368

Department of Agriculture of South Australia

BULLETIN No. 368

Flax

Cultivation and Experiments

A reprint of the following articles from the *Journal of Agriculture of South Australia*:—

" Flax as an Economic Crop " (R. C. Scott), May, 1941

" Flax Growing in Cereal Districts " (O. Bowden), March, 1941

" Fibre Flax " (K. A. Pike), April, 1941

ADELAIDE
FRANK TRIGG, Government Printer, North Terrace

1941

Flax as an Economic Crop

[By R. C. Scott, R.D.A., Chief Agricultural Adviser.]

Flax has received a good deal of publicity during the last few months, and therefore a few remarks about the crop, and why it has become so important might be of interest.

In the first place there are two distinct types of flax, and although both are the same botanically, each has been developed for a particular class of product.

What is usually termed Fibre Flax, has been developed for the length and strength of the fibre that is produced, whilst the other type is commonly referred to as linseed, and has value for its capacity for high yields of oil-carrying grain. Each of these is of very considerable economic importance, but the one urgently needed by Great Britain to-day, is the Fibre Flax.

This type must not be confused with the New Zealand Flax, which is a perennial plant growing in swampy land in that country, and often planted to a limited extent by market gardeners in the Adelaide Hills. It has long broad fibrous leaves, and the gardeners use thin strands torn from these leaves to tie bunch vegetables, such as carrots or turnips.

On the other hand, Fibre Flax is an annual plant, having about the same growth period as wheat, and produces fibre, which not only has great strength, but is also resistant to damage from water, heat, or friction.

There is a wide range of goods manufactured from the fibre of flax. From this material we obtain fine quality fabrics and sheeting usually termed linen, and then all grades extending to heavy tarpaulins, together with threads, cordages and the strongest of ropes.

Amongst the fine quality fabrics there are such articles as wearing apparel, linen handkerchiefs, bed linen, table linen, and many other similar classes, whilst as the fibre is woven into heavier material, we get waterproof sheeting and heavy tarpaulins.

It will be realized, therefore, that it is from flax that such goods as canvas, fire hose, sails, and waterproof coverings generally are obtained.

The flax or linen threads and cordages are extremely strong when compared on a weight basis with other fibres, and also have the advantage of retaining their strength, even when frequently subjected to wet and dry conditions. For example, it is linen thread that is used for sewing boots and shoes, because it is able to withstand the wear and tear and exposure better than any other class of thread. Consequently, even in times of peace there is strong demand for flax, but that demand is very much increased when the country is at war. More tents, tarpaulins, sails, groundsheets, and similar goods are required; the cordage of parachutes, the light sheeting of aeroplane wings (where aluminium has not been used) are but some of the things made from flax, that are essential under war conditions.

It may be asked why, despite the value of flax fibre, should its production in Australia become suddenly so important, and also why it has not been grown commercially in Australia previously.

In early years flax was planted in Australia, and in this State there are records of flax mills at Lyndoch, Aldinga, Goolwa, and other places, some 70 years ago. However, these went out of existence for various reasons, and although from time to time attempts were made to revive the industry, Australia could not economically compete against the imported article, and it was not until about 1935 that progress was made in Victoria, due to the introduction of new varieties suited to our climatic conditions, improved cultivation methods and good organization by a flax production firm in that State. By 1940 the area planted had grown to 8,000 acres, and mills had been erected to process the crop. The industry was, therefore, commencing to make headway, but war conditions necessitated much more rapid expansion.

The position is that in normal times the United Kingdom used about 80,000 tons of flax fibre annually, but of this only 8,000 tons, or 10 per cent, was home grown, with practically nothing imported from the Dominions.

Russia is the biggest flax producing country, and accepting 1938 figures, the output from her mills was 560,000 tons, or seven-tenths of the world's supply of 800,000 tons.

However, in late years the crop in Russia has been controlled, and exports limited, with the result that the United Kingdom has had to obtain her supplies from Belgium, France, Northern Ireland, and the Baltic States.

With the collapse of France and Belgium, and the over-running of other European countries by the enemy, the flax position became serious for England, since America is not a large producer of this commodity.

Therefore, in addition to encouraging planting at home, Great Britain asked the Dominions—Australia, New Zealand, and Canada—to help produce supplies, and shipped seed for sowing, with the result that eventually 21,000 acres were planted in the Commonwealth in 1940.

South Australia was not included in this planting scheme, as owing to the late arrival of the seed, spring sowing was necessary, and there are few localities in this State where August or September planting is likely to be successful. However, even before the appeal from England was received, experimental work with flax had been in progress. At the Waite Agricultural Research Institute it has been regularly planted over the past five seasons, whilst, last year, upwards of 40 experimental fields were sown in the higher rainfall areas.

The most suitable climate for flax is a cool, moist one possessing steady ripening conditions. The minimum rainfall required is not known, but the limit is probably somewhere in the vicinity of 20in., although where the land has been well prepared and the rains are evenly distributed over the growing period of the crop, flax could probably be grown on less than 20in. annual rainfall.

Good loam soils that are well drained are most satisfactory. Flax does not thrive in sandy land of low fertility, whilst with over-rich land flax tends to lodge and cause difficulty at harvest time. Briefly the same conditions necessary for strong growing hay or cereal crops are necessary for flax, and the areas within the State where it can be grown are in the high rainfall fertile lands from Murraytown, Wirrabara, Laura Hills extending across to Bundaleer and Gulnare, then down through the Clare Hills from about Andrews and Rochester to Rhynie and Salter's Springs. Tarlee may be a little on the dry side, but the area would be met again at Kapunda with one line travelling towards Goolwa in the south and the other following the range of hills right round till the sea is met at Brighton. Within the whole of this area, including the cereal cropping land of Aldinga and the Southern Districts, flax can be grown. Again, in the Lower South-East from about Naracoorte downwards it should be possible to grow flax without difficulty.

Flax has approximately the same growth period as a late mid-season variety of wheat and can be planted and harvested with the same machinery as that used for cereal hay. Therefore, it is a crop which a farmer can adopt without incurring expenditure for additional equipment.

The land needs good preparation and must be clean, as flax will not thrive in competition with weeds, which not only crowd it out but also reduce the value of the produce.

A fine, firm seed bed is necessary, as the seed is small and must be sown at a very shallow depth.

The time of planting will vary with the district, but in general a good guide is the period which experience has shown to be the best for cereal hay crops. In most areas this will extend from about mid-May to mid-June and as late as August in the very wet districts.

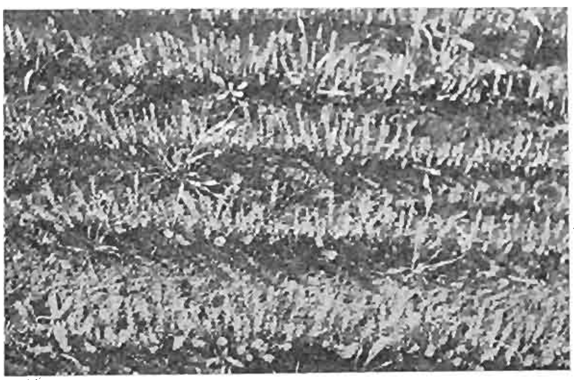
The seeding rate for fibre flax is 70lb. per acre and the grain can be distributed through the fine side of the cups of ordinary cereal drills, whilst a dressing of at least 1cwt. of super per acre should be given.

Flax is a very attractive crop in the field, producing a mass of pale-blue flowers that ripen to round pods or bolls about a quarter of an inch in diameter. It is ready to harvest when most of the bolls have turned a golden-brownish colour. In Australia a binder is used, although in other countries the crop is either hand-pulled or gathered with special pulling machines. Provided that the binder is in good order, it can be cut without difficulty. After harvesting, the sheaves are placed in small stooks like hay to dry out before being carted to the mill. An average yield is about 2 tons per acre, although last year many 3-ton crops were gathered in Victoria and Tasmania, whilst at the Waite Institute the mean return for the last 4 years is 2 tons 16cwt. per acre.

Flax Growing in Cereal Districts

[By O. Bowden, R.D.A. (Agricultural Adviser, Lower North District).]

While produced on a limited scale south of Adelaide in past years, the flax crop is comparatively new to the wheatgrowing areas, and has certainly never had extensive testing in these localities. Used extensively in times of peace, the exigencies of warfare have brought a demand for increased supplies for military use, and the shutting out of the regular countries of supply has prompted the move to obtain requirements in the Dominions. While the national aspect is the all-important one at the moment, other factors also focus attention upon the crop, and not the least of these is the fundamentally important one of finding an alternative crop which can replace some of the normal wheat area. In point of fact, this work was already in hand before the demand for military use became really important.



