EXPERIMENTS IN UTILIZATION OF WALLUM COUNTRY IN SOUTH-EASTERN QUEENSLAND

By C. R. von Stieglitz, F.R.A.C.I., M.A.I.A.S.*, A. McDonald, B.Sc., M.A.I.A.S.† and L. R. Wentholt, L.I., M.A.I.A.S.‡

SUMMARY

Experimental work on the development of lowlying sandy coastal country for cropping and grazing is reported. The results indicate that improved pastures for beef or dairy cattle may be established and maintained and that horticultural crops may be grown successfully.

I. INTRODUCTION

In March 1952 an area of Crown land typical of much of the infertile coastal strip of south-eastern Queensland, popularly known as the "wallum", from the aboriginal name for the common tree *Banksia serratifolia,* was taken over by the Queensland Department of Agriculture and Stock for experimental purposes.

The term "wallum," used in its broadest sense, refers to the sandy coastal strip which extends in an almost unbroken line from Coffs Harbour in New South Wales to Bundaberg in Queensland, and intermittently along the coast further north. Andrew and Bryan (1955) computed the section from the border to Bundaberg as 1,920,000 acres. General descriptions of the main types of soil-vegetation associations occurring in the wallum have been given by Hubble (1954) and Andrew and Bryan (1955).

The property at Coolum (Portion 470 and 610, Parish of Maroochy), which contains a good cross-section of wallum country, has been described by Talbot and Rossiter (1959) in their detailed soil survey of the 1,930 acres of the property, then known as Coolum Field Station. The main soil-vegetation types on the Station are shown in Figures 1-5 and profiles of important soil types in Figures 6-8.

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* Formerly Agricultural Chemist, Queensland Department of Agriculture and Stock

† Chemist associated with the work until 1958

‡ Soils Technologist, Queensland Department of Agriculture and Stock

Fig. 1.—Eucalypt forest area.

Fig. 2.—Tea-tree in drainage line near heath (centre) and *Banksia* (left centre).

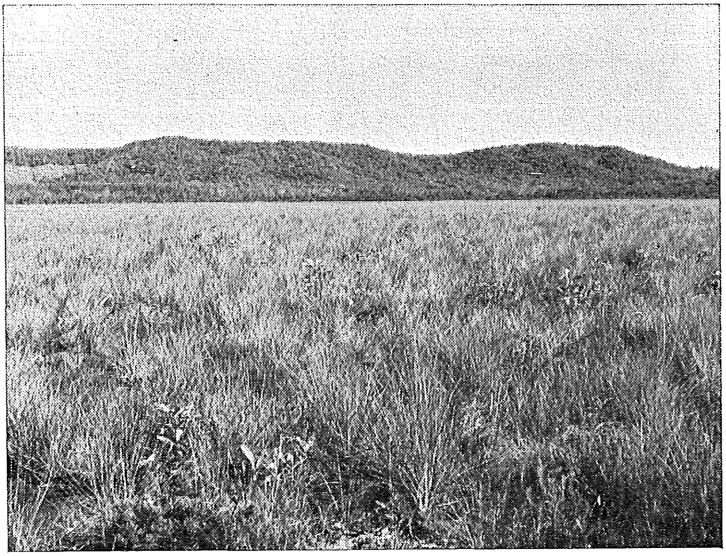

Fig. 3.—Typical heath country. Forest ridge in background.

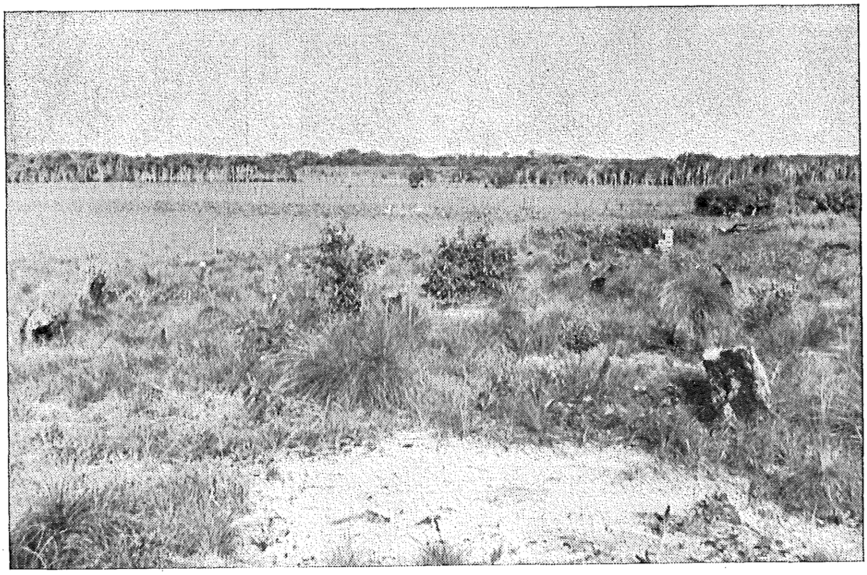

Fig. 4.—General view of experimental area following initial clearing.

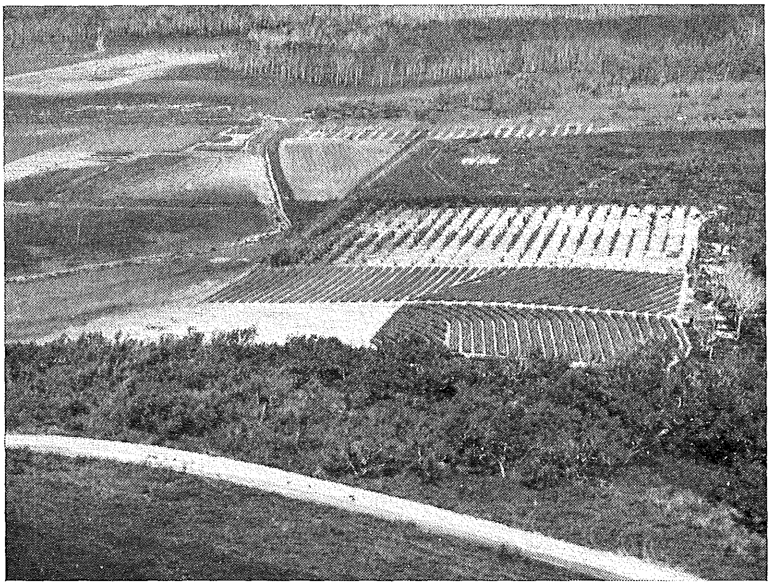

Fig. 5.—Main experimental area, 1956.

