in clusters of pods which grow from flowering shoots. These mostly develop in the upper part of the plant. The typical pea-flowers are pale yellow and about 1 cm in diameter. The mature seed is green, rounded in shape, and small for a grain legume. The 1 000 grain weight ranges from 33 to 70 g.

Varieties

The two varieties available in Queensland are Berken and Celera. These are both

quick-maturing grain varieties taking 80 to 100 days to mature in southern Queensland. They have a fairly determinate flowering habit i.e. a decided ripening or "finishing" stage, unlike forage cowpeas. Celera however, is not quite as determinate as Berken.

Trials run by the Department of Primary Industries recently have shown that the two varieties have similar yielding ability†. The work indicates that Berken produces better than Celera under good conditions. Under a harsher regime, Celera appears to yield more than Berken.

However, Celera has a major defect in its excessively small seed size. Tests have shown that the seed size of Celera (1 000 seed weight of 33 to 36 g) is associated with a high proportion of weak and spindly sprouts. In addition, Celera commonly produces some hard seeds, which do not germinate readily. In fact, there have been complaints from the market about the poor sprouting quality of Celera.

On the other hand, seed of Berken is about 70% (or more) larger than that of Celera (1 000 seed weight ranges from 58–70 g). The sprouts of this variety are large and vigorous, and so Berken is very well received by the market.

Climate and Soils

Mung bean is adaptable to a wide range of soils provided the drainage is good. Besides doing well on better drained plain and brigalow soils the crop thrives on soils considered too light for sorghum and maize. The crop should be suited to the box, softwood scrub, light forest and sandy soils in Queensland.

The crop is moderately drought tolerant although a reserve of subsoil moisture should be available at planting. Mung bean will survive short periods of waterlogging. It is not affected by *Phytophthora* stem rot which can be so devastating to cowpea in wet situations.

A hot, humid summer followed by dry autumns and the frosts of early winter, normal in most parts of the State's grain growing districts should suit the crop admirably.

† Refer to "Berken, a New Mung Bean Variety" *Qld. Agric. Jour.*, Nov.-Dec. 1975, p. 659.



Mr. C. McDonald, Manager of Australian Estates 'Wainui' property near Bowenville, checks Celera on his right and Berken mung bean on his left.

Planting Time

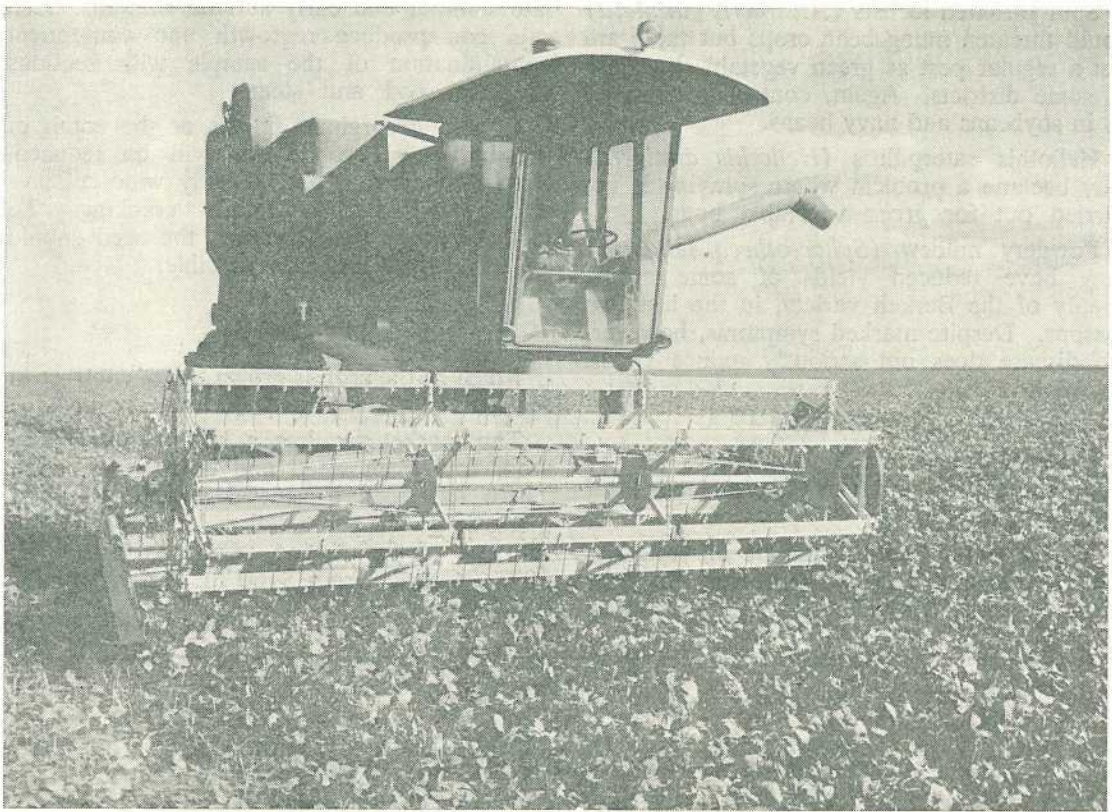
On the Darling Downs the crop's growing period is 80 to 100 days. The first frost is usually received about the end of April, so planting from mid-December to mid to late January is satisfactory. In central Queensland grain growing districts the crop period is around 70 days and the first frost is normally recorded in mid-May to mid-June. Thus a sowing time in January and February should suit the crop in this region. However, moisture stress with resultant reduced yields are more likely with a later sowing.

Early planting of mung bean is not recommended because of the likelihood of wet weather damage to the ripening crop.

Planting Rate

Because of the big difference in seed size, planting rate varies between varieties. The small-seeded variety, Celera, with 29 000 seeds per kg should be planted at about 15 kg/ha while Berken with some 17 000 seeds per kg should be drilled at 22 to 25 kg/ha.

A combine can be used at 53 cm and 71 cm row spacings with satisfactory results, but use of a precision planter should improve evenness of stand. The wider row spacing would be preferable in weedy situations so that the crop may be inter-row cultivated.



Mr. D. Williams of Jimbour harvesting a one tonne per hectare crop of Berken mung beans.

Inoculation

Mung bean is a legume so the seed should be inoculated with the appropriate strain of nodule bacteria. The cowpea/peanut strain should be used before planting unless nodulated peanuts, cowpeas or mung beans have been grown recently in the paddock.

This will ensure successful nodulation which will provide the whole of the crop's nitrogen requirement.

Fertilizing

The requirements of the crop for other nutrients, especially phosphorous and zinc, may be met in the same way as for cowpea or soybean.

Pest and Diseases

One major pest of mung beans is green vegetable bug (*Nezara viridula*). This, however, may not be a problem in districts where production of soybean, navy bean, cowpea or mung bean is uncommon. Control of this pest in mung bean is the same as in these other grain legume crops.

The green vegetable bug feeds on young pods, directly reducing yield. It is important to keep an eye on the crop once flowering has started. If one bug is seen per metre of row, spraying with a suitable insecticide such as endosulphan at 750 g/ha would probably be worthwhile. Two or three applications may be necessary over the flowering-pod development period.

Spur throated locusts (*Austracris guttulosa*) could threaten mung bean crops but these are not a regular pest as green vegetable bugs are in some districts. Again, control is achieved as in soybeans and navy beans.

Heliothis caterpillars (*Heliothis armigera*) may become a problem where spraying is not carried out for green vegetable bugs.

Powdery mildew (*Sphaerotheca fuliginea*) may have reduced yields of some crops, mainly of the Berken variety, in the last two seasons. Despite marked symptoms, however, the disease does not seriously reduce yields.

Harvesting

Harvesting presents few problems to the experienced graingrower as the crop lends itself to direct heading.

Ideally, mung bean should be harvested as soon as the crop is ripe. However, this may not be possible with an early crop experiencing

late summer and early autumn rainfalls. Such rain can produce regrowth and consequent contamination of the sample with sections of green pod and stem.

By fitting sorghum fingers at the comb of the harvester, crop losses will be reduced. Slow drum speeds and a fairly wide concave setting will minimise grain cracking. To further reduce this cracking, the seed should be handled as little as possible.

Marketing

Much of the crop is grown under contract to seed merchants who provide planting seed.

The market requires a large, unblemished seed, free from weed and other crop seeds. There has been a general upward trend in prices in recent years with a bonus payable at the end of the season. Contract prices for 1975-76 range from \$160 to \$180 per tonne delivered at Dalby.

Cattle disease research

A fascinating insight into research on control of cattle diseases in Australia is given in a new book released by the Australian Meat Research Committee.

The book is one of a series being produced by the Committee, outlining research sponsored by AMRC over the period 1962-1975.

In this period, the AMRC and its predecessor the Australian Cattle and Beef Research Committee allocated almost \$8 million to support research into the disease and parasite problems described.

Topics range from the dung beetle project through bloat, diseases, nutritional disorders (including poison plants) and worms. A large section on the cattle tick problem is included.

This is by no means a do-it-yourself diagnosis or treatment book. Rather, it outlines the significance of the problems, and traces the efforts of Australian scientists to deal with

them. It describes the difficulties, the failures and the successes in coming to grips with these problems in an interesting, easy-to-read, and often fascinating style.

At the same time, the background it gives to the behaviour of the pests and diseases, reactions by the stock themselves, and the interlocking of management and treatment should give any cattle owner a much broader understanding of the difficulties he faces, and the role research has played, and is continuing to play, in their solution.

Other books yet to be published in this series will deal with research into breeding, feeding, management and other facets of the Australian cattle industry.

The 132-page book, 'Cattle Research 1962-75, No. 2 Diseases', is available from the Australian Meat Research Committee, 5 Elizabeth Street, Sydney, 2000, at \$4.50 to cover publication, distribution and postage.

A predacious mite

possibilities for two-spotted mite control

by LEONIE E. MARKWELL,
Entomologist.

A newly discovered predator of two-spotted mite on strawberries from the Redland Bay District may have potential for biological control.

STUDIES are in progress to investigate the predator's life history, its potential as a predator and its resistance to chemical sprays.

The two-spotted or "red spider" mite, *Tetranychus urticae*, and other plant-feeding mites have become a major problem only since World War II. Before this, these mites, although damaging at times, were not as perennially severe as they have since become. The main reason for this is that the widespread use of insecticides like DDT, and later the organophosphates, has been harmful to the natural enemies which previously kept mite populations at non-damaging levels.

A further problem with these mites has arisen because of their capacity to develop resistance to the chemicals used to control them. Some compounds which even three or four years ago achieved satisfactory control of two-spotted mite are no longer effective. The continuous development of new miticides is very costly and these costs are an added burden to the grower. Biological control of two-spotted mite is, therefore, a most attractive proposal.

The mite predator

The newly discovered predator is a Phytoseiid mite, *Amblyseius womersleyi*. It has been found widely distributed on strawberry farms in the Redland Bay district and has also been recorded on papaw, hops, beans and roses.

Amblyseius womersleyi is similar in size to two-spotted mite (just visible to the naked eye) and is cream to orange in colour. It moves quickly, unlike two-spotted mite and is found mostly near the midrib and veins on the underside of the strawberry leaf.

Adults and eight-legged nymphs of *A. womersleyi* feed on all stages of two-spotted mite—the egg, the nymph and the adult. They feed by grasping the prey with their chelicerae or claws and sucking out the body fluid.

Laboratory trials have established that the predator consumes large numbers of eggs of two-spotted mite. Adult female predator mites eat an average of 16 eggs per day. The predator probably eats fewer in the field where it must first search out its prey, but the figures give an indication that *A. womersleyi* is a vigorous predator.

Life cycle studies

The predator mite has a life cycle consisting of four immature stages—the egg, the six-legged larva, the eight-legged protonymph and the eight-legged deutonymph. The main change in appearance as the mite develops is an increase in size. Duration of the life cycle is 6 days from egg to adult, and the female mite lives on average about 33 days. She is capable of laying eggs for about 14 days and can produce a total of up to 36 eggs in her lifetime.

Computer analysis of data obtained from life cycle studies suggests that the predator populations under favourable conditions could increase by a factor of 14 every two weeks. This means that predator mite populations can build up in numbers very quickly and so cope more effectively with an outbreak of two-spotted mite.

Resistance to chemical sprays

To be effective, the predator mite must be able to tolerate the sprays used in the control of the main insect pests of strawberries. These are cutworm *Agrotis* spp., cluster caterpillar *Spodoptera litura*, corn earworm *Heliothis*

armigera and strawberry aphid *Chaetosiphon fragaefolii*.

The family of mites to which *A. womersleyi* belongs, the Phytoseiidae, contains a number of members which have developed resistance to organophosphate insecticides. Pest management schemes are being successfully carried out on a variety of crops in the United States and Europe using these resistant species. In these schemes, the crop is sprayed for its array of insect pests with chemicals which do not harm the Phytoseiid predator. This allows biological control of plant-feeding mites to continue, as the natural enemy has not been eliminated.

To date, a total of fifteen insecticide/miticides and four fungicides have been tested. Three of the insecticide/miticides and four of the fungicides were not harmful to the predator mite and based on experience overseas, resistance to more compounds may develop. Successful introduction of the biological control method for control of two-spotted mite on strawberries will, in fact, depend on the development of a predator strain with appropriate insecticide resistance.

FOURTH EDITION—FARM MANAGEMENT BOOK

The fourth edition of this handbook is aimed at providing a ready reference to technical and financial data which can be used by educational institutions, extension officers, farmers, graziers and others concerned with property planning and development.

The handbook has been completely revised and converted to the metric system. It brings together reference data from numerous sources and presents it, for convenience, in a single publication.

To obtain your copy of the Farm Management Handbook, send \$2.50 to: Director of Economic Services, Department of Primary Industries, William St., Brisbane, 4000.

Identifying Insects—

STICK INSECTS

(Order Phasmatodea)

by I. D. GALLOWAY, Entomology.

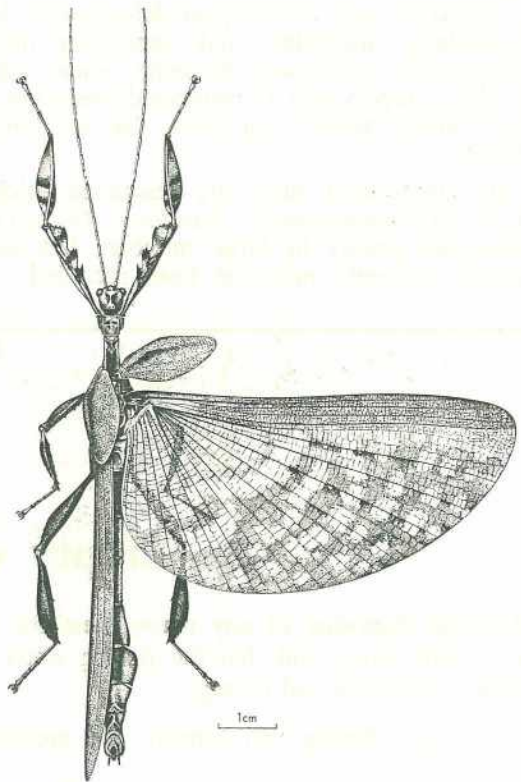
STICK insects are large terrestrial insects found chiefly in the warmer parts of the world.

Though relatively few in number they frequently attract wide attention because of their size and rather forbidding appearance. This draconian facade belies their life as placid vegetarians feeding among the leafy branches of trees and shrubs.

Few insects blend into their environment as perfectly as stick insects. Through a combination of colour patterns, body shape and an ability to remain immobile for long periods stick insects are virtually indistinguishable from their surroundings.

Despite this excellent camouflage they still fall prey to a number of birds who, at times, depend on stick insects for a substantial part of their diet.

The life histories of most stick insects follow a similar pattern. From the relative safety of a foliage shelter the female drops her eggs to the forest floor beneath. In some species the eggs are projected a short distance by a sharp flick of the female abdomen. This rather casual mother then takes no further interest in the fate of her offspring. In the course of a lifetime a female may lay from a hundred to a thousand eggs depending on the species involved.



Extatosoma tiaratum (Macl.) Male.

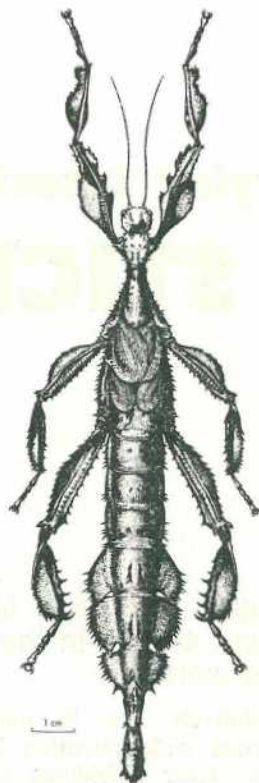
A typical phasmid egg is quite large and seed-like and is fitted with a small cap or operculum which is pushed off when the young stick insect emerges. The outer shell of the egg is frequently ornamented with ridged or bark-like decoration.

A young stick insect is a pale wingless replica of the adult with rudimentary reproductive organs. Upon hatching, the nymph quickly ascends the nearest upright support and will continue to climb until it finds shelter in suitable foliage. Over a period of two or more years the nymph frequently sheds its skin until it finally attains reproductive maturity.

Though stick insects are essentially solitary creatures a few species are more gregarious and are responsible for extensive defoliation of eucalypt forests in New South Wales and Victoria.

The alpine ash (*Eucalyptus delegatensis*) is particularly susceptible and apparently dies after severe defoliation. In areas where this eucalypt plays a role in watershed protection, stick insect attack can have far reaching effects.

In Queensland only the tessellated stick insect (*Ctenomorphodes tessulatus* (Gray)) sometimes occurs in large numbers but no serious outbreaks have yet been recorded.



Extatosoma tiaratum (Macl.) Female.

(Illustrations through the courtesy of C.S.I.R.O. Division of Entomology and Melbourne University Press).

Empty containers

BEFORE disposing of any empty pesticide containers, ensure that they are rinsed at least twice with water, and that the rinsing water is preferably added to the spray tank to avoid waste of pesticide and money.

Double rinsing will remove the greatest portion of the container's contents.

By courtesy Agricultural and Veterinary Chemicals Association.

Improving environment for the farm worker

by GILES ARCHER

(Supplied by the British High Commission)

BRITAIN'S Royal Show held in July this year took place just after new regulations on the safety and comfort of tractor drivers took effect. As such it provided an unparalleled early opportunity for farmers to see and judge what is probably the most comprehensive series of improvements in tractors to have taken place in a single year.

A complete new generation made an appearance, with redesigned cabs far in advance of the crude "afterthought" structures which have served up to now on many farms.

Although the changes in tractors were the most striking, similar improvements have been made in the driver's environment on other self propelled machines, and over the past 10 years or so a vast change has taken place in most implements and plant used by British farmworkers.

Not only machinery has altered, but attitudes on the part of designers, farmers and workers are completely different from those of a generation ago. What was seen at the show this year merely represented an important milestone in developments that have been taking place steadily over many years, stimulated by some official publicity but carried along by the growing awareness of safety and comfort by workers and farmers alike.

Seating and Controls

Initially this was fuelled by research findings. A Nottingham University team delivered heavy criticism of the seating and controls of the tractors of the 1960's after carrying out exhaustive ergonomic studies.

At the National Institute of Agricultural Engineering (NIAE) studies into back troubles among older tractor drivers attributed damage to many hours of absorbing shocks from the tractor. Also at NIAE it was found that many older tractor drivers had impaired hearing—similarly attributable to their working environment.

It was found comfort was not simply a matter of making life easier for the worker. Further NIAE investigations revealed that a large number of tractor drivers avoided working as fast as they might have done—when ploughing, for example—because of the discomfort involved in doing so. As a result it was

common for big tractors to be used continuously at only about 80% of their work potential.

Operator efficiency also suffered. Response to the need to make an adjustment were slower or non-existent towards the end of a fatiguing day. Noise, vibration and jolting contributed to fatigue.

Knowledge of all these factors was invaluable in changing attitudes; this was happening in the 1960's, and safety consciousness was also helped by the introduction of legislation demanding the guarding of many moving parts of both field and barn machinery.

In this atmosphere, increasing numbers of workers were to be seen wearing ear muffs, while deluxe seating became more common on tractors and more cabs with heaters were bought.

Health and Safety

Concern about health and safety naturally spread to other farm work. In particular, research alerted men dealing with livestock to the possible dangers in inhaling dust from grain and hay. When studies were made it was found that the crippling disease "farmer's lung" was more common than many had thought.

Respirators came into more and more frequent use but, more significantly, dust extraction systems were designed which could be incorporated into grain stores and food preparation buildings.

In addition to providing new cabs in time to comply with a new statutory limit to the permissible noise as measured at the driver's ear, a number of the major British tractor manufacturing companies have altered many other features. They have the opportunity created by the need to design the cab as a separate unit from the tractor working parts—the "capsule" cab concept—as opposed to merely surrounding the driver with sides, doors and roof.

An example of the type of change made is seen in one make⁽¹⁾ where hydrostatic power steering has been added as standard equipment on all models as well as hydraulically operated clutch and foot brakes. Also on this make of tractor there is an option of

semi-automatic gearbox which allows the driver to make smooth gear changes on the move without using the clutch.

The new cab on this make of tractor, as on many others, provides a comfortable workplace comparable with the modern commercial vehicle cab. The maximum noise at the driver's ear, as recorded in official tests, was no higher than 85 decibels—well below the new mandatory limit of 90 decibels. The padded, armchair type seat is hydraulically damped and adjustable for both the height and weight of the driver.

It is placed in the centre of an almost completely clear floor space with rubber covering. The main manual controls are grouped to one side of the seat, leaving a clear route to either of the ample doors, while new soundproofed console for electrical switches and gauges encloses the steering column.

Minimising Noise

The desire to minimise noise brought about many of the changes. Mechanical steering columns were known to transmit engine noise into the cab and foot brake and clutch pedals projecting through the cab floor inevitably necessitated openings through which external noise could penetrate. The need to construct the cab as a capsule with its own floor, led to the clear, flat platform, with no awkward transmission tunnel for the driver to negotiate when getting in and out.

Padding is used generously over all main metal surfaces, and although the main reason for this was to provide insulation against noise one of the effects is to protect the driver to some extent in the case of overturning. As with all British tractors, the frame of the cab has to be strong enough, and its attachment points sufficiently secure, to stand overturning without collapsing.

Though differing in detail, new cabs and tractor models introduced by the other major manufacturers in Britain have similar improvements^(2, 3, 4 and 5). In some cases additional features include automatically dimming glass to protect against glare from bright sunlight, two or three speed blowers to ventilate the cab and create a slight pressure to exclude dust, and extra fittings making it easier to hitch up and adjust implements used on the tractor hydraulic linkage.

With the same point in mind a new hydraulic control system has been developed by a British implement manufacturing company⁽⁶⁾ for its latest range of ploughs. With this optional extra the driver will be able to adjust front furrow width of the plough without the strain of reaching backwards from his seat and without the need to open the cab rear window—an important convenience when working on side slopes.

Combine Harvesters

As an increasing number of self propelled harvesters come into use on farms, needs similar to those of tractor drivers have been felt. In the past 12 years a new company⁽⁷⁾ specialising in designing cabs for a wide range of powered machines such as combine harvesters, foragers and root crop harvesters has found a substantial and increasing market for its carefully engineered, purpose built cabs. Including models built for industrial machines and farm tractors, the company has produced a total of more than 1 500 different cab designs.

In the standard cab, which is a one piece welded frame with large, toughened safety glass windows, are a filtered air two-speed fan unit, pressurising the entire cab with clean air, windscreen wiper, grab handles, sliding or hinged doors, and complete wiring ready for connection to the machine's electrical system.

Extras include a refrigerated air-conditioning unit, additional sound insulation, tinted glass, internal light and powerful external working lights, screen washer, heater and demister and radio-cassette player. The last named is now not an unusual extra to purchase.

In addition to providing for the driver's comfort in extremes of heat and cold, manufacturers of self propelled harvesters have recognised the importance to efficiency of creating a comfortable working position for the driver and a clear view of the work.

This is particularly noticeable in the design of modern British sugarbeet harvesters⁽⁶⁾ and⁽⁸⁾ where the driver has been positioned for a good view of the beet topping mechanism, offset to one side of the harvester.

At the same time as giving the driver the best possible chance to work efficiently, careful ergonomically correct design reduces the strain involved in maintaining accurate steering for hours on end.

Opportunity for Visitors

Guards to prevent the accidental loss of fingers and arms through unwary behaviour close to belt and chain drives, rails to avoid falls and shields to prevent machines from throwing stones or pieces of metal in the direction of the driver or bystanders have become an accepted necessity on farms in Britain. They are now automatically allowed for at the machine design stage.

It is easy to forget that this state of affairs has existed for only a decade or so and that not all countries produce machinery with such care for the safety of the operator.

Overseas visitors at British shows will have the opportunity to see many hundreds of examples of safety provisions that look natural and obvious, and may not be immediately recognisable as thoughtful examples of engineering response to the Health and Safety at Work Act 1974.

This places responsibility on designers, manufacturers and suppliers to ensure that machines are safe and without risk when properly used. Obligations on similar lines demand that employers ensure the health and safety of their workers, while employees are charged with the duty of taking reasonable care for themselves and others.

Pallets for Fertilizers

Many developments have been made independently of specific official rules. An example is provided by the now widespread use of pallets for handling fertilisers and other heavy farm materials. Their use has depended upon agreement between distributors and farmers, and the purchase by farmers of fork-lift attachments for tractors⁽⁹⁾, but this has proved no obstacle in a large number of cases.