Early development of the fibre flax plant. Note habit of growth and absence of stooling, indicating the inability of flax to compete with weeds and the need for clean land.

A Description of the Crop.

Flax is a plant with a similar growing season to that of our late varieties of wheat, and is of varying height and branching habit, according to the variety used. The seedling is two-leaved, and a single stem develops with small alternate leaves closely attached to the stalk. When the blue flowers appear the plant is very beautiful. The flowers are later replaced by the seed pods, or bolls, and gradually the plant yellows and browns off as maturity is reached.

There are numerous varieties. The shorter, many-branched types are harvested for seed (linseed of commerce), and tall, straight-stemmed types are gathered for fibre, while some dual varieties are moderately good for either purpose.

Of recent years a new flax variety has come into prominence, and appears likely to extend the area where the crop can be grown. Known as Liral Crown, the variety has given excellent results for fibre. Seed of this variety was distributed in the autumn of 1940, and 8 plots each of one-fifth acre were sown in the Lower North, one each at the following centres:—Angaston, Kapunda, Riverton, Auburn, Saddleworth, Clare, Andrews, and Maitland.

Requirements of the Crop.

Recommendations in regard to growing the crop have insisted upon generous rainfall with a cool moist spring period, good, loamy, well-drained soil, complete absence of weeds, careful tillage to produce a fine tilth over a shallow seedbed, seeding rates of 70lb. to 80lb. for fibre (half these amounts for seed), from 1cwt. to 2cwt. of super per acre with early and shallow sowing of the seed.

While it was realized that the rainfall in the districts concerned did not reach the 22in.-24in. level usually considered essential for satisfactory growth, it was thought that long fallow of these areas, as compared with the autumn prepared land of the higher rainfall districts, would in part off-set the moisture deficiency of the 18in.-20in. cereal areas. At the same time, it was hoped that early sowing would allow the crop sufficient time to mature before the high temperatures of late spring operated.

The experience of this very adverse season indicates that rainfall may not prove such a severe limiting factor as suggested, but that all other recommendations are fundamentally important, while some other factors also come into the story.

The outstanding features appeared to be the inability of the crop to withstand high temperatures in the spring, a particular weakness in coping with the usual farm weeds, and a poor response where sowing was deeper than the actual surface tilth. In regard to the former locations sheltered from hot north winds are essential, and this automatically eliminates all the plain country of the district. On the other hand, the area north of Hamley Bridge, through Clare to near Andrews, and extending eastwards to a line from Angaston to near Eudunda, and then to Farrell Flat, together with the main portion of Yorke Peninsula and a few small areas on the eastern aspect of pronounced hills, constitutes a fairly large scope of country with the necessary climatic conditions.

Referring to weeds, it is obvious that most farms carry far too many aggressive plants, such as sheep weed, poppy, fumitory, soursob, Cape weed, mustard, wild oats, and other winter types, to permit the slow-growing rather weak, non-aggressive flax plant to establish. Even well-worked fallow, which could be expected to produce a clean wheat crop, does not overcome the weed problem, unless the land is clean in the first place. With few exceptions, only land which has rested to pasture for a few years, land not frequently cropped, or comparatively new land is likely to produce clean flax crops.

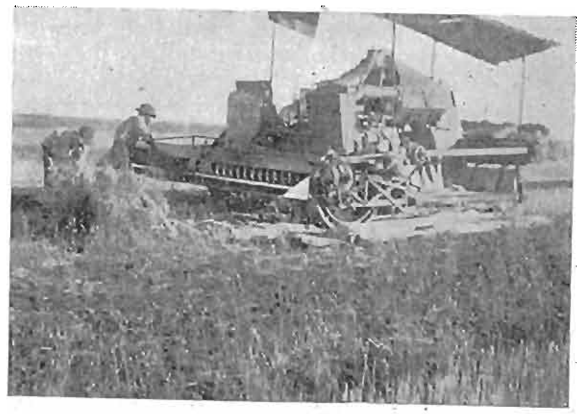
In regard to obtaining a satisfactory crop establishment, the important consideration concerns the depth of sowing. Being a two-leaved seedling, the plant has very poor penetrating ability, and seed must therefore be sown close to the surface. Ordinary farm technique, and for that matter the usual implements also, need considerable adjustment to change successfully from cereal seeding to that of surface sowing as required by flax. While the ideal condition would consist of a fine ashy tilth, this is not practicable with the long fallow method, owing to the danger of erosion and setting of the soil. It is suggested that the ordinary fallow prepared as for wheat should be cultipacked or rolled immediately in front of the drill, which should work with hoes or tynes just marking the surface and followed at once by harrows. Alternatively, the seed should be sown just below the surface of the ordinary fallow and the land cultipacked or rolled afterwards, followed by harrowing to prevent the crust which is almost certain to form after a few points of rain.

Dealing with other aspects, the seeding rate must be well up to the recommended rate of 80lb. per acre to cramp the plants and cause erect stems without branches, though where grown for the seed half of this quantity should be sufficient.

The super dressing should be generous and on fallow appears to be the only fertilizer required, except on that portion of Lower Yorke Peninsula where manganese is deficient. Application of nitrogen is not recommended, because this is conducive to lodging and rankness of the crop.

Referring to time of sowing, the crop appears to have a slightly longer growth period than the mid-season wheat varieties now widely grown in these districts. For this reason, sowing cannot be delayed until successive weed crops have been destroyed, and this is the main consideration insisting on clean land. It is suggested that early to mid-May for the earlier districts previously mentioned, to late May in the higher rainfall and later areas, is the ideal seeding period.

The crop is susceptible to damage by lucerne flea, red-legged earth mites, and similar pests in the seedling stage, and grubs attack the seed bolls in the late spring period. Farm animals, rabbits, and hares relish the plant, and several plots were eaten right back to the butt in mid-winter. The plant recovers well after grazing, but it is likely that this treatment reduces the fibre yield and value.



Deseeding by means of an auto-header on the property of Mr. E. V. Wilsdon, Andrews.

The seed runs very freely and escapes readily from any opening in the seed box of the drill. These openings exist in even the comparatively new machines, and once the mechanism starts to move the seed pours from the sides of cups and valves. Where the seed can be controlled in the seed box, a setting for 55lb. of wheat through the fine side delivers 75lb. to 80lb. of flax seed per acre. It was found more satisfactory to mix the seed with super during the sowing of the plots, and, by using settings slightly in excess of the total weight of seed and super combined, the required sowing rate was approximated. In other words, to sow 1cwt. of super and 80lb. of seed per acre, those amounts should be mixed together and the super drive set to sow 200lb. to 210lb. per acre.

Time and Method of Harvesting.

When it is to be harvested for seed, the crop is left until mature, when light stands can be gathered with the stripper equipped with a roller beneath the comb. Heavy crops require the use of a header harvester with the comb spaced slightly wider than for wheat and a finer riddle to facilitate cleaning. A good deal of seed escapes through badly fitting tin or woodwork under this method. Alternatively, the crop can be cut and stooked at a late stage of maturity and threshed by stationary machinery.

When intended for fibre, the usual time of gathering is when most of the bolls have turned a brown colour and the lower leaves have dropped from the stem. At this stage the seed rattles in the earlier bolls and a yellowish colouring is evident in the bottom part of the stems. It is possible that an even earlier stage of harvesting would be preferable, but the recovery of some seed dictates the later period. In this regard it is possible that the cereal districts not suited to the production of first-class fibre could grow the crop for the seed, and allow other districts to concentrate on producing fibre only.

Labour problems dictate the policy of cutting and binding the crop instead of the pulling method adopted in other countries. Naturally, the machine should be set to cut as low as practicable and a fine soil surface greatly facilitates this. The ordinary binder can be used for the purpose, but the crop is inclined to hang over the outer divider and an attachment to split the top growth apart before the stems are cut is essential. The stems are tough, and a set of double fingers with a sharp, plain-bladed knife simplifies the cutting operation. Speeding up the knife action should not be difficult if the demand for this type of machine made it worth while, though a power drive would possibly make more appeal where tractors operate.

The size of sheaf will depend on the stage of maturity. Cut on the green side sweating in the sheaf or stook must be guarded against, whilst over-mature and branched material does not pack readily. The experience obtained this year suggests that the crop should be handled on the same lines as hay once it has been cut, but both sheaves and stooks should be smaller to avoid sweating.

Results from Experimental Plots, 1940.

In the first place the season was very severe and the plants had to struggle against conditions which pre-conceived ideas suggested would be completely fatal to the satisfactory development of the crop. While it is thought that only one plot reached a commercial standard, very encouraging returns came from most areas.

Sowing conditions were not at all favourable, and only 3 of the 8 plots contained sufficient moisture to guarantee germination at the time of seeding.