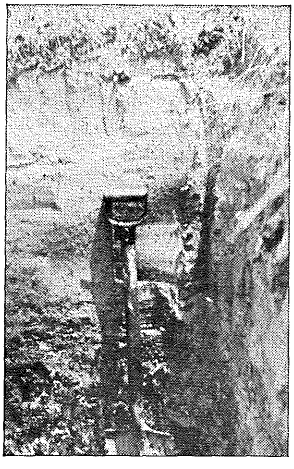

Fig. 6.—Profile of Peregian Loamy Sand, a lateritic-podzolic soil carrying eucalypts.

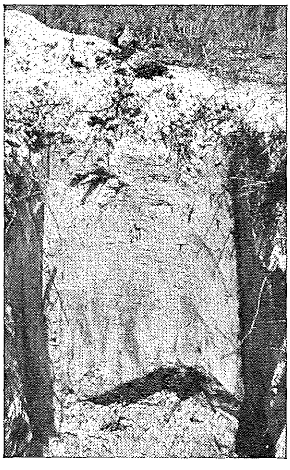

Fig. 7.—Profile of Wallum Sand. Vegetation is mainly species of *Banksia*.

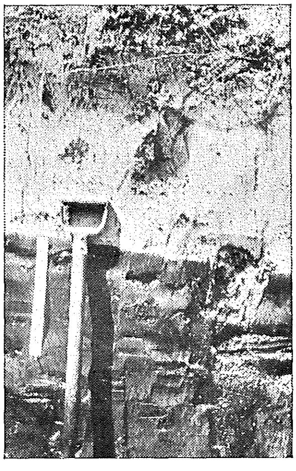

Fig. 8.—Profile of Coolum Sand. Vegetation is heath.

Work at the Station has been concentrated on the sandy soils associated with a low heath vegetation. These come in the aeolian and marine alluvial sands or the acid swamp soils described by Talbot and Rossiter (1959). It has been estimated by J. E. Coaldrake (unpublished data) that there are 300,000 acres of this country between Brisbane and Gladstone. The area of similar country between Brisbane and the border has been omitted because of current real estate operations which will remove most of it from the sphere of primary production.

The average monthly rainfall figures (in inches) taken over a 32-year period at Coolum Beach post office are:

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
8·45	9·45	9·12	6·61	6·32	4·53	3·24	1·90	2·63	4·33	4·31	5·95	66·90

This shows the typical high summer rainfall incidence common to south-eastern Queensland.

A meteorological station has been in operation on the property since 1953 but this is too short a period to allow reliable averages to be quoted. However, the records obtained do indicate the wide variability of monthly rainfall from year to year and the pattern of diurnal variation in temperature and humidity.

The mean monthly distribution of rainfall at Coolum Beach post office is shown in Figure 9 against the corresponding records at the station for 1955, 1956 and 1957. The typical high summer incidence in southern Queensland is evident. Rainfall over the period 1953-1960 for two important crop-planting months—April and October—varied from 0·14 to 22·29 in. for April and 0·72 to 11·16 in. for October.

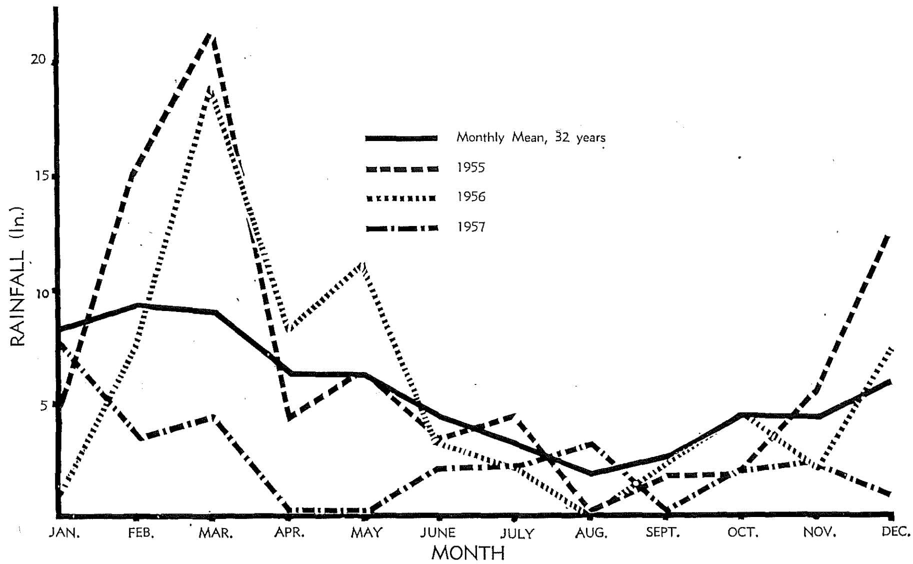

Fig. 9.—Mean monthly rainfall distribution, Coolum Beach.

The mean diurnal temperature variations for four centres have been given by Andrew and Bryan (1955). Those for Tewantin would be similar for temperatures found at Coolum. The maximum shade temperature at Coolum seldom exceeds 100°F.

Very high temperatures may occur in summer at the surface of the light-coloured sandy wallum soils (Figure 10). The success of summer plantings, particularly of legumes, may be endangered by such particularly high soil surface temperatures.

