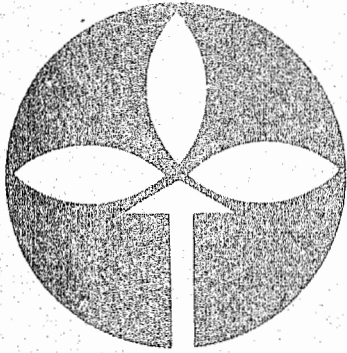


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DEPARTMENT OF AGRICULTURE AND FISHERIES, SOUTH AUSTRALIA

Agronomy Branch Report

THE AUSTRALIAN PLAGUE LOCUST CONTROL

CAMPAIGN OF 1955

J.D. McAuliffe
Regional Control Officer of
the Campaign.

Report No. 84

6. Observations by Field Officers during the Hopper Stage of the Control Campaign

(1) Organisation

(a) More Departmental time could have been given to destruction of locusts in the hopper stage.

(b) Efficient organisation and work during the hopper stage of the campaign is extremely important. Contrast Robertstown Council area with Truro. During the hopper stage Robertstown Clerk issued 4 gallons of spray where as the Truro Clerk issued several thousand pounds worth. From the Robertstown area came thousands of acres of fliers while no swarm worth spraying came from the Truro area.

(c) Earlier propaganda work would probably be very valuable in the Station country.

(d) Farmers should be made well acquainted with the Act and if a few fines were imposed for its non-observance a lax attitude could be avoided.

(e) Better publicity with more demonstrations is needed to advise farmers on how to handle their own equipment.

(f) More equipment is needed where outbreaks are bad and to assist farmers when they are harvesting.

(g) Councils should have men and equipment to enforce the Act on the small number of farmers who do not co-operate.

(h) The greatest limitation to these organising the campaign appeared to be the shortage of Departmental equipment, trucks, utilities, landrovers and ground spraying equipment.

(i) Splitting infested areas into districts in charge of an Officer was a good move as it gave farmers a point of contact which was not too remote. This arrangement should have come into force earlier.

(j) Difficulty in organising was mainly in not having definite indications of requirements and inability of suppliers to meet requirements at short notice. Although many firms circularised Councils it was often necessary to ring three distributors before a supply could be obtained.

(k) Consider that such an outbreak should be considered a National Emergency.

(l) Landholders should be relieved of the sole responsibility to destroy hoppers.

(m) One still meets the odd person who is sceptical of the value of an attempt to combat grasshoppers with insecticides, but it is found that a discussion with an Officer brings better results than an argument put forward by a local Council Officer.

We think that the effort put forth by the Department of Agriculture through its Officers was the most effective method of handling the grasshopper plague. The response was prompt and appeared to be effective.

(n) The communications system could have been very much improved by the use of two way radio sets.

(o) Not all landholders were prepared to take an active part in the campaign. Very few were inclined to do any work on their own accord. Some District Councils were very lax and slow to secure and supply chemicals.

(p) Our organisation was insufficient in the early stages. It commenced too late with insufficient Officers to get a full cover of contact.

(q) Our organisation threw a tremendous burden on the Clerks of each District Council. I think they could have been assisted by giving them better financial understanding and better circulars with lower "fog indexes" e.g. The spraying recommendations were not clear and caused a lot of confusion.

(r) I think that on the whole nothing more could have been done by the Department than was done to combat locusts while still in the hopper stage. I commend the decision not to use aircraft on hoppers.

(s) The Councils were greatly assisted in all matters of organisation by the Officers of the Department of Agriculture stationed at Jamestown.

(t) A close liaison was kept with Officers of the Department of Agriculture who it would appear should have sole charge of such operations. Council Officers have neither the knowledge or the time for a task such as this.

(u) Within District Council areas the effectiveness of landholders effort during the hopper stage of the campaign was determined very largely by the keenness of the District Council concerned especially by the Clerk of the Council.