Onwards from sowing, plots were subjected to drought conditions, heavy frost in late July and early August and exceptional heat in mid-October.

Further damage resulted from the eating back of 3 plots by either sheep, rabbits, or hares, while lucerne flea and red-legged earth mite checked another plot.

Where the germination was good, lightly-stemmed, dense crops developed, varying in height according to situation, but generally too short for commercial use. When the germination was poor, thick-stemmed, many-branched, fairly tall plants with numerous seed bolls came under notice.

In mid-October a heavy mortality of plants followed the high temperatures of that period, and those which did survive, and were later gathered for seed, did not yield at all well, in spite of the good prospects from the lightly established areas.

At convenient times, samples were collected from each plot and forwarded for testing for quality of fibre produced, but it was not possible to do this just when an ideal stage of maturity had been reached, and, as a result, some samples were probably under or over mature.

The report on the quality of fibre secured from the different experimental plots is not yet available.

All fields were planted with Liral Crown variety of flax and dressed with 1cwt. of super per acre. Particulars of each and the results secured are as follow:—

J. K. Angas, Angaston.

Rainfall: Average, 22.28in. (1940, 16.79in.). *Soil Type*: Dark sandy loam. *Previous History of Field*: New land cropped with cereals 1939; ploughed May, 1940; cultivated, harrowed, and cultivated before sowing. *Seeding*: Planted 24th May through grain box of old drill. Shallow sowing in damp upper layer of soil at rates of 60lb. 70lb., and 80lb. per acre, and some double sowing across both ends of plot, culti-packed as sown. *Development*: Generally good germination, patchy in some rows; by mid-October developed into dense attractive crop in fairly late flowering stage with early bolls showing. Sample collected 11th November, 171 days from sowing. *Crop*: Tall and dense, especially where double sown. Light, clean stems, a little thicker with more branching where lighter sown. Rather green when collected and seed did not mature in sample. Estimated yield 2½ tons, height 36in to 38in.

S. DENNISON, AUBURN.

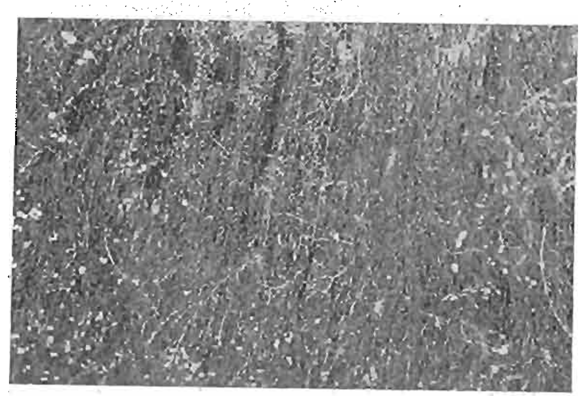
Rainfall: Average, 23.87in. (1940, 16.20in.). *Soil Type*: Heavy dark to calcareous loam. *Previous History of Field*: Fallow-wheat. Good fallow 1939, cultivated twice in the month before sowing. *Seeding*: Planted 10th June through grain box of a modern combine, fine side, setting for 52lb. to 60lb. of wheat. Medium depth sowing in slightly damp soil of fine tilth, top ½in. quite dry. Harrowed as sown. Approximately 68lb. and later 76lb. per acre. *Development*: Good germination and few weeds showing. Eaten back by rabbits by early August, and some tipping of plants as though by frost; weeds prominent by early October, but crop also making good progress, early bolls showing. Two samples collected, one 31st October (143 days) and one 7th November (150 days). *Crop*: Fairly dense, medium height, rather weedy crop. First sample golden tinge of stalk with bolls browned off. Second sample full golden colour of plant with dark-brown bolls, which rattled freely. Some seed matured in both samples. Estimated yield 2 tons. Height 26in. to 30in.

K. BRUCE, RIVERTON.

Rainfall: Average, 20.83in. (1940, 15.63in.). *Soil Type*: Heavy dark clay loam with red type towards one end. *Previous History of Field*: Pasture-fallow-wheat. Heavy medic establishment turned under in preparing 1939 fallow. Cultivated early May. *Seeding*: Planted 20th May through super feed of combine set to 190lb. and later 200lb. Shallow to medium depth sowing in dampish top layer of soil with 65lb. to 70lb. of seed increasing to 75lb. over final third of area; fine soil tilth, harrowed as sown. *Development*: Sound germination, a few weeds. Badly tipped as though by frost in early August, but recovered well by late September, when crop was flowering freely. Two samples collected on 29th October (162 days) and 19th November (173 days). *Crop*: Rather patchy, but mainly of fair density, though short and weedy. First sample rather green and second over mature. Both contained some dead plants. Seed did not mature in first sample, but was fairly good in second. Some grub damage. Estimated yield 1¼ tons. Length, 24in to 28in.

M. THOMAS, CLARE.

Rainfall: Average, 24.45in. (1940, 13.52in.). *Soil Type*: Heavy grey sandy and in places clay loam. *Previous History of Field*: Pasture ploughed, harrowed and rolled in autumn. *Seeding*: Planted 22nd May through grain side of old combine, set to sow 52lb. of wheat. Shallow sowing in damp slightly cloudy topsoil at rate of 72lb. per acre, with harrow attached. *Development*: Showing in rows 15 days after sowing, and 6in. to 8in. high by mid-August. Promise of a good crop in late September, with early indications of flowering. In full flower early October, about 50 per cent mortality of plants by late October and other plants browning off in bolls. Sample collected 30th October (161 days). *Crop*: Some areas dead, sample collected from healthy patch, where plants deep golden colour and bolls rattled freely. Fairly dense, of medium height and attractive where not affected by extreme heat. Some seed matured in sample. Estimated yield 1¼ tons. Length 20in. to 30in.



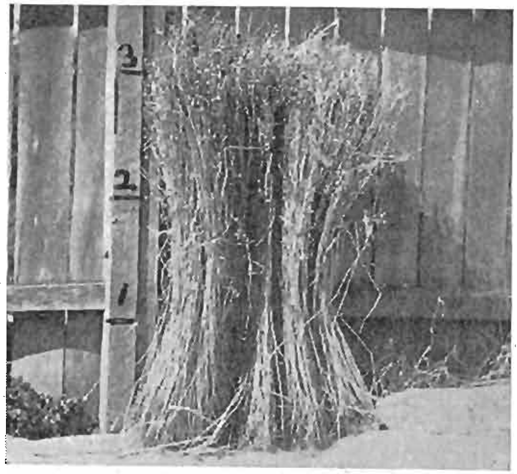
Liral Crown flax on the property of Mr. J. K. Angas, Angaston. Note early flowers just appearing and solid wall of dense well-grown crop.

E. WILSDON, ANDREWS.

Rainfall: Average, 18.50in. (1940, 10.15in.). *Soil Type*: Red sandy loam. *Previous History of Field*: Fallow-wheat-peas. Good fallow of fine tilth, worked in May. *Seeding*: Planted 3rd June, mixed with super, modern combine, set to sow 200lb. per acre. Medium depth of seeding in fine, rather dry surface mulch at rate of 74lb. per acre. Harrow attached to combine. *Development*: Thin, patchy germination, with a few small areas of sound crop. Early flowers by mid-September, full flower late in month. Good seed prospects with heavy branching of plants where thin by late October. Sample collected 30th October (149 days). *Crop*: Thin areas almost fully mature. Sample taken from later patch. Fair density, pale golden colour, but bolls well matured and rattled very freely. Seed good in sample, but proved disappointing in remainder of crop which was cut, stooked and threshed. Yield 1 ton. Length 24in to 28in.

G. Hazel, Kapunda.

Rainfall: Average, 19.68in. (1940, 14.95in.). *Soil Type*: Red sandy to very sandy loam on steeply sloping land. *Previous History of Field*: Pasture-fallow-wheat. Good fallow worked in autumn to fine tilth. *Seeding*: Planted 24th May, mixed with super, old combine set to sow 150lb. increased to 160lb. later. First 2 rounds shallow in very dry, fine mulch; next 2 rounds medium depth; and almost on



Sheaf of fibre flax, pulled from plot of J. K. Angas, at Angaston; 36-38in. in length, yielding nearly 3 tons per acre.

wheat seedbed for final round at rate of 62lb. increased to 72lb. of seed per acre; rolled after sowing. *Development*: Fair germination where sown at a shallow depth to very poor where deeply planted. Healthy, robust plants in mid-August, in full flower in mid-September. Heavy branching of plants, especially where thin. Sample collected 8th November (168 day). *Crop*: Rather thin, but well grown. It was fairly dense when sample taken, but appeared over-mature. There were some dead plants present. Good seed matured in sample, but there was a disappointing seed return from rest of plot. Estimated yield 1 ton. Length 24in. to 28in.