Improved performances have been noted in the field from men who have not started days of fertiliser spreading by handling bags on to trailers—despite the fact that bag weights are now limited to 25 kg.

In a similar way, farmers and their men have found ways to avoid long hours of work in dusty grain and food stores, and respirators ⁽¹⁰⁾ are often worn when such work is essential for short periods.

An important development in this field has been the automation of feed preparation and grain processing equipment ⁽¹¹⁾, making it unnecessary for machinery to be under constant supervision while working. Dust removal is also now considered, and any of the major companies manufacturing grain barn equipment in Britain can add dust extraction fans and ducts to either existing or new plants.

Firms mentioned in this article are:

- (1) David Brown Tractors Ltd, Meltham, Huddersfield, Yorkshire.
- (2) Leyland Tractors, British Leyland Bathgate Plant, Bathgate, West Lothian, Scotland.
- (3) Massey-Ferguson (UK) Ltd, Banner Lane, Coventry.
- (4) Ford Motor Company Tractor Operations, Cranes Farm Road, Basildon, Essex.
- (5) International Harvester Company of Great Britain Ltd, 259 City Road, London EC1.
- (6) Ransomes Simms and Jefferies Ltd, Nacton Works, Ipswich, Suffolk.
- (7) Cabcraft Ltd, Lynehill Industrial Estate, Penkridge, Stafford.

- (8) F. A. Standen and Sons Ltd, Hereward Works, Ely, Cambridgeshire.
- (9) H. Cameron Gardner Ltd, Bath Road, Woodchester, Stroud, Gloucestershire.
- (10) Martindale Electric Company, Neasdon Lane, London NW10.
- (11) E. H. Bentall and Company Ltd, Maldon, Essex.

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FRIESIAN

Behrendorff, E. C. & N. G., Inavale Friesian Stud, M.S. 786, Boonah
Evans, P. J., M.S. 28, Dragon St., Warwick
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Hickey, K. A. & M. R., Bunya
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DROUGHTMASTER

University of Queensland, Veterinary School, St. Lucia

Looking back—

SOME interesting items that appeared in issues of the Q.A.J. 75 years ago, in September and October, 1901.

- On the subject of dehorning cattle, it was pointed out that this need not be a most cruel performance. *We grant that dehorning, as was practised on a station in the Gulf country was atrocious cruelty. There, the blacks employed on the station dehorned the beasts by simply smashing off the horns with long waddies.*
- An article appeared advocating the establishment of a mohair industry.
- On the subject of milking the following good advice was given: *grasp the teat with the whole hand; press the milk out; don't forget the gentle push up against the udder; never stop nor let the work be interrupted when milk is "coming"; remember the second milking and the last drops; pat the cow when you have finished milking; have clean pails (to milk into and for carrying the milk); wash your hands before and during milking; it is best to milk with dry hands; milk in a suitable and clean smock.*
- It was reported that *some interesting experiments have been carried on at the Michigan Agricultural College, Lansing, in grazing sheep in a moveable, bottomless pen.*
- There was a short report on a new process—bringing vegetables to maturity by the application of electricity.
- Average top prices for bullocks at the Enoggera sales: £9 1s. 3d. (\$18.14).
- It was reported that a *Mr. Draper kindly offers to furnish a report on two practical methods by which he thinks the pest, water hyacinth, may be cleared out of the State. We cannot depend upon floods or freshes for removing masses of hyacinth such as once occurred in the Upper Brisbane River. Besides, the pest has in many parts spread over the roadside watertables and into paddocks and waterholes not reached by floods. Any scheme for its removal will, therefore, be gladly welcomed, and we shall await with much interest Mr. Draper's promised report.*
- A recipe for pineapple wine: *Over the peelings of two pineapples pour 1 quart of boiling water; allow it to steep until cold, then sweeten to taste, strain and bottle. Tie down the cork and place the bottle on its side; if placed in a warm place, it will be ripe in twenty-four hours. A small piece of ginger placed in each bottle will improve the flavour.*
- *The experimental overseer at Hambledon plantation, Cairns, Mr. Clarke, has been successful, we are informed, in propagating cane from seed, and has hundreds of seedling canes now coming on.*

Breeding Wheat for Overseas Markets

Reproduced from WHEAT RESEARCH—
a publication of The Australian Wheat Board.

FOR any wheat breeding program in Australia which has overseas markets in mind, a number of quality criteria can be readily identified as being important. These include milling performance as measured by flour extraction rate and ease of milling, ease of condition, and an appropriate balance between protein level, grain hardness, and dough strength.

The international wheat market recognises these basic requirements in the four clearly identifiable quality/price categories within which the major exporters compete for sales. These four categories and some of the competing wheats are:

- The hard, high protein, strong bread wheats such as Canadian Western Red Spring, U.S. Dark Northern Spring, and the higher protein grades of Australian Prime Hard.
- The intermediate protein commercial hard wheats, such as U.S. Hard Winter and Australian Hard.
- The low protein soft wheats such as U.S. Western White and Australian Soft.
- Medium to low protein wheats consisting of mixtures of hard and soft grain, such as U.S. Hard Winter (Ordinary) and Australian Standard White.

The following assessment of the existing classes of Australian Wheat has been prepared by the Australian Wheat Board's Wheat Quality Adviser, Mr R. L. Cracknell, who has included suggestions for enhancing their marketability through breeding.

Australian Prime Hard

Australian Prime Hard wheat is currently sold at three minimum protein levels, namely 13, 14 and 15%, and as a result of this wide protein range, Australian Prime Hard wheat tends to be aligned with the higher protein Canadian and U.S. Spring wheats at the top of the range and with the higher protein U.S. Hard Winter wheats at the bottom. In many

markets, and particularly those employing advanced processing methods, this has proved to be a perfectly satisfactory arrangement. However, this is not the case in other areas where baking procedures involve the minimum of mechanisation.

This can be explained by the inherent difference in dough stability shown by Australian and North American Hard wheats. The existing Australian Prime Hard varieties were selected to meet the requirements of the domestic and the then predominant export prime hard markets, such as the U.K./Continent, where highly mechanised baking procedures remove the need for ultra high dough stability and tolerance.

By contrast, the North American Spring wheats exhibit what we would call "over stable" dough characteristics which manifest themselves in a long development time and remarkable tolerance to abuse.

Although time, material, and energy consuming under modern bakehouse conditions, these over-stable characteristics are suited to the making procedures being employed in many of the Board's newfound markets in the Indian/Pacific area, and this factor is proving to be a limitation in the expansion of sales of Australian Prime Hard wheats in the area.

It would appear, therefore, that there is a need to introduce a further element of strength into the prime hard and this could be quite easily achieved through varietal composition. Prime Hard wheat from areas in Queensland, where the stable variety Mendos is widely grown, already exhibits the desired characteristics.

What is required is a class of wheat of the Gabo type but certainly no weaker, at protein levels of say 13 and 14%. This could be achieved by carefully assessing the existing prime hard varieties and any future promising crossbreds, and relegating to the No. 1 Hard class any which did not measure up to the Gabo standard. This would also have the desirable effect of up-grading the hard class both in terms of quality and quantity, to the extent that it could be marketed at protein levels of 11, 12 and 13%, in direct competition with U.S. Hard Winters.

Australian Hard

Hard wheats, that is, varieties which regularly give a Particle Size Index figure of less than 17, should only be grown in areas where they can be relied upon to produce grain with a protein content in excess of 11%. They should exhibit strong, well balanced dough characteristics, and excessive hardness, such as that shown by the varieties Emblem and Falcon, should be avoided. The variety Condor would appear to be an ideal standard variety for production in hard wheat areas.

In the past the hard wheats segregated in the various States have all been offered on the overseas market at the same premium over the Australian Standard White price. However, with the increased awareness being shown by discriminating buyers in protein content, and the possibility of a wider range of protein content being available in Australian Hard wheats, it will become necessary to market them according to protein content with minimum levels of 11, 12 and 13%.

Currently, hard wheats are being grown in areas in the Southern States which are distinctly marginal for hard wheat segregation purposes. Certain silos in southern New South Wales, South Australia and Western Australia have regularly returned protein levels at or below 11% and this is simply not sufficient to command a premium on the overseas market.

Australian Soft

The world demand for high quality soft wheat is fairly limited with the requirements of individual markets rarely exceeding 20% of the total wheat sales.

The precise quality characteristics required will depend on the level of technological advancement of the market and the particular

end use. For example, the domestic market has very strict dough quality requirements with an emphasis being placed on resistance to extension and extensibility which is rarely encountered overseas. However, in soft grain, a protein content of less than 10%, low water absorption, and extensible doughs are generally the pre-requisites.

The most common soft wheat on the world market is U.S. Western White and it is so firmly established that any alternative must be fully interchangeable with it. Of the Australian varieties currently available, Pinnacle is as good a standard variety as any, however, an Olympic type with weaker dough characteristics would probably be ideal. Under normal circumstances of supply and demand, soft wheats rarely command a premium, therefore it is important for any promising crossbreds to yield at least as well as the recommended Australian Standard White varieties in a given area.

Australian Standard White

Australian Standard White constitutes about 70% of total wheat deliveries in Australia and is best described as an all purpose milling wheat of intermediate grain hardness and protein content. On the overseas market it generally competes with the U.S. Hard Winter Ordinary and, on occasions, with Western White.

A.S.W. has replaced F.A.Q., and thus comprises all wheat which does not qualify for a premium grade or has not been down-graded because of some disability.

Rather than being regarded as a residue grade as has tended to be the custom, it is now appropriate to discuss A.S.W. as a class in its own right with clearly defined characteristics. A.S.W. wheats generally fall in the 9.5 to 12% protein range with the bulk around 10.5% and at this level of protein wheats towards the soft end of the hardness scale are desirable; this fact cannot be over-emphasised.

Australian F.A.Q. was traditionally a multi-purpose soft wheat, however, the release of high yielding, hard A.S.W. varieties in South Australia, parts of Victoria, and southern New South Wales, has resulted in a marked increase in the hardness of the A.S.W. in these States.

This shift has not been anywhere near as dramatic in Western Australia because of the dominance of the variety Gamanya, a variety of ideal hardness for the A.S.W., and because of the stand taken by the State Wheat Advisory Committee in opposing the release of Halberd in that State.

For these reasons the Australian Wheat Board is attempting, in appropriate areas, to maintain a grade of soft A.S.W. wheat in order that customer requirements, both domestic and overseas, can still be fulfilled. The growing of hard varieties has become so widespread that without such a conscious effort a genuine request for ordinary soft wheat in cargo lot quantities could not be easily met.

A.S.W. wheat is sold to a large number of markets for a wide range of applications including soft Japanese style noodles, leavened bread, both baked and steamed, unleavened bread such as the chapattis and parathas of the Indian sub-Continent, and the various unleavened breads of the Middle East.

Although these various applications all have specific minor differentiating quality requirements, it is not feasible to produce wheats to cater for all of these. It is therefore most important that A.S.W. varieties are versatile and do not display any unusual traits, and that the resultant grades of A.S.W. wheat exhibit balanced dough characteristics.

The major requirements for this are intermediate hardness, thus avoiding excessive water absorption, and a measure of extensibility which is also retained at low protein levels.

Dough extensibility is a basic requirement for the production of virtually every flour based product and a lack of extensibility, particularly at low protein, is apparent in a number of recently released Australian varieties.

During this discussion reference has been made to a series of standard varieties for the various classes, namely for Gabo for Australian Prime Hard, Condor for Australian Hard, Gamanya for A.S.W. and Pinnacle for Australian Soft. A similar situation exists in Canada where promising Red Spring wheats must be "at least equal to Marquis", a variety which has long since disappeared commercially. Under such circumstances the incorporation of standard varieties into plant trials is fraught with difficulty and it may then be necessary to resort to a set of basic specifications, the application of which, because of the effects of the environment, is only practicable after what may be loosely termed a "normal" season.

The accompanying table lists guidelines for protein content, grain hardness and extensograph resistance, the latter having been chosen as the only reliable measure of dough strength which is not markedly affected by protein content. Figures are for pure varieties which have been milled on a Buhler-type experimental mill. It should be appreciated that these specifications are only guidelines and thus should not be taken as a hard and fast rule, however, we are confident that if results of this order can be achieved, quality should not be a limiting factor in the marketing of Australian wheat.

QUALITY REQUIREMENTS FOR OVERSEAS MARKETS

Class	Protein range	Grain hardness		Extensogram height (BU)		Extensogram extensibility cm
		Particle size index	Pearling resistance	5 cm	maximum	
Australian Soft	Below 10%	over 22	below 4.5	175 ± 25	200 ± 50	above 17
Australian Standard White	9.5% to 12%	20 ± 4	4.5 ± 0.7	250 ± 25	350 ± 50	above 17
Australian Hard	11% to 13% +	14 ± 3	5.4 ± 0.4	275 ± 25	450 ± 50	above 18
Australian Prime Hard ..	13% and over	12 ± 2	5.7 ± 0.3	325 ± 25	550 ± 50	above 22

Symptoms of 2,4-D Injury to Horticultural Crops

by J. F. GAGE, Horticulturist, Redlands Horticultural Research Station.

2,4-D brought about a revolution in weed control in grain crops because of its ability to control many weeds at low rates of application without causing crop damage. However, its activity against many broadleaved plants has caused great concern to farmers whenever it is used near horticultural crops.

Many of these crops may be injured, even by very small doses of 2,4-D such as may result from spray drift or from the contamination of soil, water or equipment. Such exposure may result in loss of yield through death or damage to the crop, or reduced returns through defects in the quality of produce.

Recognizing and tracing the source of the 2,4-D causing the injury is not always easy as the damage may not become obvious until some time after exposure and the symptoms can be confused with those produced by other causes.

Trials have been carried out at Redlands Horticultural Research Station to produce information to aid in the identification of 2,4-D injury. Crops were treated with 2,4-D amine, and observations on their subsequent behaviour have been summarized and are presented in this article.

The behaviour of 2,4-D in plants

2,4-D is taken up through the surface of the plant. Absorption begins soon after application, usually within the first half hour, and may continue for several days, by which time little remains on the leaf surface. It is likely that only very prompt remedial action, such as washing the leaf, would prevent the uptake of harmful amounts of the chemical. 2,4-D

can move within the plant after it is absorbed, and it is generally considered to travel mainly to growing organs and storage tissues.

2,4-D has often been described as a 'hormone' herbicide as its behaviour in plants is similar to that of the naturally occurring plant hormones, but since it does not occur in nature it may be more appropriately described as a 'growth regulator'.

The sensitivity of plants to 2,4-D

This varies depending on a number of factors including plant species, plant vigour, stage of development, rate of application and climatic conditions.

Some plants can tolerate reasonable amounts of 2,4-D without injury and in the commercial application of herbicides in crops we make use of this tolerance level. Generally speaking, monocotyledons, for example, grasses, are more tolerant than dicotyledons (broadleaved plants), but high dosage rates will affect all plants. The tolerance seems to vary with the stage and rate of growth of the plant, and consequently the extent of the damage sustained and the ability of the plants to recover and resume normal growth also depend on these. Tolerant plants apparently have the ability to dispose of 2,4-D by breaking it down, inactivating it, or by 'leaking' it out through the roots.

High rates of application may lead to rapid death of tissue, that is, 'burn' around the site of application. This reduces movement of 2,4-D from the treated area and consequently only minor symptoms of injury are produced elsewhere in the plant. With lower rates which do not cause burning the chemical may move through the whole plant and cause more injury overall. Notwithstanding this, higher rates generally produce a wider range of more pronounced symptoms than lower rates.

Some weather conditions, particularly drought, low temperature, and low light intensity generally reduce the rate of movement of 2,4-D from treated plant parts. Since these conditions usually slow down crop growth, injury may be reduced and its appearance delayed. For example, symptoms of injury following exposure to 2,4-D during the winter months may not be obvious until the following spring.

How injury symptoms develop

Types of damage to plants following exposure to 2,4-D may be grouped into four categories: contact injury, abnormalities in existing plant parts, formative effects on new growth, and effects on the future development of the plant. At high dosages these symptoms usually culminate in the collapse and death of the plant a few weeks after exposure.

Contact injury may become visible, as scorching or burning, within a few hours of exposure, on soft tissues such as leaves or green stems, when drops of 2,4-D solution remain on them. This may be followed by leaf fall.

2,4-D may slow down or accelerate the growth of different plant tissues causing distortion. This results in the typical twisting and bending of stems, leaves and leaf stalks which may be obvious within a few hours of exposure. Though commonly described as being wilted, the affected plants are usually quite turgid and often brittle. This condition generally persists for several weeks, until the plant has inactivated the 2,4-D, and then normal leaf and growing point orientation returns provided the dosage was not sufficient to kill the plant.

There is usually permanent distortion of stems and leaf stalks, and often swelling at the bases of the leaves and leaf stalks in the regions which largely control the normal orientation of the leaves. Another growth response which may occur is abnormal elongation, particularly of stems and leaf stalks, which may give the plant a 'leggy' appearance.

New growth is disrupted because of the development of abnormal tissues.

During normal growth, leaves are in the process of formation at stem apexes. Exposure to 2,4-D affects these leaves so that they exhibit, on their subsequent expansion, a range of symptoms of injury; and leaves initiated later respond similarly for as long as there is enough active 2,4-D present. This results in a range of deformity symptoms from unaffected, through varying degrees of chronic damage, and back to normal. Similar events may take place in apparently dormant buds, the deformities becoming obvious only when they develop later. Flowers may show similar symptoms. Typically, leaves become thickened with prominent veins, and the leaf blade is reduced giving a 'fan' or 'fingered' effect, often accompanied by puckering and distortion of the margins. Veins in the leaves are bordered by pale regions (vein clearing).

Roots are more sensitive to 2,4-D than shoots, but because they are more difficult to observe, few symptoms have been recorded. 2,4-D has been reported as increasing the permeability of root membranes, leading to loss of nutrients and organic cell contents, and possibly an increased risk of invasion by pathogens.

By increasing tissue growth, 2,4-D can induce internal pressures in stems, leaf stalks and roots, resulting in splitting and callusing (production of lumpy undifferentiated tissue). Profuse root formation may occur at these points.

2,4-D can cause flower induction in some plants, and from unfertilized flowers seedless fruit may develop. Fully developed leaves do not usually show permanent formative effects after 2,4-D application but they may become discoloured or age prematurely.



Banana showing symptoms of injury 10 days after treatment with a solution containing 0.3% 2,4-D a.e. Note the leaf scorch, rolled edge of the emerging leaf, thickened and roughened leaf midrib, rolling back of the edge of the leaf stalk, and lateral leaf vein thickening.

Symptoms of 2,4-D injury to crops

CAUTIONARY NOTE—The following are descriptions of symptoms of injury which were produced in trials at the Redlands Horticultural Research Station. These symptoms are not exhaustive, and they may vary under different conditions. In most cases several symptoms occur together, but not necessarily all those described. Some appear soon after exposure while others take several weeks or even months to develop. Some may mask others, and there may be interactions, producing symptom complexes.

To complicate matters, other abnormalities caused by climatic conditions, nutritional disorders, pests and diseases, and other herbicides and/or pesticides may occur combined with 2,4-D injury or be mistaken for it. Further-

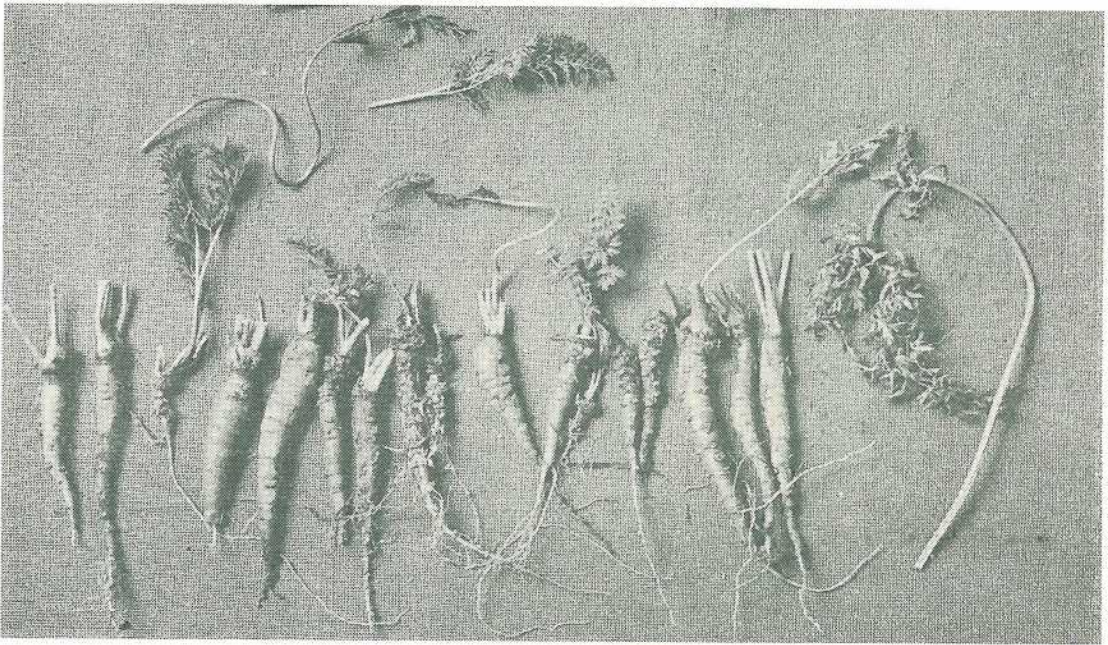
more, characteristics which are quite normal for a crop may appear, to the inexperienced eye, to be abnormal. When doubt arises all possible causes for concern should be thoroughly investigated. Weeds growing in and around the crop should be examined for abnormality.

Where evidence suggests 2,4-D injury, chemical analysis to determine residues in affected plants can help to confirm the cause of damage. However, it must be remembered that the presence of traces of 2,4-D could have resulted from a light exposure to the chemical after the symptoms developed. Other circumstantial evidence may then be required to establish the cause and origin of the damage. In the same way, failure to find a residue in the plant does not prove that 2,4-D was not involved because it may have been inactivated before the sample was taken.

Banana. Dead patches on leaves. Uneven growth at the base of the pseudostem causes this region to swell and split, usually resulting in the plant leaning and breaking off. Elongation of suckers; and extension of leaf stalks noticeable above the throat of the pseudostem. Leaf sheaths in the pseudostem may unroll. Edges of leaf stalks and the edge of the emerging leaf may be rolled back. Blades of mature leaves fold back along the midribs. Midrib thickens at its junction with the leaf blade becoming corky particularly on the upper surface. New leaves may not emerge. Flowers are discoloured. Developing fruit twist and curl and become corky at the point of their attachment to the bunch stalk. Where droplets of 2,4-D are deposited on fruit, localised swellings may result. Bunch stalk is elongated and twisted and may snap off at the throat. Fruit ripens prematurely and unevenly.

Beetroot. Leaves spread and roll. Leaf stalks twist and bend. New leaves are curved and narrow, with thickened veins and reduced leaf blades. Roots split and small knobs of callus develop at the bases of small lateral roots.

Cabbage. Leaves spread and hearts open up. Stems and leaf stalks split, particularly at the point where they join, with callus formation. Leaves redden, become quite brittle, and break easily from the stem. Young leaves thicken, have more prominent veins, and show vein-clearing and reduced leaf blades.



Symptoms of injury to carrot one month after treatment with a solution containing 0.3% 2,4-D a.e. (acid equivalent). Note the root, leaf stalk and leaf deformities.

Mandarin showing symptoms of injury following treatment with 0.3% 2,4-D a.e. Right to left untreated; treated when a young shoot—leaves curl, turn yellow and fall off, shoot die back; treated at dormant bud stage—leaves narrow and curved with thickened veins; treated when young leaves nearly fully grown—raised midrib and leaf curled.





Pumpkin after application of 2,4-D at 0.3% a.e., showing a range of formative effects produced along a single vine.

Injury to papaw induced by 2,4-D at 0.3% a.e. Note the dead patches and splits on stem and leaf stalks, leaves bent back and curled and younger leaves clawlike.



Carrot. Leaves spread and leaf stalks twist and bend. Leaves redden. New leaves have a finer, fern-like appearance. Roots develop lumpy callus at the shoulders. Callus forms at the bases of fine lateral roots, similar to that which develops on old roots or under waterlogged conditions. The tap root fails to expand, appears shrunken and may rot.

Citrus. Old leaves are quite tolerant but developing leaves twist and curl, and have a raised area along the midrib. Very young leaves turn yellow and abort, while young shoots die back. Fruit may fall off, or if it is retained it may ripen prematurely. Later growth from buds dormant at the time of exposure, and from the extension of existing shoots, may have narrow leaves with extended points, thickened veins and reduced leaf blades.

Cucurbits. (General effects). Leaf stalks and stems bend and twist, and petals of open flowers roll. Nodes swell with raised white areas, and show splitting with callus formation. Fruit is waisted, lopsided, and prone to sunburn when the covering leaves are distorted.

Pumpkin. New growth has narrow fan-shaped leaves, with thickened veins and reduced leaf blades. Later leaves are smaller and puckered, with fused veins, vein clearing and pointed margins; later still more normal leaf blades are produced but with the central veins strongly fused. Male flowers develop thickened receptacles.

Cucumber. Whitened contact injury spots appear on the leaves. New leaves are smaller, with more pointed lobes, pronounced veins, vein clearing, and reduced leaf blades.

Watermelon. New leaves are smaller, more indented, puckered, and show vein clearing and reduced leaf blades. Fruit ripen prematurely.

Rockmelon. Fruit ripen prematurely, develop with a very corky appearance, and may be seedless or have few seeds.

