Kimberley Research Station: a progress report

Department of Agriculture, Western Australia

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KIMBERLEY RESEARCH STATION

A Progress Report

(Prepared by the Supervisory Committee* of the Kimberley Research Station, September, 1960)

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   Background, location, soils and climate

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VII. CONCLUSIONS AND FUTURE WORK

* The Committee consists of—
   Mr. W. M. Nunn, Department of Agriculture, Chairman.
   Mr. G. A. Stewart, C.S.I.R.O.
   Mr. H. Hirst, C.S.I.R.O. and Resident Director of the Station.
   Mr. J. J. Basinski, C.S.I.R.O.
   Mr. E. K. Steere, Department of Public Works, W.A.
INTEREST in the agricultural potential of the Kimberley region in Western Australia dates from its early exploration and settlement in the last century. Several farming development schemes were considered for the area, but were never implemented. This could be mainly attributable to lack of knowledge of agricultural potentialities, limitations of the local environment and ways of exploiting the local environment. Up to the present the economy of the region is almost entirely based upon the extensive production of beef and to a lesser extent, wool.

Since the last war, when preliminary studies by Dumas (1944) revealed the existence of excellent dam sites on the Ord River, interest in the region's development has been largely centred on the irrigation possibilities of the Ord valley. A study of the river's hydrology and means of harnessing its waters for irrigation and power was carried out by the Public Works Department of Western Australia. To determine the extent of irrigable areas, soil and topographical surveys were undertaken by officers of the Western Australian Government and C.S.I.R.O. Finally, research into the problems of irrigated farming in the area was undertaken at the Kimberley Research Station, operated jointly since 1947 by the Western Aus-
Aerial view of Kimberley Research Station homesteads and garden area on the bank of the Ord River. Workshops and pumping station are in the foreground.

These studies culminated recently in proposals put forward to dam the Ord River to provide a storage reservoir of 3½ million acre feet and a hydro-electric potential equivalent to 110,000 KW. The proposals also include the construction of a diversion weir below the main dam to command by gravity an area of 200,000 acres found suitable for irrigation (Anon., 1960).

It is proposed that the project be implemented in stages. The implementation of the first stage, regarded as a pilot scheme where the soundness of the project as a whole can be determined, has already been
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approved and the work is in progress. This stage involves the construction of a diversion weir, which, until the main dam is built, will serve as a small dam providing storage for 80,000 acre feet, sufficient to irrigate up to 20,000 acres.

This paper is concerned with the achievements and problems of the Kimberley Research Station, which has provided the agronomic data leading to the development proposals.

The station lies at 15° 7' S. lat., and 128° 7' E. long., about 100 feet above the mean sea level. The climate of the area is characterised by a warm dry winter season and a hot wet summer season. Rainfall is virtually confined to the summer, most of it falling between early December and mid-March (Table 1). Mean annual rainfall amounts to nearly 30 in., but both quantity of rain, its distribution and the length of the rainy season are very variable. Theoretical moisture balance studies (Slatyer, unpublished data) and early field experiments have shown that in spite of the comparatively high mean annual rainfall, rain grown crops are liable to suffer serious water stresses almost every year. Irrigation is therefore a prerequisite for successful production of most crops. Temperatures in the region are suitable for a wide range of tropical and sub-tropical crops, although growth and development during the cool months is often retarded.

The predominant soil type in the potentially irrigable areas, and the one on which work described here was carried out, is an impermeable clay underlain at various depths by lighter material. Its pH varies from 7.5 to 9.5 but salt and sodium content is low. In the virgin state the soil is low in nitrogen (N = 0.02 to 0.05 per cent.) and in available phosphate (HCl-extracted P$_2$O$_5 = 0.01$ to 0.02 per cent.). Laboratory determinations and field trials have not revealed any other serious deficiencies in major and minor nutrients.

The physical characteristics of the soil lead to considerable mechanical tillage difficulties during the rains. The soil is sticky and plastic and dries slowly except on the surface. Its impermeability creates drainage problems and makes it liable to waterlogging. Cultivation, particularly land levelling, is therefore both difficult and important in ensuring satisfactory crop establishment and growth.