(v) In the Pt. Germein area each councillor was responsible for the issue of insecticide to landholders in his own ward. This system worked very well.

(w) The Market Gardeners Association at Nelshby and Napperby called a Public Meeting just as the hoppers appeared. A second Meeting was called at which control methods were discussed and local equipment organised.

(x) Hopper spraying is within the compass of farmers by ground equipment, with few exceptions.

(y) Communications could have been vastly improved if each Officer-in-Charge of a given area was supplied with a two way radio similar to those used by firefighting organisations.

(2) Equipment

(1) General

(a) The situation in the past season has by the success achieved broken down much of the prejudice against the idea of getting rid of the pest by such methods. Many landholders are now inclined to give consideration to working out ways to improve the methods of spraying. In this district quite a few experiments have been made, some of which are quite good and will as time goes on be improved on.

(b) In general, equipment used throughout the State recently was adequate and effective. In some cases it was not brought into use early enough.

(c) The control of the grasshopper is handled better by the Department of Agriculture with their equipment and spray than it would be by individual Councils.

(d) Concentration on equipment to handle the pest in the hopper period more desirable than equipping to handle locusts on the wing.

(e) Equipment should be a matter for Government expenditure as Councils have no surplus revenue for provision of equipment that may remain idle for years.

(f) If hoppers hatched out in larger numbers than last year Government organised ground equipment stationed at strategic points would be necessary to successfully combat locusts in the hopper stage in this sparsely populated area and when farmer owned equipment is limited.

Firefighting Units

(a) In future more use should be made of boom spray equipment and fire fighting units during the early stages of the campaign in lieu of the Sayers Exhaust sprayers.

(b) Army Jeeps did good work in rough country but a good firefighting plant was far more efficient.

Sayers Sprayer

(a) The Sayers Spray was a valuable emergency measure. It was many more times effective than a Knapsack but not as effective as a firefighting unit.

(b) Sayers Exhaust Sprayers are great time wasters as the exhaust systems become strained and abused the original efficiency which was low became lower. A small motor pump and a 20' boom with a 200 gallon tank in the trailer would have killed more locusts.

(c) The Jeep fitted with Sayers was ideal for rough terrain, when used on broad acres it did not perform well.

(d) The Sayers is cheap, effective and very mobile, and could have been more widely used on farm vehicles.

(e) The Jeeps gave out after completing a distance of 1,000 miles of Sayers operation.

(f) Early use of exhaust sprays of the Sayers pattern should be more effective in any future outbreak. Hatchings were well advanced before the exhaust spray was available and farmers were endeavouring to control the hatchings with Knapsack sprays.

(g) In future more use should be made of Boom Spray equipment and fire fighting units during the early stages of the campaign in lieu of the Sayers Exhaust Sprayers.

(h) Sayers equipped Jeep was very satisfactory in rough bushy country and typical water courses at Carrieton and strips of stony country at Belton.

(i) One difficulty with the Sayer Sprayer was that it would not throw spray well against the wind. One truck with Sayer pointing directly backwards from the rear of the truck, about three feet above the ground was alleged to be very effective. It could be worked cross wind at all times.

(j) The Army Jeeps with Sayers Sprays attached were responsible for the destruction of countless millions of hoppers in all stages from newly hatched up to flying.

(k) The men operating the Jeeps were most obliging in their efforts to co-operate with landholders and Officers of the Council.

(l) Army Jeeps did good work in rough country but a good firefighting plant was far more effective.

(m) Some of the Army Jeeps were staffed by reliable men but this was not always the case.

(n) Sayers equipped Jeeps could not be driven at 15 m.p.h.; 7 m.p.h. would be a very fair figure.

Boom Spray Equipment

(a) The Boom Spray is the cheapest most practical and most effective equipment for the control of locusts

in the hopping stage in the cereal growing districts.

(b) 50 foot Boom Sprays mounted on Land-rovers were particularly effective in Agricultural areas.