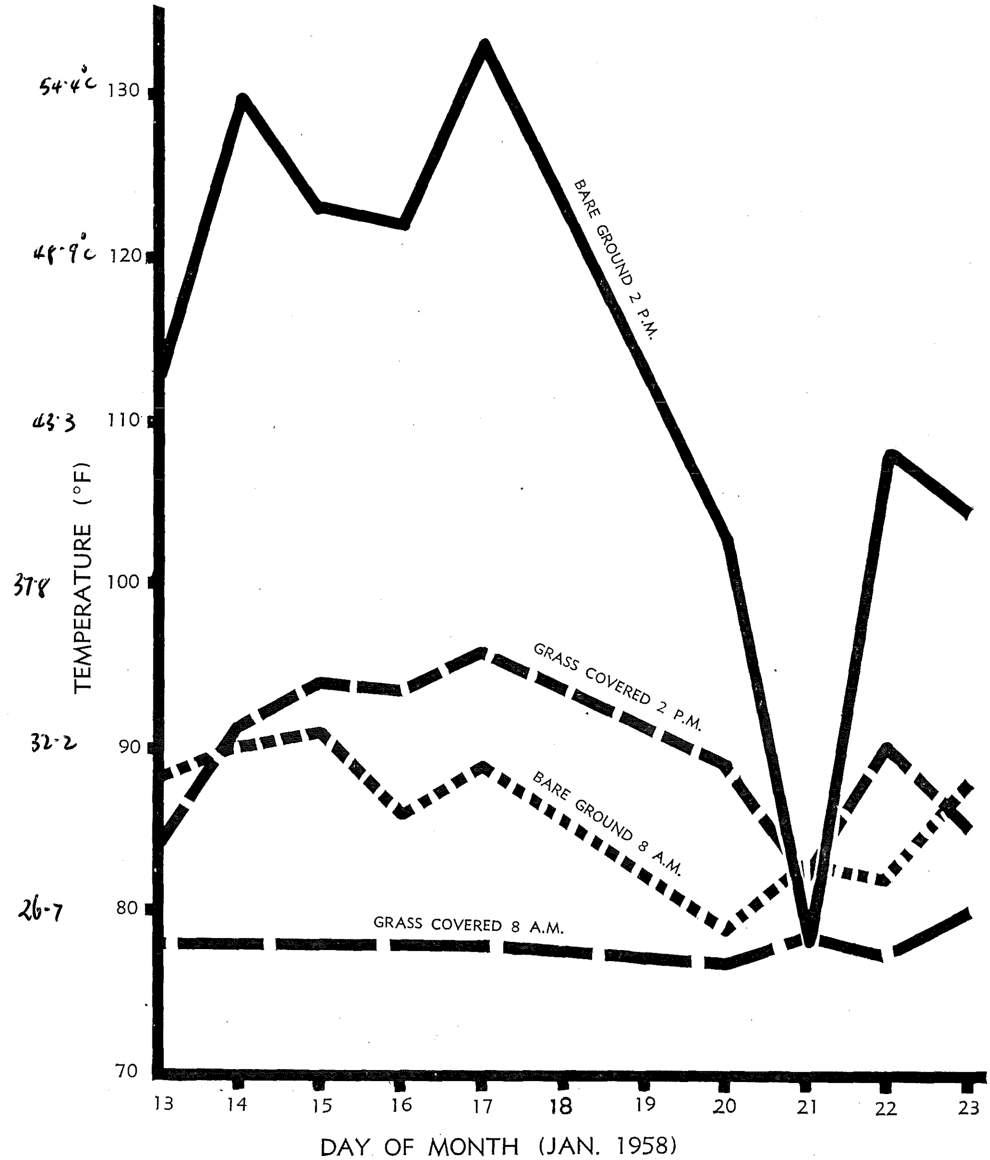

Fig. 10.—Temperatures of bare and grass-covered sandy wallum soil at 1-in. depth in summer.

Wind is an important factor in the area. An extreme case was the severe damage to native and planted species caused by the salt-laden winds which preceded a cyclone in 1954. Even in normal times, wind damage can cause pronounced tip-burn on leaves, particularly of legumes. On the soils with insufficient clay or humus to bind the surface, sand blast becomes a problem as well as the exposure or burying action caused by erosion.

As most of the heath country and certain other sections of the wallum are waterlogged for long periods of the year, drainage of the experimental area was a prerequisite to its successful utilization (Figure 11). Contour maps showing a 1-in. vertical interval were found useful in preparing the layout for drainage of this near-flat land where a change in water-table height of 1-2 in. can mean success or failure for many plants.

Fig. 11.—Main drain near north-eastern corner of Station.

The main drains were open cuts with a width of 14 ft at the surface, a maximum depth of 2 ft, and batters of 1:1 on the high side and 1:6 on the lower side where spoil was deposited. In some cases spoil was deposited on both sides. Falls are of the order of 1-2 ft per mile. It was found possible to use graders of the type available on hire from local authorities for constructing the main drains efficiently and economically.

Daily observations in a number of permanent holes showed that drains of this type removed surface water and dropped the level of the ground-water rapidly following cessation of heavy rain (see Figure 12).

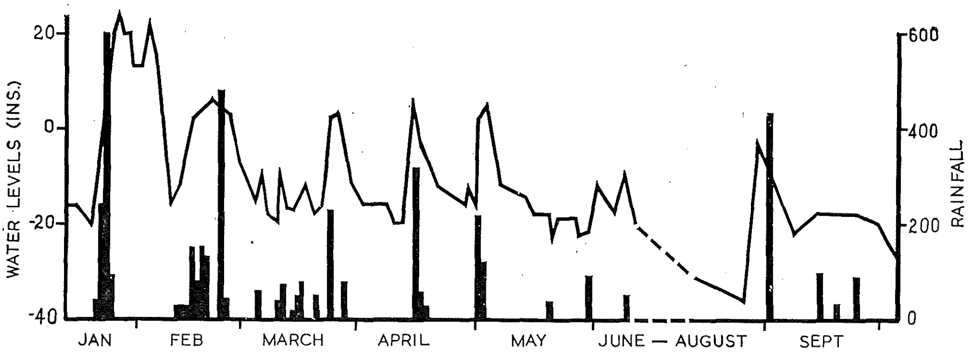

Fig. 12.—Movement of ground-water following cessation of heavy rain. Rainfall is given in points (100 points = 1 in.). (From chart prepared by Irrigation and Water Supply Commission.)