Two economic factors which will govern the pattern of future farming in the area played an important part in determining the choice of crops and farming methods studied at the research station. Because of the distance to potential markets the value of the locally produced commodities had to be sufficient to offset the high transport costs. At present the local demand for agricultural produce is negligible, although in future the established cattle industry may provide a market for some

<table>
<thead>
<tr>
<th>Table 1</th>
<th>MONTHLY CLIMATIC AVERAGES—KIMBERLEY RESEARCH STATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Month</td>
<td>Rainfall</td>
</tr>
<tr>
<td></td>
<td>inches</td>
</tr>
<tr>
<td>January</td>
<td>7.21</td>
</tr>
<tr>
<td>February</td>
<td>6.94</td>
</tr>
<tr>
<td>March</td>
<td>4.83</td>
</tr>
<tr>
<td>April</td>
<td>0.58</td>
</tr>
<tr>
<td>May</td>
<td>0.25</td>
</tr>
<tr>
<td>June</td>
<td>0.22</td>
</tr>
<tr>
<td>July</td>
<td>0.12</td>
</tr>
<tr>
<td>August</td>
<td>0.03</td>
</tr>
<tr>
<td>September</td>
<td>0.10</td>
</tr>
<tr>
<td>October</td>
<td>0.78</td>
</tr>
<tr>
<td>November</td>
<td>2.72</td>
</tr>
<tr>
<td>December</td>
<td>5.35</td>
</tr>
<tr>
<td>Year</td>
<td>29.44</td>
</tr>
</tbody>
</table>

* Average.

1049
crops and by-products such as safflower meal. Secondly, in contrast to many tropical areas, labour supply is very limited, seasonal labour completely absent and labour costs are very high. Consequently farming must be highly mechanised and labour requirements must be distributed as evenly as possible.

II.—RICE

It was recognised early in the investigation of farming potentialities of the lower Ord valley that climate, soil and the prospect of plentiful irrigation water favoured rice production. Consequently rice has been given major attention in the research programme of the station. In recent years the yields recorded at the station have been between 3,000 and 4,000 lb. of paddy per acre. Considerably higher yields (up to nearly 7,000 lb. per acre) have been recorded in some experimental treatments. Although there is still much to be learned about rice culture under Kimberley conditions, with existing knowledge and good husbandry yields of 1½ tons per acre should be obtainable on a farm scale. Rice has been recommended as one of the main crops for the pilot farming project being established.

Initial trials indicated that rice could be grown as both a wet and dry season crop, and that, in general, indica varieties are better adapted to wet season and japonica varieties to dry season conditions. The variety of rice to be grown should be determined by considering the period the land is available for preparation and sowing. Figure 2 gives the period suitable for sowing and the period during which crops are recommended for sowing.

Fig. 2—Suitable planting dates for 17 varieties of rice

<table>
<thead>
<tr>
<th>Wet Season</th>
<th>Dry Season</th>
</tr>
</thead>
<tbody>
<tr>
<td>Meli No. 2</td>
<td></td>
</tr>
<tr>
<td>Faya</td>
<td></td>
</tr>
<tr>
<td>KI-53</td>
<td></td>
</tr>
<tr>
<td>A36-3</td>
<td></td>
</tr>
<tr>
<td>HR22</td>
<td></td>
</tr>
<tr>
<td>RDR 7</td>
<td></td>
</tr>
<tr>
<td>Mas</td>
<td></td>
</tr>
<tr>
<td>Sigadis</td>
<td></td>
</tr>
<tr>
<td>Remadja</td>
<td></td>
</tr>
<tr>
<td>No. 2811</td>
<td></td>
</tr>
<tr>
<td>No. 3734</td>
<td></td>
</tr>
<tr>
<td>Blue Bonnet</td>
<td></td>
</tr>
<tr>
<td>Rexoro</td>
<td></td>
</tr>
<tr>
<td>Magnolia</td>
<td></td>
</tr>
<tr>
<td>Coloro</td>
<td></td>
</tr>
<tr>
<td>Taichu 65</td>
<td></td>
</tr>
<tr>
<td>CI7-56</td>
<td></td>
</tr>
</tbody>
</table>