French bean. Leaf stalks and leaves show twisting and bending. There is vertical leaf orientation accompanied by bending back of leaf stalks and young shoots. The base of the leaf and leaf stalk enlarges and becomes corky. Beans twist and curl, and may develop to be

seedless or have few seeds. New leaves have narrow, pointed leaflets, with thickened and prominent veins, and the leaf blade is reduced and finely puckered. Stems split and are corky.

Lettuce. Hearts open and leaves curl, and there is profuse root development at and above soil level. Leaves have increased brittleness, thickened veins and vein clearing, and reduced blades.

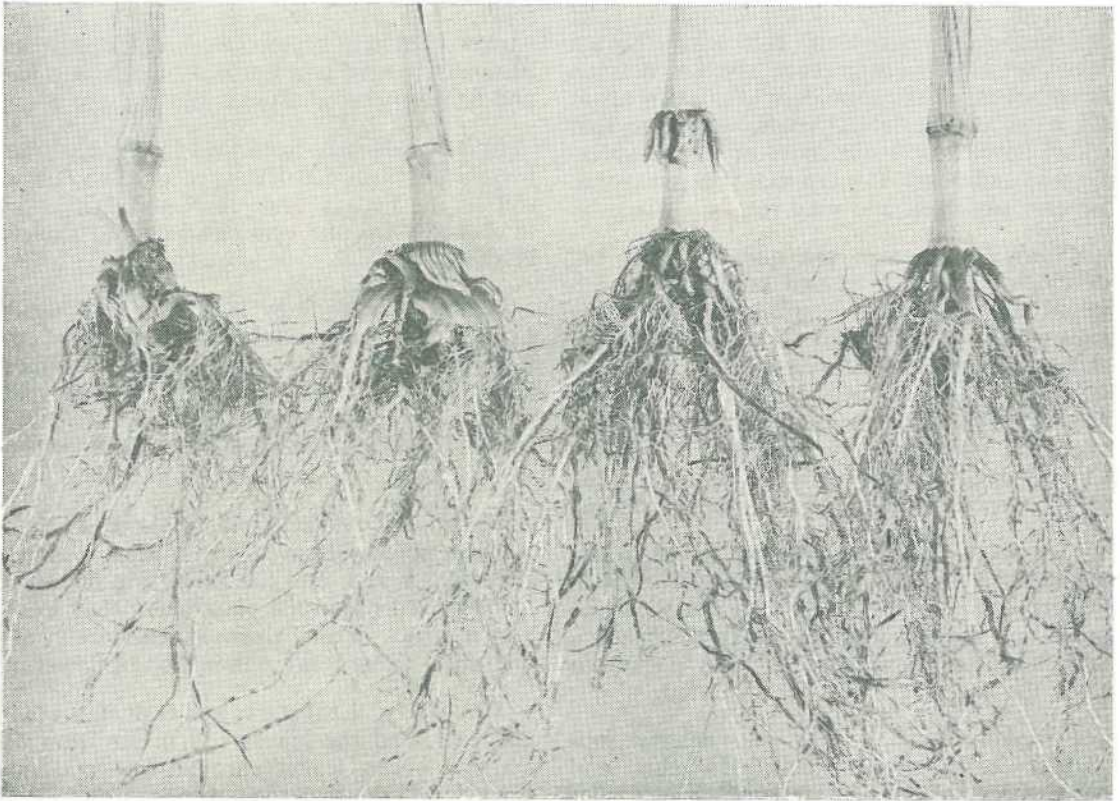
Papaw. These show leaf burn and death. Leaf stalks twist and bend; swellings at the base of the leaf stalk and leaf are enlarged, and the leaves curl. Dead areas and splits appear on stems. New leaves are clawlike, curved upwards, and show thickened veins, vein clearing, reduced blades and pale colour.

Pineapple. Affected plants show death of growing points. Leaves turn yellow and die. The plant bends, and the leaves are elongated and whorled round the plant axis. New leaves are narrow. Fruit ripens prematurely and unevenly. There is often induction of flowering.

Strawberry. Leaf stalks and fruit stalks twist and curl, and the leaves roll under from the margins. New leaflets are narrow and fan-shaped, and the margins appear more serrated; and there is vein clearing and reduction in leaf blades. Petals and sepals on open flowers curl, and fruitlets may die. Flowering may cease temporarily. Unripe fruits expand and ripen unevenly giving a lumpy effect with mottled colour, developing to more even colour at full ripe. Brown blemishes occur on fruit.

Sweet corn. Treatment when prop roots are forming results in these roots becoming flattened and fused. Root tip growth may cease and profuse lateral root growth occurs behind the tip. Leaves may pucker across the margins. Further development may be inhibited.

Tomato. Leaves, stems and leaf stalks show twisting and bending. Stems thicken, and whitened raised lumps are produced which may split, with callus formation. Flowers are spindly and may abort or produce elongated or pointed, fleshy fruit with small locules, containing few or no seeds. New growth is spindly with narrow, spikey, puckered leaflets with thickened veins and reduced leaf blades. Hairs are still present on the plant.



Sweetcorn. Prop root deformity following treatment with 2,4-D at 0.3% a.e. when prop roots were forming.

DO not burn containers which have held weedkillers such as 2,4-D and its derivatives. When these herbicides volatilize, the resulting vapour may damage nearby plants, crops and shrubbery. Also, herbicides or defoliant containing chlorates may explode when heated.

Dispose of these containers in this manner:

- Break glass containers and chop holes in the top, bottom and sides of metal containers so they cannot be re-used or collect water. A sharpened pickaxe is best for this purpose.
- Bury all weedkiller containers to a depth of 18 inches at a safe disposal site or take them to a dump where they will be covered with soil.

By courtesy Agricultural Veterinary Chemicals Association.

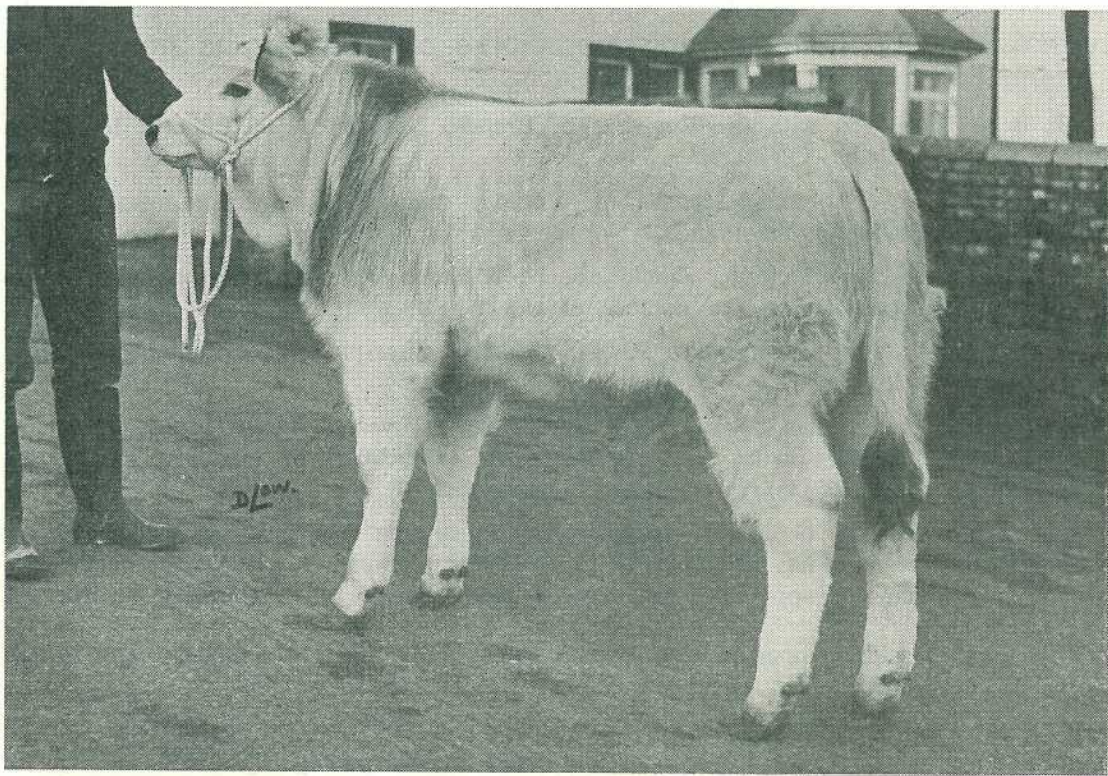
First U.K. pure-bred Romagnola calf heads for Texas

CONSIDERABLE interest was created in world-wide cattle breeding circles last year by the first importation of Romagnola beef cattle from Italy to the U.K.

The import, comprising 194 heifers and 6 bulls, disembarked at Dundee in June 1975 and were released to their owners in July following the statutory quarantine period.

Strong evidence of the soundness of the British Romagnola Cattle Society's decision to introduce the Romagnola breed to Britain was seen recently at Perth Sales in Scotland when the first pure-bred Romagnola calf to be born in the U.K. was sold for £2,205.

The seven months old heifer calf *Altonhill Panessa*, sired by *Scottish Dritto*, was owned and bred by Mr. Archie Howie Borland of Altonhill, Kilmarnock, Ayrshire.



Altonhill Panessa—the first pure-bred Romagnola calf to be born in the U.K.—which sold at seven months for £2,205 to Waltrip Ranches of Texas at the recent Perth Sales (Scotland).

An extremely strong and healthy calf from birth, when she weighted 93 lbs., *Altonhill Panessa* showed a daily liveweight gain of 3.2 lbs.

The first-class conformation and obvious all-round excellence of the calf proved a source of considerable favourable comment when she appeared in the sale ring. Interest was such that bidding rose quickly until the calf was secured at £2,205 for the Waltrip Ranches of Houston, Texas.

Commenting on the transaction, British Romagnola Cattle Society Council Member and internationally famous breeder and Show

judge Mr. Russell Taylor of Moncur Pedigree Herds, Inchtute, Perth said "The excellent impression made by *Altonhill Panessa* on the discriminating breeders present at the Perth Sales proves that our confidence in the Romagnola breed is well-founded.

"Waltrip Ranches of Texas are well-known to breeders throughout the globe. Their purchase of this calf shows their obvious appreciation of the Romagnola breed."

Former owner Archie Borland considered the price "A reasonable one in view of the current unsettled economic climate."

Horse and cattle brands being cancelled

EVERYONE who holds a registered horse or cattle brand must lodge a brand return form each year.

It is to be lodged with the Registrar of Brands, Department of Primary Industries, William Street, Brisbane, Q. 4000.

The Registrar of Brands (Mr. K. M. Vernon) said failure to lodge returns would lead to the cancellation of the brand.

He said brand return forms should not be confused with stock returns with which a levy is paid depending on the number of stock held.

About one-third of Queensland's 93 000 registered three-piece horse and cattle brands are not being used.

A brands revision has been in progress for several years. Those brands that have been cancelled following a lack of response from notification of intending cancellation letters become available for re-issue later in the year.

An acute shortage of brands available for registration has followed an amendment to the Brands Act requiring all sale cattle over 100 kg liveweight to bear one brand. Any clear brands which are apparently not required will quickly be re-registered to someone else.

Mr Vernon said any person who has not been in the habit of lodging brand returns (Form 373) and desires to retain ownership of it should advise him.

As an alternative, brand owners could obtain a copy of the brand return form from the local office of the Department and lodge it immediately.

COMMON QUEENSLAND MUSHROOMS

1. EDIBLE SPECIES

A large variety of mushrooms occurs in Queensland in many different habitats, but very few are recommended for eating.

When gathering mushrooms, it is important to know the characteristics of the edible field mushroom so that toxic species are not collected by mistake. Throughout this series, the term 'mushroom' is used to refer to both edible and toxic species. The term 'toadstool' is not used because it refers to all mushrooms other than the common field type, and strongly implies they are all toxic.

The common field mushroom (*Agaricus campestris*) which grows only in the wild, and the cultivated mushroom (*Agaricus bisporus*) are very similar in appearance so are discussed together.

What to look for

1. a distinct pink colour of the young gills (Plate 4). This is present from the outset, although colour does change to dark-brown in about 24 hours.
2. a ring on the stem (Plates 2 and 3). This is a little more fragile on the common field mushroom and may disappear quickly after opening.
3. a fleshy cap i.e., the thickness of flesh between the top of the stem and the top of the cap should be about one-fifth of the diameter of the cap (Plate 2). The cultivated mushroom is slightly fleshier than the common field mushroom.
4. a cap diameter of 4 to 9 cm, and varying from a uniform, white surface (Plate 1) to one with brownish or greyish scales (Plate 4). These scales generally result from a drier atmosphere or because of a difference in mushroom strain.

Habitat

Pastures and lawns.

A smaller but similar species may also be found in these places. The young gills are also pink and the species is edible.

— Compiled by J.E.C. Aberdeen and N.T. Vock, Plant Pathology Branch.

(Further information may be obtained by writing to the Director, Plant Pathology Branch, Department of Primary Industries, Meiers Road, Indooroopilly, Q. 4068).

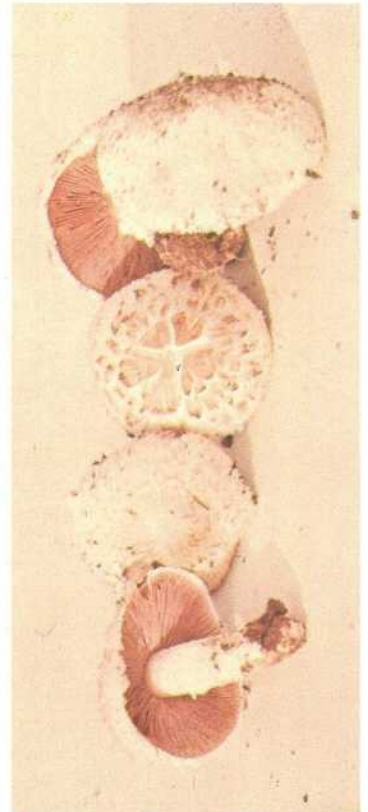


COMMON QUEENSLAND MUSHROOMS

1. EDIBLE SPECIES



1 Upper and lower left: Cultivated mushroom (*Agaricus bisporus*). Lower right: common field mushroom (*Agaricus campestris*).



3

4

COMMON QUEENSLAND MUSHROOMS

2. TOXIC SPECIES



1 Gold top mushroom (*Psilocybe cubensis*).



2 Iodoform mushroom (*Agaricus xanthodermus*).



3



4

COMMON QUEENSLAND MUSHROOMS

TOXIC SPECIES

OVER the years, a number of tests have been reputed to be useful in determining whether a mushroom is toxic. It must be emphasized however, that there is no simple guide to a mushroom's toxicity. The best plan is to learn to know the characteristics of the edible common field mushroom and avoid eating any others.

Two more toxic species are discussed here, the gold top mushroom and the iodoform mushroom.

A. GOLD TOP MUSHROOM (*Psilocybe cubensis*) (Plates 1 and 3)

This mushroom is characteristically associated with animal manure but occasionally occurs in other places where decaying vegetable matter is present.

What to look for

1. cap yellow-brown in colour.
2. some caps tend to be pointed in the centre (upper left of plate 1).
3. a thin, skirt-like ring on the stem.
4. very dark gills which are joined to the stem. This is in contrast with the common field mushroom where the gills do not touch the stem.
5. stems and cut surfaces of the cap tend to have a bluish-green stain when observed closely (Plate 3).
6. at times, the spores fall from the gills of a higher cap to form a dark layer with a purplish tinge on the top of a lower cap.

Habitat

Associated with manure in grazing paddocks. Frequently observed in warmer months of the the year following rain.

Toxicity

Definitely toxic. Small amounts produce hallucinations while larger amounts result in a very unpleasant sickness. Some people are more sensitive to the toxic principle than others. In Queensland, it is illegal to have possession of this mushroom.

B. IODOFORM MUSHROOM (*Agaricus xanthodermus*) (Plates 2 and 4)

This species is closely related to the edible field mushroom but differs in a number of characteristics.

What to look for

1. a cap larger on the average than the edible field mushroom, up to 15 cm in diameter.
2. a cap very even white in colour.
3. the young gills first a very pale cream in colour, then greyish-pink, and finally dark brown.
4. a ring much more distinct and thicker than the edible field mushroom.
5. the mushrooms grow in groups of two to four with the bases of the stems close together and consequently tapered in shape.
6. a yellow stain may appear after handling or at the stem base if cut.
7. an unpleasant smell. Unfortunately, not everyone can detect this but it is emphasized with cooking. In addition, a yellowish juice may be produced during cooking.

Habitat

Similar situations to the edible field mushroom.

Toxicity

Some people are able to eat this species and relish the extra flavour but many become sick and suffer iodine-flavoured 'burps' for some time afterwards.

(Further information may be obtained by writing to the Director, Plant Pathology Branch, Department of Primary Industries, Meiers Road, Indooroopilly, Q. 4068).

Burning Fire Breaks

by N. SCOTT,
Rural Fires Board.

NO land owner or occupier should expose his property to the ravages of wild fire. His family, home and many assets are enclosed by a fence which is no protection against floods and fire. Decreasing fire danger, however, can be made a part of his land management and will be more successful than anything he can do to prevent flood damage.

IF every land owner or occupier looked to his own property and co-ordinated his near boundary efforts with those of his neighbours, disastrous wild fire could only occur under the most extreme "blow up" climatic-fire conditions. Even then his losses would be considerably reduced.

The residential area containing the home, machine sheds, barns, sheds, silos, or yards for valuable stock, should be surrounded by fuel reduced areas such as cultivation or heavily grazed paddocks. The areas should not be wasted or converted to desert as this degree of safety is unnecessary. Within the residential area trees should be spaced and clear of buildings, bushes shrubs and hedges should be clear of trees, the grass should be mown or kept short by other means.

In unkept areas or where grass, shrubs and trees grow close together and are close to the residence or sheds, the ladder fuels transport ground fire to the top level of fuels, leaves in guttering, accumulations of spider webs, bales of fodder, curtains, and flammable material. Under hot summer conditions a badly constructed or situated incinerator, or

hasty rubbish fire, could start a fire that would quickly get out of control resulting in the damage or destruction of valuable property.

Having cleaned up his residential area the wise land owner will then plan a similar operation for the whole of his property.

In planning fire hazard reduction and fire safety projects the land owner should keep in mind that the work he carries out can also be used to prevent soil erosion, creek and dam siltation and provide many other advantages. Roads and tracks will subdivide the property into a number of sections and provide quick access. Green tree fire breaks also act as wind breaks, provide shade for stock and retain soil.

Irrespective of the use of the property it should always be divided into sections or compartments so that each area becomes a separate unit in which fire can be controlled.

Protective burning operations are called many names, Hazard Reduction, Control Burns, Prescribed Burns and just plain "Burning Off". It would be desirable to generally refer to this type of fire as "Prescribed Control Burns".

Over the past decade considerable research has been carried out in the field of "Prescribed Control Burns" and it has been definitely established that the continuity and quantity of fuels can be reduced without damage to timber, soils and the ecological balance in general.

To understand fire behaviour it is necessary to have an understanding of the types and distribution of fuels.

Ground Fuel

This fuel is considered to be those flammable materials in close contact with the soil: humus, peat, decomposing vegetation. Such fuel burns or smoulders very slowly, and is often very difficult to extinguish.

Surface Fuel

This fuel covers everything from ground level to a height of about 2 metres (6 ft.) and is made up of litter, grass, leaves, branches, twigs and the heavier fuels of large branches, logs, stumps, etc.

Because of the arrangement of fine, coarse and heavy fuels, much of which is in suspension, the surface fuel ignites easily and quickly, burning fiercely and generates great heat.

Aerial Fuel

This is the dead and growing vegetation that forms the canopy of the forest and may be a hundred feet or more above ground level. Except in some scrub forest types the various fuel components have plenty of air space and excessive flame height in the surface fuels, or intermediate ladder fuels, are required to initiate combustion in the aerial fuel.

The object of prescribed control burns is to remove as much as possible of the surface fuel without causing scorching damage to the canopy and at the same time leave a layer of litter on the humus to protect soil values, prevent erosion and avoid the introduction of fire induced vegetation such as bracken or blade grass.

Should a wild fire occur in an area on which fuel has been reduced the flame height and heat intensity will cause little harm to timber or damage soil values. Even under severe conditions the fire can be controlled by fire fighters, generally using a close parallel method of attack.

It has been estimated that a ground fuel cover of 2 to 3 tons per acre is needed to protect soil value and other desirable features so the prescribed control burn must be controlled so a residue of 2 to 3 tons per acre of litter will remain unburnt.

Normal leaf fall is from $\frac{1}{2}$ to 1 ton per acre per year so once an area has been reduced it will not need further fires for three to four years.

Control burns cannot be carried out in hot summer days or on any occasion when the fire danger rating is above a moderate reading. Under hot conditions timber and soil damage cannot be kept to the desirable level. Prescribed control burns should therefore be confined to the normal period from April to August, during which period the temperature seldom exceeds 24°C. Wind strength should not be in excess of 10 knots.

Fuel moisture content is important to ensure a successful prescribed burn. Conditions should be such that the lower layers of the ground fuel are moist and the humus and soil are wet. With low air temperatures, below 24°C, and low wind speeds the surface fuel will burn at a low intensity.

Most fine grasses will burn a few hours after rain but ground fuels need up to a week to dry out if 25 mm of rain, or more, are received. Burning can be carried out 48 to 72 hours after 12 mm of rain if temperatures do not exceed 24°C and wind force is under 10 knots. When heavier falls have been received burning should be carried out no later than seven days after the rain.

The time of the day is important. The heat of the day covers a period from 12 noon to 2 p.m., after this the air becomes cooler and by night the air is moist.

Wind and local air movements are subjected to many changes during the course of a day. By night the air cools and becomes heavier. Local air masses move down the slopes of hills and gullies and creeks.

Prescribed control burns can often be carried out during the hours of night but the fires must be patrolled and watched the next day.

The topography of the area must also be taken into consideration. Fire moves quickly up a slope, increasing in intensity as the higher

level fuels become preheated from the convection current and normal up hill air currents. Fuels on northern and western slopes are also much drier than similar fuels on eastern and southern slopes. The former may carry an intense fire when the latter may be reluctant to burn.

Burning should therefore be started from the ridge top and allowed to move downhill. Eastern and southern slopes may have to be burnt at a later date.

Although the principles of prescribed control burning remain, the areas and localities over which it is employed will vary with the purposes for which the land is used.

Fire protection work is necessary to help the fire fighter in his unequal battle against the potentially greater forces of a wild fire.

MAN

The average man is under 6 ft. in height. He finds it difficult to work in temperatures

above 50°C. A human immersed in water of 42°C for a period of three minutes is DEAD.

FIRE

Flame heights can range from one to several hundred feet with fire temperatures from 1 100°C to 3 300°C.

A fire fighter's physical capacity to work close to the fire front is therefore limited.

If fire fighters are to succeed in their objective to control a fire within a minimum area the odds must be reduced to work in his favour.

The reduction of fuel quantities, the breaking up of fuel supplies and the provision of a safe control line from which to use his strength and equipment aid the fire fighter to achieve success.

Every land owner and/or occupier should do his utmost to ensure that his property favours the fire fighters and not the fire.

Accounting and Planning for Farm Management

The second edition of this text book on Farm Management has just been printed.

No changes have been made in the text which is still a valuable reference for accountants, farm management economists, extension officers and primary producers.

If you do not already have a copy use the order form below to obtain one:

Director of Economic Services,
Department of Primary Industries,
William Street,
Brisbane, 4000.

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Please supply copy/copies of ACCOUNTING AND PLANNING FOR FARM MANAGEMENT at \$3.50 per copy.

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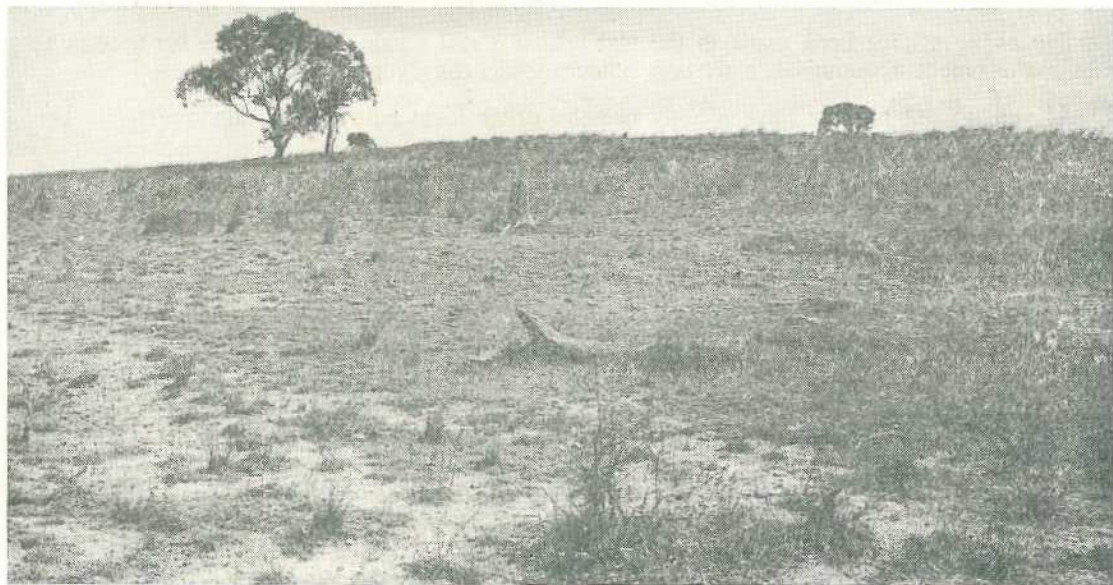
Signed:.....