Main drains need to be constructed at intervals of 5-10 chains, with subsidiaries at right-angles on intervals of ½-1 chain. The latter can be built with normal farm machinery and if the land is being cultivated can be formed by the plough-outs.

The tall banksia or light eucalypt forest requires heavy equipment such as a bulldozer to clear it, with subsequent ripping to bring roots to the surface for gathering. The land is then ploughed once or twice before it can be harrowed to form a seedbed.

The low heath was initially brought into readiness for planting by the use of a rotary hoe, once to kill the heath and a second time to cultivate the land before it was harrowed. In later years a light tractor with either a disc or a mouldboard plough used once or twice, followed by the same tractor fitted with disc harrows, was found to result in satisfactory land preparation.

Large areas of wallum are used as reserve grazing for cattle in drought years, but in its natural state the area has an extremely low carrying capacity. Pineapple and citrus growing are carried out in favoured areas, while 200,000 acres are reserved for afforestation. Small farms principally devoted to truck crops are in evidence mainly close to the larger centres of population. Much of the area is close to markets and is well served by road, rail and electric power.

The main reasons for the lack of systematic development of the wallum are:—(a) the low level of fertility; (b) high clearing costs for forest ridges; (c) difficulty of controlling moisture in sandy soils to prevent either waterlogging or excessive drying out of the surface; and (d) inadequate testing of crop and pasture plants.

It had been known for many years that cattle depastured on wallum country were prone to a depraved appetite typical of aphosphorosis and that they frequently suffered from copper deficiency. In addition, cattle having access to heath country often developed "wamps", probably due to the ingestion of *Xanthorrhoea hastile* (Hall 1958).

Soil analyses carried out over a period of many years had consistently given low values for phosphorus, and many of the samples examined had a strongly acid reaction. Records existed in Departmental files of small crops or orchard trees in the area exhibiting foliar symptoms of deficiencies of one or more of the nutrients phosphorus, nitrogen, potassium, calcium, magnesium, zinc, copper, boron and molybdenum.

For reasons of soil types and accessibility, a 25-acre block at the eastern end of the property was cleared and planted first. The area included—(1) "melon-hole" heath, 2-3 ft above mean sea level, with water retained in the depressions for the greater part of the year; (2) "dry" smooth-surfaced heath, 4-7 ft in elevation, with a water-table at about 27 in. in the dry period of the year; (3) "ponded" heath with restricted surface drainage, elevation about 6 ft, which has water on the surface for most of the year; and (4) rising ground with a maximum elevation of 27 ft, with *Banksia serratifolia* as the dominant tree associated with various eucalypts and tea-trees.

This area was used for preliminary work on clearing and drainage methods coupled with nutritional and plant species studies.

Plants were first tested in pilot rows, then in larger plots, from which the most promising were moved into variety or fertilizer trials. An area to the east of the access road (now the coastal highway) was used for similar studies. This has now been abandoned since it is outside the declared experimental area. Concurrent with this development, more extensive pastures on which stock could be grazed were planted on the area now referred to as blocks I, J, K, and L, while horticultural trials were being conducted with pineapples, bananas and citrus on the sandy ridges.

The experience gained in establishing pastures on wallum heath land was used as the basis for a paper by McDonald and von Stieglitz (1958) presented at the Australian Agrostology Conference, Armidale.

Results obtained in the preliminary grazing trials indicated that it was worth planting larger areas and in 1959 a start was made on the establishment of 1-ac borders of the more promising pastures in the area now referred to as block P. More than 25 ac of low heath country has now been prepared in this part of the property and grazing by Station stock is carried out whenever the pastures are in a suitable condition.

The adjoining area, designated block Q, has been the site for nutrition and variety trials on pasture species and crops suitable for winter grazing.

In the same locality, studies have also been undertaken on the possibility of using summer legumes as cash or grazing crops and/or soil improvers.

II. RESULTS OF TRIALS

In the development of a new area such as wallum, many nursery and observation plots must necessarily be established and observed. Although this is valuable and time-consuming work, it is mainly the replicated trials which followed on these preliminary investigations which are reported below.

(a) Summer Pasture Variety Trial—Planted 1953

A pasture variety trial was planted in October 1953 on a slightly sloping area passing from the lowlying heath to a higher portion. Paspalum (*Paspalum dilatatum*), Rhodes grass (*Chloris gayana*), Kikuyu grass (*Pennisetum clandestinum*), green panic (*Panicum maximum* var. *trichoglume*) and para grass (*Brachiaria mutica*) were planted and oversown with lucerne, centro (*Centrosema pubescens*) and strawberry clover (*Trifolium fragiferum*). All plots received a basal dressing of 2½ tons of dolomite and 5 cwt of 5:14:5 meatworks fertilizer containing also copper sulphate (14 lb/ac), borax (28 lb/ac), zinc sulphate (7lb/ac) and molybdate equivalent to 18 oz/ac of sodium molybdate. Ammonium sulphate at ½ cwt per acre was applied in December 1953.

Mean green weight yields for 11 harvests from January 20, 1954, to April 12, 1956, are given in Table 1. The legumes did not make a significant contribution to the yields.