Period suitable for Sowing
Generally too wet for land preparation and sowing
Crops sown during this period subject to high sterility
Crops sown during this period mature during rainy season.
varieties to dry season conditions. A more
detailed study carried out recently (Lang­
field and Basinski in press) has confirmed
the existence of large intervarietal differ­
ences in response to time of planting. In
several varieties a fortnight’s difference
had a considerable effect on growth, tiller
numbers and spikelet sterility. The results
summarised in Figure 1 indicate suitable
planting dates for the 17 varieties tried.
Over 400 varieties were subjected to pre­
liminary adaptation tests. On the basis of
subsequent variety trials, indica Meli No.
2 and japonica Caloro were provisionally
chosen as standard varieties for agronomic
work in the wet and dry seasons respec­
tively. Meli No. 2 was selected from a
number of indica varieties with similar
grain yields because of its somewhat
superior straw strength.

In fertiliser trials, significant yield re­
sponses to superphosphate have been re­
corded with applications of up to 2 cwt./
aacre, even on previously-manured land.
Considerable attention has been given at
the station to nitrogen nutrition. In experi­
ments described by Langfield and Chap­
man (1959) grain yield response of wet
season grown indica varieties was non­
significant above the 40 lb. N/acre level.
In contrast japonica varieties gave sig­
nificant yield responses up to 120 lb. N/acre.
With indica varieties high rates of nitrogen
application increased vegetative growth considerably and led to severe lodging
while the vegetative response of japonica
varieties was less marked.

Split application of nitrogenous fertiliser
(Langfield 1959a), with part given at seed­
ing and part about a month prior to ear
emergence, increased the yields of slow­
maturing indica varieties but tended to
reduce yields of japonica varieties.

It has been shown ((Langfield 1959b) that
3 in. deep placement of ammonium sul­
phate applied at seeding increases yields
of Meli No. 2 and Caloro (Table 2). Current
trials indicate that the same is true of
urea, and that greater depth of placement
has no advantage.

Results of a study of the effects of de­
layed harvesting on grain moisture content and percentage of broken grain (Langfield
1957) show the importance of timely
harvesting in determining the quality of
rice grown under local conditions (Table
3).

<table>
<thead>
<tr>
<th>Days from Flowering</th>
<th>Moisture Percentage at Harvest</th>
<th>Whole Grain Percentage on Shelling</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Shive Pu</td>
<td>Hnan-wa-phing-gauh</td>
</tr>
<tr>
<td></td>
<td>Hnan-wa-phing-gauh</td>
<td>Hnan-wa-phing-gauh</td>
</tr>
<tr>
<td>28</td>
<td>20(^{0})8</td>
<td>26(^{0})2</td>
</tr>
<tr>
<td>29</td>
<td>19(^{0})9</td>
<td>25(^{0})5</td>
</tr>
<tr>
<td>30</td>
<td>18(^{0})2</td>
<td>25(^{0})6</td>
</tr>
<tr>
<td>31</td>
<td>17(^{0})2</td>
<td>22(^{0})3</td>
</tr>
<tr>
<td>32</td>
<td>17(^{0})8</td>
<td>23(^{0})1</td>
</tr>
<tr>
<td>33</td>
<td>16(^{0})6</td>
<td>21(^{0})8</td>
</tr>
<tr>
<td>35</td>
<td>16(^{0})2</td>
<td>16(^{0})7</td>
</tr>
<tr>
<td>37</td>
<td>16(^{0})0</td>
<td>15(^{0})5</td>
</tr>
<tr>
<td>39</td>
<td>11(^{0})8</td>
<td>13(^{0})0</td>
</tr>
<tr>
<td>42</td>
<td>11(^{0})6</td>
<td>11(^{0})5</td>
</tr>
<tr>
<td>45</td>
<td>11(^{0})1</td>
<td>11(^{0})3</td>
</tr>
<tr>
<td>58</td>
<td>11(^{0})1</td>
<td>11(^{0})3</td>
</tr>
</tbody>
</table>

Cutting of variety Shive Pu commenced 7th May, 1956, and Hnan-wa-phing-gauh on 14th May, 1956.