T. Ash, Maitland.

Rainfall: Average, 19.81in. (1940, 14.99in.). *Soil Type*: Red sandy to calcareous loam. *Previous History of Field*: Fallow-wheat-barley on previously new land, slightly cloddy fallow worked to fine tilth before sowing. *Seeding*: Planted 8th June, mixed with super, modern combine set to sow 200lb. per acre. Medium depth of sowing in fine tilth at rate of 70lb. to 72lb. per acre. Harrowed 3 days later. *Development*: Very patchy germination in some rows and only fair in others, approximately 1½in. high in mid-July. Grazed out by sheep twice and commenced to shoot again in late August. Sample collected 6th November (151 days). *Crop*: Thin, coarse-stemmed, heavily branched, plants with excellent seed prospects. Sample appeared over mature and covered with a sticky substance similar to honey dew. Splendid seed matured in sample. Estimated yield 1 ton. Length 26in. to 28in.

F. Coleman, Saddleworth.

Rainfall: Average, 19.66in. (1940, 13.02in.). *Soil Type*: Dark clay loam. *Previous History of Field*: Two years of fallow, very fine shallow mulch. *Seeding*: Planted 23rd May, mixed with super, modern combine set to sow 180lb., increased to 196lb. per acre. Shallow sowing in moist topsoil, but dampness did not extend into mulch. Rate of seeding 64lb. per acre, increased to 76lb. later. Topsoil damp enough to stick to wheels of combine and tractor, leaving large strips of compressed soil after sowing; not harrowed. *Development*: Poor germination because of the inability of plants to break through the wheel marks and clods left by combine and tractor. Lucerne flea and red-legged earth mite in evidence and attacking plants by mid-July. Recovered from attack by pests, some tipping as though by frost and weeds taking possession by mid-August. Poor crop, and as weeds were in possession by late August the plot was abandoned.

Fibre Flax

Investigations at the Waite Institute

[By K. A. Pike, R.D.A., Farm Manager, Waite Agricultural Research Institute.]

Introduction.

The increased demand for flax fibre, particularly since the growth and spread of the war, has aroused considerable interest in the possibilities of establishing the flax industry in southern Australia. Rapid commercialization of flax production has already occurred, especially in Victoria and Tasmania, and although this stage was not reached in South Australia during 1940, investigations of the flax crop have been in progress at the Waite Institute since 1937.

Recent advances in Australia have been largely associated with the use of the Liral Crown variety of flax, which was imported by Flax Fibres Ltd. in 1936-37. This variety was bred for increased yield and quality of fibre by the Linen Industries Research Association at Lambeg, Northern Ireland, and has proved well adapted to the climatic conditions of the Adelaide plains, bordering the foothills of the Mount Lofty Ranges.

Seed of this variety was obtained in 1937 by Dr. A. E. V. Richardson, then Director of the Waite Institute, and a programme of investigational work was commenced in that season.

The trials were designed to indicate the optimum time and rate of seeding required for maximum yields and to assess the suitability of the district for flax-growing. It was believed that conditions might favour seed production rather than the production of fibre.

The yields recorded in the initial year were particularly good and demonstrated that fibre of high quality could be produced in addition to the seed.

Further trials were carried out in each of the three following seasons, 1938-40, and the results obtained over the four years are described hereunder.

Soil and Climatic Conditions.

All trials were conducted on red-brown loam overlying a red clay subsoil. The area used each year had been ploughed to a depth of 4in. the previous year, and had lain in fallow for approximately 10 months. The working of the fallow was designed to produce a fine, firm tilth, and to control all weed growth. Rainfall is the most important factor in any consideration of climate in relation to flax production, and a favourable distribution of the seasonal precipitation is necessary for maximum growth. The rainfall data for the period 1937-40 are summarized in Table I.

Table I.—*Showing Monthly Rainfall and Number of Rainy Days Recorded at the Waite Institute for the Years* 1937-40 *Compared with the* 15-*year Average,* 1925-39.

	Rainfall (Inches).						Number of Rainy Days.					
	1937.	1938.	1939.	1940.	Mean, 1937-40.	Mean, 1925-39.	1937.	1938.	1939.	1940.	Mean, 1937-40.	Mean, 1925-39.
January	2·82	0·77	1·18	1·49	1·56	0·85	11	11	4	7	8·2	6·3
February	0·55	2·21	1·97	0·54	1·32	1·08	5	15	10	6	9·0	5·7
March	1·01	0·15	1·56	0·67	0·85	0·95	6	5	6	4	5·2	6·4
April	1·13	5·94	2·53	3·78	3·35	1·98	8	12	14	14	12·0	12·1
May	4·69	1·29	2·52	1·07	2·39	3·09	19	9	14	12	13·5	14·8
June	2·21	2·66	5·05	1·07	2·75	3·13	18	20	19	13	17·5	18·9
July	1·73	3·09	2·43	3·85	2·78	2·96	17	19	18	23	19·2	21·0
August	3·65	2·70	4·74	1·74	3·21	3·31	20	17	21	17	18·7	20·0
September	3·59	1·02	1·52	1·68	1·95	2·67	21	11	16	16	16·0	17·5
October	0·78	1·01	1·18	0·70	0·92	1·71	9	6	15	10	10·0	13·8
November	2·03	0·70	4·02	1·97	2·18	1·30	9	8	14	12	10·7	8·7
December	1·65	0·49	0·28	1·30	0·93	1·05	11	4	7	8	7·5	7·0
Total	25·84	22·03	28·98	19·86	24·19	24·08	154	137	158	142	147·5	152·2
May-October	16·65	11·77	17·44	10·11	14·00	16·87	104	82	103	91	94·9	106·0

The chief characteristics of the four seasons were as follow:—

(i.) 1937—

Rainfall for the year, 25.84in., was slightly above the average for the period 1925-36 (23.69in.), and its distribution was favourable for maximum plant development. Opening rains in May were very substantial, and early spring falls were above average, supplying adequate moisture for the crops to mature satisfactorily during a relatively dry October.

(ii.) 1938—

The total rainfall was below the 1925-37 average by only 1.82in. Its incidence and distribution, however, were not favourable. The seasonal precipitation (1st May to 31st October) was 11.77in., only 53 per cent of the total for the year.

The number of days on which rain was recorded was the lowest for the period under review. A dry spring hastened maturity but did not affect the quality of the seed or fibre.

(iii.) 1939—

This was a year of high rainfall, 28.98in., much of which fell during early winter, keeping the ground very wet and making seeding operations difficult. The rainfall was fairly well distributed, with a high number of rainy days. Heavy falls in November delayed harvest.

(iv.) 1940—

This was the driest year experienced at the Waite Institute since its inception. The total rainfall recorded, 19.86in., was 4.22in. below the average for the 15-year period 1925-39, whilst only 10.11in. were recorded during the growing period of the crop.

Figure 1.—Portion of the 1937 trial with Liral Crown Flax.

The season opened with good rains in April with 3.78in. for the month. Excellent germination and early growth was obtained with all seedings, and it is evident that the liberal rains received in April were responsible for this result, as the May and June falls were too light to be credited with the satisfactory growth obtained.

Good rains in July set the foundation for exceptionally heavy yields, but insufficient moisture due to abnormally light spring rains caused premature ripening, affecting the yield of seed in particular.

Experimental Methods.

Throughout the trials the individual treatments have been replicated four times with a randomized block system.

The plots were single drill-strips sown adjacent, thus eliminating pathways. In order to overcome any border effect and to separate the plots for harvesting, the outside drill row on either side of each plot was removed and discarded shortly before the crop was ready to harvest.

(i.) *Method of Seeding.*—In all seasons light cultivation was followed by harrowing to produce a fine level surface. A disc drill was used for seeding the plots, the discs being set so that the seed was not buried deeper than half an inch; actually much of the seed was not covered by the drill, but a light harrowing gave the desired covering. Shallow seeding was taken as being essential for satisfactory germination.

Super was applied with the seed in the usual manner, but the sulphate of ammonia used in 1937 was broadcast on the surface and harrowed in.

(ii.) *Weeding.*—As the plots were sown on well-worked fallow, weeds were not at any time troublesome. In order to minimize the error occasioned by weed growth, however, all tall growing or rosette type weeds, such as wild oats (*Avena fatua*), Salvation Jane (*Echium plantagineum*), and Cape weed (*Cryptostemma calendulaceum*) were removed during early growth of the crop.

(iii.) *Harvest Notes.*—Throughout the trials every endeavour was made to harvest the plots at the same stage of maturity. In order to do this it was necessary to hand-pull the crop, as the blocks were randomized and the early sown plots were ready for harvesting some time before those sown later.