(c) It was a combination of the Boom Spray and Wilmist Air Blast Machine which brought 100 square miles of concentrated hoppers on the western side of the Flinders Range under control in 11 days. (Only one flight of adults left this area and they were destroyed by dusting 1,000 acres at Butlers Bridge).

Air Blast Machines

(a) The Wilmist equipment gave excellent control in creek beds and over rough topography of the Flinders Range.

(b) Effective in certain localities e.g. gullies.

(c) Operates at low cost.

(d) It was the combination of the boom equipment and the Wilmist Air Blast Machine which brought a hundred square miles of concentrated hoppers on the western side of the Flinders Range under control in 11 days (only one flight of adults left this area and they were destroyed by dusting 1,000 acres at Butlers Bridge).

(e) Wilmist duster is mobile, gives quick cover, very useful in broken rough country, but dirty to use.

(f) Duster gives good drift in hilly country quick coverage under moderately breezy conditions.

(g) Wilmists with spray solutions were excellent for the control of hoppers.

(h) The Wilmist unit using a liquid spray requires approximately 12 gallons of water per acre.

Sand Blast Machines

(a) Sand blasting equipment is mobile, fine droplet spray is effective but needs a lot of water and is limited by rough conditions.

(b) Too slow and expensive for the work, much time was needed to fill the hopper and build up pressure after emptying (11 hours for 290 acres).

(c) Were effective, but large cumbersome units in small paddocks.

(d) On Sand Blast Machines the second operator seemed unnecessary and uneconomical, thought something mechanical could be devised to give an area of cover behind the truck

thus reducing it to a one man unit.

(e) Operators of Sand Blast Machines were on high wages £40 per week plus £14 living expenses and efficiency and co-operation were lacking.

(f) Ideal for flat country. For steep hilly country there is too much weight too high.

(g) Sand Blast equipment should be tested before being sent to the country. Ours was quite useless, so was its crew.

(h) The Sand Blast Machines are equivalent to the Wilmist Machines (wet) but the heavy compressor etc. limits it to flat country and also the speed is limited.

(i) Much time was lost due to minor repairs and lack of spare parts; lack of intelligence on part of operators also contributed to wasted time.

(j) Main problem was organising a good water supply, filling from dams and tanks was slow.

(3) Technique

(a) Much more effort and concentration on handling locusts before they fly is essential.

(b) Army Spraying - We directed spray on to the main masses of hoppers. We did not attempt any barrier spraying ahead of swarms.

In the early stages of the campaign we could spray all day wherever hoppers were found. Towards the end of the hopper stage effective spraying in open country could only be done in morning and evening because hoppers were so wide spread and too active in the heat of the day. During this period green feed was becoming scarce and we did most of our spraying in watercourses where swarms tended to concentrate.

(c) With Jeep equipment had to spray all the hoppers for a kill as there was no evidence of confining them by spraying a band around them.

(d) Land holders were alerted and advised to look for hatchings. It was known that egg laying had taken place over most of the area although only one case had been reported.

(e) It was found that spraying in front of advancing hoppers (swarms) would not stop them for more than a few hours. Spraying to be fully effective had to be directed at and on to the moving swarms.

(f) Hatchings in inaccessible places such as mountain ranges could not be sprayed. In these cases the locusts were attacked as they swarmed towards the plains. Many of these swarms got away.

(g) On one farm locust hatchings were spread over 600 acres. The locusts were concentrated in barley grass. As the number of locusts were considered a threat to adjoining farm lands a party of local men were organised to burn the 600 acres of grass. This method accounted for 90% of the locusts.

(h) Farmers tended to spray young hoppers too early - before banding.

(i) Hoppers in the eastern pastoral country were scattered, a spotting service was necessary on the larger holdings. On Koomooloo a man on a motor bike reported swarms to the owner at lunch time and again in the evening. The Army Jeep was then sent out to ring the swarms with insecticide. This had the effect of turning them in on themselves and greatly concentrated an otherwise scattered swarm which would be sprayed by another vehicle better suited to handling large concentrations. The Jeeps would ring several swarms then come back and assist the other vehicle by mopping up pockets in very rough going.