TABLE 1

SUMMER PASTURE VARIETY TRIAL—PLANTED 1953

(Mean Green Weight Yields in cwt/ac, 20.i.54 to 12.iv.56)

Para grass	337
Green panic	266
Rhodes grass	208
Paspalum	133
Kikuyu grass	43

Once established, para grass consistently outyielded the other grasses until mechanical renovation became necessary about two years after planting. At this stage, both green panic and Rhodes grass were better than para grass. The deleterious effect of repeated mowing on regeneration of the stand by rooting of stolons contributed to the decline of the para grass yield. Kikuyu grass yielded poorly throughout the trial as the environment requires a much higher level of nitrogen for this species than was provided in the trial.

This trial is still being continued as an observation plot to study survival of the species.

(b) Summer Pasture Variety Trial—Planted 1954

In this trial, planted in October, 1954, there were six replications of six grasses—green panic, Rhodes grass, *Paspalum secans, P. notatum, P. dilatatum* and buffel grass (*Cenchrus ciliaris*)—all oversown with *Glycine javanica* and *Centrosema pubescens.* Dolomite and fertilizer were applied as for the 1953 trial. An additional application of 1 cwt ammonium sulphate per acre was made in August 1955.

Green yields of the three grasses which gave reasonably good yields are shown in Table 2.

TABLE 2

SUMMER PASTURE VARIETY TRIAL, PLANTED 1954
(Mean Yields in cwt/ac Green Matter)

Grass	16.iii.55	16.viii.55	1.ii.56	12.iv.56	21.ix.56	31.i.57	29.xi.57	12.ii.58	Total
Green panic ..	15·6	3·2	26·9	21·2	4·7	14·9	16·6	21·7	124·8
Rhodes	17·7	5·6	19·0	18·2	5·2	11·2	11·6	6·6	95·0
Paspalum secans ..	6·2	1·8	19·4	22·4	6·0	15·2	19·2	13·9	104·0

16.iii.55: Rhodes, Green panic >> *P. secans*
16.viii.55: Rhodes >> Green panic > *P. secans*
1.ii.56: Green panic >> Rhodes, *P. secans*
12.iv.56: *P. secans* >> Rhodes; Green panic > Rhodes
29.xi.57: *P. secans* >> Rhodes; Green panic > Rhodes
12.ii.58: Green panic >> *P. secans* > Rhodes
Total: Green panic >> Rhodes, *P. secans*
>> Significant 1%; > Significant 5%

As in the 1953 trial, green panic gave good yields, and although *P. secans* was not far behind in yield, it is a coarse grass of low protein value. By the end of the 1959-60 summer, *P. notatum* had provided a good soil cover and looked attractive. The legumes made good growth during this summer after additional phosphorus and potassium fertilizer had been applied, but were badly damaged by the unusual frosts of 1960.

Analyses of pasture samples in December 1956 and January 1957 showed protein values averaging between 6·5 and 9·4 per cent. (dry-matter basis) for the grasses and between 13·2 and 20·6 per cent. for the legumes.

(c) Para Grass/Legume Pasture Fertilizer Trial—Planted 1953

In this trial there were four replications of six treatments which included basal applications of dolomite (0–2 tons per ac) and 5:14:5 meatworks fertilizer (5 cwt per ac) with and without trace elements at planting in September 1953, and additional broadcast applications of fertilizer from time to time. Method of application of basal fertilizer (drill v. broadcast) was also tested. The legumes used were lucerne, centro and strawberry clover. The yields from six harvests are given in Table 3.

TABLE 3

PARA GRASS/LEGUME PASTURE FERTILIZER TRIAL

(Mean Yields in cwt/ac Green Matter)

Harvest Date	24.ii.54 and 1.iv.54			19.viii.54			11.xi.54 and 15.iii.55			16.viii.55		
	Dol.	Fert.	Appn.*	Dol.	Fert.	Appn.	Dol.	Fert.	Appn.	Dol.	Fert.	Appn.
1st level	19·8	16·9	17·9	3·67	3·85	3·20	24·2	29·1	25·8	5·76	7·57	7·47
2nd level	16·9	17·6	16·5	4·36	4·15	4·80	32·2	33·2	36·5	8·90	8·94	9·04
3rd level	14·9	..	..	3·97	..	..	36·8	..	..	10·10	..	..

* Drill or broadcast application

24.ii.54 and 1.iv.54—No significant differences

19.viii.54—Broadcast > Drill

11.xi.54 and 15.iii.55—Dolomite 1 ton, Dolomite 2 tons > > Dolomite 0

16.viii.55—Dolomite 1 ton, Dolomite 2 tons > > Dolomite 0

>> Significant 1%; > Significant 5%

In spite of the highly significant increase in yield of the last three harvests due to dolomite, there was no advantage in using the rate of 2 tons per acre. Lucerne was the only legume which grew satisfactorily at any period, and then only in those plots which had dolomite. There was no response in this trial to the quantities of zinc, copper, boron or molybdenum used and no consistent difference in yield due to method of fertilizer application.

(d) Lucerne Field Trials

As lucerne had appeared promising, several trials were carried out to determine how it could be satisfactorily established and maintained. The results in general indicated that stands could be maintained for only short periods, and then only after costly soil treatment. Heavy rains and high winds destroyed some experimental stands.

Some of the data obtained during the series of trials are presented hereunder.

The total yields for two harvests from a 1955 sowing with a constant basal fertilizer application of 5 cwt of 5:14:5 meatworks mixture but with varying levels of dolomite were:

Dolomite (tons/ac)	Yield (cwt/ac)
0	1·5
1	13·1
1½	12·7
2	10·7
2½	12·6

When lime and dolomite at equivalent neutralizing rates were compared as soil ameliorants on plots receiving a basal fertilizer application of 5 cwt of 5:14:5 meatworks mixture, the only worthwhile harvest (the second) made before cyclone damage occurred yielded as follows:—

Dolomite or Lime (tons/ac)	Yield (cwt/ac)	
	Dolomite	Lime
0	0	. .
1½	14·0	10·8
2	14·3	. .
2½	16·7	15·0

These two trials showed that dolomite or lime is essential to lucerne establishment.