Hand-pulling enables the total crop of straw to be harvested. When cut with the reaper and binder some loss in the stubble left behind is inevitable. The amount of loss will depend on the height of cutting, and may be very substantial if a level surface has not been prepared at seeding.

The stage of growth selected was when most of the bolls had turned brown. At this stage the seeds are quite firm, and of a brownish hue, and the stems are changing from green to a golden shade, the leaves having withered and fallen from the lower half of the plant.

The sheaves were put into small stooks and left until uniformly dry, when the weights were recorded and the crop deseeded.

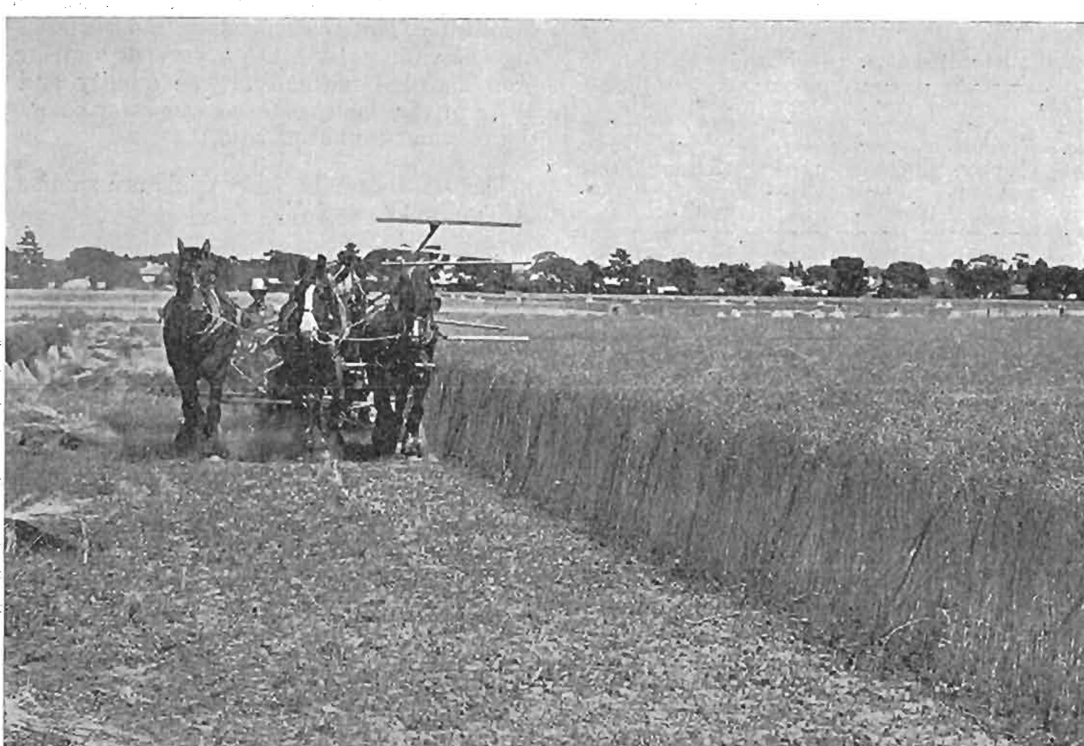


Figure 2.—Harvesting a crop of Liral Crown Flax with a reaper and binder, October, 1940.

Results of Trials in Each of the Four Seasons, 1937-40.

(i.) 1937—

The treatments employed were early and late sowing (21st May and 22nd June). Seed rates of 40lb., 60lb., 80lb., and 100lb. per acre, and the application of 2cwt. of super with and without 2cwt. sulphate of ammonia.

Conditions at seeding were very favourable, resulting in an excellent germination. The crop made vigorous growth and at harvest was 42in. to 45in. high. Time of sowing had little effect on the ultimate height of the flax.

Considerable lodging occurred in the plots sown with 80lb. and 100lb. of seed per acre; the lodging was more apparent where sulphate of ammonia had been applied.

Sustained wet weather whilst the crop was stooked caused considerable damage to the seed, reducing the yield and lowering the viability.

The results for 1937 are summarized in Tables II. and III.

Table II.

TABLE II.—*Showing Total Yield of Hand-Pulled Flax in cwt. per acre,* 1937.

Seed Rate Lb. per Acre.	Sown 21st May.		Sown 22nd June.		Mean of Times of Sowing and Fertilizers.
	2cwt. Superphosphate.	2cwt. Super + 2cwt. Sulphate Ammonia.	2cwt. Superphosphate.	2cwt. Super + 2cwt. Sulphate Ammonia.	
40	48·31	53·41	36·59	39·19	44·38
60	49·75	58·91	36·72	41·53	46·73
80	52·12	66·37	40·28	40·50	49·82
100	52·22	61·44	40·16	41·59	48·85
Mean of all seed rates	50·60	60·03	38·44	40·70	
Mean of all seed rates and fertilizers ...	55·32		39·57		

Time of sowing had the greatest effect on yields, May sown plots yielding 15.75cwt. per acre more than those sown a month later. The application of sulphate of ammonia in addition to super gave increased yields, particularly when applied to the early sown plots. The higher seed rates produced small but significant increase in yield. The maximum yield of total produce was obtained with a seed rate of 80lb. per acre.

TABLE III.—*Showing the Yields of Seed in bushels per acre,* 1937.

Seed Rate Lb. per Acre.	Sown 21st May.		Sown 22nd June.		Mean of Times of Sowing and Fertilizers.
	2cwt. Superphosphate.	2cwt. Super + 2cwt. Sulphate Ammonia.	2cwt. Superphosphate.	2cwt. Super + 2cwt. Sulphate Ammonia.	
40	13·58	12·24	7·81	7·42	10·26
60	11·99	11·83	7·67	5·56	9·26
80	9·75	10·83	7·50	5·52	8·40
100	11·05	9·77	5·38	3·77	7·49
Mean of all seed rates	11·59	11·17	7·09	5·57	
Mean of all seed rates and fertilizers ...	11·38		6·33		

(ii.) 1938—

In this season the treatments employed were early and late sowing at seed rates of 20lb., 40lb., 60lb., and 80lb. per acre with super at 1cwt. and 2cwt. per acre. Seeding conditions were again favourable, and the flax made good growth during the winter. Despite a very dry spring, the crop matured normally. The quality and viability of the seed produced was comparable with the original imported seed.

The results of the 1938 trials are summarized in Tables IV. and V.

TABLE IV.—*Showing Total Yield of Hand-pulled Flax in cwt. per acre,* 1938.

Seed Rate Lb. per Acre.	Sown 24th May.		Sown 22nd June.		Mean of Times of Sowing and Fertilizers.
	1cwt. Superphosphate.	2cwt. Superphosphate.	1cwt. Superphosphate.	2cwt. Superphosphate.	
20	35·02	33·89	17·65	21·39	26·99
40	46·46	47·69	28·70	30·49	38·33
60	47·50	50·54	32·31	31·42	40·44
80	48·21	51·16	32·52	36·72	42·15
Mean of all seed rates	44·30	45·82	27·79	30·01	
Mean of all seed rates and fertilizers ...	45·06		28·90		

The mean yield of all early sown plots, 45.06cwt. per acre, was 16.16cwt. higher than that of the late sown plots. The application of 2cwt. super per acre gave a small but significant increase in yield over 1cwt. per acre.

Seeding at the rate of 20lb. per acre produced a light crop, especially when sowing was delayed until 22nd June. There were only small differences in yield between the other seed rates. These differences, however, were in favour of the higher rates.

The average height of the early sown flax was 42in. compared with 37in. for the late sowing.

TABLE V.—*Showing Yields of Seed in bushels per acre,* 1938.

Seed Rate Lb. per Acre.	Sown 24th May.		Sown 22nd June.		Mean of Times of Sowing and Fertilizers.
	1cwt. Superphosphate.	2cwt. Superphosphate.	1cwt. Superphosphate.	2cwt. Superphosphate.	
20	9·56	9·78	3·69	4·32	6·84
40	9·24	8·79	6·08	6·18	7·57
60	8·78	8·72	6·54	6·23	7·57
80	7·80	7·64	5·90	7·08	7·11
Mean of all seed rates	8·84	8·73	5·55	5·95	
Mean of all seed rates and fertilizers ...	8·79		5·75		

The yields of seed were increased by early sowing, but were not significantly affected by the higher phosphate dressing. The use of higher seed rates lowered the seed production of the early sown flax, but tended to have the opposite effect for the later sowing.

(iii.) 1939—

The investigations were continued in 1939, using the same treatments as were employed in 1938.

The early sown plots were drilled under fair conditions on 23rd May, but the seeding of the late sown plots was delayed until 3rd July, when they were sown under rather wet conditions following 505 points of rain in June. The lucerne flea and red-legged earth mite attacked the crop in large numbers at the seedling stage, causing a very severe check to early growth. The growing season was long with heavy rains in November which delayed harvest.