For several years stem-borer damage has
been serious in wet season rice crops. The
main species responsible has been identi­
fied as Tryporyza innotata Walker. During the last few years damage has been
negligible. It is still uncertain whether
this is due to recently-introduced control
measures (frequent dusting with Endrin
and early dry season ploughing of rice
bays to allow soil infested with over­
wintering prep-pupae to dry thoroughly)
or whether other factors have been
responsible for the general reduction in
the stem-borer population.

Table 2
EFFECT OF DEEP PLACEMENT OF AMMONIUM SULPHATE ON YIELDS OF RICE AT KIMBERLEY RESEARCH STATION

<table>
<thead>
<tr>
<th>Ammonium Sulphate</th>
<th>Yield in lb./acre</th>
</tr>
</thead>
<tbody>
<tr>
<td>Depth of Placement</td>
<td>Time of Application</td>
</tr>
<tr>
<td>3 in.</td>
<td>At seeding</td>
</tr>
<tr>
<td>1 in.</td>
<td>At seeding</td>
</tr>
<tr>
<td>Surface</td>
<td>At seeding</td>
</tr>
<tr>
<td>Surface</td>
<td>Early tillering</td>
</tr>
<tr>
<td>L.S.D. at P = 0.05</td>
<td></td>
</tr>
</tbody>
</table>

Table 3
EFFECT OF DATE OF HARVEST ON SUN-CRACKING OF RICE GRAIN

<table>
<thead>
<tr>
<th>Days from Flowering</th>
<th>Moisture Percentage at Harvest</th>
<th>Whole Grain Percentage on Shelling</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shive Pu</td>
<td>Hnan-wa-phing-gauh</td>
<td>Hnan-wa-phing-gauh</td>
</tr>
<tr>
<td>28</td>
<td>20(^{0})8</td>
<td>26(^{0})2</td>
</tr>
<tr>
<td>29</td>
<td>19(^{0})9</td>
<td>25(^{0})5</td>
</tr>
<tr>
<td>30</td>
<td>18(^{0})2</td>
<td>25(^{0})6</td>
</tr>
<tr>
<td>31</td>
<td>17(^{0})2</td>
<td>22(^{0})3</td>
</tr>
<tr>
<td>32</td>
<td>17(^{0})8</td>
<td>23(^{0})1</td>
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<tr>
<td>33</td>
<td>16(^{0})6</td>
<td>21(^{0})8</td>
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<tr>
<td>35</td>
<td>16(^{0})2</td>
<td>16(^{0})7</td>
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<tr>
<td>37</td>
<td>16(^{0})0</td>
<td>15(^{0})5</td>
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<tr>
<td>39</td>
<td>11(^{0})8</td>
<td>13(^{0})0</td>
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<tr>
<td>42</td>
<td>11(^{0})6</td>
<td>11(^{0})5</td>
</tr>
<tr>
<td>45</td>
<td>11(^{0})1</td>
<td>11(^{0})3</td>
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<td>58</td>
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</tr>
</tbody>
</table>

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measures (frequent dusting with Endrin
and early dry season ploughing of rice
bays to allow soil infested with over­
wintering prep-pupae to dry thoroughly)
or whether other factors have been
responsible for the general reduction in
the stem-borer population.
The second crop recommended for the pilot farming project is safflower. Yields during recent years have been between 2,000 and 3,000 lb./acre and no major difficulties have been encountered in growing the crop (Beech 1960). The oil content of the variety provisionally selected for agronomic work is of the order of 30 to 35 per cent. If the oil were to be extracted locally safflower meal would prove useful to the existing cattle industry.

Successful growing of safflower is confined to the cool dry season. To obtain high yields the crop must be planted as soon after the rains as possible. Planting is generally impracticable until early May but there is an appreciable yield reduction if planting is delayed beyond early June (Table 4). The decline in yield is associated with diminished vegetative growth, fewer branches and flowering heads, lighter grain with lower oil content and an increased proportion of unfilled grain.