Good traprock pastures need proper grazing management

by E. J. H. GLAVIMANS, Soil Conservation Branch.

IMPROVED pastures are a valuable asset to many grazing properties in the traprock region of Queensland. However, overgrazing of pastures to the extent that root systems contract and ground cover deteriorates, has led to serious erosion which in this fragile environment is hard to remedy.

This has been associated particularly with the grazing of sheep, which tends to keep the pasture undesirably short. The modification of management practices will result in the prevention of erosion and in longer lasting, more productive improved as well as native pastures.



Poor pasture management will result in minimal ground cover and will cause erosion of valuable top soil.

The area of approximately 760 000 ha (1 900 000 acres) of traprock soils in the south-eastern border region is bounded roughly by Pike and Rosenthal Creeks in the east, the Cunningham Highway from Warwick to Inglewood in the north, the Inglewood to Texas road in the west and the New South Wales border in the south.

Soils in the traprock area generally are fairly shallow and stony. The topography often is rugged and slopes are from medium to steep. Under these conditions it is obvious that great care has to be taken to prevent loss of soil when timber is cleared and the land prepared for improved pasture planting. It is estimated that 80% of cultivated land is susceptible to erosion.

Improved Pastures

Many landholders in the area realise the need for improved pastures to supplement the native grasses or to permit a change of enterprise. For this reason pasture development has been expanding on traprock properties. Land which is not all suitable for

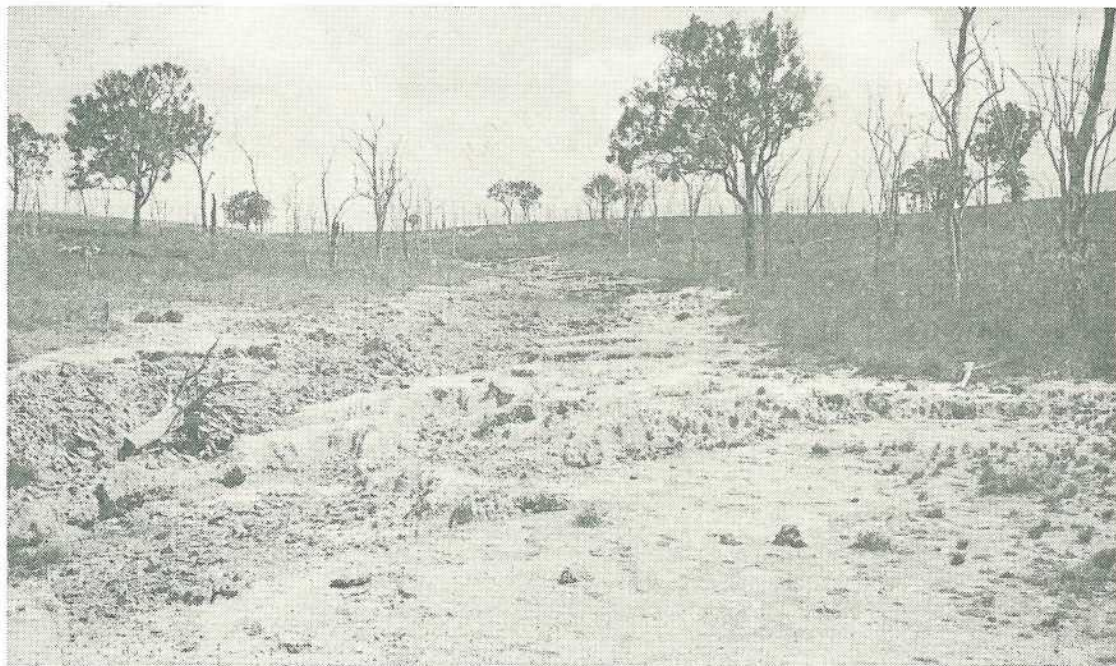
cultivation is being cleared, ploughed and sown to grazing crops and pastures.

A considerable amount of time and finance can be lost when the right approach is not adopted. The successful experience of several landholders in obtaining a maximum lifetime, and a maximum output, from introduced pastures is, however, available. To ensure the proper use of land some of these proven practices need to be followed.

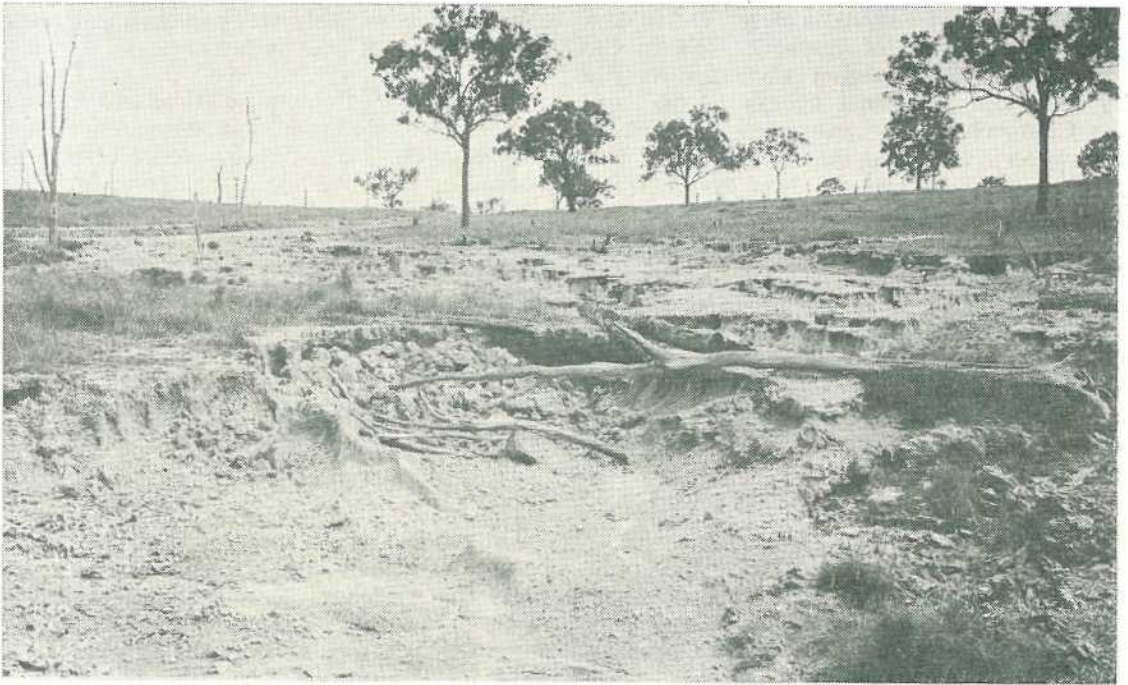
Contouring

To prevent erosion, contour lines should be surveyed on these areas to ensure that all workings and plantings are at least carried out on the contour.

On gentle and short slopes these lines may be used as guidelines only. After one or more years the guidelines tend to disappear as a result of grazing. Therefore they should be reploughed at regular intervals to avoid the need for resurveying when the pasture has to be replanted.



An added result of poor ground cover is increased runoff and erosion of natural drainage lines.



Another example of advanced drainage line erosion. Prevention is easier than the cure, because stabilisation at this stage will be extremely difficult.



Level contour banks trap runoff water for prolonged infiltration into the soil and aid the replenishment of dam water.



Well managed improved pastures, planted on properly surveyed contour lines, prevent erosion and produce abundant feed.

On the steeper and longer slopes, or on areas with large top catchments, construction of contour banks is necessary to control runoff water and erosion. To date most of these banks are level and can pond runoff water. Seepage through the banks will provide extra moisture for the pasture.

The "gap spreader" bank is a type of level bank that has openings at appropriate intervals along its length. Through these "gaps", water will flow over the pasture during times of high runoff. With the extreme susceptibility of the traprock soils to erosion this type of bank is not recommended.

The preparation of a seedbed should preferably be carried out with tine implements because disc implements can cause erosion. A cloddy surface should be kept as long as possible especially when these preparations are done during the summer rainfall season.

Natural drainage lines should be left in native grass and should not be cultivated. Fertilizer should be applied to these drainage lines to ensure optimum grass growth. This will slow down water flow and minimise erosion danger.

Poor Grazing Management

The grazing management that causes serious erosion can be best described in the words of one landholder:—

"First two weeks plenty, second two weeks less, last two weeks dust".

Some graziers claim that lucerne pastures have to be grazed this way to ensure a satisfactory regrowth of the individual plants. This claim, however, is not supported in practice. Continuous overgrazing is harmful to lucerne and pasture, and is often the cause of plants dying out in what was previously a good stand.

Continuous overgrazing has the two-fold effect of reducing the root system of the plants and limiting the depth to which roots penetrate the soil. This results in a lower capacity of roots to bind soil particles together and can limit the ability of plants to exploit moisture reserves. This latter effect can reduce the life of the pasture.

It should also be realised that heavy, continuous grazing leaves the soil surface highly vulnerable to permanent damage caused by the force of raindrops and by wind erosion. This is especially the case in lucerne stands because of the bare spaces between tussocks. Mixed grass and medic pastures normally form a better soil surface cover.

With insufficient soil cover raindrops dislodge the finer particles. These displaced particles clog the pore spaces in the surface layer with the result that water infiltration is greatly reduced. A reduction of rainwater infiltration into the soil will increase runoff over the surface and will carry more soil—especially the finer particles—down the slope into the creeks. The coarser, less fertile components of the soil are left behind. This will also be the result of wind erosion.

In this light any claimed advantages of intensive prolonged grazing can only have a very short term benefit.

To prevent further serious erosion in the area, overstocking and close grazing of both native and introduced pastures should be discontinued. Only the occurrence of severe drought conditions could warrant an occasional period of overgrazing.

Regular burning of native pastures results in destruction of surface litter and reduces

ground cover. Consequently this practice is not recommended.

Proper Grazing Management

To ensure productive native and introduced pastures the loss of valuable topsoil should be prevented. Retaining adequate soil cover should therefore be the aim of the adopted systems of grazing.

Lucerne may not stand over as well as grasses and should be used when available. This means, in practice, that rotational grazing should be adopted to obtain maximum production.

Grazing of grasses and medics should be discontinued as soon as the average height has been reduced to 10 or 12 cm (4 or 5 inches).

Pastures and lucerne must be spelled to allow regeneration from the crown, and seedling establishment in thin stands.

The combination of these measures will ensure the maintenance of sufficient ground cover through all seasons and a more rapid regrowth of the pasture. This will have a beneficial effect on the soil surface and will allow more water to infiltrate into the soil where it will be available to the pasture.

Summary

Good native and introduced pastures can be grown on traprock soils provided the required measures are applied to prevent erosion. These measures include the use of contour guidelines or contour banks for improved pastures, rotational grazing and the maintenance of ample ground cover by limiting the grazing to a minimum height of ten or twelve centimetres.



Trigger Plants

THE wildflower we know as a triggerplant was first described in 1807 and was given the generic name *Stylidium*. This is derived from the Greek word *stylos* which means a column. In these plants the stamens are united with the style to form a column. It is the sensitive trigger action of this structure which gives the plants their common name. This trigger action is a unique method of pollination.

The slender column rises from the throat of the flower. The filaments of the two anthers are joined to the style with the two-celled sessile anthers at the apex of the column, one on each side of the stigma. In young flowers this may be completely concealed by the anthers or protrude between them.

When the trigger is at rest it is bent down to one side between and below the petals. The flowers produce a very attractive nectar. When an insect visits a young flower in search of this nectar, while it is sipping, the trigger is suddenly released and swings straight upwards across the flower, and hits the insect on its body, showering it with pollen. As the flower ages and the anthers become empty, they shrivel and are pushed aside by the stigma. This is in the form of a hairy cushion or brush. When insects which have visited other triggerplants and have been dusted with pollen land on this old flower, the hairy stigma brushes the pollen from the visitor's body and cross pollination is achieved.

Trigger plant flowers have a calyx consisting of five sepals, with the calyx tube adnate to the ovary. The calyx lobes are either quite free or are united into two lips, with three lobes in the upper lip and two in the lower. The calyx tube may be almost globose or very long and narrow.

The corolla is usually irregular and deeply divided into five lobes. The lowest, called the labellum, is much smaller or very different in shape from the others, and usually curves down like a little hook. At first glance these flowers appear to have only four oval petals, two on either side of the column. Closer examination will reveal the labellum underneath the poised trigger. Small teeth or lobes

are often found standing erect at the mouth of the corolla tube forming a ring at the base of the petals. The function of these structures, called appendages, is obscure.

The flowers are arranged in erect simple spikes or racemes or in more complex branched inflorescences, particularly in the tropical triggerplants. Glandular-tipped hairs are usually found on the outside of the ovary and the calyx lobes, and on the peduncle. In some species the whole inflorescence except the petals is covered with these glistening hairs, and on some they are even found on the outer surface of the petals.

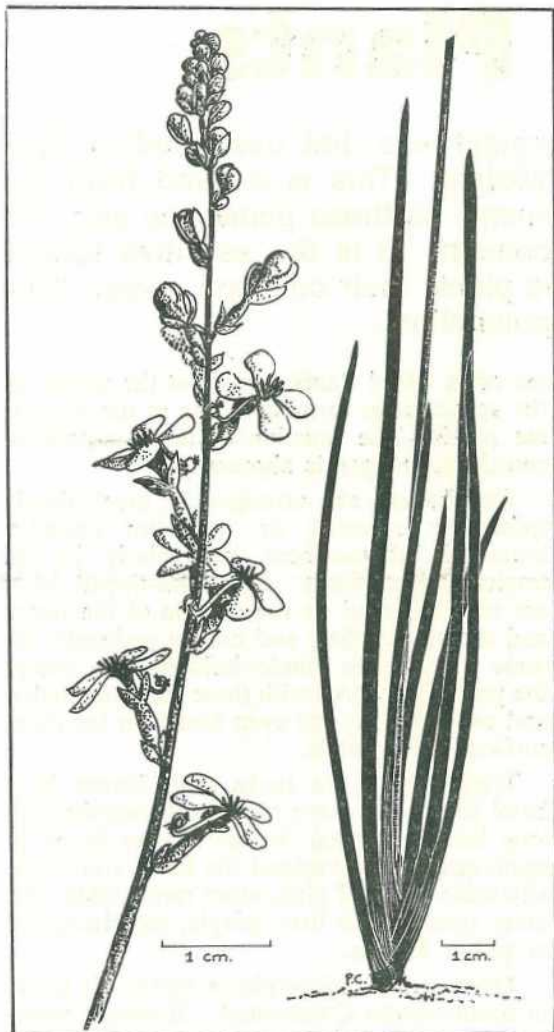
Triggerplants are herbs with leaves in a basal rosette, or more rarely undershrubs with long leafy branches. In the species found in south-eastern Queensland the flowers are usually some shade of pink, more rarely white, but other species have lilac, purple, red-violet, red or yellow flowers.

There are five triggerplants commonly found in south-eastern Queensland: *Stylidium graminifolium*, *S. laricifolium*, *S. ornatum*, *S. debile*, and *S. uliginosum*. Another species *S. capillare* has been recorded from south-eastern Queensland but the most recent collection was in 1930 from Redcliffe. It is a very slender annual, 3 to 5 cm tall with only one or two very small flowers which have a slender calyx and white petals.

Grass Triggerplant

The specific epithet means resembling grass and this also provides the common name for this triggerplant.

by **BERYL A. LEBLER**,
Senior Botanist.



Styliidium graminifolium.

DISTINGUISHING FEATURES. The habit of this triggerplant, with its basal tuft of grass-like leaves and a simple, erect flowering scape, are sufficient to distinguish this from the only other large triggerplant in south-eastern Queensland, *S. laricifolium*.

DESCRIPTION. It is a perennial herb with a tuft of grass-like leaves forming a clump at ground level. These are firm in texture and variable in length and breadth, the more luxuriant being 15 to 23 cm long. A single erect

firm stem, from 15 to 45 cm high has the flowers massed in the upper quarter or half. In this portion the scape is densely covered with short hairs tipped with round red glands. These glands are also found on the short pedicels, the small bracts at their bases, the calyx tube and sepals and are scattered over the outside of the petals. The pedicels are less than 0.5 cm long, with the calyx tube as long. The free calyx lobes are about half the length of the tube. In south-eastern Queensland the corolla is lavender-pink, while in other parts of Australia it varies from pale to bright pink. The petals are joined at the base into a short tube. The four oval petals spread in two pairs on either side of the trigger, with the inconspicuous labellum curved down under the trigger like a hook which lies alongside the corolla tube.

The appendages at the base of the petals are linear, erect and very glandular. They are not uniform in length and are the same colour as the petals. The column is deeper in colour and is strap-shaped. When at rest, the portion lying alongside the corolla tube is about 0.5 cm long. The whole flower is about 0.8 cm long and the same diameter. It is pollinated by a small native bee.

FLOWERING TIME. The main flowering occurs in spring to early summer but flowers can be found in autumn and winter, especially after bushfires.

HABITAT. It grows on sandy wallum flats, or stony slopes in open eucalyptus forests, and in shallow rocky soil on sandstone ridges.

DISTRIBUTION. It is common throughout the coastal regions and on the Great Dividing Range in the eastern states, in South Australia and Tasmania.

Tree Triggerplant

The specific epithet means larch-leaved, and was apparently chosen because of the similarity the dense, narrow leaves had to those of the European larch tree.

DISTINGUISHING FEATURES. The size of this undershrub, its leafy branches and crowded narrow leaves readily distinguishes this triggerplant.

DESCRIPTION. This is an undershrub about 30 cm high with up to ten branches spreading from the top of the stem. These branches are 20 to 30 cm long, each ending in a flower scape. The grass-green leaves are crowded along the slender woody stems. They are sessile, flat, about 2.5 cm long, and less than 0.1 cm wide. Their tips can be blunt or pointed. On the lower portion of the stems the leaves spread widely, but just below the flower scape they point upwards. The scape can be 15 to 45 cm long with one central stem and three or four racemes spreading out around its base. Using a hand lens a sparse covering of dark coloured gland-tipped hairs can be seen on the flowering stem and the calyx. The four spreading petals are rose pink with a deeper coloured mark at the base. They are almost equal in size, oblong in shape and the tip is blunt. The upper pair is 0.6 cm long, 0.4 cm wide, and the lower 0.4 cm long, and 0.3 cm wide. The labellum is green, not pink, has two very small dark red triangular wings at the base and curves down.

A few glandular hairs are sprinkled on the outer surfaces of the petals. Only one flower opens at a time on each of the flowering branches.

FLOWERING TIME. Springtime.

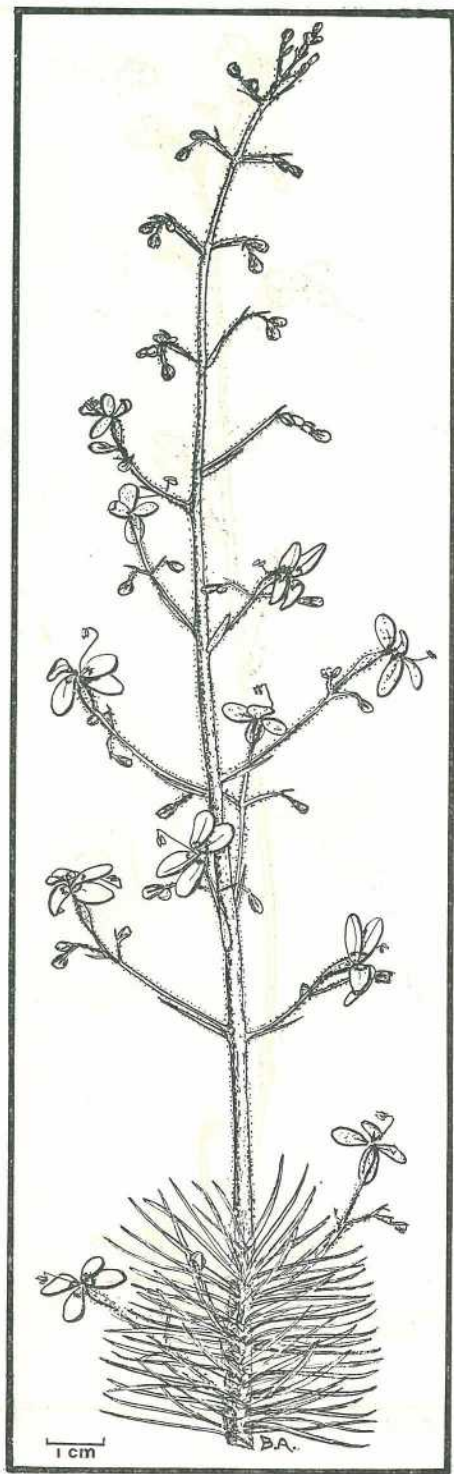
HABITAT. It grows in mountainous country, in rock crevices on rocky places on sandstone or granite.

DISTRIBUTION. It is found in the eastern mainland states to as far north in Queensland as Rolleston.

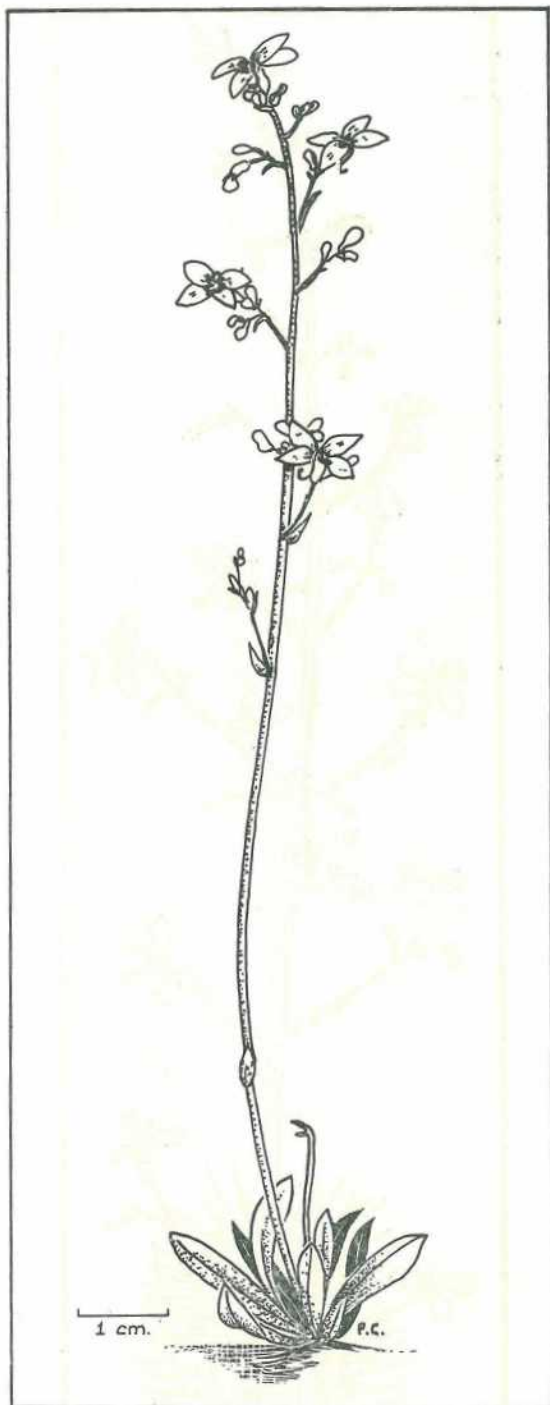
Wallum Triggerplant

The Latin objective *ornatum* means decorated. It describes the petals which are decorated with red spots, near the throat of the corolla tube.

Until 1963 when the species was described by Dr. S. T. Blake this plant was confused with Frail Triggerplant *S. debile* which is widely spread in Queensland and the northern part of New South Wales. Both plants grow in swampy ground, and both are perennials with a branching rhizome. In *S. debile* the erect branches project well above the surface of the soil as leafy stems with scattered leaves below a loose rosette of a few ovate leaves. Appendages are



Styliidium laricifolium.



Styliidium ornatum.

absent from the corolla of *S. debile* and glandular hairs are scattered on the outer surfaces of the petals.

The following description applies to *S. ornatum*.

DESCRIPTION. This is a perennial herb with a branching rhizome which produces well developed rosettes of leaves at ground level. The leaves are rather thick in texture, dark green in colour, oblanceolate or spatulate in shape with a blunt tip. The flowering scape is erect, slightly flattened, with very much reduced leaves scattered along its length. It can be 25 cm tall. Frequently short oblique lateral flowering stems curve from the axils of the stem leaves, each bearing several flowers towards the end. For most of its length the main stem is quite glabrous but very short hairs with dark glandular tips are scattered over the lateral branches and the upper portion of the main flowering stem. These can be seen with the naked eye. These hairs are also scattered over the ovary but the five sepals are always glabrous and the corolla lobes are also glabrous on both surfaces. The flower colour varies from almost white to apricot-pink or rose pink but in all cases the blue tinge seen in *S. graminifolium* is absent. At the base of each petal is a darker spot and inside this two small appendages project upwards. The flattened darker coloured column bends down over the labellum, which is thin and lanceolate, and pink in the upper half. The stigmatic plate is green.

FLOWERING TIME. Usually in the warmer months but it will flower in any season after bushfires.

HABITAT. It grows on wallum flats, in swamps or bogs.

DISTRIBUTION. To date it has been found only in south-eastern Queensland on the islands in Moreton Bay, and the coastal lowlands as far north as the Burrum River and on Fraser Island. Because of the confusion with *S. debile* it is possible it may occur elsewhere.

Swamp Triggerplant

The Latin word *uliginosus* means growing in swamps or wet places. It provides the specific epithet for this plant and describes the habitat in which the plant grows.