The results are summarized in Tables VI. and VII.

TABLE VI.—*Showing the Total Yield of Hand-pulled Flax in cwt. per acre,* 1939.

Seed Rate Lb. per Acre.	Sown 23rd May.		Sown 3rd July.		Mean of Times of Sowing and Fertilizers.
	1cwt. Superphosphate.	2cwt. Superphosphate.	1cwt. Superphosphate.	2cwt. Superphosphate.	
20	32·37	31·28	14·25	15·12	23·26
40	52·44	52·78	21·50	26·87	38·40
60	56·92*	57·04*	26·06	31·00*	42·76
80	61·59	60·37	29·59	32·87	46·11
Mean of all seed rates	50·83	50·37	22·85	26·46	
Mean of all seed rates and fertilizers ...	50·60		24·66		

* Yield corrected to eliminate effect of damage by red-legged earth mite to one replicate.

TABLE VII.—*Showing Yields of Seed in bushels per acre,* 1939.

Seed Rate Lb. per Acre.	Sown 23rd May.		Sown 3rd July.		Mean of Times of Sowing and Fertilizers.
	1cwt. Superphosphate.	2cwt. Superphosphate.	1cwt. Superphosphate.	2cwt. Superphosphate.	
20	9·52	9·09	2·94	3·44	6·25
40	13·12	13·63	4·66	6·16	9·39
60	13·52*	12·17*	5·75	6·62*	9·52
80	13·50	13·06	6·00	6·94	9·87
Mean of all seed rates	12·42	11·99	4·84	5·79	
Mean of all seed rates and fertilizers ...	12·20		5·31		

* Yield corrected to eliminate effect of damage by red-legged earth mite to one replicate.

Time of sowing greatly affected both total yield and seed production, the early sown plots yielding 105 per cent more total produce and 130 per cent more seed than those sown six weeks later.

The application of the higher rate of super had no significant effect on the yields of early sown plots, but gave slightly higher yields of both total produce and seed when the flax was sown in July.

Increasing the seed rate from 20lb. to 40lb. per acre greatly increased the yields of both total produce and seed. The higher seed rates significantly increased the yields of total produce, but had little effect on seed production.

(iv.) 1940—

The results of the 1937-39 trials indicated the necessity for early sowing with a fairly substantial seed rate for the production of maximum yields of fine flax straw.

The trials in 1940 were designed to determine the effect of sowing two weeks earlier and later than the date of early sowing in previous years, with three seed rates—40lb., 60lb., and 80lb. per acre. All plots received a basal dressing of 168lb. of super per acre.

Relatively dry conditions prevailed at seeding and throughout June. However, substantial rains in April had made possible the thorough preparation of a good seedbed, with the result that an excellent germination was obtained for all sowings and the light rains experienced in May and June were sufficient to maintain early growth.

The July rainfall was well above average, but only 4in. of rain were recorded during the next three months. Despite this, the crop grew vigorously and stood up well to the hot, dry weather in early October.

At harvest the crop was 42in. to 45in. high, and there was practically no difference in height between any of the treatments. The seed sample was not as good as that produced in 1938 and 1939.

The results are summarized in Tables VIII. and IX.

TABLE VIII.—*Showing the Total Yield of Hand-pulled Flax in cwt. per acre,* 1940.

Seed Rate Lb. per Acre.	Time of Sowing.			Mean of Times of Sowing.
	8th May.	22nd May.	5th June.	
40.........	52·00	40·99	37·22	43·40
60.........	55·92	46·25	40·06	47·41
80.........	60·54	49·84	40·29	50·22
Mean of all seed rates	56·15	45·69	39·19	47·01

Seasonal conditions favoured the seeding made on 8th May, which gave an increased yield of 10.46cwt. of total produce and 2.77bush. of seed over the sowing on 22nd May. Sowing on 5th June resulted in decreased yields of both total produce and seed.

TABLE IX.—*Showing the Yields of Seed in bushels per acre,* 1940.

Seed Rate Lb. per Acre.	Time of Sowing.			Mean of Times of Sowing.
	8th May.	22nd May.	5th June.	
40.........	10·43	7·63	7·03	8·36
60.........	10·02	6·70	6·69	7·80
80.........	9·08	6·89	6·74	7·57
Mean of all seed rates	9·84	7·07	6·82	7·91

Yields of total produce increased with the increase in seed rate. The increases were greater for the May sowings. The highest yield of total produce at each sowing date was with a seed rate of 80lb. per acre, whilst the highest yield of seed was with a seed rate of 40lb. per acre.

During rough, rainy weather in September considerable lodging occurred in the early sown plots, but the crop completely recovered during the dry period which followed.

Cut worms made their appearance in the crop soon after flowering and became very prevalent, causing a considerable loss of seed. No estimate was made of the damage to the Liral Crown flax used in this trial, but work done with linseed varieties in an adjacent area indicated that the seed yield was reduced by the cut worms to the extent of 25 per cent to 30 per cent.

Influence of Time and Rate of Seeding over the Four Seasons, 1937-40.

The yield data for the four seasons are summarized in Table X. In compiling this table only the three seed rates employed in all four seasons were included, and the yields are those obtained with 2cwt. super for the first three seasons, and with 1½cwt. super per acre in 1940.

Yields from plots sown on 22nd May, 1940, have not been included; 8th May has been taken as the early sowing and 5th June as the late sowing for this season. The weather conditions for the four seasons varied considerably, and the rainfall recordings for 1939 and 1940 were the highest and lowest respectively since the commencement of records at the Waite Institute. Despite this, the yields of total produce from the early sown flax were consistently high in all four seasons.

In European countries, where flax is normally spring sown, the growing period is 85 days to 100 days. With autumn sowing at the Waite Institute crops sown in May were ready to harvest in 162 days to 169 days; those sown in June were ready in 145 days to 153 days.

TABLE X.—*Showing the Effect of Time of Sowing and Rate of Seeding on the Yield of Flax (Total Produce and Seed), Waite Institute,* 1937-40. (*Basal dressing of super 2cwt. per acre* 1937-39; $1\frac{1}{2}$*cwt. per acre* 1940.)

(i.) Total produce (cwt. per acre)—

	Early Sown.				Late Sown.			
	40lb.	60lb.	80lb.	Mean.	40lb.	60lb.	80lb.	Mean.
1937	48·31	49·75	52·12	50·06	36·59	36·72	40·28	37·86
1938	47·69	50·54	51·16	49·80	30·49	31·42	36·72	32·88
1939	52·78	57·04*	60·37	56·73	26·87	31·00*	32·87	30·25
1940	52·00	55·92	60·54	56·15	37·22	40·06	40·29	39·19
Mean	50·20	53·31	56·05	53·18	32·79	34·80	37·54	35·04

(ii.) Seed (bushels per acre)—

	40lb.	60lb.	80lb.	Mean.	40lb.	60lb.	80lb.	Mean.
1937	13·58	11·99	8·75	11·77	7·81	7·67	7·50	7·66
1938	8·79	8·72	7·64	8·38	6·18	6·23	7·08	6·50
1939	13·63	12·17*	13·06	12·95	6·16	6·62*	6·94	6·57
1940	10·43	10·02	9·08	9·84	7·03	6·69	6·74	6·82
Mean	11·61	10·72	9·88	10·74	6·80	6·80	7·06	6·89

* Yield corrected to eliminate effect of damage by red-legged earth mite to one replicate.

In all seasons the highest yields of total produce from both early and late seeding were obtained when 80lb. of seed was used. The differences in yield between the three seed rates—40lb., 60lb., and 80lb. per acre—were not very great. The higher seed rates, however, produced thicker stands, resulting in good quality, fine straw of greater fibre content than the coarser straw from the lower seed rates.

The mean yields of early and late sowing for the four seasons are summarized in Table XI.

TABLE XI.—*Showing the Mean Yields for the Three Seed Rates, 40lb., 60lb., and 80lb. per acre,* 1937-40.

	Early Sown.	Late Sown.	Increase due to Early Sowing.
(i.) Superphosphate 2cwt. per acre ($1\frac{1}{2}$cwt. 1940)—			
Total produce (cwt. per acre)	53·18	35·04	18·14
Seed (bush. per acre)	10·74	6·89	3·85
(ii.) All fertilizer dressings—			
Total produce (cwt. per acre)	54·10	34·58	19·52
Seed (bush. per acre)	10·80	6·52	4·28

The yield of total produce from all early sown plots for the four seasons was 54.10cwt. per acre and exceeded the yield of the late sowing by 19.52cwt. The yield of seed was 4.28bush. per acre greater with early sowing.

In a normal season in this district sowing as early as 8th May may be attended with some risk, because a heavy, tall crop is likely to result and lodging may be serious.