Significant yield differences at the single harvest obtained from a fertilizer trial planted in 1955 using the following rates per acre:—muriate of potash at 84 lb and 112 lb better than 42 lb; superphosphate at 6 cwt better than 3 cwt, and the yield with no superphosphate insignificant; sulphate of ammonia at 56 lb and 112 lb no better than nil. Dolomite (2 tons/ac) and trace element applications were common to all plots.

In a 1956 fertilizer trial, again with 2 tons dolomite and a constant trace element application, 9 cwt superphosphate was better than 6 cwt and 6 cwt was better than 3 cwt; there was no additional response to muriate of potash beyond 84 lb.

(e) Molasses Grass Dolomite and Fertilizer Trial—Planted 1954

The main trial area, planted on October 6, 1954, was given a basal dressing of dolomite at 2¼ tons per acre, while of eight observation plots, four received no dolomite and the other four 1 ton of dolomite per acre. Four different fertilizer treatments were given. Plot variations prevented useful statistical analysis, but it appears from the results given below that irrespective of fertilizer or trace elements applied, dolomite at 1 ton or more depresses the yield of molasses grass.

MEAN YIELD IN CWT/AC GREEN MATTER

Dolomite	Harvest	
	15.iii.55	15.ii.56
Nil	69·7	49·7
1 ton	26·7	29·0
2¼ tons ..	30·4	32·2

(f) Molasses Grass—Trace Element Trial

All plots of a factorial trace element trial received a basal application of 5:14:5 meatworks fertilizer at 5 cwt/ac, and boron, copper, molybdenum and zinc were applied singly and in various combinations.

The main indications from the trial were :(1) mean yield was depressed by 14 lb bluestone plus 13 lb boric acid; and (2) 13 lb boric acid plus 1 lb ammonium molybdate had no effect on yield, whereas mean yield for each of these compounds applied separately and in various combinations with 7 lb zinc sulphate and 14 lb bluestone was reduced.

The depression of yield by the simultaneous application of copper and boron has been observed also for pine seedlings in Queensland by C. R. von Stieglitz and T. J. Beckmann (unpublished data).

(g) Summer Legume Dolomite and Fertilizer Trials—Planted 1959

These trials were established to study the effects of various rates of dolomite (0, 1 and 2 tons/ac), superphosphate (3, 6 and 9 cwt/ac) and muriate of potash (1, 2 and 4 cwt/ac) on centro and stylo (½, 1 and 2 cwt/ac muriate of potash) following the successful work of Bowen (1959) on a nodulation problem in the area.

Mean yields (in cwt green matter per ac) for centro at harvest in the autumn of 1960 were:

	Dolomite	Superphosphate	Muriate of Potash
1st level ..	9·07	21·96	20·85
2nd level ..	26·41	20·61	23·51
3rd level ..	31·65	24·56	22·77

Dolomite at 1 or 2 tons was highly significantly better than no dolomite. There was a significant interaction of dolomite and superphosphate, with the effect of 2 tons dolomite being more marked at the highest level of phosphorus (9 cwt superphosphate). There was also a significant interaction of phosphorus and potassium. When 1 cwt muriate of potash was used, the yields decreased as the amount of superphosphate increased. At levels of 2 and 4 cwt muriate of potash, the yields increased slightly as the superphosphate was increased.

The response to dolomite was very marked in this trial, although 1 ton was apparently sufficient for the period used for recording. Some of the response is apparently due to the magnesium contained in the dolomite, as plants in the no-dolomite plots had leaves exhibiting typical magnesium deficiency symptoms.

The interaction of phosphorus and potassium supports numerous observations made on centro in the grazing blocks.

The material harvested from the centro plots was also analysed chemically to obtain an estimate of the value of the legume as stock food. Plots receiving no dolomite gave low or zero yields and were not included in the statistical analysis.

Protein values (percentage crude protein) were:

	Dolomite	Superphosphate	Muriate of Potash
1st level ..	..	15·27	17·00
2nd level ..	18·48	16·53	17·03
3rd level ..	17·13	17·81	15·58

The main effect for superphosphate is significant, while superphosphate at 9 cwt produced more protein than at 3 cwt, the difference being highly significant.

Calcium values (percentage CaO) were:

	Dolomite	Superphosphate	Muriate of Potash
1st level ..	..	1·155	1·109
2nd level ..	1·071	1·047	1·173
3rd level ..	1·131	1·101	1·020

Differences were not significant.

Phosphorus values (percentage P_2O_5) were:

	Dolomite	Superphosphate	Muriate of Potash
1st level ..	..	0·312	0·458
2nd level ..	0·424	0·446	0·402
3rd level ..	0·405	0·486	0·384

The main effects for superphosphate and muriate of potash were highly significant. Superphosphate at 6 or 9 cwt resulted in material with highly significantly more phosphorus than when 3 cwt was used. Muriate of potash at 1 cwt increased phosphorus significantly more than at 2 cwt and was highly significantly better than 4 cwt. An extra response to superphosphate at 9 cwt was noted when dolomite was used at 1 ton rather than 2 tons. The interaction of P and K was highly significant. The potassium effect was only evident when 9 cwt superphosphate was used.

At the second harvest (autumn 1961), mean yields (cwt green matter per ac) and main effects for centro were as follows:

	Dolomite	Superphosphate	Muriate of Potash
1st level ..	7·83	7·90	11·72
2nd level ..	14·44	13·70	13·27
3rd level ..	14·62	15·24	11·91

Dolomite at 1 or 2 tons was again highly significantly better than Nil; superphosphate at 6 or 9 cwt was highly significantly better than at 3 cwt.