DISTINGUISHING FEATURES. The small size of the plant, the linear calyx tube and the sessile white flowers is sufficient to distinguish this from the other triggerplants in south-eastern Queensland.

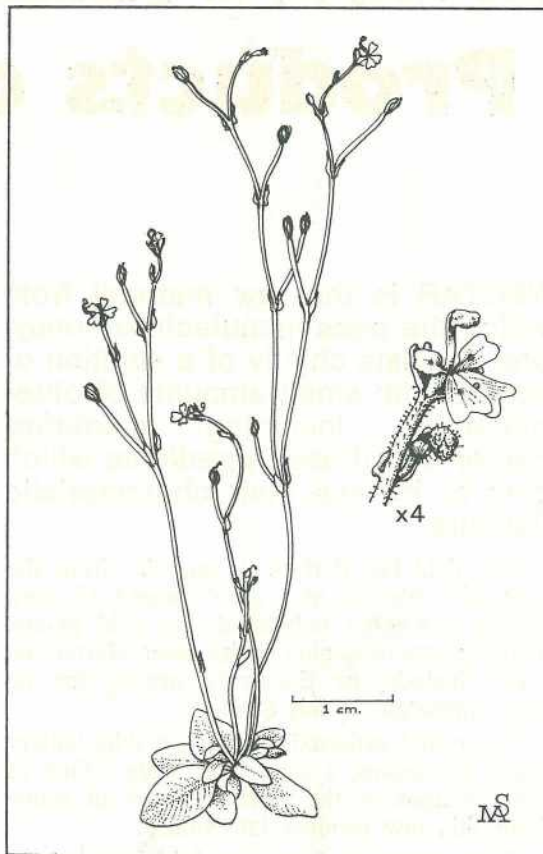
DESCRIPTION. This is a very small annual herb with a basal rosette of petiolate leaves up to 1.5 cm long, and 0.5 cm broad. They are oblong, ovate or almost round. More than one scape can be produced on a plant, and these can be simple but more often are branched. They can be 12 to 16 cm tall. The tiny flowers are sessile in the forks and along the branches, each in the axil of a tiny bract.

The calyx tube is linear, up to 0.5 cm long and ends in linear lobes 0.2 cm long. Three are completely free, but the others are joined almost to the apex. Minute red-tipped glandular hairs are very sparsely scattered on the branches and the calyx. The corolla is white, the tube as long as the calyx lobes. The spreading lobes are 0.1 cm long, and are deeply notched. A red dot is at the base of each lobe.

FLOWERING TIME. Sporadic in the cool to cold months.

HABITAT. In tea-tree swamps, swampy ground near mangroves and bare damp places in wallum flats.

DISTRIBUTION. It is found in Queensland, the Northern Territory, Southern China, and the Malayan Peninsula. It also grows in Ceylon.



Styliidium uliginosum.

FIELD KEY TO TRIGGERPLANTS IN SOUTH-EASTERN QUEENSLAND

1. An undershrub, densely leaved along the stems, with long terminal flower spikes
Styliidium laricifolium
- Herbs with leaves forming a basal tuft or rosette 2
2. Leaves long, narrow, erect and grass-like, forming a tuft at ground level. Inflorescence
to 45 cm high *Styliidium graminifolium*
- Leaves in a basal rosette, flat, oval, ovate, oblong-lanceolate or spatulate 3
3. Flowers sessile *Styliidium uliginosum*
- Flowers pedicellate 4
4. Glandular hairs present on outer surface of corolla, appendages absent from corolla
throat *Styliidium debile*
- Glandular hairs absent from outer surface of corolla, appendages present on corolla
throat *Styliidium ornatum*

Bee Keeping in Queensland

Products of the Hive

by C. ROFF, Chief Adviser in Apiculture.

NECTAR is the raw material from which the bees manufacture honey, and consists chiefly of a solution of sugars with small amounts of other materials, including colouring matter and those ingredients which give to honeys their characteristic flavours.

The field bee derives its supplies from the successive blooms of a great variety of trees, shrubs and other cultivated and wild plants. Those plants belonging to the order Myrtaceae, which include the Eucalypts, are by far the most important in this State.

When first gathered, nectar is a thin, watery liquid possessing a raw, rank taste. One of the functions of the worker bee is to transform this raw product into honey.

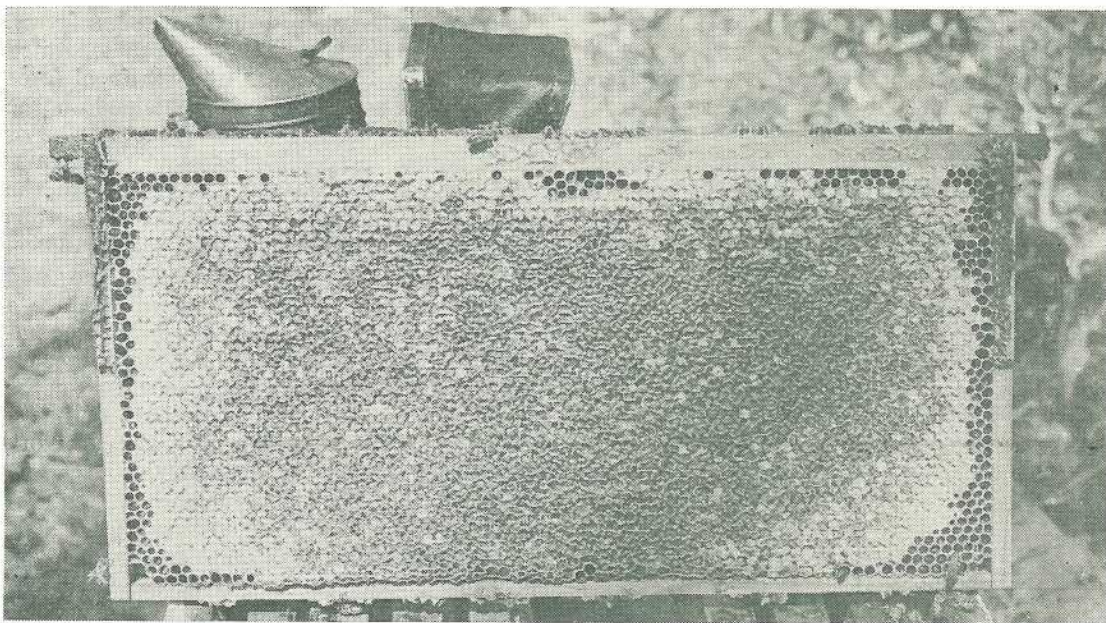
After returning from the field, the nectar-carrying bee delivers her load to one or more house-bees. These then put the nectar through a process of kneading with their mouth-parts. This apparently reduces its water content and probably permits the addition of enzymes such as invertase, which are produced by the salivary glands. Instead of depositing the entire load in a single cell, the house-bee often distributes the nectar by attaching a small hanging drop to the roof of each of several cells. These small hanging drops present relatively large surfaces, from which moisture can evaporate rapidly. Later, the droplets are collected, and are again put through the process of manipulation by the mouth-parts.

The evaporation of the nectar is carried to a further stage by worker bees, which station themselves in line near the hive entrance.

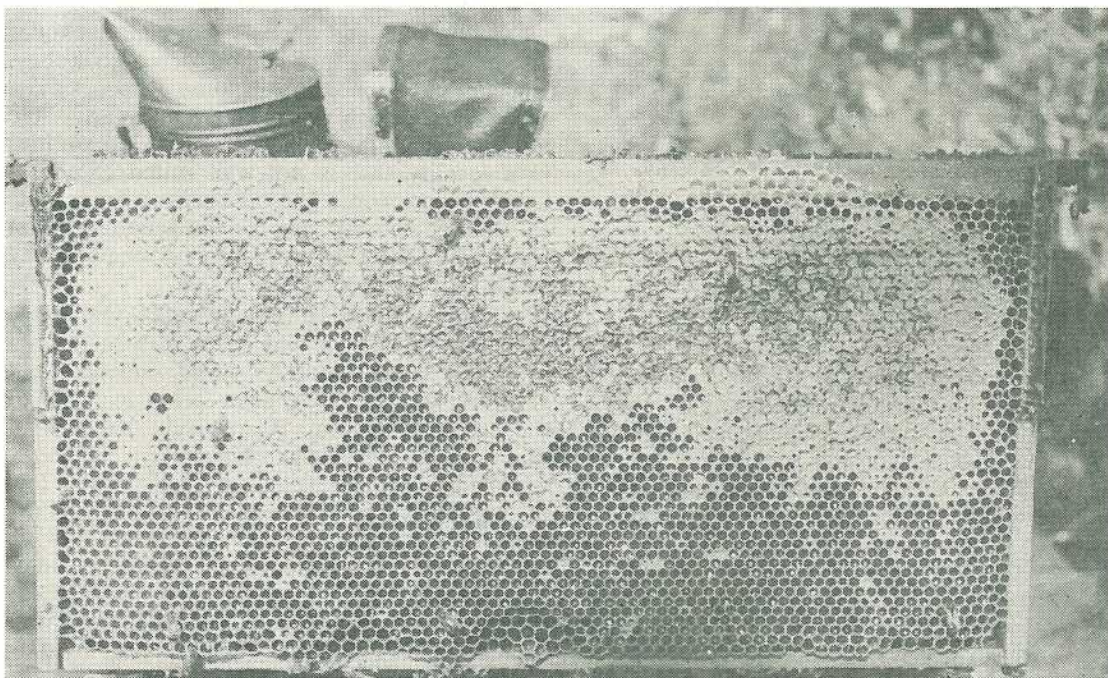
These, by the continual fanning of their wings, drive currents of air into and out of the hive and over the comb surfaces. If a piece of tissue paper is held before the entrance at such a time a strong current of air will draw the paper either outwards or inwards. The loud buzzing heard at night during summer time is due to the wings of the workers engaged chiefly in ripening nectar. When this process is finally completed, the water content has been reduced to between 15 to 20%, and the disagreeable odours and flavours, probably due to volatile oils, have also been drawn off. The finished product is stored in cells above and around the brood nest and the main cluster of bees. The work of sealing with waxen caps then goes forward rapidly. This sealing of the cells indicates to the beekeeper that the honey is ripe and in the right condition for extraction. In the drier western parts of Queensland honey is often extracted when the cells are full and before much sealing has taken place. This is unwise in coastal districts.

All honey contains yeasts and when extracted with a water content above 17% may ferment. (Above 19% it will ferment.) Storage below 10°C prevents fermentation. Carefully heating extracted honey in a water bath to 45°C for 30 minutes will destroy honey yeasts. This means that under good storage the honey will be safe from fermentation for about a year.

Because honey is viscous and flows slowly, it presents handling problems. This character is important to the beekeeper, who extracts the honey; to the packer, who packages the honey; and to commercial users such as bakers and confectioners who find that honey will only flow slowly. Warming to 35°C makes honey easier to handle.



A well sealed honeycomb like this is ready for extracting.



A honeycomb partly sealed like this is often unsuitable for extracting in coastal districts, particularly during the wet season.

Ordinarily honey is judged by its colour, flavour, and density. The very great range in its colour is due entirely to the sources from which it is obtained. The colour varies from almost white, through straw and amber to reddish. It has been known to be blood-red, and again to have a greenish tinge, and still be absolutely pure. To help in the marketing of honey, colour is calibrated in millimetres on an instrument known as the Pfund Honey Grader.

Australian Official Classification 1970	Pfund Honey Colour Range in Millimetres	Pfund Honey Colour Range in mm as used by Australian Honey Packers
	0	0
Extra White	17	..
	..	19
White .. .. .	..	20
	..	29
	..	30
	34	..
	..	39
Extra Light Amber ..	..	40
	..	49
	50	50
Light Amber .. ..	..	59
	..	60
	65	..
Pale Amber .. ..	..	69
	..	70
	75	..
	..	79
Medium Amber .. ..	..	80
	..	89
	90	90
	..	109
Dark Amber .. ..	..	110
	114	and over

NOTE.—The upper limit in each colour range is defined as the value not exceeding the given figure. For example, light amber exceeds 50 mm but does not exceed 65 mm

The aroma and flavour of the honey also varies very considerably. Lightness of colour alone is not conclusive evidence of superior quality, and honey of the darker colours, as well as honey of the lighter colours, may be of the higher grades and quite suitable for table use. Some of the most prized honeys—such as that gathered from orange blossoms in California—is of a very deep colour, and the famous heather honey of Europe is quite dark. Yet no honeys stand higher in popular esteem in their places of origin. Similarly stringybark and ti-tree honeys which are also darkish are popular in Queensland.

Honey is marketed in three principal forms. Extracted or liquid honey, has been separated from the uncrushed comb by centrifugal force or gravity. Comb honey is contained in the cells of comb, usually in 454 g sections. For chunk honey, the comb is cut into rectangular pieces and placed in the container with the liquid honey when, packed in glass, this increases the attractiveness of its appearance.

Most of the honey is marketed in extracted form. Bees are ordinarily able to produce a large quantity of honey if they are not compelled to build comb for it. So the beekeeper empties the combs and replaces them in the hive. This means that in periods of heavy nectar secretion the bees can get to work immediately to store more honey.

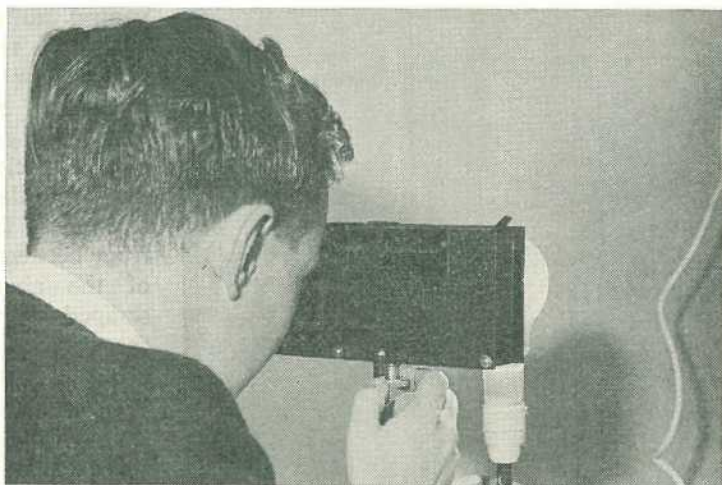
The production of comb honey requires much greater skill and experience on the part of the beekeeper, and can be carried out successfully only in limited areas where the conditions are favourable. It should not be attempted in localities where the honey flow is slow or intermittent, where the character of the honey flow is such that it granulates quickly in the comb while it is on the market, or where the honey is dark in colour.

Yellow box and Caley's ironbark localities are good for the production of comb honey. Local market conditions in some instances may, of course, be such as to make it seem advisable to produce comb-honey in limited quantities in a locality that is not well suited to comb-honey production. The beekeeper who expects to produce comb-honey for the general market should first be sure that his is a comb-honey locality.

Almost all honeys may granulate or candy after a time. Those which are high in glucose or grape sugar, impurities and moisture will granulate very quickly after being exposed to the air by extraction. Conversely, the normal liquid condition is maintained best by honey which is high in levulose or fruit sugar, low in impurities and moisture. The most favourable temperature for granulation is 15°C. Higher or lower temperatures delay granulation. Honey stored in the "deep freezer" as against the "refrigerator" seldom granulates, because it is "super-cooled".

Various methods have been proposed for preventing complete granulation of honey once the change has started, but none is entirely

A Pfund Honey Grader.

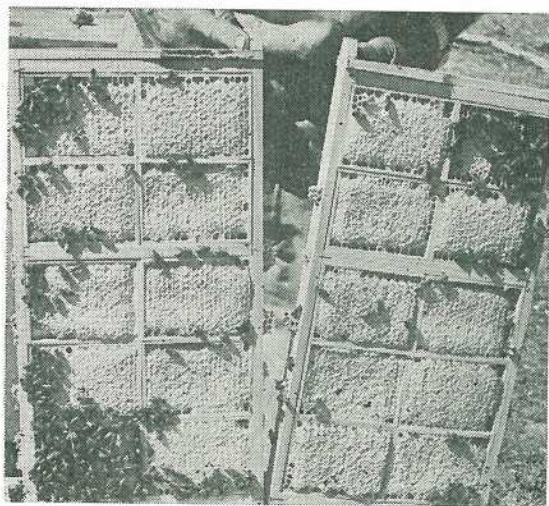


Extracted honey is packed in glass tumblers.



Glass jars of extracted honey being packed in cartons for the retail trade.





Honeycomb—the best way of eating honey.

satisfactory. Heating is probably the most useful since heat removes the initial crystals. The temperature to which honey can be safely heated is about 64°C providing it is cooled quickly. As the danger of darkening honey by overheating is considerable, care must be taken to see that this temperature is rigidly controlled.

When honey has already candied, it cannot be liquified hurriedly. From eight to ten hours in a hot water bath at a temperature of 38°C will be needed for honey set hard in 27.2 kg cans. In melting candied honey the heating agent must not come in contact with the can holding the honey, otherwise scorching will result and ruin the flavour.

When large quantities of candied honey in cans are to be liquified, provision should be made for heating a number of containers simultaneously in a water bath. The can should rest on strips of wood to prevent contact between the tins and the bottom of the bath and to allow the water to circulate all round the containers. In honey factories larger containers (80, 170 and 300 kg) are heated in controlled temperature rooms.

Beeswax

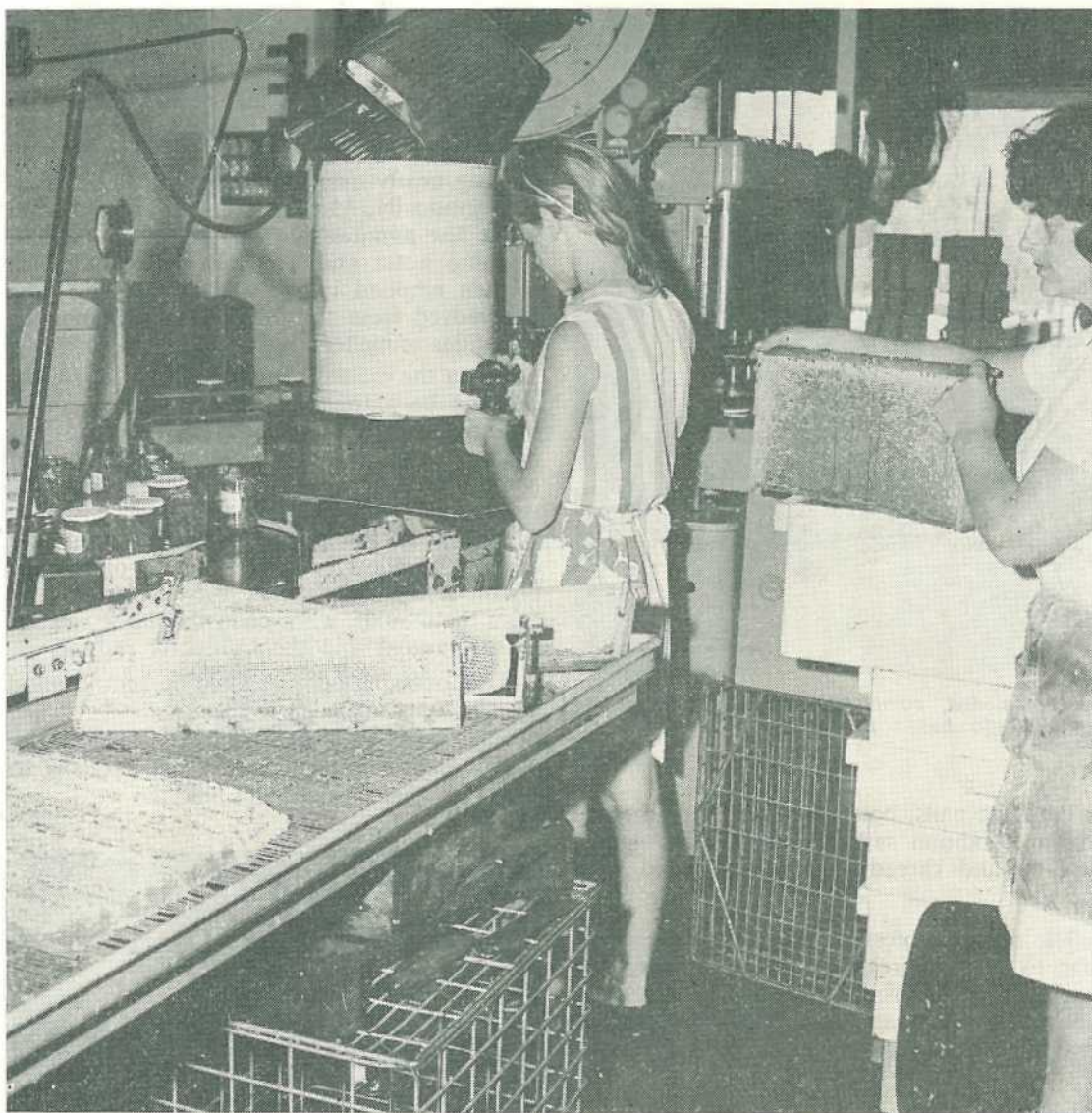
Beeswax is secreted by special glands in worker honey bees from 12–18 days old, these eight glands being situated inside the

ventral surface of the abdomen. A reasonably high temperature together with a good honey flow and pollen supply are needed. Bees need about 3.8 kg of honey to build about 454 g of wax on foundation. If the bees are closely watched under these conditions, little pearly discs of wax somewhat resembling fish scales will be seen protruding from between the segments on the under side of the abdomen. These wax scales are scraped off with the spines of one hind leg, then pushed forward and grasped by the front legs and transferred to the mandibles, where they are manipulated or masticated, after which they are applied to the comb. During the process the bee stands on three legs, the two intermediate legs and one hind leg not in action, while the other hind leg and the two fore legs, in connection with the mandibles, perform the manipulations. Each individual bee removes its own wax scales without any help. When cell-building is taking place in a hive a white line of wax is noticeable between the becombs at the top as the upper cells are extended or constructed.

At the time a swarm is hived there is no wax in the hive under natural conditions. The wax secretors, however, become very active, and very soon the hive is supplied with combs. It is also true, of course, that wax is secreted at any time during the active season, when more combs have to be built to accommodate brood or stores, provided, of course, there is room. If a comb is removed from the centre of the brood chamber or from the super, it is replaced as needed, but, as a rule, not so rapidly as in the case of a newly-hived swarm. The speed of the honey flow has a major influence on this wax secretion.

With modern methods of extraction the honey is removed from the combs. These are returned to the bees or carefully stored away for use during the following season. The wax which the beekeeper now obtains results from the melting-up of cappings, old combs, or combs showing faults such as stretched cells, or those having too great a proportion of drone cells.

Beeswax has many uses, both in the arts and in commerce, and fresh uses are continually being found for this product.



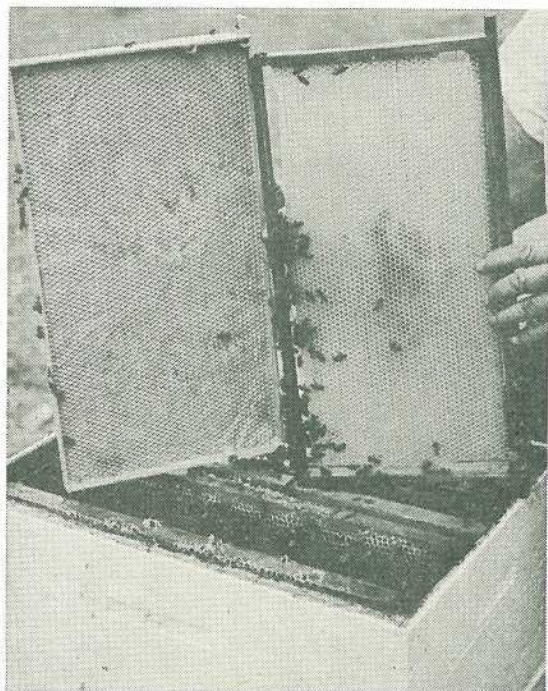
Packing honeycomb for the retail trade.

A very satisfactory floor finish can be made by melting 454 g of beeswax, and while it is cooling stirring into it some turpentine, the proportion varying according to whether the mixture is to be thin or thick.

Certain grades of blacking, harness oils, and lubricants need pure beeswax in their manufacture.

Large quantities of beeswax in the form of church and decorative candles are used. There are "do-it-yourself" kits available for making decorative candles for house use.

The electrical supply business is a consumer, since the windings of some electric cords are soaked in beeswax so they will not be affected by extremes of heat or moisture. It is used



Beecombs, left, completely natural beeswax and right, plastic based becomb.

to lubricate nails, bolt, screw and pipe threads and to condition saws. Some canvas goods, clothing and threads are waterproofed with beeswax.

The dental profession uses quantities every year to take impressions in the mouth, and much is used in cosmetics. Last, but not least, the beekeeper himself is a large consumer of wax foundation, as well as being a producer of wax.

Rendering wax from old combs

To get the maximum amount of wax from old combs the following procedure should be adopted.

Stand a few clean open top 27.2 kg honey tins on a stand about 30 cm high, so a fire may be built under the tins. Then half fill the tins with soft water and heat it. Put in each tin enough comb to make a free mush, and let this stand at about boiling point, stirring occasionally until well melted. Then

pour a quantity into a wax press, which contains a straining cloth (a sound sugar bag is satisfactory).

Small quantities of the melted mass with a fair supply of hot water give the best results. When a sufficient quantity is in the press, fold the bag neatly over and apply the screw pressure gradually. Leave the hard pressure on for a few minutes and tip the press forward, draining water and wax into a bucket which is then emptied into a vat. The slum gum is removed from the press and the remaining quantities of melted comb are treated similarly.