Yield and Quality of Fibre.

The chief concern of the grower is the yield of flax straw that can be produced, but the ultimate success of any district for flax-growing depends on the amount and quality of fibre that can be obtained from the straw by the processors.

In order to determine the effect of local conditions and the various treatments employed in the trials on the yield and quality of fibre, samples of straw from each treatment in 1937 and 1938 and from the early sown plots in 1939 were sent to the Division of Forest Products, Council for Scientific and Industrial Research in Melbourne, for experimental retting and scutching.

The following is a summary of the report, received from Mr. A. M. Munro of the Division of Forest Products, on the samples from the 1937 harvest:—

"On comparison with flax fibre received from abroad and with fibre prepared in our laboratory and at the Colac Mill all the samples are, in our opinion, of excellent quality, particularly with regard to length, colour, uniformity, and tensile strength.

It would appear that it is not possible, at any rate on the scale of these tests, to connect either fibre quality or yield with various sowing rates or systems of manuring."

The report indicated that the fibre obtained from the samples of straw submitted compared more than favourably with material from local sources that had previously been received.

Samples from each plot of the 1938 trial were forwarded for retting and scutching, and the detailed data obtained were subjected to statistical analysis. Time of sowing and fertilizer treatments had no effect on the fibre content of the straw. The differences in percentage of fibre between the seed rates were not significant in the late sown plots, but there were significant differences in favour of the higher seed rates with early sowing.

The report on the samples of straw from the 1938 crop with reference to the percentage of fibre and its quality is summarized as follows:—

Percentage of Fibre.

Sowing Date.	Rate of Seeding, Lb. per Acre.				
	20.	40.	60.	80.	Mean.
24th May	11·7	14·1	15·1	15·5	14·1
22nd June	13·8	14·3	13·5	14·7	14·1

"The fibre from each test, although somewhat dark, is of good average quality, and no difference can be ascertained between the samples from the different plots."

Composite samples from the four replicates of each treatment of the early sown plots were retted and scutched in 1939, and the results are summarized in the following table:—

Showing the Percentage of Total Fibre as Calculated on Original Straw, 1939.

Fertilizer.	Rate of Seeding, Lb. per Acre.				
	20.	40.	60.	80.	Mean.
1cwt. Superphosphate.	16·1	16·5	18·7	19·2	17·62
2cwt. Superphosphate.	15·7	17·0	18·2	19·1	17·50
Mean	15·90	16·75	18·45	19·15	17·56

An examination of these figures reveals an upward trend in percentage of fibre with increased rate of seeding, similar to that obtained with early sowing in 1938.

The amount of super applied did not affect the yield of fibre.

The highest percentage of fibre was obtained with a seeding rate of 80lb. of seed per acre.

"The fibre was of good colour, long, glossy, of high apparent density, and of good tensile strength."

Summary.

During the four years 1937-40 the "Liral Crown" variety of flax was successfully grown at the Waite Institute.

The average total rainfall for the four years was equal to the mean for the 15-year period 1925-39, viz., 24in., but the average rainfall during the growing period (May to October, 14in.) was 2.87in. below the 15-year mean for the same period.

Despite two very unfavourable years the average yield of undeseeded straw from all plots sown in May was 54.10cwt. per acre, included in which was 10.80bush. of seed.

Time of sowing had a pronounced effect on the yield of undeseeded straw and seed. Early sowing appears to be an essential factor for maximum yields. The crop is obviously more sensitive to time of sowing than the cereal crops grown in South Australia. Flax sown in May yielded 19.52cwt. of total produce and 4.28bush. of seed more than that sown approximately four weeks later. The seed rate, 80lb. per acre, has in every year given the highest yield of undeseeded flax straw, with an average of 56.05cwt. per acre for early sowing with 2cwt. super. On the other hand, seed yields have been highest at a seeding rate of 40lb. per acre.

The results suggest that 1cwt. to 1½cwt. of super per acre is the optimum fertilizer dressing and that the most suitable seed rate is between 60lb. and 80lb. per acre. The applica-

tion of a higher dressing of super and the use of sulphate of ammonia have given slight improvements in yield but increased the tendency of the crop to lodge.

Favourable reports as to quality and percentage fibre content of the straw were received from the Division of Forest Products, Council for Scientific and Industrial Research, who carried out retting and scutching tests on samples from the trials in 1937, 1938, and 1939.

The results indicate that with early sowing the fibre content of the straw is increased by the use of higher seed rates, but there is no indication that time of sowing or fertilizer treatment affect the fibre.

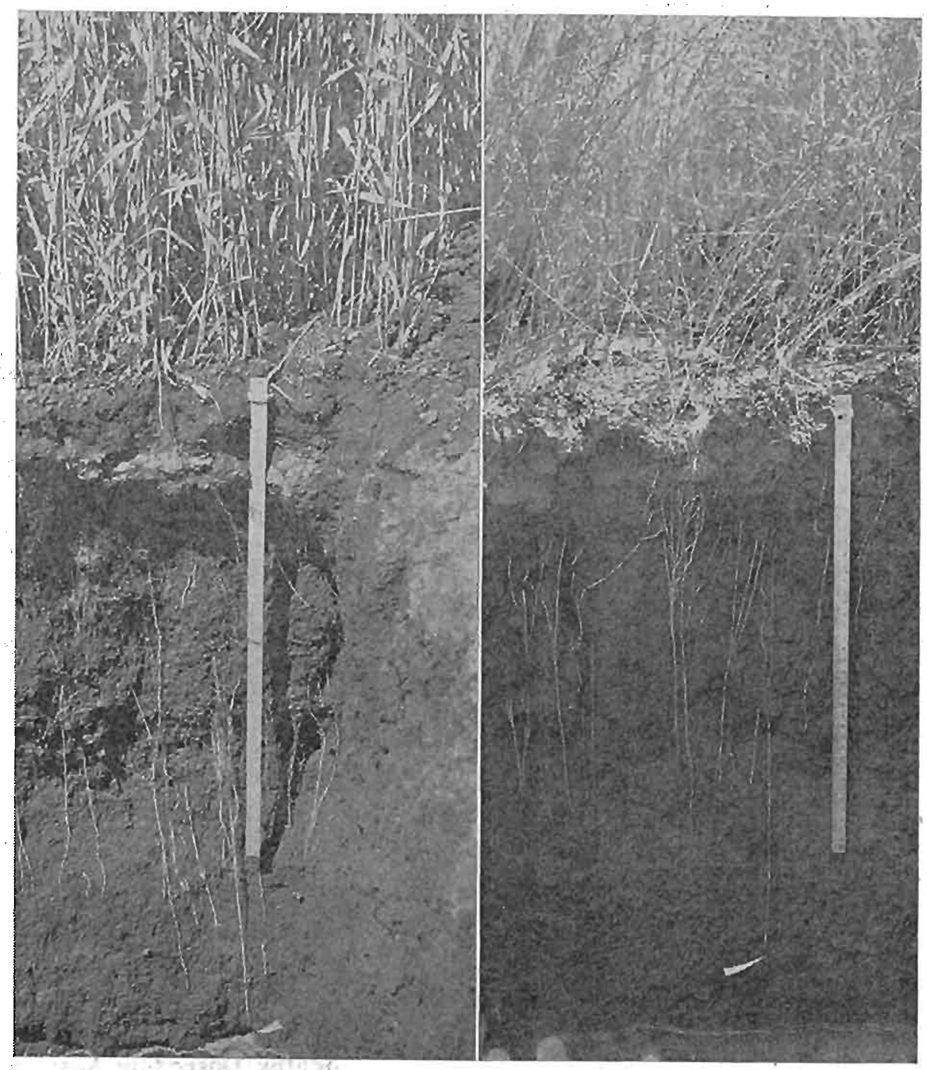


Figure 3.—(*Left*) Roots of wheat; and (*right*) Roots of Liral Crown Flax, showing depth of penetration.

Acknowledgments.

The author desires to acknowledge his indebtedness to Dr. A. E. V. Richardson, under whose direction these trials were commenced, for his active interest and supervision in the initial year; to Dr. H. C. Trumble, Senior Agronomist, and Dr. I. F. Phipps, Geneticist, of the Waite Institute, for their ready advice and helpful criticism; and to Mr. E. A. Cornish, now of the Council for Scientific and Industrial Research, for carrying out the statistical analyses of yield data.

Thanks are also due to the Division of Forest Products, Council for Scientific and Industrial

Research, for retting and scutching samples of straw from the trials, and to Mr. A. D. Cocks, of the Waite Institute, for the photographs appearing in this paper.

Appendix I.

A Note on the Root System of Flax.