The material from the second harvest was analysed for protein (percentage crude protein) with the following results:

	Dolomite	Superphosphate	Muriate of Potash
1st level ..	15·55	14·43	16·33
2nd level ..	16·37	16·04	15·91
3rd level ..	15·86	17·30	15·54

Main effect for phosphorus at 9 cwt superphosphate was significantly better than 6 cwt and the latter was highly significantly better than 3 cwt.

The mean yields and main effects for the stylo harvest in the autumn of 1960 (cwt green matter per acre) were:

	Dolomite	Superphosphate	Muriate of Potash
1st level ..	107·11	138·08	115·81
2nd level ..	139·81	141·04	136·79
3rd level ..	156·59	124·38	150·92

Dolomite at 1 or 2 tons was highly significantly better than no dolomite. Muriate of potash at both 2 cwt and 1 cwt was highly significantly better than ½ cwt.

As in the centro trial, dolomite greatly improved the yield; 1 ton was sufficient to produce the maximum yield. Although the difference between the effects of 1 and 2 cwt of muriate of potash is not significant, there is a tendency for the higher rate to improve yields.

(h) Clover Lime and Dolomite Trial—Planted 1959

Dolomite was applied at 5, 10, 20, 30 and 40 cwt per acre and lime at equivalent neutralizing values. Results are shown in Table 4.

TABLE 4

CLOVER LIME AND DOLOMITE TRIAL

(Yields in cwt/ac Green Matter)

Application Rate (cwt/ac)	5	10	20	30	40	Means
Dolomite	7·92	12·82	15·87	15·64	15·61	13·58
Lime	6·66	12·01	14·35	12·68	15·64	12·27

Yields at 10, 20, 30 and 40 cwt of dolomite or lime at equivalent neutralizing values are highly significantly better than yields at 5 cwt level of dolomite or lime. The maximum yield for dolomite was produced at the 20-cwt level. For lime there is strong evidence that the same result would be reached at levels exceeding the 20-cwt mark.

(i) Grazing Trials

The first of the grazing trials was planted in 1956, using green panic, para grass and molasses grass as the grasses, and lucerne, red clover, centro, kudzu, stylo and white clover in various combinations as the legumes. All mixtures received 1 ton of dolomite and 5 cwt of 5:14:5 meatworks fertilizer per acre.

In 1957, similar areas were established but buffel grass was added and the legumes were planted only in the spaces between the grass rows. Stylo and buffel were impressive, while red clover was most attractive in the first season.

Fig. 13.—Cattle grazing buffel grass/stylo pasture.

Cattle were maintained in good condition on these pastures, including the 1957 drought period, without supplementary feeding. The stocking rate was a little better than 1 beast to 3 ac.

One para grass block in a moist area provided 281 beast grazing days per acre per annum, which is approximately 1 beast to 1·3 ac.

A *Paspalum dilatatum*–centro block was established in 1958 and following the application of additional phosphate and potassium (4 cwt/ac of a 1·75:11:25 fertilizer) in November 1958 an excellent pasture was obtained. The carrying capacity of this was 1 beast to 1·7 ac for a full year. At the same time, a similar dressing of fertilizer to the buffel/stylo block gave excellent results (Figure 13).

In the para grass block the legumes had disappeared by December 1958 when it was topdressed with 1·75:11:25 fertilizer at 4 cwt/ac. The block was then planted with sprigs of *Lotononis bainesii* and centro on a 6-ft grid. These plantings were commenced in autumn of 1959 but were not completed until spring. The block received 2 cwt superphosphate and 1 cwt muriate of potash per acre in the spring of 1960. Cattle were allowed to graze the area whenever it carried a reasonable body of feed.

After two years' intermittent grazing there was a marked difference between the Lotononis and centro areas. The former had covered all intervening spaces in the 6 ft by 6 ft grid and was vigorously invading the centro, which, though still persisting, had made little headway. The para grass associated with Lotononis was a healthy green colour and was obviously obtaining nitrogen from the legume.

In October 1959 the main plantings in block P were commenced. The grasses used were *Paspalum plicatulum* (Figure 14), para, pangola (*Digitaria decumbens*) (Figure 15), green panic and *Paspalum dilatatum*. The associated legumes were centro, stylo, *Glycine javanica* and *Lotononis bainesii*.

Fig. 14.—*Paspalum plicatulum*. Planted October 1959; photographed April 1960.

Fig. 15.—Pangola grass (*Digitaria decumbens*). Planted October 1959; photographed April 1960.

(j) Pineapples

An acre of the deep wallum sand was cleared and ¼-ac blocks planted in successive seasons appropriate to the type of planting material used. The first planting was made in the spring of 1953 with slips. Normal 10:6:10 pineapple fertilizer with copper and zinc was used at the standard rate and time of application. Later crops were given additional potash as 1½ cwt muriate of potash.

The growth of the crop was very satisfactory (Figure 16). In 1956, when pineapples were a good price, though not at their peak, the February-August harvest from ¾ ac, comprising ¼ ac first ratoon and ½ ac plant crop, gave a gross return of £438. With freight charges at £32 and fertilizer at £35, the return was considered very satisfactory, since losses due to bird damage and rejection of over-ripe fruit were heavier than would occur on a plantation of commercial size.

The fertilizer cost on the wallum was little higher than in recognized pineapple areas, while maintenance cost was low as there was practically no weed problem.

Pineapples also did reasonably well on raised beds on the low heath country.

Fig. 16.—Plant crop of pineapples planted in 1953.

In a pineapple copper/zinc experiment planted in September 1956, five replications of four treatments were superimposed on an area established according to commercial practice, including 10:6:10 fertilizer without copper or zinc. Statistical analysis was not considered warranted because of the variability of the data. There was an apparent tendency for combined copper and zinc treatment to induce earlier natural flowering than no trace elements, with zinc possibly having more effect than copper. Zinc also seemed to reduce leaf-tip dieback. Copper, on the other hand, seemed to increase the incidence of dieback.