When the melted comb from the tins on the fire has been treated, the hot water may be drained from the vat into the melting tins again, and a start made with a fresh lot of comb. After completion of the pressing, the wax may be drained from the vat into moulds which should be placed in warm water and covered to allow necessary slow cooling. To obtain a high-grade wax the blocks of wax from the moulds, when cool, should be cleaned at the bottom and then properly refined.

The following points should be kept in mind by the operator:—

1. Soak very old combs in cold water overnight to soften the cocoons so that they will not hold the wax.



Beeswax, in foreground, ready for foundation production and in the background mainly for overseas export for pharmaceutical purposes.

2. Have convenient handles on the tins on the fire so that they can be lifted off readily.
3. Do not allow the wax to boil over.
4. Have an extra tin of water on hand to douse the fire if necessary (Although there should be no trouble if care is taken.)

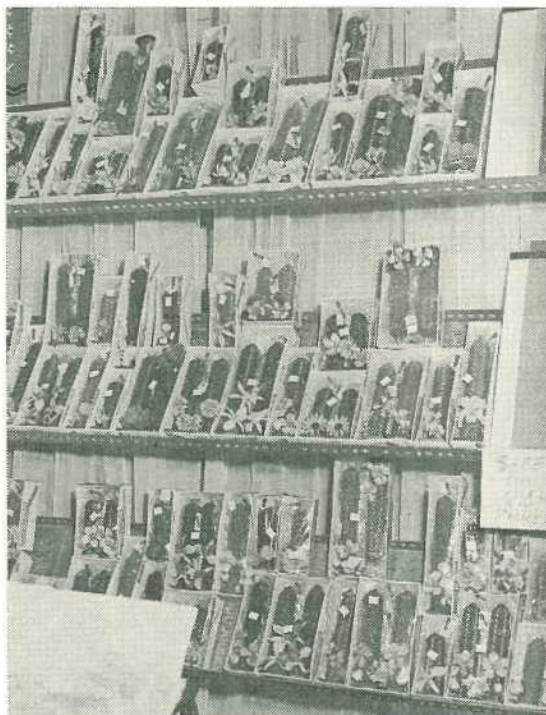
Refining beeswax

The blocks of wax for the refining process come from the cappings reducer, the rough ones resulting from periodical meltings throughout the season, and from the final culling of combs during the late autumn when many supers are removed from the hives. A simple and effective refining method is as follows:—

Secure a good oil drum and thoroughly scour it out, first with a detergent and then with boiling water. Fit it up on bricks so that a fire may be placed under it. About a quarter fill the vessel with soft water, add blocks of wax and melt them slowly and thoroughly, then withdraw the fire and allow the wax to stand, well covered, for half an hour or so for impurities to settle. It is then decanted off from the top into suitable moulds, until the underlying impure matter is reached. The moulds, preferably having flanged sides, should be first smeared inside with glycerine. When they hold the molten wax, the moulds should be placed in warm water to ensure slow cooling. When properly cooled off, the wax is removed from the mould. Any impurities may be scraped off and held over to be remelted with the next batch.

Pollen

Pollen is the reproductive substance of flowers, it is transferred from the male to the female portion of the flower, or from the male flower to the female flower to reproduce the species. Nature has provided various methods for this transfer. Amongst these are flying insects, of which honey bees are the most important. Pollen is highly nitrogenous and contains vitamins necessary for the development of bee brood. Nature is always prolific, and



Decorative beeswax candles made from "Do-it-yourself" kits.

provides more than is needed for reproductive purposes. Bees as they visit flower after flower, carry the pollen from the anthers and fertilize the style. In doing this they take a toll for their service, and carry some of the surplus pollen away to their hives to make food for their young larvae. When breeding is taking place, the nurse bees convert honey and pollen into chyle food, which is deposited in the larval cells. Pollen is generally yellow or orange in colour, but it may be other colours, such as white, green or blue, according to the source from which it is obtained.

Pollen may be collected by the worker bee upon its mouth-parts, upon the brushes of its legs, and upon the hairy surface of its body. When the bee collects from small flowers, or when the supply is not abundant, the mouth-parts are chiefly used for gathering it. The specialised brushes on the legs are



A steam wax melter and press.

used to remove the pollen grains from the body and transport it to the pollen baskets on the hind legs.

The pollen grains are slightly moistened with nectar to make them cohesive, and after the load has been carried to the hive it is deposited by the bee within one of the cells of the comb. It is then packed in the cell by some other worker, whose duty it is to flatten out the rounded masses with its head and add more fluid to them.

Propolis

Propolis is known to every beekeeper under its commercial name of bee glue. It is generally supposed to be collected by bees from the waxy bud scales and other parts (bark)

of various trees. Bees have been known to collect resinous substitute materials such as plastic paint and caulking compound. In any case, the bees bring it in from the field in much the same manner as pollen. Nevertheless propolis gatherers seem to be a restricted but constant few in the colony. Their uses for it are many; with it the frames are cemented in place, the covers and bottom boards are glued fast and cracks are stopped against cold draughts and robber bees. During inspections mounds of propolis may occasionally be seen on the floor of hives, and examination often shows a dried mouse under each mound. The mice had evidently crept into the hives and had been stung to death by bees, but finding that the bodies were too heavy to drag out, the bees had sealed them to the floor of the hive with a thick coating of propolis. Because propolis gives off a very pleasant odour while burning, it sometimes serves as a sort of incense, especially for church rites. The Chinese Joss houses established during the

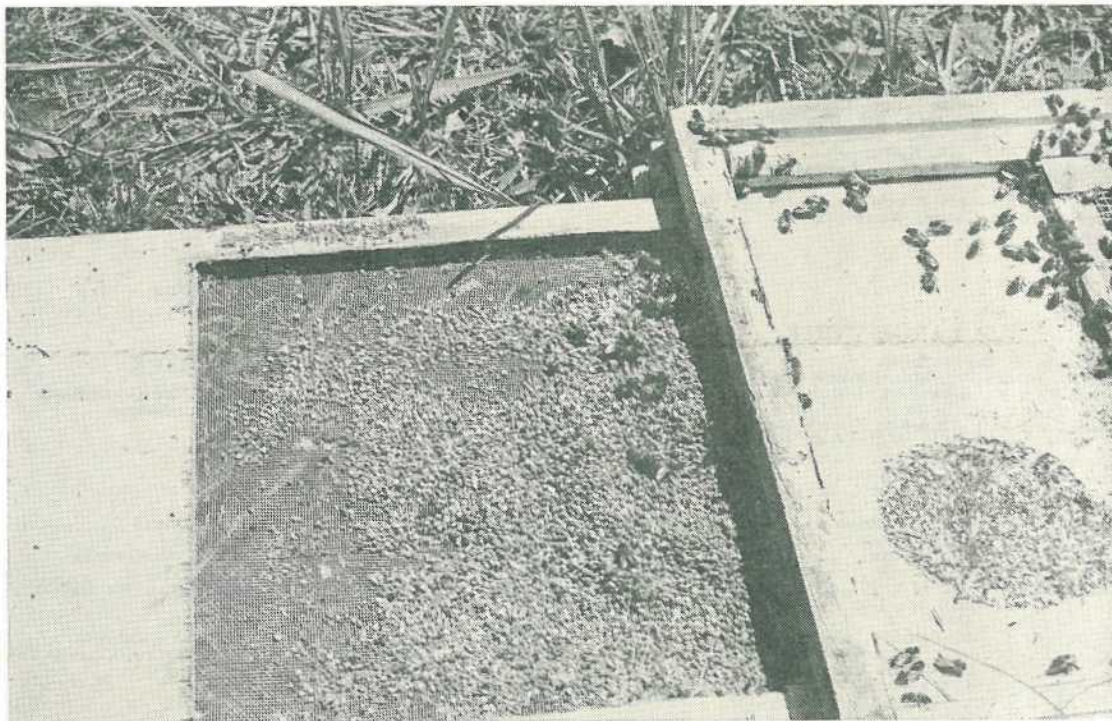


A steam wax melter for handling old becombs inside the gauze cylinder.

early history of the State were reported to have burnt propolis as incense.

Propolis was the principle component of the varnish used on Stradivarius and some other famous Cremonan violins.

At present propolis is achieving some commercial value in Europe for pharmaceutical purposes. In Australia research into this area would be needed as irresponsible promotion could be harmful.



Pollen being collected from the legs of worker honey-bees.



Brucellosis-Tested Swine Herds (As at 21 February, 1975)

BERKSHIRE

Clarke, E. J. & Son, "Kaloon Stud", Boonah
 Cochrane, S., "Stanroy", Felton
 Crawley, R. H., Rockthorpe, Linthorpe
 H. M. State Farm, Numinbah
 H. M. State Farm, Palen Creek
 Handley, Est. J. L., "Meadow Vale", Lockyer
 Handley, G. R., "Locklyn" Stud, Lockyer
 Kimber, E. R., Tarella, M.S. 805, Mundubbera
 Ludwig, A. L., "Beau View" Stud, Cryna, via Beaudesert
 Neuendorf, W., M.S. 794, Kalbar
 Queensland Agricultural College, Lawes
 Research Station, Hermitage
 Rosenblatt, G., Rosevilla Biloela
 Westbrook Training Centre, Westbrook

LARGE WHITE

Ballon, E. E. & E. Maclagan
 Barrier Reef Islands Pty. Ltd., Hayman Island
 Batterham, P. & N., Raby Park, Inglewood
 Beutel, G. R. and Son, Brookdale Stud, M.S. 786, Boonah
 Bool, A. R. and B. E., Rossvale, Crow's Nest
 Briskey, R. G. and M. J., Wallingford, Pittsworth
 Brosnan, D. J., "Bettafield", Mt. Murchison, via Biloela
 Cauley, J. R., M.S. 918, Toowoomba
 Cauley, T. P., M.S. Jondaryan 444, Rosalie
 Clegg, J. A. & M. A., "Karoma" Stud, Mundubbera
 Coleman, C. J., Merriland Stud, Britannia Station, Charters Towers
 Corney, F. D. and E. C. W., Pagel, Tara
 Cotter, N. J., "Olaroy", Goomeri
 Craig, K. F., "Echoes", Bancroft, via Monto
 Crawford, B. P. & B. J., M.S. 757, Kingaroy
 Department of Aboriginal and Island Affairs, Cherbourg
 Diète, E., Ingoldsby, 4343
 Duckett, R. and L. M., Fairview, Capella
 Duncan, C. P., "Colley", Flagstone Creek, Helidon
 Duncan, J. A. & B. L., Ma Ma Creek
 Dunlop Meats Pty. Ltd., Coondulla, Robertson Pk., Murray Upper
 Eagle, D. R. & J. A., "Walurga", 134 Hogg St., Toowoomba
 Fisher, J. & L., Lyndhurst, Jimbour
 Flegler, T. C., Wongabeena, Dalby
 Fletcher, L., "Par-en-eri" Stud, M.S. 806, Mundubbera
 Forster, I. S. & D. E., 112 Drayton Rd., Toowoomba
 Fowler, K. J. & B. D., "Kenstan", M.S. 195, Pittsworth
 Fowler, K. P., Northlea Stud Farm, 156 Hogg St., Wilsonton, T'ba
 Franke, K. H. and B., "Delvue" Stud, Cawdor
 Freeman, W. A., "Treviac", Rosewood
 French, A., "Wilston Park", Pittsworth
 Gosdon, T. C. & E. A., "Naumai", Dalby
 Graham, T., Dunleigh, Highfields
 Grayson, D. G., Wodalla, Killarney
 Harwood, L. B., Cobar, Tara
 H. M. State Farm, Numinbah
 Head, G. A., M.S. 825, Ipswich
 Hinchcliffe, D. F. & R. K., "Oakview", Milman, 4702
 Hockings, J. & M., "Quambi", Kumbarilla
 Hudson, R. F. & V. D., "Rondel", Hogg St., Wilsonton, Toowoomba
 Jones, K. B. & I. R., "Cefn" Stud, Clifton
 Kajewski, C. & D. I., "Glenroy", Glencoe, via Toowoomba
 Kanowski, A., "Exton", Pechey
 Kimber, E. R., "Tarella", M.S. 805, Mundubbera
 Kruger, V. F. & B. L., "Greyhurst", Goombungee
 Kuhl, V. and C. A., "The Mounts", M.S. 222, Oakey
 Le Gros, W., "Elourea Stud", Marburg
 Little, R. S., P. M. & G. W., "Glengarry", Jimbour
 Maranoa Stud Piggery, Mitchell
 Marsden, M., "Fernflat", Canaga
 Mathieson, K. N., "Iderway", Gayndah
 Philip, R. J. and M. M., Boolarong Stud, Elimbah
 Postle, R. S., G. C. & Son, "Yarallaside" Stud, Pittsworth
 Queensland Agricultural College, Lawes
 Quilter, P. E., Paga Paga Piggeries, Postman's Ridge
 Radel, V. V., "Braedella" Stud, Coalston Lakes
 Robin, A. B., Blaxland Rd., Dalby
 Rosenblatt, G., Rosevilla, Biloela

LARGE WHITE—continued

Research Station, Biloela
 Ruge, A. F. & V. M., "Alvir" Stud, Biggenden
 Ruge, G. H. & I. E., "Al-Lester" Stud, Woowoonga, Biggenden
 Sharp, D. W. & L. J., "Arolla", Lavelle, Q., 4357
 Smyth, R., Barambah Rd., Goomeri
 Ward, R. J., "The Plateau", Mulgildie
 Whiteman, J. H. & A. B., Long's Bridge, via Warwick
 Willdo Farming Co., Southbrook
 Willet, L. J., "Wongalea", Irvingdale
 Williamson, K., Cattermul Ave., Kalkie
 Withcott Stud Piggery, Rowbotham St., Toowoomba
 Wolfenden, C. B. & J., Rossmoya

TAMWORTH

Kanowski, S. E., Pinelands, via Crows Nest

WESSEX SADDLEBACK

Douglas, Mrs. W. S. & Son, "Greylight" Stud Goombungee
 Smith, C. R. & Son, "Belton Park", Goombungee

LANDRACE

Ballon, E. E. & E. Maclagan
 Barrier Reef Islands Pty. Ltd., Hayman Island
 Batterham, P. & N., Raby Park, Inglewood
 Bertolotti, F. E. J. & N. I., "Mascotte", Wallumbilla
 Bool, R. A. and B. E., Rossvale, Crow's Nest
 Brosnan, D. J., "Bettafield", Mt. Murchison, via Biloela
 Cauley, J. R., M.S. 918, Toowoomba
 Cauley, T. P., M.S. Jondaryan 444, Rosalie
 Clegg, J. A. & M. A., "Karoma" Stud, Mundubbera
 Coleman, C. J., Merriland Stud, Britannia Station, Charters Towers
 Crawford, B. P. & B. J., M.S. 757, Kingaroy
 Crowe, N. & D., Cooranga North, 4408
 Diète, E., Ingoldsby, 4343
 Duckett, R. and L. M., Fairview, Capella
 Dunlop Meats Pty. Ltd., Coondulla, Robertson Pk., Murray Upper
 Fisher, J. & L., Lyndhurst, Jimbour
 Flegler, T. C., Wongabeena, Dalby
 Fletcher, L., "Par-en-eri" Stud, M.S. 806, Mundubbera
 Forster, I. S. & D. E., 112 Drayton Rd., Toowoomba
 Fowler, K. J. & B. D., "Kenstan", M.S. 195, Pittsworth
 Fowler, K. P., "Northlea", 156 Hogg St., Wilsonton, Toowoomba
 Fowler, N. E. P. & M. F., c/- Kewpie Enterprises, Kingaroy
 Gosdon, T. C. & E. A., "Naumai", Dalby
 Graham, T., Dunleigh, Highfields, 4352
 Grayson, D. G., "Wodalla", Killarney
 Harwood, L. B., Cobar, Tara
 Hinchcliffe, D. F. & R. K., "Oakview", Milman, via Rockhampton
 Hockings, J. & M., "Quambi", Kumbarilla
 Hudson, R. F. & V. D., "Rondel", Hogg St., Wilsonton, Toowoomba
 Jones, K. B. & I. R., "Cefn" Stud, Clifton
 Kajewski, C. & D. I., "Glenroy", Glencoe, via Toowoomba
 Little, R. S., P. M. & G. W., "Glengarry", Jimbour
 Maranoa Stud Piggery, Mitchell
 Marsden, M., "Fernflat", Canaga
 Marsh Pastoral Co., Brymaroo
 Nielsen, L. R., "Sunny Hill", Ascot, via Greenmount
 Peters, L. A., "Moonlight", Bongeon
 Philip, R. J. and M. M., Boolarong Stud, Elimbah
 Quilter, P. E., Paga Paga Piggeries, Postman's Ridge
 Radel, R. M., Turua Stud, Biggenden
 Robin, A. B., Blaxland Rd., Dalby
 Rosenblatt, G., Rosevilla, Biloela
 Ruge, A. F. & V. M., "Alvir", Biggenden
 Sharp, D. W. & L. J., "Arolla", Lavelle, Q., 4357
 Trout, L. B. and L. J., "Caminda", Crawford, Kingaroy
 Whiteman, J. H. & A. B., Long's Bridge, via Warwick
 Willdo Farming Co., Southbrook
 Willet, L. J., "Wongalea", Irvingdale
 Williamson, K., Cattermul Ave., Kalkie

Part 5

Guide to soils and plant nutrition

by N. G. CASSIDY.

In this section—

Plant nutrients.

Water—The vehicle of nutrition.

The uptake and translocation of nutrients.

Mobile ions in the plant system.

Cation exchange capacity of roots.

STRICTLY speaking the term "plant foods" would have to include the elements carbon, hydrogen, oxygen and their compounds because these make up the great bulk (85%) of the dry matter produced by a plant.

They are derived from carbon dioxide obtained by diffusion of air through the leaf pores (stomata), and water obtained from the soil by way of the transpiration stream.

The mineral components of plantfoods may then be termed "nutrients". These are derived from the soil. They consist of two groups:—

1. *Major elements.* These are the ones needed in larger quantity e.g. 50–300 kg per hectare.

Nitrogen
Phosphorus
Potassium
Sodium
Sulphur
Calcium
Magnesium

Sodium is most necessary in certain species (Beet e.g.) in which it can substitute partly for potassium.

2. *Minor or trace elements.* These are required in minor or smaller quantity, but are definitely as essential as the major elements.

Iron
Manganese
Zinc
Copper
Boron
Molybdenum
(Chlorine)
(Cobalt)

Chloride has been shown to be necessary only to the extent of 250 parts per million: it is seldom deficient under natural conditions.

Cobalt is more directly necessary to animals than it is to plants.

The order of magnitude for an application of boron may be only 15–30 kg per hectare: and for molybdenum it may be as little as 0.15–0.50 kg per hectare.

To put the matter of quantities in perspective, the following recommendation is for fertilizer treatment to establish a legume pasture on pure sand ("Wallum") in south-east Queensland:

Superphosphate	.. ..	680 kg/ha
Potassium chloride	.. ..	140 kg/ha
Limestone	.. ..	680 kg/ha
Copper sulphate	.. ..	8.5 kg/ha
Zinc sulphate	.. ..	8.5 kg/ha
Sodium Molybdate	.. ..	0.25 kg/ha

Some of the trace elements are needed in such small quantities, that it is not surprising to find they can easily be applied in amounts that are toxic. For example there are about ten species of plants that are sensitive to borax dressings of 10 to 30 kg/ha.

Laws of Growth

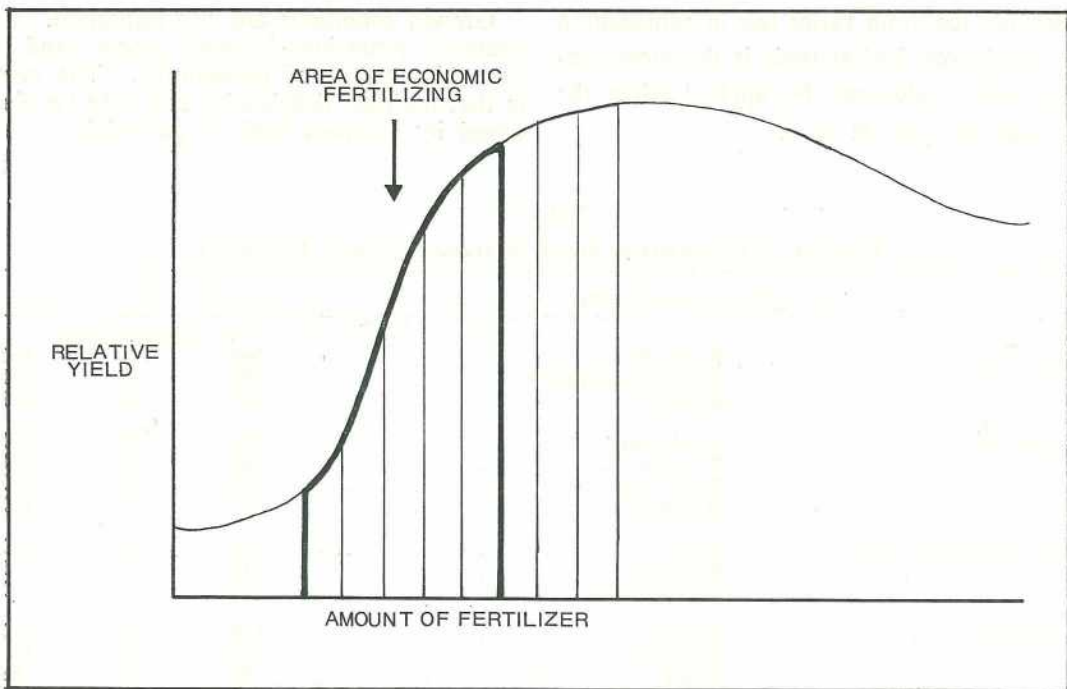
There are two important *Laws of Growth* in plant nutrition.

- Growth and yield are limited by the nutrient that is available in smallest amount. (Liebig's Law of the Minimum).

If this primary deficiency is not remedied, all other fertilizing is likely to be wasted. It may even induce further deficiency and cause a depression of the original poor yield.

- When only one element is in deficient supply the growth curve (yield v fertilizer applied) has an S shape. This is the Law of Diminishing Returns.

If very little of the element is added, the growth is scarcely improved. As more is added the result is much better and the curve goes into a steep rise, (see graph opposite page) before levelling off and slowly falling again. The shaded area represents worthwhile fertilization. Smaller or larger dosages are both wasteful.



Fertilizing is a skilled business, particularly when the nutrient content of the soil is also taken into consideration. Economically speaking, it is possible only to select a fertilizer for a given crop on a given soil, and not for soil or crop alone.

It is worth noting that two soils, classified as belonging to the same soil-type, may be quite different in fertility. Cultivation-history can be all important.

In addition to the direct effects of fertilization there may also be side effects. For example the *relative amounts* of nutrients present may be of great importance. Too high a proportion of nitrogen can cause excessive leaf growth at the expense of yield of grain or fruit.

Again, a high dosage of potassium may cause a deficiency of magnesium. This is an example of an **INDUCED DEFICIENCY**. This effect is always likely to follow an application of fertilizer that was not needed. It means that unskillful use of fertilizer can even reduce yields. The reasoning that "if a little is good, a lot will be much better", may prove expensive in plant nutrition.

Soil Analysis

The need to evaluate the natural fertility of a soil should now be evident. *Soil analysis* is the normal way of attempting this. The use of plant analysis is complementary, because it may show directly what is happening to the growing plant. This provides guidance for supplementary fertilizing, as by foliage sprays.

The balance of nutrients in plant foliage is usually quite different from that in the fruit or seed for which the plant is grown. Thus the potato plant in the vegetative stage has a completely different composition from that in the reproductive stage.

Deficiencies

The composition of plants is important in the *diagnosis of nutrient deficiencies*. To make a diagnostic system valid one must study the distribution of nutrients in various plant parts, as well as the effect of age, species, climate etc. on the concentration of the nutrient concerned.

Because the grain varies less in composition than the leaves, leaf analysis is the more sensitive; and it also can be applied when the crop has not yet set seed.

Growth conditions are also important. For example potassium-deficient plants tend to have high values of phosphorus. The result is that multiple deficiencies can only be diagnosed by complex field or pot trials.

TABLE I
REMOVAL OF NUTRIENTS IN PLANT MATERIAL ACTUALLY HARVESTED

Type of removal, and plant species		N	P	K
kilograms per hectare				
High removal	Rhubarb	260	70	370
	Cabbage, cauliflower	230	35	200
	Beetroot	150	20	230
High potash	Pineapples	110	15	230
	Tobacco	130	20	200
	Sugar cane	85	25	160
	Bananas	65	7	170
Root crops (high to low)	Cassava	60	20	220
	Potatoes	95	15	145
	Sweet potatoes	70	10	90
Miscellaneous	Maize	128	20	100
	Coconut	75	15	100
	Grape	80	15	75
	Cotton	85	15	65
	Peanuts	90	10	45
	Pome and stone fruits	75	10	55
	Flax, Linseed	60	20	60
Low removals	Cereals	65	10	50
	Rubber	25	5	20
	Tea, coffee, cocoa	40	5	20
MEAN	Twenty crops	100	20	120

Equivalent fertilizer per harvest	}	Urea 240	Super 200	Potash 250
950 kg/ha of 11 : 2 : 14 Mixture	}	or S/Amm. 500		

For the benefit of chemistry students, if N and P are taken as heptavalent and potassium as monovalent, the ratio in chemical equivalents is:—

$$\text{MEAN} \dots \frac{N}{11} : \frac{P}{1} : \frac{K}{1}$$

The *balance of nutrient elements* is shown to be important because plants will take them up in proportions which are different from those in the nutrient solution. Ten different plant species were presented with a nutrient solution containing 25% of each of the cations, Ca, Mg, Na, K. None of the plants contained the four cations in equal proportions. In all cases K was *selectively absorbed* and

Na was even more selectively excluded. The mean proportional values for all species was:—

	Ca	Mg	Na	K
	As % of total cations			
Ratio in nutrient solution	25	25	25	25
Ratio found in plants	19	21	7	53
	In another case of the same kind:—			
Ratio in nutrient solution	15	15	..	70
Ratio found in plants	8	10	..	82

In the first case the proportion of K for corn and oats was 70%; and the proportion of Na for saltbush reached 20%.