(j) On the Gums Station, locusts were concentrated on a strip of swamp country about $\frac{1}{2}$ mile wide. A strip was sprayed across the head of the advancing swarm and resprayed whenever it seemed likely that the weight of advancing numbers was going to force a passage across.

(k) When spraying hoppers a spotter with iron droppers on which a paper was tied marked the bed of hoppers. When the spraying unit sprayed the area concerned the dropper would be collected.

(l) There was a tendency on the part of farmers to spray hatching instars too early.

(m) On several paddocks where egg beds were found before they had hatched the settler ploughed or cultivated the areas. Where a crop was sown after such cultivation the young hoppers hatched out in the crop.

(n) The spraying of locusts in the early hatching stages with knapsack sprays and Booms was very successful. Difficulty was experienced when the locusts reached the larger hopper stage and spread their activities over larger areas. When scattered in the grass and scrub they were difficult to control. Some farmers ceased control measures for this reason.

(o) Two men spraying hopper bands with firefighting equipment in country south of Quorn had the right idea - just a quick once over. This was apparently very effective. Many people had the idea that it was necessary to spray all the ground until it was wet.

(p) An attempt to protect a crop by spraying a strip one chain wide in front of an advancing hopper band resulted in the hoppers actually sprayed being killed. Those moving in from behind moved straight through the sprayed area into the crop. There was no observable repellent or insecticide action from the spray.

(q) Sayers equiped Jeeps could not be driven at 15 m.p.h.; 7 m.p.h. would be a very fair figure. It did not seem to be practicable to start around the outside edge of a swarm and gradually work inwards. Wind made spraying in certain directions practically impossible. Most of the work I saw was in an arbitrary criss cross sort of pattern.

(4) Insecticides

General

(a) Landholders were seen applying B.H.C. and Dieldrin at up to 10 times recommended strengths. Double recommended strength was very common.

(b) Hoppers seem to avoid sprayed areas to a large extent.

(c) No ill effects were noted with stock which had access to sprayed areas regardless of the insecticide used.

(d) Liquid forms of insecticide were more effective and distribution was more even.

(e) Dieldrin was better than B.H.C. - less needed per acre making transport easier.

(f) Dusts appeared to drift too far and an accurate application of chemical was difficult.

(g) Dieldrin compared with B.H.C. is greater in its residual effect.

(h) The residual effects of any of the insecticides used, worked only when sprayed feed was eaten by the incoming locusts.

(i) There is need for higher concentrations to kill when grass is dry and hoppers are not feeding.

(j) The State owes a big debt to the chemists who worked out the formula for the spray materials.

(k) Councils loth to spend big sums on insecticides as no guarantee given for reimbursement of unused supplies.

(l) Consider the Department should establish a bulk depot in Adelaide from which supplies of recommended insecticides could be drawn.

B.H.C.

(a) Gammexane was more spectacular in its results. Rapid kill was very pleasing psychologically.

(b) B.H.C. - emulsion and dispersible powder were very effective in dealing with hoppers. Death occurred within 20 minutes after application in some cases.

(c) Landholders liked B.H.C. because it gave a faster kill.

(d) B.H.C. was observed in one case to be still effective after a 21 day period.

(e) B.H.C. had a repellent effect not seen with Dieldrin.

(f) Gammexane dust was highly effective against fliers and crawlers.

(g) Lindane was very effective on hatchings of young hoppers in suburban areas.

Dieldrin

(a) Weather played a big part in the time taken for a locust to show effects. During the warm weather the locusts seemed to show effects after 12-14 hours. The effects of spraying firstly seemed to interfere with their sense of direction, only able to hop a few yards. If cool weather prevailed the time to kill seemed to be up to 48 hours.