It is evident from the work of the station that dense safflower stands are essential not only for high yields but also to avoid prolonged flowering and uneven maturation. In a rate of seeding experiment significant yield responses were obtained with an increasing seed rate up to 80 lb./acre. Such high rates are probably essential at present because establishment counts indicate high pre-emergence and post-emergence seedling mortality. The factors causing this are under investigation. Although no significant yield differences were recorded as a result of row spacing treatments ranging from 7 in to 21 in., close row spacing is favoured, particularly on weed infested fields.

Rather variable results were obtained in safflower fertiliser trials. They showed that, particularly on virgin land, superphosphate application is necessary. Application of nitrogenous fertilisers alone, failed to produce a significant yield response, although in one trial increased yields were obtained where nitrogen and phosphate were applied in combination.

Without effective control measures the damage caused by insect pests can be serious. For example, in 1959, an untreated plot yielded 600 lb./acre less than a crop regularly sprayed with Endrin and DDT.

<table>
<thead>
<tr>
<th>Date of Planting</th>
<th>1956</th>
<th>1957</th>
<th>1956</th>
<th>1957</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Yield</td>
<td>Oil</td>
<td>Iodine Value</td>
<td>Yield</td>
</tr>
<tr>
<td>1 May</td>
<td>2,179</td>
<td>31.7</td>
<td>150</td>
<td>1,974</td>
</tr>
<tr>
<td>17 May</td>
<td>2,214</td>
<td>31.6</td>
<td>148</td>
<td>1,983</td>
</tr>
<tr>
<td>31 May</td>
<td>1,980</td>
<td>28.9</td>
<td>146</td>
<td>1,435</td>
</tr>
<tr>
<td>14 June</td>
<td>2,011</td>
<td>29.0</td>
<td>149</td>
<td>1,105</td>
</tr>
<tr>
<td>28 June</td>
<td>1,701</td>
<td>29.6</td>
<td>149</td>
<td>897</td>
</tr>
<tr>
<td>12 July</td>
<td>1,061</td>
<td>28.7</td>
<td>144</td>
<td>812</td>
</tr>
<tr>
<td>26 July</td>
<td>680</td>
<td>27.4</td>
<td>144</td>
<td>734</td>
</tr>
<tr>
<td>9 August</td>
<td>412</td>
<td>27.4</td>
<td>144</td>
<td>250</td>
</tr>
<tr>
<td>L.S.D. at P = 0.05</td>
<td>162</td>
<td></td>
<td></td>
<td>280</td>
</tr>
</tbody>
</table>

Table 4

EFFECT OF DATE OF PLANTING OF SAFFLOWER ON YIELDS, OIL CONTENT AND IODINE VALUE
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IV.—COTTON

Until 1955, when a satisfactory technique of insect control was evolved, insect damage hampered cotton research by seriously reducing yields and obscuring treatment effects. During the last few years, however, experimental cotton yields of over 2,000 lb. seed cotton/acre have been common, and yields approaching 3,000 lb./acre have been recorded in some trials. Lint quality has been generally satisfactory. Provided processing and marketing problems can be overcome cotton should become one of the main commercial crops of the area.

Cotton in boll at Kimberley Research Station

A large range of varieties, belonging to all main races of cultivated cottons, has been included in preliminary adaptation trials. At present, because of the type of lint required by Australian spinners, cotton varietal work is mainly concerned with *hirsutum* varieties, although long staple *barbadense* varieties grow well. D&PL is currently used for agronomic experiments, but it is felt that further improvement in yield, and quality can be achieved by selection and breeding for local conditions.

Time of planting is one of the main problems of cotton growing under local conditions of soil and climate. The physical nature of the soil is such that for dependable machinery operation cotton has to be planted by early December before the heavy rains. With this date of planting, bolls of the varieties so far available begin to open before the end of the wet season and are exposed to rain damage. When grown as an irrigated dry season crop the growth and development of cotton is affected by cool mid-winter temperatures and maturity is delayed until the following early rains. The solution to the problem is sought through the development of land preparation and planting techniques which would permit cotton to be planted during the dry spells after early December and through selection and, if necessary, breeding of late-maturing varieties.

Another problem, which has by now been largely overcome by a general improvement in farming technique, is that of establishment. Unless careful levelling ensures uniform drainage, cotton planted on the flat is liable to suffer from water-logging, resulting in uneven patchy stands. Establishment on ridges is under investigation and there are indications that the method may prove successful.