Nutrients removed

The amounts of *nutrients removed* from the land in an average crop varies widely with the crop, but the mean value for a number of species is as follows:—

	N	P	K	
Mean of several species	100	20	120	kg/hectare

This is equivalent to a fertilizer consisting of:—

N	..	..	500 kg Ammonium sulphate
P	..	..	200 kg Superphosphate
K	..	..	250 kg Potash
Total	..	..	950 kg/ha

The figures give the amounts of nutrient contained in the actual material harvested. It is understandable that a sugar-cane crop weighing 90 000 kg will contain more nutrients than a rubber crop of 400 kg latex. Nevertheless there are also differences in the relative amounts of the individual elements N, P and K removed by different crops. This is shown in Table 1.

The economic value of the plant nutrients in soil is shown by the following assessments of the cost of establishing pasture on two very different kinds of country.

COST OF ESTABLISHMENT

		PER HECTARE	
Wallum (pure sand; heath vegetation)	\$125	(70% = cost of fertilizer)	of
Brigalow (heavy soil; leguminous trees)	\$50		

TABLE II
GUIDE LINES TO THE VALUE OF PLANTS AS FODDER

(Note that the true feeding values can only be determined by considering their digestibilities in the animals to which they are fed)

Plant	Stage of growth	Crude Protein	Crude Fibre	Calcium	Phosphorus
% of water-free material					
<i>Grasses—</i>					
Native pastures	Very young (1 month)	18.4	28	0.34	0.21
	Young (2 months)	5.9	33	0.38	0.14
Carpet (mat) grass	Before or after wet season ..	6.2	32	0.25	0.13
Paspalum	Short, young	20.6	24	0.29	0.27
	Old and stemmy	4.1	41	0.17	0.06
Kikuyu	Young growth	16.7	31	0.31	0.38
	From old plants	8.8	27	0.30	0.31
Guinea grass (All conditions)	Mean maximum	15.1	36	0.76	0.27
	Mean minimum	7.5	33	0.42	0.14
Bush hay	Autumn (mean)	4.5	35	0.43	0.23
Edible trees	Mean of several (leaves) ..	13.0	..	1.60	0.10
<i>Legumes—</i>					
Lucerne	Young, leafy	29.4	17	1.41	0.44
	Old, mature	18.4	33	2.53	0.30
White clover	Young, leafy	29.9	17	1.12	0.52
	Old growth	18.1	22	1.48	0.23
Centro	Wet season	23.8	..	2.58	0.37
	Dry season	15.8	30	1.03	0.21

General characteristics

Legumes—High in crude protein, calcium and phosphorus. Quality deteriorates slowly.

Grasses—Comparable with legumes only when very young. Quality deteriorates rapidly.

Bush hay—Very low in protein and in phosphorus.

Edible tree (leaves)—Fair crude protein content: very low phosphorus; high calcium. Protein does not decrease during drought.

When a harvested crop removes in its own substance large amounts of nutrient, there is no doubt that replacement must be made by some form of fertilizing, because even a rich soil will eventually suffer when this is not done. The fertile soils of the Darling Downs in Queensland and the extraordinary rich soils of Pitcairn Island (subject to erosion) have both suffered from heedless exploitation in this way.

When a crop removes only a small amount of nutrient in the harvested material, it does not follow that no more need be added to the soil than can be shown to have been removed in this way. Tree crops need to continue their growth, and deciduous ones will also need to replace the large loss in the leaves that are shed annually. Some species may be poor "getters" of plant nutrients because of a meagre root system or some other cause. Only careful experimentation can show what is the replacement need for a particular species in a particular situation.

The guidelines to effective plant-nutrition become clearer when a species exhibits a special need. The banana plant is a case in point. Not only does the fruit remove much potassium, little phosphorus and a moderate amount of nitrogen, but these characteristics apply to the composition of all parts of the banana plant. For healthy growth and high productivity these proportions should ideally apply in the soil, and they should certainly be maintained in the fertilizer used. It has been found that when good banana soils are radically reduced in their content of exchangeable potassium, grasses become much more competitive, and yields of fruit are seriously reduced. Bananas need a fertilizer ratio of the kind:—

N:P:K:—10:1:25

Fodder

Some indication of the *value of plants as fodder* is given in Table II. Here the nitrogen content is converted to crude protein by multiplying by a factor of 6.25.

The table may be misleading if digestibility of protein is ignored. In general, digestibility is proportional to the amount of crude protein present, but there may be exceptions. Moreover, total digestible nutrients (or energy value) can only be calculated if carbohydrates

and fat are also known. The real value of the table lies in its discrimination between different kinds of fodders, and in its demonstration of change in feeding-value with age.

It is important to note that the low digestibility of poor roughages such as bush hay may be transformed by the inclusion in the total diet of a good high-protein concentrate. For dairy cows in calf a ration with about 10% C.P., 0.15% P and 0.15% Ca is desirable, with a higher level for heifers. The standards can be lower for beef cattle.

Soil Fertility

The *maintenance of soil fertility* has concerned soil scientists for many decades. Soil resources can be exhausted by erosion, which is a physical process, and by depletion of plant nutrients, a bio-chemical process. In either case, it effects the *available nutrients* present in the soil. These are the elements that would be accessible to plants during the lifetime of a crop. For the three major elements:—

Nitrogen is measured by water-soluble nitrogen though total nitrogen is acceptable, especially for the long-term view.

Phosphorus is assessed as "available phosphorus" by standard dilute acid extraction techniques.

Potassium is assessed from the exchangeable potassium. This is found by replacement from the soil, using an ammonium salt solution.

The results of land usage in Fiji for food gardens and for a commercial pineapple-canning industry gave the following:—

	Total N	Available P	Available K
	%	ppm	me. %
Food-gardens (Wet Zone)—			
Virgin soil	0.093	13.6	0.22
Cultivated	0.093	19.6	0.33*
Reverting to jungle	0.079	17.0	0.25
Pineapple plantation (Dry Zone)—			
Virgin soil	0.068	9.8	0.64
Cultivation 1	0.054	10.7	0.22†
Cultivation 2	0.057	12.3	0.28†

* Only the difference in K is significant.
 † As above. During the War period K fertilizer—Nil. N—150 kg/ha per crop. P—50 kg/ha per crop.

There was no significant loss of N or P, either in Fijian food-gardens or in the commercial pineapple plantation.

The cultivation of food gardens actually

increased available K in the soil, but commercial exploitation under pineapples (in a period when potash fertilizer was not available) produced a very serious reduction in potassium.

Water—The Vehicle of Nutrition

PLANTS cannot live without water, because it makes up most of the weight of the various plant parts. The table below shows what proportion of the fresh plant material consists of water. The papaw represents succulent plant-forms and citrus the more woody types.

In addition, water is the vehicle by which nutrients are brought to the plant and distributed throughout its members. TRANSPIRATION is the process by means of which this is done. It takes from 300 to 800 units of water to pass through a plant to produce one unit of dry weight.

Lucerne—800. Rice—600. Sorghum—360.

THE PROPORTION OF WATER IN LIVING PLANTS

Papaw (succulent-type) (% by weight)					Citrus (woody-type) (% by weight)				
FRUIT	..	..	..	90	..	..	..	..	78
LEAF	Immature	..	..	89	Very immature	..	..	75	
	First Mature (lamina)	..	..	85	Immature	..	..	60	
	(petiole)	..	..	92	First mature (whole)	..	..	56	
	Sixth mature (lamina)	..	..	82	Old leaf (whole)	..	..	53	
	(petiole)	..	..	90					
STEM	Upper	..(bark)	..	82	Limbs (up to 12 mm)	..	..	47	
		(pith)	..	92	(12-60 mm)	..	..	40	
	Lower	..(bark)	..	81	Trunk (whole)	..	..	42	
		(pith)	..	91					
ROOTS Large	..	..	..	86	Fibrous (small)	..	..	64	
					Large	..	..	32	

Water Movement

In normal circumstances, when the soil is sufficiently moist, water will move in a continuous manner within the conducting channels (the xylem) from the root tips to the topmost leaves. Evaporation of the water from pores in the leaves (STOMATA) keeps the movement going, regardless of how high above ground level the top leaves may be. The very strong force of adhesion which holds

liquid water particles together, prevents this column of water from breaking at any time.

Leaves may transpire as much as 10 times their own weight of water per day. Transpiration from top leaves in sunlight may be twice as much as from leaves in the shade. Even leaves on the same shoot may show this difference. It follows that young leaves, growing tips and young fruit have priority in the transpiration stream. For this reason older leaves may wilt before younger ones.

Distribution

Plant nutrients derived from the soil are distributed to all parts of the plant in this manner; although other means are used to distribute sugars etc, manufactured by the action of sunlight in the plant leaves. (*Photosynthesis*).

There is thus an upward movement of water through the dead, woody cells of the xylem, whilst the living cells (sieve tubes) of the phloem carry plant foods in an opposite direction to the deepest roots. Vascular bundles containing both xylem and phloem, pass from each major tree-root to the major limbs directly above. This can provide a striking illustration of the function of water. If a solution of nitrogen fertilizer is supplied to a major root in the eastern segment of the root system, greening will take place in the eastern segment. Similarly if a salt solution is supplied only to the western segment, salt-injury will appear first in the western segment of the canopy.

PHOTOSYNTHESIS has been mentioned above. This is the primary mechanism by means of which plants convert the energy supplied by sunlight into plant growth. The materials are carbon dioxide gas absorbed through leaf pores (stomata) and water taken in by the plant roots. Simple sugars and then other carbohydrates are formed in the leaves.

The green colouring matter chlorophyll is essential for the process. Oxygen is released as a by-product. With the aid of nitrogen (nitrate) the product of photosynthesis can then be converted by the plant to proteins.

The Uptake and Translocation of Nutrients

IN this section it is intended to note the principal facts, rather than to examine fundamental causes.

The rate of uptake of nutrients, and the relative amounts concerned, depends on the plant species (even the variety) and in the case of grafted trees, upon the rootstock.

Sometimes there are apparent reasons for this. One species may have a large and aggressive root system, whilst another may have a very insignificant one. This applies to

Excess water

The question of excess of water in the soil has already been dealt with from the point of view of high water-tables and lack of oxygen in the soil. This relates to a fairly permanent situation; but it is also possible for plants to suffer injury from *temporary inundations* of the soil surface.

The effect of such inundations depends considerably on the stage of development of the crop. Wheat in Queensland showed no serious mortality after flooding to depths of 30 cm for periods up to nine days. If flooding occurred after the late vegetative growth stage, an increase in yield resulted. Barley reacted similarly.

When linseed was inundated in the mid-vegetative growth period, up to 90% mortality of plants occurred.

Pasture plants become less tolerant of flooding if it occurs shortly after cutting.

Water deficiency

In Australia, particularly in the 200–500 mm rainfall zone, *water* is most often the *primary deficiency* amongst all the factors which influence plant growth. In this semi-arid zone total water-deficiency in permanent pastures (drought) occurs almost every seventh year. In these circumstances the large body of knowledge concerning plant nutrition cannot begin to be applied, unless and until some means can be found for the mitigation of drought in these vast, dry pastoral areas.

Kikuyu grass and white clover respectively; but it is modified by the fact that the grass makes its best growth in the summer, and the clover is at its best in the winter and spring. Again, the common Privet hedge is far more aggressive than ordinary garden plants. Part of the success of aggressive plants lies in the fact, that having attained dominance, they exclude sunlight from their competitors.

Leaving now the question of competition, there are certain principles that apply to individual plants. They concern the interaction

of nutrients, and also their distribution within the plant.

Nitrogen, phosphorus and potassium are found to be higher in the young leaves, whereas calcium, magnesium are higher in the older leaves. This is allied to the fact that some elements move into the young leaves from the old ones, as the latter become senescent; other elements simply remain where they are, and therefore, accumulate in the older tissue. This mobility in action, is known as **TRANSLOCATION**.

Elements that are mobile *Elements that are not mobile*

Nitrogen	Sulphur
Potassium	Calcium
Magnesium	Manganese
(Phosphorus)	Copper
Chlorine	Boron

The symptoms of deficiency, for nitrogen, phosphorus, potassium and magnesium are therefore to be observed mainly in the older leaves, because the younger leaves have become reinforced in these elements by the normal process of translocation.

The use of chemical analysis to measure *the nutritional status of plants* must take cognisance of the fact of translocation of nutrients. This is done by standardizing the time of sampling. The kind of tissue that is used, can also be important. A part of the plant that changes readily in its composition will be a more sensitive indicator than one that does not change readily. For this reason leaves are better indicators than grain.

In absolute terms, nutrient content seems to be characteristic of genetical make-up and not indicative of potential yield. This means that criteria of sufficiency must relate to the particular plant species and even the variety. In all, care must be taken to select the right kind of plant material, at a fixed stage of its development. Table II illustrates the amount of change that takes place with age.

An important phenomenon in the study of plant nutrition is known as **GROWTH DILUTION**. This refers to the fact that during the grand growth-period, a plant tends to

produce dry matter faster than it absorbs nutrient elements. The result is that at the fully mature stage the concentrations of these elements may be less than they were in the young seedling. An extreme case arises when the untreated plants in an experiment make no growth at all because one of the major elements is almost completely lacking. The control plants are then runts; yet the percentage of N or P etc. may be higher in these runts than in any of the well-grown plants.

Nevertheless this does not remove the validity of comparisons between treatments in which a reasonable amount of growth has taken place. Here, significant differences may exist between the plant-weights, and between nutrient contents. It may then become possible to establish a **THRESHOLD VALUE**, or critical percentage of an element, below which a good increase in yield can be expected from applied fertilizer.

When gross deficiency exists, an addition of the deficient element may produce a good increase in yield but no increase in the percentage of the element in the plant tissues. The latter increase may depend on a more massive addition of the deficient element.

The rate of uptake of one element can be strongly influenced by other elements. An ion that has a high diffusion velocity tends to accelerate ions carrying the opposite charge, and to slow down ions having the same charge. Thus, potassium tends to prevent the uptake of the cations calcium and magnesium, but to assist the uptake of the anions nitrate and phosphate. The competitive aspect as between potassium and calcium (or magnesium) is known as an **ANTAGONISM**. In a similar way nitrate can depress the uptake of phosphate.

The total cation uptake remains constant when anion uptake is constant. An increase in the anions causes an increase in cations.

It is normal for the uptake of inorganic cations to exceed the uptake of inorganic anions. This is so because the balance is restored by organic anions (malate, citrate, tartrate) manufactured in the plant.

A fast cation e.g. K is accelerated in solution with a slower cation, or with a fast anion.

In general monovalent cations are taken up faster than cations of higher valence e.g. $K > Ca$, Mg , and monovalent anions are taken up faster than divalent anions, $Cl > SO_4$. There appears also to be a Power of Exclusion: e.g. Na may be excluded by K (except in halophytes).

Field conditions affect the uptake of nutrients by plants. Moisture, aeration and temperature are the factors mainly concerned.

Poor conditions for plant growth are, not surprisingly, poor for the uptake of nutrients. For example phosphorus, potassium and boron show poor uptake under very dry conditions, and under wet but undrained conditions.

At least for some species, uptake may be greater at 25°C than at 45°C. This is the same as saying that plants should be grown under the most suitable temperature regime.

In short, the greatest uptake of nutrients and the best growth will be achieved when all the field conditions are at optimum for the particular plant species.

Root Zone

The uptake of nutrients by a plant will clearly depend on the extent of the ROOT ZONE available to the plant. Some control of this can be exercised by planting close or far apart; but the main factor is the depth of arable soil. Utilization of the root zone depends on presence of moisture and on the rooting habit of the plant species.

Under regular irrigation, plants are not compelled to forage for moisture because there is no scarcity of it. Root zones for different species may not therefore show great differences.

Under drier conditions, roots will have to forage for moisture, and here the rooting habit that is characteristic of the particular plant species will be more evident.

(In all cases plant roots will not grow into soil that is below the WILTING POINT.)

It is also true that, for a given species, the root zone tends to be shallower for a heavy soil and deeper for a sandy soil.

Tables III and IIIA are intended to provide guidelines as to the depth of the ROOT ZONE under conditions of medium-texture soil, and embracing 80-90% of the root system.

TABLE III

Depth (range)	Plant species		
	Field crops	Small crops	Horticulture
30-45 cm ..		Beetroot	Passion fruit, Strawberry
45-60 cm ..	Pasture ..	Bean, Pea, Cucumber, Turnip, carrot	..
60-90 cm ..	Parsnip, Potato, Swede, Sweet potato	Artichoke, Spinach, Watermelon	..
90-120 cm ..	Cotton, Grain sorghum, Safflower, Maize, Wheat, Linseed, Kikuyu and Star grasses	Pumpkin, Tomato	Apricot, Peach, Apple, Pear, Cherry, Plum
600-900 cm ..	Lucerne, Bulrush Millet	Asparagus	..

The depth of the root zone will depend on the particular plant species, provided the soil offers no special resistance or assistance to root-penetration.

The depth of wetting of heavy clay soils is restricted by low infiltration rate. Even good rain such as 20 cm in a period of several days does not penetrate beyond 75 cm. This shows how difficult it can be to get the full growth potential of soils in semi-arid regions.

TABLE IIIA
GUIDE LINES TO THE DEPTH OF THE ROOT ZONE

Depth	Derived from depth of water-extraction under rainfall	Derived from crops under irrigation	
30 cm	.. .. .	Onion, raddish .. .. .	..
45 cm	Lettuce	Beet, lettuce, passion-fruit, strawberry	..
50 cm	.. .. .	..	Pasture
55 cm	Sweet corn, winter wheat	..	..
60 cm	.. .. .	Beans, carrot, cucumber, turnip, banana	..
75 cm	.. .. .	Potato, parsnip, sweet potato, water-melon	..
90 cm	.. .. .	..	Oats, cotton, soybean
95 cm	.. .. .	..	Barley, canary grass
105 cm	.. .. .	Pumpkin, citrus, pome and stone-fruits, tomato	Linseed, safflower, sorghum (grain), maize, wheat
110 cm	.. .. .	..	Lucerne
180 cm	Asparagus, Sudan grass	..	..
225 cm	Apricot, almond .. .. .	..	..
240 cm	Tomato .. .. .	..	..
380 cm	Walnut, lucerne .. .. .	..	..

Extreme rooting depths

Kikuyu and Star grass	.. .. .	6 metres
Phalaris tuberosa and Bulrush millet	.. .. .	9 metres
Lucerne	.. .. .	12 metres

Foliage Sprays

Although plants normally take in their nutrient elements through the roots, their leaves are also capable of *absorbing nutrients from foliage sprays*.

This method of "feeding" plants through the leaves is often adopted for minor elements, because only a small dosage is required and the treatment is a very direct one.

In the case of one major element—nitrogen—it is sometimes a commercial practice to spray trees with a solution such as urea. This compound can be absorbed into bananas, pineapples and other plants within a period of several hours. Absorption continues after the leaves have dried.

Sprays should contain 1% of urea or less, and there should be a low content of the impurity biuret.

Chloride

An opposite situation exists in the deleterious absorption of chloride ions from spray irrigation. Citrus trees are sensitive to about

60 ppm. Cl in the irrigation water, and tobacco leaf-quality is sensitive to about half this concentration. For citrus, the sprays should be set underneath the tree canopy, and they should not be used during the heat of the day.

Boron may be toxic in the same manner. Horticultural crops under furrow irrigation should not be subjected continuously to *water containing more than 0.5 ppm. B.*

Foliar sprays are absorbed, not through the STOMATA but through the CUTICLE of the leaf, in the vicinity of the guard cells. The high SURFACE TENSION of water prevents direct entry through the pores, which are usually under 20 microns wide.

Conditions are different for atmospheric colloids, especially in a maritime environment. Here the AEROSOL consists of salt particles within the size range 0.1–10 microns, freely suspended in the air. This *Cyclic Salt* can kill rice plants which bear leaf-hopper punctures, or shorten the life of trees (coconut, pines) before finally returning to the ocean in the natural rainfall.

Mobile Ions in the Plant System

SOME of the nutrient elements taken up by plants become incorporated into the permanent structure of the plant. They are therefore no longer wholly water-soluble, or mobile. This is very well illustrated by phosphorus which is partly metabolized into protein.

Other elements show a degree of water-solubility which is characteristic of the particular element. Values obtained from citrus leaves are as follows:—

Constituent	% extractable by water
Chloride	100
Potassium	95
Magnesium	93
Sodium	75
Sulphate	77
Calcium	62

Sulphur like phosphorus is also fixed as protein. Calcium is precipitated as pectate in cell walls and also as salts of organic acids e.g., malic, oxalic, citric, tartaric.

On the other hand chloride and potassium are completely water-soluble. (Magnesium is withheld to some degree in pectin and in chlorophyll, the green colouring matter of plants.)

The "fixed" elements in plants can quite rationally be reported on the basis of the total dry substance in the plant. This method is completely illogical for a water-soluble element because the "dry substance" contains none of the element. The only rational way is to report chloride and potassium as percentage in the sap or as milliequivalents per litre of sap. For practical purposes the moisture content may be used as a measure of the "sap" present.

This system rationally reports the amount of Cl or K present in plant tissue and also allows one plant part to be compared with any other. The use of % dry weight as a basis merely produces a nonsense result that depends on the ratio water/dry substance in the plant. See Table following.

The rational method shows that potassium and chloride are fairly uniformly distributed

and are certainly not concentrated in the plant parts that happen to have very little dry substance. The data refers to the banana plant.

POTASSIUM AS % DRY WEIGHT, REFLECTS ONLY THE RATIO OF WATER TO DRY SUBSTANCE

Plant part	Water Dry substance	Potassium (% dry wt.)	Potassium (% sap.)
Leaves ..	1.4	2.9	2.1
Roots (small)	4.7	2.1	0.44
Fruit ..	4.9	3.6	0.73
Roots (large)	5.1	4.1	0.80
Leaf stem ..	5.7	4.2	0.74
Flower ..	8.5	7.9	0.97
Pseudo stem	9.4	8.2	0.76
Fruit stem ..	17.9	14.3	0.80

It will be seen that Potassium (% dry weight) increases as the ratio of water to dry substance increases, and not according to any rational arrangement of the plant parts sampled. Yet on a % sap basis, Fruit and Fruit stem become the same, and they agree with all other plant parts except leaves and small roots. It is quite reasonable that the leaves, as the centre of metabolic activity, should contain significantly more potassium than the rest of the plant.

Moisture Content

Plant leaves and other plant parts tend to have a steady *moisture-content* which is characteristic of the particular part and plant species. Deficiencies may develop temporarily in the heat of the day, but leaf fluctuations do not usually exceed 3% of the normal value. This applies to leaves which are all the same age. The "hardening" of young leaves as they grow older can be deduced from the table on page 495. It shows a general decrease in moisture as the leaves mature. For mobile ions, the content of the element concerned must be related to the actual moisture content. A list of "characteristic" moisture contents must therefore take into account the plant species, the plant part and the age at time of sampling.

When drought occurs, transpiration is drastically reduced, yet the leaves also undergo a *chronic deficiency of water*. The moisture content may fall to about 70% of the expected

value after allowing for the normal decrease in moisture due to aging. If this loss of moisture is exceeded the leaves are likely to die.

It will be realised that a big loss of moisture in the plant cells means an increased osmotic pressure. Many experiments set up to measure "water stress" due only to withholding of water, automatically produce an elevated osmotic pressure especially when generous fertilizing has been a part of the treatment. This of itself can give toxic effects which preclude a simple assessment of the results of water stress.

The subject of *excess of salt* has already been discussed, chiefly from the point of view of the soil.

The present discussion will refer mainly to sodium chloride, as it is most often the dominant salt present in the soil.

The salt moves into the transpiration stream, beginning at the roots. Since the ions Na and Cl are not metabolized like nitrogen, phosphorus and sulphur they tend to accumulate at the tips and margins of leaves. However sodium is less mobile than chloride, and much of it does not get far beyond the roots. The leaves are therefore best suited for the *detection of chloride ion* and so of sodium chloride salinity; but sodium (in leaves) is quite unsuitable as such an indicator ion. At best, sodium will show up in the roots and lower parts of the plant.

At equal osmotic pressure the effect on the plant of different salts tends to be about the same. NaCl at an osmotic pressure of 3.5 atmospheres in the soil solution (or 0.25% Cl in plant sap) is damaging to most crops. An osmotic pressure of 5 atmospheres generally prevents germination and growth.

The effects of salinity may be:—

1. Slow and decreased germination.
2. Physiological drought (wilting).
3. Stunted growth: small leaves and short stems.
4. Bluish-green leaf colour.
5. Retarded flowering: fewer flowers, sterility, smaller seeds.
6. A patchy crop (because soil salinity is patchy).

The leaves can be expected to develop tip and marginal burning. This is the most common symptom, and the most useful.