(b) Herbage sprayed with Dieldrin proved lethal to locusts for two or three weeks after spraying. One case was noted where hoppers were dying on Dieldrin sprayed herbage six weeks after spraying. This occurred after the herbage had been wetted with rain.

(c) Better results were obtained where herbage was well wetted with insecticide solution using 15 gallons of solution or more per acre.

(d) Third instar stage hoppers sprayed with Dieldrin showed signs of being affected after half an hour, after 24 hours most were dead. After three days some were still dying from the effect of the spray.

(e) Dieldrin which had been sprayed on to an area to kill crawlers still killed fliers after a 23 day period.

(f) Dieldrin affected locusts slowly. Usually 2-3 hours would pass after spraying before dying hoppers could be noted. Dying and affected hoppers have been noted up to 48 hours after spraying. The hoppers die quicker during the warm weather. The locusts often move off after spraying and die in masses around buildings and near shelter.

Effect of Dieldrin on Operators

(a) Among people who handled Dieldrin, headaches and upset stomachs were fairly common. Two people were weak and sick for one day.

(b) Dieldrin seemed to have little effect on humans even when carelessly handled. Men working boom equipment had it sprayed over them, every time a breeze blew, for a fortnight and very often undiluted chemical was spilt on their hands and they did not suffer any ill effects.

(c) Dieldrin was used in Knapsack Sprays in the Le Hunte area. No harmful after effects were reported.

(d) No detrimental effects on Dieldrin noted in Stock or men.

(e) No instance was noted where Dieldrin was actually ingested by the men but smoking while handling the insecticide was quite common with no ill effects.

(f) Dieldrin in its concentrated form has a definite burning effect on eyes and skin if spilt on them, but with reasonable care little harmful effects will occur.

VI. Destruction of Flying Locusts

1. Organisation

By the end of October it was apparent that large numbers of locusts would reach the flying stage and invade the Agricultural areas.

A remarkable job had been accomplished in the destruction of hoppers. Within the Agricultural areas a very good control had been effected and control efforts had extended to the pastoral areas where excellent work had been done in some sections. However, hopper destruction had not been complete enough in itself to prevent swarms of locusts penetrating the main cropping districts of the State. Plans, therefore had to be made to deal with the adult migrating swarms as they moved southward. It was only reasonable to make strenuous efforts to protect landholders, who had worked so well destroying hoppers, against the threat of mature flying locusts flying in from the pastoral country.

This phase of the campaign was designed on the use of aeroplanes supported by ground operated equipment. All of this equipment in addition to the insecticide was sponsored by the Government. This was the third time during the campaign that Government had stepped in with large scale assistance to stimulate landholder efforts. It followed decisions, made in August to meet the cost of insecticides used in the destruction of locusts, and in October to sponsor the use of Army Jeeps and personnel to assist control in Pastoral areas.

Where locusts were still in the hopper stage control measures were continued as usual. The second phase of the campaign differed from the first in that all equipment was being provided by the Government and distribution of insecticides became more direct i.e. from Agent to points of operation and not through District Councils.

At the out-set it was thought that locating swarms would be one of the most difficult aspects of the campaign. After considering the use of the Fire Fighting Organisation as a spotting service it was decided that District Councils, which invariably incorporated many of the personnel of the Fire Fighting Service, supported by a perimeter of spotters situated in the pastoral areas would be better. To obtain the support of District Councils in locating swarms and to announce the proposed aerial spraying the Minister of Agriculture issued the following Circular:-

Office of Minister of Agriculture,
Agriculture Building,
Gawler Place,
ADELAIDE.

CIRCULAR TO COUNCILS

3rd November, 1955.

Dear Sir,

GRASSHOPPER CONTROL

Notwithstanding the substantial success of control measures taken against locusts in the hopper stage, there are extensive swarms of hoppers which have reached, or will shortly reach, the winged adult stage. From previous experience of earlier plagues and consideration of environmental factors influencing their movements, it has been forecast that the general migration will be in a southerly or south-eastern direction and that within a week or so winged locusts will begin their migration. At this stage the small flying swarms usually build up into flying masses which could cover areas up to hundred of acres. Ground attack on such large flying swarms would be comparatively ineffective.