Cotton, like other crops grown at the station, responds to phosphate applications. No significant responses to nitrogen fertiliser have been recorded, though this conclusion is not regarded as final and further nitrogen nutrition studies are in progress.

Prior to 1955 insect damage was severe. Boll damaging insects were the main cause of depressed yields, since in many cases the early damage to foliage, stems and terminals was largely compensated for by subsequent growth. At present control is achieved through frequent spraying with a mixture of Endrin and DDT. Further pesticide research and study of insect pest ecology is under way to reduce the costs of plant protection.

Angular leaf spot is common at Kimberley and on occasion develops into the more severe blackarm stage (Thomson and Basinski 1959). In general, *hirsutum* varieties are less affected than *barbadense*, although Sudan-bred BAR varieties of the latter species have also proved blackarm resistant (Thomson and Basinski 1960). The recovery from blackarm of *hirsutum* varieties after the advent of dry and cooler weather has been remarkably good.

V.—SUGAR CANE

In spite of very promising results from earlier research, work on sugar cane has...
been recently suspended because of lack of market prospects.

The yields obtained (Anon 1958) compare favourably with those in areas where cane growing is well established in Queensland. In all trials carried out between 1951 and 1956 the mean yield of all treatments, varieties and harvests (including third ratoons) was 30.8 tons of cane per acre with average CCS of 13.84, giving an estimated mean sugar yield of 4.25 tons per acre. The corresponding figures for the best varieties were:

<table>
<thead>
<tr>
<th>Variety</th>
<th>Cane (tons/acre)</th>
<th>CCS</th>
<th>Sugar (tons/acre)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pindar</td>
<td>39.9</td>
<td>13.00</td>
<td>5.0</td>
</tr>
<tr>
<td>POJ 2878</td>
<td>36.3</td>
<td>14.71</td>
<td>5.9</td>
</tr>
<tr>
<td>Q 28</td>
<td>30.6</td>
<td>15.05</td>
<td>5.0</td>
</tr>
</tbody>
</table>

A number of varieties tried are of value in the local environment. Some, like Pindar, grow well whether planted early or late, others like POJ 2878 ratoon well, while yet others have a high sugar content. Undoubtedly still further improvement could be achieved by introduction of new varieties.

Standard methods of land preparation, planting and subsequent cultivation have been found satisfactory under local conditions. With the majority of varieties planting early in the dry season leads to better yields of plant crop although the yield differences tend to disappear in ratoon crops. Highly significant yield responses were obtained from annual applications of phosphatic and nitrogenous fertilisers, the response of nitrogen increasing in ratoon crops.

The sugar content of cane grown under Kimberley conditions reaches a peak between July and October according to variety and age of the crop so that harvest could be spread over three to four months to allow efficient operation of a mill. The yields obtained indicate that in general a third ratoon would not be profitable.

The cane grown at the station has been remarkably free from serious diseases and pests.

Enough work has been done to show that, given the right economic conditions, cane could play a major part in the agricultural development of the area.

VI.—OTHER CROPS

Apart from safflower, linseed appears to be at present the most promising dry season oil crop. The clay soil is ill-suited to the preparation of the fine seed-bed required for linseed, but during the last few years, satisfactory establishment has been achieved through improved land preparation technique, shallow seeding and introduction of bigger seeded varieties. Time of planting proved important in linseed growing, as illustrated by the results of a recent trial given in Figure 2 (Beech, unpublished data.)

In early trials, peanuts grown as a wet season crop gave promising yields, some treatments exceeding 3,000 lb./ac. However, they present a problem both in harvesting on heavy clay soil and in separating nuts from soil lumps of similar size.