The effect of salinity is accentuated by high temperature because this promotes a higher transpiration rate. Older leaves are affected first, because accumulation of chloride has been going on longer in them. Very low temperatures tend to conceal the presence of soil salinity.

When the surface of a living, healthy leaf remains intact, water will not penetrate it and the contents of the leaf cells remain secure. If the cells are ruptured for any reason, either by abrasion, insect damage or disease, or by death from senescence, the cell contents can be extracted from the damaged cells with water.

In a large tree there are always some leaves undergoing senescence and therefore liable to be affected by water in this way. This can be shown by comparing analyses of rain water collected from beneath the "drip" of a tree and rain water collected out in the open.

It is found that rain from the drip of a tree contains much more sodium, potassium, and magnesium as well as more calcium and phosphate than rain that falls in the open. The nutrients removed in this way may even be comparable with those that reach the soil in normal leaf-fall.

Chloride is also very much concerned in this process. When plant leaves suffer marginal burn as a result of chloride salinity the burnt areas can be expected to contain more Cl than adjacent green areas. A paradox occurs if much rain has fallen on the leaves. The dead cells then lose much of their chloride content and the adjacent green areas are found to contain more chloride than the dead areas.

Pairs of samples were taken from affected banana leaves.

ILLUSTRATING A PARADOX WITH SALT DAMAGE
Chloride in Banana Leaves (% sap)

Sample pairs	Green tissue	Adjacent dead tissue
1	0.25	0.13
2	0.17	0.10
3	0.24	0.11

Cation Exchange Capacity of Roots

THE ability of soil minerals to take up and hold cations has already been mentioned. All plant tissues possess this CATION EXCHANGE CAPACITY. The roots are particularly concerned when plant nutrition is being considered, because cations can be transferred from soil to plant by this means.

The exchange reaction is not dependent on METABOLISM because dead roots possess the same property. High cation exchange capacity indicates an ability to absorb and hold divalent ions more strongly than monovalent ions. This applies both to soils and to plant roots.

DICOTS such as legumes have a high C.E.C. and MONOCOTS such as grasses have a low value. For this reason legumes take up calcium (divalent) more readily than grasses, but the situation is reversed for potassium (monovalent ion).

Lucerne and clover have a value of about 40 m.e. per 100 g whereas grasses have a value of about 20 milliequivalents.

Genetical make-up can be a factor. Seven rye-grass hybrids showed high and low values that differed over-all by a factor of 1.5.

The origin of the cation exchange reaction lies in the negative charge present on root surfaces. This attracts cations, because of the positive charge they bear, and tends to repel anions.

A cation that is divalent (two charges) or trivalent (three charges) can neutralise the negative charge on the root surface and so aid the absorption of the associated anion.

For two species S_1 and S_2 the following relationship appears to fit fairly well:

$$\frac{\text{C.E.C. of roots } S_1}{\text{C.E.C. of roots } S_2} = \frac{(\text{Ca in leaves } S_1)^2}{(\text{Ca in leaves } S_2)^2} = \frac{\text{K in leaves } S_2}{\text{K in leaves } S_1}$$

When there is competition for potassium, grasses may suppress legumes. Conversely when potassium fertilizer is applied the advantage held by the grasses may be removed.

For the naturalist

Wild ducks and other water fowl in Queensland

by Dr. H. J. Lavery

Available from the Queensland Department of Primary Industries, William Street, Brisbane

Price: \$1.00—Posted \$1.18

THE FARM FAMILY

with ANN COOK

I HAD a number of inquiries recently from parents about measles vaccination for their pre-school children. They were not certain if measles vaccination was a once only requirement.

A query to the Queensland Health Education Council informed me that a State Government Health Department spokesman said measles vaccination was "supposed to last at least 20 years". However, there was yet no definite medical opinion on the exact period of immunity.

He said measles in Queensland was common in autumn, though some people even could be having it in winter.

Measles is mainly a childhood disease and should not be taken lightly. Although relatively harmless in healthy school children, measles can be serious or even fatal in children up to five years, if secondary infections occur. Pneumonia is the most severe complication, though ear infections are a frequent hazard and occasionally, encephalitis (inflammation of the brain) may develop.

Early measles symptoms are similar to those for a head cold . . . sneezing, red, watery eyes, hoarseness and a harsh, irritating cough.

The eyes are also sensitive to strong light. There is little or no fever at first, but in a day or two, the patient's temperature increases and he develops a furry tongue.

If you suspect measles, look for the skin rash about four days after the "head cold" symptoms. The rash starts behind the ears,

spreads to the face and neck, then to the trunk, arms and legs.

The patient usually feels worse at the height of the rash, which lasts about a week. The two days before the rash appears are usually the most infective stage of the disease, but there is also an infection risk for about four days after the rash.

Measles are spread by discharges from the nose, mouth and eyes. So keep children away from others with colds during a measles epidemic.

Build up your children's resistance to illness with regular, adequate sleep and nutritious meals, and keep them away from crowds during the measles season. If symptoms appear, call a doctor to diagnose and treat the illness. This is especially important if the patient is a baby or a young child.

Children can be immunized against measles and its complications if they are between one and nine years of age. Immunization before 12 months is not recommended by doctors.

Only one vaccination is necessary for long-lasting and complete immunity, giving effective protection within a fortnight after the vaccination.

See your doctor or local authority clinic for advice on common measles immunization.

REALLY SICK?

PARENTS at some time or another have to determine if a school child is really sick when he wants to stay home.

It is not an easy task. If you make the wrong decision and send him to school when he is sick, you could feel guilty. On the other hand you could keep the child home and find that by about ten o'clock he is not sick.

And if Mum has a full-time job, it could mean she too has to take a day off, or inconvenience a neighbour by asking her to look after the child. If the child is really sick, he could feel neglected if Mum were not around.

There are numerous reasons why children feel "school sick", especially school beginners. And it is the parent who has to make the decision because there is no doctor around at that time.

It could be that the youngster has not been doing his home work; or, he was in trouble at school the day before; or, perhaps he just needs an extra dose of Mum's tender loving care.

Sometimes, the youngster just needs reassurance, a pep talk or a lift to school.

Teachers understand beginners' sickness and the child who is likely to play up. It saves worry if parents keep in touch with teachers.

In the early morning rush, a few guidelines can be handy for both children and adults when deciding whether they should be kept home or sent off.

Early detection of sickness can prevent it gaining a hold of the patient. Every home should have a thermometer. A child, or even an adult, with above normal temperature is

better kept at home, even if he is not feeling feverish. He could be sickening for something.

Sneezes and wheezes spread germs so isolate the germ spreader. A persistent cold should be treated by a doctor. Other complaints that need close attention are stomach-ache, coughing or sore throat, ear-ache and rashes.

Cramping pain, diarrhoea or vomiting are good enough reasons for staying home, too.

A number of small virus infections cause sore throat. A child with sore throat, fever and white spots in the throat should see a doctor.

Most tooth-aches are caused by infection and should be checked by a dentist as soon as possible.

A cold is sometimes preceded by ear-ache. A rash on a child could be measles, scarlet fever or just an allergy.

An unexplained rash with fever should be checked by a doctor.

(From The Queensland Health Education Council).

Does a newborn baby see?

PARENTS often are confused about whether their newborn baby can see and when they should worry about their child's eyes. Newborn babies can see, but this is one ability which is not fully developed at birth. Babies are not adults in miniature but are immature developing human beings. Development as well as growth continues for years after birth. It takes 3-6 months for the new baby's eyes to develop enough for them to see things with the same clarity as the adult.

In the new baby it is often seen that the pupil dilates in darkness and constricts in bright light. This is a reflex action and doesn't indicate adult vision. The eyes during those first months of life often move independently. It is usually difficult to see baby's eyes during those first weeks as 20-22 hours a day should be spent sleeping. As more time is spent awake it is easier to see

the eyes and to note whether they work together. If they don't and one appears to be looking in a different direction from the other, the parents should make regular monthly observations and if this is still present at 6 months the advice of an eye specialist should be sought. It has to be remembered that each baby is an individual and develops at an individual rate. No comparison should be made with other children.

Before starting school it is important that children should have their vision tested and that their eyes are checked to exclude squint. Animal vision charts can be used for this purpose. Such testing is one of the services offered by the trained nurses at the baby clinics.

After children start school it is not unusual to find that problems do occur—a squint appears, they work very close to the book, they screw up their eyes to see the board etc. Advice should be sought if any of these problems develop. One of the great tragedies is that if a squint is not discovered and treated (and this treatment may take 18 months or over 2 years) by the age of 8 years permanent loss of vision may result.

Sight is one of our greatest assets and every effort should be made to protect it.

Any further information on this or other matters concerning children may be obtained by personal communication with the Maternal and Child Health Service, 184 St. Paul's Terrace, Brisbane or by addressing letters to P.O. Box 285, Broadway, Brisbane 4000.

And finally, some hints for home dressmakers

- Fill a pin cushion with steel wool to keep needles and pins rust-proof and sharp.
- Before stitching the pocket on to an apron, outline the position with a length of tape on the wrong side of the garment and stitch the pocket to it. This prevents the pocket pulling away at the corners.

- Before sewing cotton material, rinse it in warm water and let it drip dry. This will help prevent shrinkage later.
- When punching eyelet holes in lightweight materials, place a piece of cardboard under the material. The hole is then much neater.
- When making children's dresses, insert a length of fine string in the hemline. When the hem has to be unpicked to let down, you will find the string has prevented any permanent crease mark from repeated pressing.
- When sewing on a patch pocket, especially on children's clothes, pin so there is a slight tuck along the top opening to prevent corners tearing.
- Replace the ordinary machine sewing needle with a ball point needle when sewing nylon, and any fine fabric. There is no puckering, and sewing is just plain sailing.
- Machine a line of fine stitching down the selvages of long net curtains and they will never crinkle at the edges.
- With children's clothing, use press studs instead of buttons. Sew buttons over the press studs for trim. This eliminates button-holes and frayed tempers when dressing in a hurry.
- When hemming a garment you never have to gather or pleat-in extra fullness if all seams are tapered at the hemline. This makes a firm, neat hem that hangs well.
- When sewing coarse material that frays easily, spray the raw edges with hairspray. This prevents them from fraying until you start neatening the seams.
- When sewing, a good substitute for a pin cushion is an ordinary cork table mat. It holds the pins and needles firmly, and at the same time, keeps the points sharp.

Gardening Notes

Growing carrots, beetroot and parsnips in the home garden

by Officers of Horticulture Branch.

THE root crop vegetables, carrots, beetroot and parsnips are relatively easy to grow, yield well, and have similar cultural requirements.

Carrots

Cool conditions are preferred for carrots and the crop can be planted from early autumn to late spring.

Varieties

Growers have several varieties from which to choose.

King Chantenay is a popular variety. The roots are of medium length and have excellent colour.

Topweight produces roots 150 to 200 mm long, and does well under most conditions. The tops are strong and of medium length.

Western Red is another popular variety in home gardens. It has long roots 200 to 250 mm in length which are smooth and tapering to a point.

'Baby' carrot is a baby or finger carrot growing only about 100 mm long and 20 mm thick. It has very little top leaf growth.

Soils and fertilizers

Carrots do well on most garden soil types provided the drainage is good. A soil that sets hard after rain is less suitable than one that is free-textured. Usually the sandy loams produce the better shaped roots.

Carrots grow best in an area which has been enriched with manure or fertilized heavily for a previous crop. Fresh animal manure or raw organic matter should not, however, be added to the soil just before planting as this tends to produce forking and distortion of roots.

Several weeks before sowing, dig the soil as deeply as possible without bringing up any subsoil, and incorporate 50 to 100 g of a complete fertilizer mixture containing approximately 5% nitrogen, 6% phosphorus, and 4% potash (5:6:4 NPK) to each square metre of soil.

A fine seedbed is necessary to ensure a good and even germination of seed.

Planting

The seed should be sown 10 mm deep in rows about 300 mm apart. After planting, the ground is lightly firmed and watered. A thin mulch of well-rotted manure, sawdust or lawn clippings can be placed along the rows to keep the surface soil moist and make it easier for the seedlings to emerge.

Germination usually takes 9 to 14 days. When the seedlings are 50 mm high, they are thinned to a spacing of 50 to 75 mm apart or, alternatively, the home gardener may thin out surplus plants gradually and use the young roots as required.

The bed should be watered before thinning to soften the soil, and again after thinning to refirm the soil around the roots.

Cultivation and watering

Control of weeds in the young carrots is very important, as they can quickly cause crop failure.

Watering should be done regularly to ensure a uniform germination and to maintain growth in the established crop.

Pests and diseases

Aphids can be found on the crown and roots of the carrot. Yellowing of the young leaves may occur and is accompanied by a certain amount of stunting in plant growth if the aphid population is high.

Aphids may be controlled by dimethoate (Rogor (R)) applied as required.

The *brown vegetable weevil* can damage the foliage and roots of carrots. The adult weevil is greyish-brown, 8 mm long and possesses two obliquely-placed greyish-white patches on the back which form a distinct V-shaped mark. The larva is a small pale green slug-like grub.

Spraying with carbaryl is effective against adult populations of this pest.

Two fungi cause leaf spotting or blighting of carrots. The spots are dark-grey or brown in colour, but the yellowing of the surrounding leaf tissue is perhaps more noticeable.

If leaf spots appear, apply a copper oxychloride, mancozeb, maneb, metiram or zineb fungicidal spray.

Root knot nematodes cause rough nobbly galling of the roots. Serious losses to all root crop vegetables grown on infested soil can occur.

The method of treatment is relatively more difficult and the home gardener is advised to ask for a leaflet with detailed instructions.

Beetroot

Beetroot grows best under cool conditions, but it can be grown successfully almost all the year round except during the hot summer months.

Varieties

Early Wonder is a quick maturing variety, producing roots that are smooth skinned and of good colour and texture.

Derwent Globe is a deep round beet and is noted for its good quality and dark colour.

Soils and fertilizers

The soil requirements are essentially the same as for carrots.

Beetroot is sensitive to acid soils, and an application of lime or dolomite to the soil may be necessary before planting.

However, care must be taken not to over-lime, as beetroot is susceptible to a deficiency of boron, a trace element that becomes unavailable when too much lime is applied.

Boron deficiency causes an internal breakdown of the roots and development of multiple crowns.

Beetroot does particularly well after a well-manured crop, but an application of fertilizer is still usually required.

A 5:7:4 NPK mixture is satisfactory on most soils and is broadcast over the bed at 50 to 100 g per square metre a few weeks before planting.

Planting

The seed is planted 12 to 20 mm deep, in rows 30 to 40 cm apart.

Beetroot seed is really a cluster of several seeds surrounded by a tough, corky covering.

When the seedlings are about 50 to 75 mm high they are thinned to a spacing of about 100 mm. Failure to thin results in an excessive number of small and often malformed roots.

Cultivation and Watering

Weeds should be controlled at all times but, as many of the roots of beetroot plants are near the surface, cultivation should be shallow.

Beetroot should be grown quickly for, if they receive a check in growth, the roots become tough and unattractive. Therefore, the soil should not become dry at any time.

Pests and diseases

The *brown vegetable weevil*, a pest of carrots, also attacks beetroot and control measures are the same as for carrots.

It is seldom necessary to undertake specific disease control measures in beetroot. A leaf spot is the commonest disease causing a conspicuous spotting which is easily recognized. The leaf spot can be suppressed by practising crop rotation, 2 to 3 years being allowed to pass in between plantings in the same garden bed.

Parsnips

The parsnip is a cool-weather crop. The crop is planted between March and May on the coast, but early spring planting is preferred on the cooler tablelands.

Varieties

Only one variety, *Hollow Crown*, is grown in Queensland. It has cream-coloured flesh and a fine core with little fibre if harvested at the correct stage of maturity.

Soils and fertilizers

Parsnips grow best in deep sandy loams. The long tender root of the parsnip reacts quickly to any checks in its downward movement and forks badly under adverse soil conditions.

Preparation of the garden bed, cultivation and fertilizer usage follows closely those practised in growing carrots. However, initial preparation of the bed should be more thorough and the soil dug as deeply as possible as the roots go down further than those of carrots.

Planting

The seed is sown rather thickly to a depth of 15 mm in rows 30 to 40 cm apart. Only fresh seed should be used as germination is frequently unsatisfactory in seed that is more than 1 year old.

Seedlings should be thinned to a final spacing of 100 mm between plants.

Harvesting

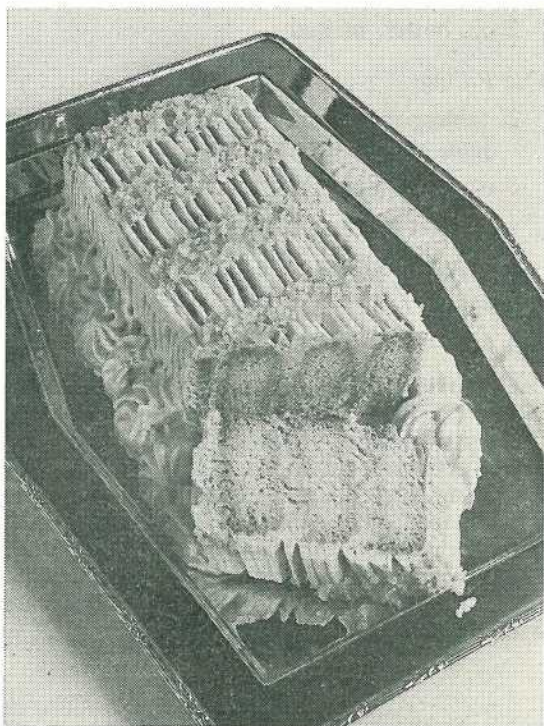
Roots will be ready to lift in about 4 to 5 months after planting, and harvesting can extend over a long period provided the weather is cool.

Pests and diseases

Many of the pests and diseases that attack carrots also affect parsnips, and control measures are the same for the two vegetables.

Take a hint

- If you have tall patio plants that are rather bare at the base, plant parsley seeds around the base to give a decorative look.
- Collect ice-block sticks from the children and use them to identify your pot plants. Neatly print the name of the plant on the stick, and place it in the soil on the pot.
- An old teapot makes an excellent substitute for a watering can when watering pot plants, both indoor and outdoor.



Spicy Biscuit Ripple

Consider the Sweet Biscuit . . .

Salted, seasoned or plain, savoury biscuits with any cheese is a known and appreciated snack yet the range of 'supermarket' sweet biscuits appears limitless, their flavours and textures unestimated as a food ingredient.

Consider crushed wheatmeal baked in a pie crust with a creamy Ricotta custard; hazelnut wafers roughly crushed in meringue layers sandwiched together with a blackcurrant Cottage cheese filling; or whole plain sweet biscuits either dipped in port and orange, joined together with a clove and cinnamon Cream cheese; or as an oven-baked apple and orange crisp with Cheddar and marmalade topping.

Whatever way—don't underestimate the sweet biscuit, it's versatility is clearly seen as a contrast to Australian cheese varieties in these desserts.

In all recipes a standard 250 ml measuring cup and 20 ml tablespoon are used. All measurements are level.

Spicy Biscuit Ripple

- 1, 8 oz. packet Nice biscuits
- $\frac{1}{4}$ cup each port and orange juice
- $1\frac{1}{2}$ tablespoons finely chopped mixed peel

The Spicy Cream Filling

- 4 oz. Australian Cream cheese
- 1 cup cream
- $\frac{1}{4}$ teaspoon ground cloves
- $\frac{1}{4}$ teaspoon ground cinnamon
- 2 tablespoons sugar

Mix port and orange juice together. Cream cheese till smooth. Add remaining filling ingredients. Beat to a whipped cream consistency. Dip biscuits in port and orange mixture then join together with spicy cream. Arrange directly on a flat serving plate to form a log. Repeat till all biscuits are used. Cover surface entirely with remaining spicy cream. Using a fork, run the prongs along surface to form a ridged pattern. Decorate with mixed peel as desired. Refrigerate overnight. Cut into diagonal slices. Serves 8.

Hazelnut Wafer Meringue

The Meringues

- 4 egg whites
- 1 cup castor sugar
- 1, 8 oz. packet hazelnut wafers

Cut two $7\frac{1}{2}$ " circles from greaseproof paper. Place on a large flat baking tray. Break wafers into pieces. Beat egg whites till stiff. Gradually beat in sugar. Fold in wafers. Divide meringue between paper rounds, spreading out to reach edges. Bake in slow oven (250°F) for $1\frac{1}{2}$ hours. Remove, invert onto wire rack and cool. Remove greaseproof paper. Spread filling (see below) over one meringue layer and sandwich carefully together with the other. Serves 6.

The Filling

- Cream together thoroughly:
- 8 oz. Australian continental style Cottage cheese
- 1, 8 oz. carton blackcurrant yoghurt
- 2 tablespoons ground hazelnuts

Apricot 'N Berry Ricotta Tart

The Crumb Crust

- 4 oz. wheatmeal biscuits, crushed
- 1 teaspoon ground cardamom
- 2 oz. butter, melted

The Filling

- 2 tablespoons each raspberry and apricot jam, mixed together
- 8 oz. Australian Ricotta cheese
- $\frac{1}{2}$ cup cream
- $\frac{1}{4}$ cup castor sugar
- 1 egg
- 1 egg yolk

Combine biscuits, cardamom and butter together. Press into 8" pie plate to form a thick shell. Chill. Spread mixed jams over base. Cream Ricotta cheese till smooth. Add remaining ingredients. Beat till mixture is well blended. Pour into prepared shell. Bake in moderate oven (350°F) for 35 minutes until filling is just set and beginning to brown around edges. Remove and allow to cool. Decorate with whipped cream. Serves 6.

Marmalade Apple Crisp

- 2 cooking apples, peeled and sliced
- 1 orange, peeled and chopped roughly
- $\frac{1}{2}$ cup sugar
- 1, 8 oz. packet morning coffee biscuits
- 1 cup grated Australian mild Cheddar cheese
- 3 tablespoons sweet marmalade jam

Cook apples, orange and sugar in a saucepan for 15 minutes or till apples are pulpy and liquid has evaporated. Arrange 8 biscuits side by side on lightly buttered flat baking tray to form a rectangle. Spoon apple mixture on biscuits, spreading gently out to reach edges. Place 8 more biscuits, firmly on top. Combine cheese and marmalade together. Spread over top of biscuits. Bake in hot oven (400°F) for 10 minutes. Serve hot with whipped cream. Serves 4 or 8.

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COMMON QUEENSLAND MUSHROOMS

OTHER TOXIC SPECIES

IN the absence of information on the toxicity of our wild mushrooms, it is recommended that only the common field mushroom be eaten. From information on species in other countries, we would anticipate that relatively few Queensland mushrooms would be sufficiently toxic to cause death, but that a number would cause an illness severe enough to require hospitalization.

Four common toxic species are discussed here.

A. GREEN-SPORED PARASOL MUSHROOM (*Chlorophyllum molybdites*) (Plate 1)

What to look for

1. distinctive brown scales on the cap.
2. gills cream in colour at first then progressing through green to greenish-brown.
3. a relatively tough ring on the stem which eventually becomes movable up and down the stem.
4. a large cap up to 12 cm or more in diameter.
5. the stem may discolour brown with handling.

Habitat

Lawns and pastures after rain particularly during the warmer months of the year.

It may form a fairy ring.

Toxicity

This is one of the two species of mushrooms most likely to cause mushroom poisoning in summer. It is definitely toxic either raw or partially cooked causing severe stomach upsets. Nevertheless, a small number of people have eaten this mushroom without ill effects after thorough cooking.

B. WHITE-SPORED PARASOL MUSHROOM (*Lepiota dolichaula*) (Plate 2)

What to look for

1. a large cap up to 20 cm in diameter.
2. a uniform, white colour broken only by small, similarly-coloured scales.
3. gills white to very pale in colour.
4. a tough ring around the stem which eventually becomes movable up and down the stem.

Habitat

Pastures, on grassy footpaths and similar situations.

Toxicity

Either cooked or uncooked, this mushroom is distinctly toxic to some people, causing severe stomach upsets.

C. *Amanita* sp. (Plate 3)

This mushroom illustrates the characteristics of a group which contains a number of very toxic species.

What to look for

1. a skirt-like ring on the upper part of the stem.
2. a cup-like structure with an uneven edge in which the stem is placed. This is sometimes called a 'death-cup' because of its association with known toxic species.
3. white gills.

Habitat

Eucalypt forests around Brisbane. Species of *Amanita* are always associated with trees.

Toxicity

Any mushroom with a 'death-cup' and white gills should be regarded as potentially very poisonous.

D. *Amanita ochraphylla* (Plate 4)

This mushroom represents another group of *Amanita* which does not have the obvious 'death-cup' and ring on the stem.

What to look for

1. cap pale biscuit-brown in colour with an occasional pink flush.
2. gills pale-brown in colour.
3. a distinctive smell unpleasant to most people.
4. a swollen stem base with uneven lines circling the stem just above it.

Habitat

Eucalypt forests around Brisbane. Species of *Amanita* are always associated with trees.

Toxicity

Probably toxic. Always avoid eating any mushroom with a swollen stem base.

— Compiled by J.E.C. Aberdeen and N.T. Vock, Plant Pathology Branch.

(Further information may be obtained by writing to the Director, Plant Pathology Branch, Department of Primary Industries, Meiers Road, Indooroopilly, Q. 4068).

COMMON QUEENSLAND MUSHROOMS

3. OTHER TOXIC SPECIES



1 Green-spored parasol mushroom (*Chlorophyllum molybdites*).



2 White-spored parasol mushroom (*Lepiota dolichaula*).



3 *Amanita* sp.



4 *Amanita ochrophylla*.