Consequently, the State Government has agreed to meet the cost of organised aerial spraying of these flying masses of locusts. Organisational arrangements will be controlled by the Director of Agriculture (Dr. Callaghan). It will be necessary to develop in the most vulnerable sections of the settled areas a system for reporting the appearance of flying swarms and an organisation to ensure that rapid and effective control measures are taken.

Therefore, the co-operation of your Council and all fire fighting organisations within your area is sought for the purpose of advising the presence of grasshopper swarms in a similar way to which outbreaks of fire are reported. Such reports should be made to officers of the Department of Agriculture, who will be named specifically through the press in the near future. Similar co-operation is being sought from the S.A. Stockowners' Association.

Officers of the Department of Agriculture will visit some of the councils as soon as possible for the purpose of conferring with the District Clerk and making necessary arrangements.

Approval has been given for the Director of Agriculture to hire for urgent use as required, all available commercial aircraft capable of aerial spraying. It is also intended to place ground spraying equipment in strategic places throughout the State for use wherever practicable.

The general intention is that insecticide used for aerial spraying of migratory swarms will be controlled by the Department of Agriculture.

Thanking you in anticipation of your co-operation.

Yours truly,

MINISTER OF AGRICULTURE

In addition to the above it was considered desirable to seek the assistance of pastoralists to determine the movement of flying swarms before they reached the agricultural areas. Advice was needed of any movement of flying swarms noticed and information as to the size of swarms and direction of flight. The owners or management of the following Stations were approached and agreed to help.

1. Commodore
2. Yadlamulka
3. Holowilena
4. Cotabena
5. Oraparinna
6. Lilydale and Mutooroo
7. Mt. Victor
8. Manunda
9. Kunamore
10. Teetulpa
11. Braemar
12. Kia Ora
13. Koomooloo
14. Glenora
15. The Gums

A close watch was also being kept of the situation north of the Murray from Waikerie to Renmark. Departmental Officers organised this from their bases in the fruit growing districts.

At this stage more Departmental Officers were becoming fully occupied with the organisation of the control campaign.

The planned organisation and distribution of insecticides as designed before the flier's developed is contained in the following Circular issued by the Director of Agriculture.

CIRCULAR:

GRASSHOPPER CONTROL

As the grasshoppers are reaching the stage when the migration of flying swarms may soon be expected on an extensive scale, plans have been made to deal with the insects in this phase. The strategy which has been decided on is to attack roosting swarms as opportunity allows. The movement of swarms is very largely dependent on temperature and under normal conditions swarms will be "grounded" from about 4 p.m. to 8 a.m. In addition cold weather will keep them on the ground.

It will therefore be possible to use both aircraft and ground equipment to deal effectively with locust swarms.

The following is the present position regarding equipment. This position could vary by the engagement of further equipment or the relinquishing of equipment at present engaged.

A. 1. Aircraft

A contract has been signed with Rural Aviation Co. Ltd. whereby five Tiger Moth aircraft have been made available for hire by the Government. In addition two Tiger Moth aircraft and one Cessna may be hired from Robbys Aerial Services if required.

2. Ground Equipment

One "Wilmist" airblast sprayer is on hire from Research Industries Ltd. and another will be engaged shortly.

One modified sand blast machine has been hired for a trial period of a week and if it proves satisfactory another two are available for hire.

Each of the above ground equipment will be manned by labour supplied by the companies concerned and the equipment is mobile.