Flax is generally considered as a crop requiring a cool climate and a rainfall in excess of 25in. per annum, but the ability of the variety "Liral Crown" to produce heavy yields of good length straw and mature good quality seed under the conditions existing at the Waite Institute in the growing seasons of 1938 and 1940 indicated that its drought resistance was greater than generally assumed. In each of these two seasons only a little over 4in. of rain fell during the latter half of the growing period, and the weather was abnormally warm at the time of flowering. The crop, however, did not appear to be any more affected by the dry conditions than adjoining wheat crops.

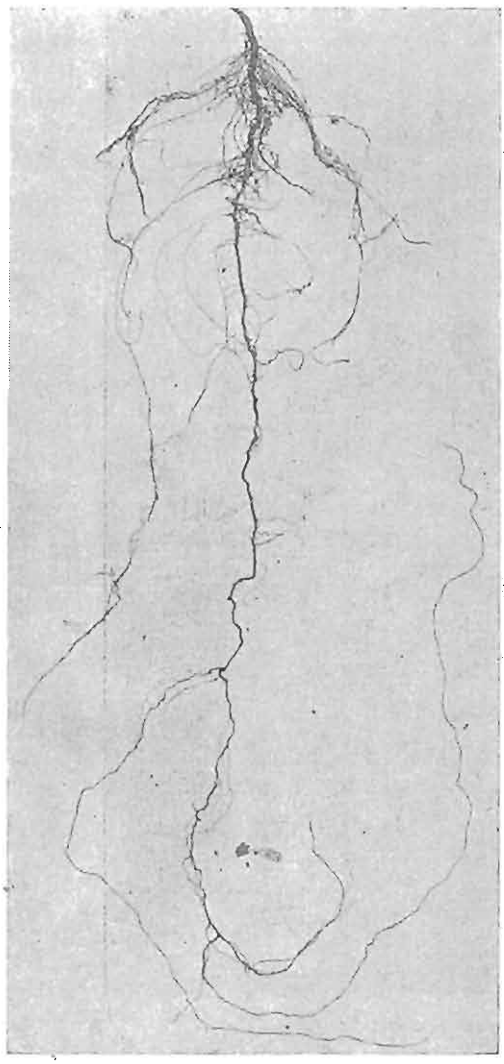


Figure 4.—Root system of a single plant of Liral Crown Flax.

In September, 1940, a comparison was made between the root systems of flax and wheat by digging a pit to a depth of 6ft. between adjacent areas of the two crops, so that the roots of flax plants were exposed on one profile and the roots of wheat plants on the other.

The soil was very dry to a depth of several inches but became moister with increasing depth, the clay at the bottom of the pit containing sufficient moisture to enable it to hold in a lump when pressed together in the hand.

The root systems of typical plants of flax and wheat were traced by carefully excavating and washing away the soil with a fine spray of water.

The roots of both plants had penetrated into the moister region of the heavy clay subsoil. The maximum penetration of flax roots showing on the profile was 4ft. 6in., whilst on the opposite side of the pit wheat roots were traced to a depth of 5ft..

The exposed profiles showing the root systems of the wheat and flax plants are depicted in Fig. 3.

The root system of flax consists of a slender tap root and its numerous ramifications (Fig. 4) and differs materially from that of the wheat plant, which is entirely fibrous.

The extent of the vertical penetration of the flax roots into the subsoil is no doubt the explanation for its relative drought resistance, enabling it to utilize during a dry period in spring moisture which penetrated to the subsoil during the winter months.

Appendix II.

A Flax Deseeding Machine.

In commercial flax culture deseeding is done at the flax mills prior to retting, but in the experimental work at the Waite Institute the yields of seed were required in addition to the total yield. The need arose for a machine capable of deseeding quickly and effectively relatively large quantities of flax.

In deseeding flax it is essential that the straw is not damaged or tangled. The seed is easily separated from the straw by lightly crushing the bolls, each of which contains a maximum of ten seeds.

Commercial deseeding involves much hand labour. The flax is received from the grower in sheaves, the bands of which are cut and a portion of the sheaf is opened out fanwise and the heads or bolls passed several times between two steel rollers revolving in opposite directions, the deseeded straw being passed on to be retied.

A machine was devised by the foreman of the Waite Institute, Mr. B. W. Hollins, and the author, and constructed by the former, in which the deseeding and retying were accomplished with one handling.

The machine depicted in Fig. 5, although still in the experimental stage, requiring several minor adjustments and improvements, successfully deseeded 12 tons to 15 tons of flax this season.

The main working parts of the machine are:—

1. A double set of steel rollers in two gangs of four revolving in opposite directions. The top set of four are adjustable and can be set to give the pressure necessary for effective crushing of the bolls.

2. A pair of conveyor canvasses, which run the full length of the machine and are set at the side, in the same plane as the steel rollers, so that they grip the lower portion of the flax straw at the same time as the rollers grip the heads. The object of these canvasses is to keep the straw straight during its passage through the machine and to convey it to the binding attachment after it passes beyond the rollers.

3. A pair of light beaters, attached to a crankshaft and operating alternatively. The beating action is in the same direction as the movement of the straw, so as not to interfere with the speed at which the flax is being conveyed by the canvasses. These beaters operate on the top 18in. of straw as it passes over an iron grid, removing any seed that is still attached.

4. A binding attachment from an ordinary reaper and binder, which straightens, packs, and ties the deseeded straw into sheaves.

The mixture of seed and crushed bolls falls from the rollers and through the iron grid on

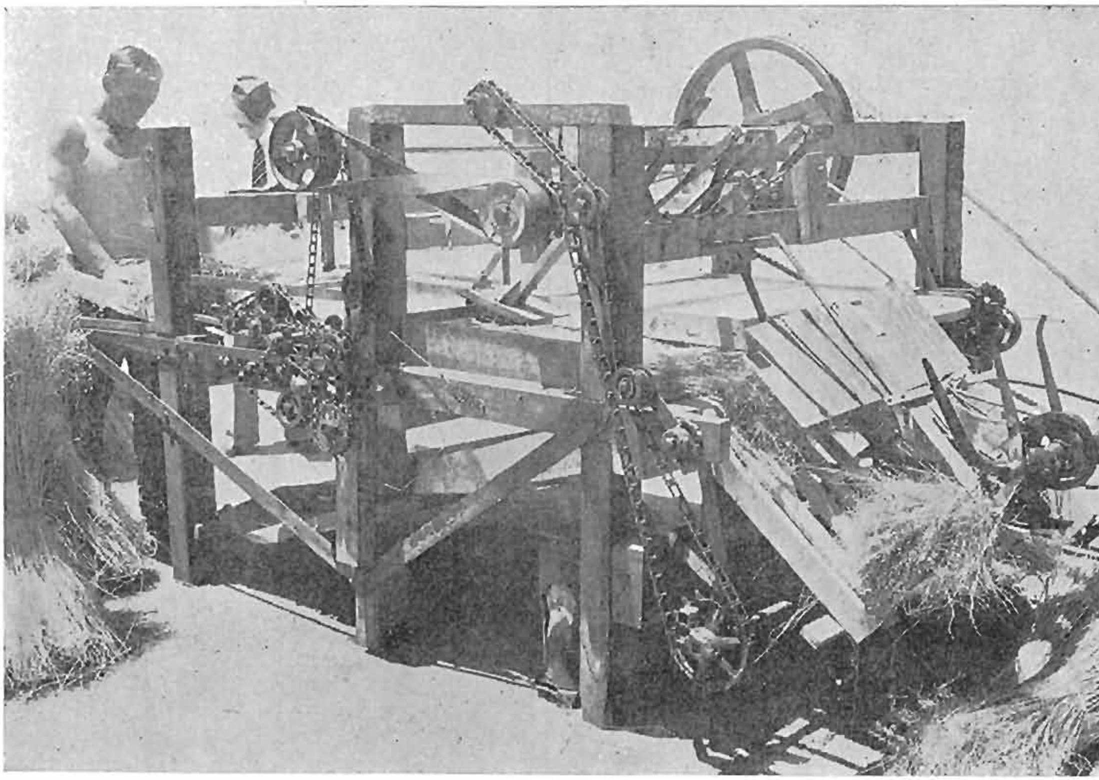


Figure 5.—Deseeding flax with the machine devised at the Waite Agricultural Research Institute.

to a sloping tray which delivers it to the side of the machine.

The machine was driven quite easily by a 2 h.p. petrol engine.

Deseeding with the machine was practically 100 per cent efficient when the flax was thoroughly dry and the sheaves had been well tied and carefully handled.

The rate at which flax can be deseeded with the machine depends on the amount that can be handled by the feeder who has to spread the sheaf and feed a fairly thin layer into the rollers.

It is estimated that a commercially built machine of similar design, but embracing small improvements, could handle up to 2 tons of flax per hour.