Sunflower has been tried as both a dry and wet season crop, but because of high post-emergence mortality and imperfectly filled seed heads the yields have been disappointing. Soya bean grows reasonably...
well during the wet season, but all varieties
tried up to date mature unevenly and
shatter badly, making mechanical harvest­
ing impracticable. Preliminary trials
 carried out recently with castor and
sesame indicate that the former justifies
further attention as a dry season crop.
Experiments with sorghum demonstrated
that it can be grown successfully as a wet
season crop, providing it escapes bird
damage, a factor which has ruined many
trials. The highest yield recorded was
5,000 lb./acre, although the general yield
level was less than 1 ton/acre. Trials
with millets and maize were also seriously
affected by pests; locusts and birds were
the most important. Wheat grown in
preliminary dry season trials yielded up to
2,000 lb./ac. Yields of oats and barley
have been disappointing. Early trials also
included jute, kenaf, and roselle hemp. The mean yield of jute over a three year period was 10½ tons/acre, with 5 per cent fibre content. Kenaf yields were higher than jute, but fibre was of inferior quality.

The results of trials with a wide range of fodder and pulse legumes (cowpeas, pigeon peas, grams, guar, etc.), were disappointing. Dry season growth was generally poor, while in the wet season legumes proved particularly susceptible to sporadic flooding and waterlogging, difficult to avoid under local conditions. With the exception of *Clitoria ternata*, the legumes so far tried have proved susceptible in varying degrees to the virus disease “witches’ broom” which is common amongst the native plants of the region.

In the early years of the Station considerable effort was made to find suitable irrigated pasture species and fodder crops for the local cattle industry. Without exception all introduced legumes and grasses made the maximum growth in the wet season when productivity of native pastures is high and when grazing on irrigated clay soil presents considerable difficulties. Fodder conservation is also difficult during the rains. If left uncut or ungrazed until the early dry season pastures and fodders lose their feeding value. It is thought at present that protein-rich concentrates, the by-products of oil crops and cotton, may provide at least a partial solution to the problem of dry season deterioration in quality of the native pastures, although further search for suitable pasture and fodder species is justified.

VII.—CONCLUSIONS AND FUTURE WORK

The difficulties encountered in the work of the Station over the last 15 years are common in initial research in many underdeveloped areas without previous agricultural experience and an established farming industry. In these circumstances the research worker is left alone to determine environmental potentialities and limitations, define research problems and to assess their relative importance.

Early work at the Station was handicapped largely by the lack of practical experience in farming difficult clay soils under the local environmental conditions, an art rather than a science. Moreover, until suitable crops and varieties were found and their proper growing periods determined, little progress could be made in agronomic work, while lack of agronomic knowledge (nutritional requirements, method of sowing, spacing, irrigation requirements, etc.), affected the search for right crops and varieties. Damage by pests, particularly insects, also hindered the work until satisfactory protection measures were developed. Early progress was therefore inevitably slow.

The work of the past 15 years has laid the basis for the development of commercial farming in the area, but many problems require further investigation and development will undoubtedly reveal many new ones. Further entomological work is needed to reduce the cost of pest control. Weed infestation has been increasing over the last few years and a special study of weed ecology and methods of weed control has been recently initiated. Although irrigation requirements were determined approximately in the early work, a more basic study of plant-water relationships is commencing, to provide the foundation for the proper planning of the irrigation and drainage regime necessary to ensure maximum yields. Further nutritional investigations, particularly on soil and plant nitrogen problems are also in progress. The search for new cultivars is also continuing.

Studies will shortly start on the best use for protein supplements which may be available to the local beef cattle industry when oil crops and cotton are grown. Since the development of irrigation farming may provide a stimulus for the parallel development of dryland agriculture on adjacent lighter soils, a study of the potential and problems of these soils has recently begun.

The knowledge gained at the Station is most directly useful in farming the areas adjoining it. However it has also wider application in other localities in Northern Australia where climate, soil and water resources are similar to those found in the Ord Valley.

REFERENCES


Anon (1960).—“Ord River Project, Outline of Scheme.” Public Works Department, Western Australia, 20 pp.
A Western Australian beekeeper designed and built boom-loaders (which enable a man, single handed, to load and offload the beehives and drums) for himself and several other beekeepers. The illustration shows a typical beekeepers’ truck with a long range tank and the Western Australian designed boom-loader. The boom-loader is powered by an airforce-disposal electric winch driven by the truck battery and will lift and place on the truck hives weighing up to 2 cwt. The development of the boom-loader was a forward move in beekeeping in Western Australia. While boom-loaders have been used for some years in U.S.A. these were the first boom-loaders in Western Australia.

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