Pineapples have been established for some years on the cleared eucalypt forest area. The experiment is a long-term rotation trial which has yielded satisfactorily when normal types and rates of fertilizers have been applied.

(k) Bananas

Both Mons Marie and Lady Finger varieties were planted in 1954 on an area of wallum sand adjacent to the acre of pineapples. Growth on this soil type was unsatisfactory. Evidence was obtained that the poor growth was due mainly to the dry hot sand which resulted as soon as surface moisture had dried out. Attempts to reduce this effect by using a cover crop or sawdust mulch were only partially successful.

The same varieties were tried in the forest area, plantings being made in 1956 and 1957. Lady Finger (Figure 17) grew well when standard Departmental recommendations for all cultural operations were used. Mons Marie

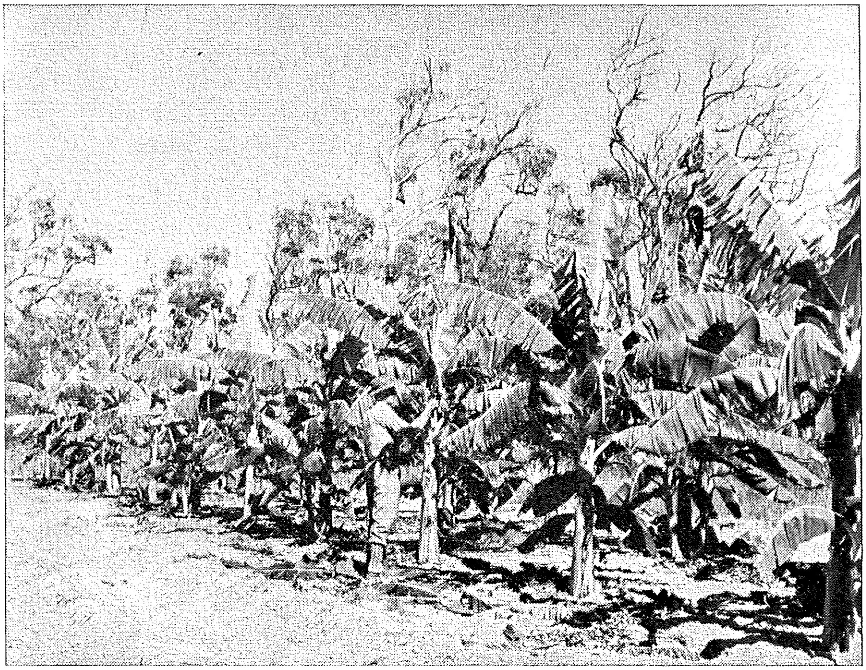

Fig. 17.—Bananas growing on forest ridge area.

produced some excellent bunches but behaviour was very erratic, although recommended cultural operations were carried out. Average bunch weight for Lady Finger produced in 1960 and 1961 was 32 and 31 lb respectively. In both years the best bunches weighed more than 50 lb.

(l) Citrus

A block on the forest ridge was planted to citrus in 1956. Several varieties of oranges, lemons and mandarins were tried on different rootstocks. Most varieties produced reasonably well for the first few years, but, as well as trees suffering from the pests and diseases common to citrus grown near the coast, trace elements deficiencies were also noticed. When foliar symptoms of these occurred the appropriate corrective treatment was applied. As a group the lemons performed better than oranges or mandarins: Meyer was the best variety.

III. CONCLUSIONS

As a result of the work reported here and of additional work on pastures to be reported elsewhere, some general observations can be made.

The sandy heath soils are capable of producing satisfactory summer-growing pastures. The most successful grasses tested have been para grass, green panic, pangola grass (*Digitaria decumbens*), paspalum and *Paspalum plicatulum.* Molasses grass and Napier grass (*Pennisetum purpureum*) are useful pioneer species. Of the winter grasses tested, ronpha grass (an interspecific *Phalaris* hybrid) and *Phalaris tuberosa* seem to be the most likely to succeed.

Lotononis bainesii has been established on a range of soil types and in various pasture mixtures. Stylo and centro are the next most useful summer legumes for mixed pasture. White clovers show promise for the winter/spring period.

Productive pasture has been established on the low heath country at a cost of about £25 per acre, including drainage. Annual fertilizer requirements cost £2-3 per acre.

Oats has been grown successfully for winter grazing, and cowpeas and mung bean may be useful summer legumes. Lucerne has proved unsatisfactory.

Pineapples can be grown successfully on the forest country or on well-drained heath. The cost of clearing forest areas and ploughing once, with removal of roots, could exceed £50 per acre if large-scale methods were not employed. Various fruits and vegetables can be produced on the forest areas.

Drainage of the heath land is a prerequisite for both pasture and crop establishment. With modern machinery and techniques this presents no major problem of time or cost, but it is necessary to plan drainage operations ahead, as wet weather can prevent the use of the most economical equipment.

There are generally adequate supplies of surface water available but in addition the heath land normally has permanent underground water at a depth of 11-20 ft. Bores or wells which tap this supply are normally of low yield, fewer than 1000 gal per hr, due to the fine sand beds. Water in the streams, local catchments, and from underground is of suitable quality for all stock and for the irrigation of most crops provided there is no direct influence from the ocean.

The main possibilities for obtaining closer settlement on the wallum are (a) improved pastures for either beef or dairy cattle, and (b) horticultural or truck crops. In some parts, mixed farms would be best because of the varied terrain. Assured markets would be required to permit planned development of the area.

IV. ACKNOWLEDGEMENTS

Assistance was given by various Branches of the Department in taking land levels, preparing drains, and establishing pastures and pineapples in the early stages of the investigations. The Queensland Irrigation and Water Supply Commission assisted with drainage matters and underground water supplies. Officers of the Division of Tropical Pastures of the Commonwealth Scientific and Industrial Research Organization provided advice and information. All this assistance is gratefully acknowledged.

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(Received for publication November 15, 1961)