B. Control of Equipment

The effectiveness of control measures will depend very largely on proper allocation of the equipment and direction of its use. With the object of achieving this, the following organisation has been set up:-

1. Regional Control Officer: J.D. McAuliffe, assisted by P.M. Barrow
2. Regional Officer, Eyre Peninsula: R.J. French
3. Regional Officer, River Murray Area: C. Cooper
4. District Officers:-

Northern: These officers are responsible to Mr. J.D. McAuliffe:-

D.C. Wilmington: N. Smith, Lands Inspector, Jamestown
D.C. Orroroo: G.D. Webber
Pt. Germein (E. of Range): P. Judd
Pt. Pirie and part of Pt. Germein (W. of Range):
A.F. Tideman
Hallet and Burra: G.F. Young
Crystal Brook, Laura, Gladstone: D.B. Winn
Jamestown: D. Puckridge
Georgetown and Spalding: G. Fuss
Red Hill, Pt. Broughton: E.J. Polden
Peterborough: B.K. Robinson
Kadina)
Bute) B. Johnson
Snowtown)

Riverton	}	R.L. Wishart
Blyth		
Clare		
Upper Wakefield		

Pt. Wakefield	}	F.E. Eckhold
Balaklava		
Owen		

Kapunda	}	A.L. Clarke
Truro		
Eudunda		

Mudlawirra	}	J.P. Jennings
Mallala		
Freeling		
Angaston		

Morgan: A.J. Marrett

Saddleworth	}	J.D. Purdie
Robertstown		

Eyre Peninsula:

These officers are responsible to R.J. French:-

Kimba: J.A. Richards

Franklin Harbour: W.C. Johnston

Cleve: R.J. French

River Murray Area:

The regional officer will be assisted by other officers stationed in this area.

The responsibilities of the above officers are as follows:-

1. District Officers

- (1) To obtain and discuss reports of swarms with district clerk and to inspect swarms if necessary.
- (2) To report on swarms to regional officer.
- (3) To direct control measures on instructions from regional officer.
- (4) Where an aerial attack is to be conducted the District Officer shall:-
 - a. Select landing strip.

- b. Notify pilot of location of strip and time of commencement of operation.
 - c. Arrange to have the following at the strip:-
 - (1) Aviation fuel and oil.
 - (2) Insecticide
 - (3) At least 200 gallons of water and engine driven pump.
 - (4) 2 hand pumps.
 - (5) 12 markers: if required 2 or 3 men to act as markers.
 - d. Mark the area to be sprayed.
 - e. Be responsible for refuelling and loading: another person will be needed to assist with these.
- (5) Where ground equipment is to be used, the District Officer shall:-
- a. Notify operator of time and place of spraying.
 - b. Define area to be sprayed.
 - c. Ensure supply of insecticides
 - d. If necessary, assist in obtaining supplies of water.
- (6) The District Officer shall notify the Regional Officer when the operation has been completed.
- (7) Except for emergency calls, the District Officer shall contact the Regional Officer at times to be arranged.
- (8) The District Officer shall keep a check on the issue of insecticide by the district council and report to the Regional Officer.

2. Regional Officers, Eyre Peninsula and Murray Area

- (1) To receive reports from District Officers and from spotters outside the council areas of their district and to relay these to R.C.O.
- (2) To allocate within their districts, equipment made available by the R.C.O.
- (3) To station district officers under his control at his discretion.

3. Regional Control Officer

- (1) To receive reports from district officers of his region and from other regional officers and from spotters in the northern, north-eastern and eastern pastoral country.
- (2) To allocate equipment.
- (3) To advise operators and district officers and/or regional officers of the allocation and the period over which it applies.

C. Supplies

Supplies are to be based at the following centres:-

Wilmington	Peterborough	Burra	Snowtown
Orroroo	Pt. Pirie	Gladstone	Kapunda
Melrose	Jamestown	Red Hill	Cowell
	Kimba	Renmark	

These supplies are to be held by the district officers concerned who shall arrange for storage. The maintenance of supply is the responsibility of the regional officers, who on request by the District Officer, will arrange transport from regional depots. Regional depots will be at Pt. Pirie and Gladstone.

The following materials are to be placed as soon as possible:-

2 Simac hand pumps: one with 15 ft. of 1" industrial hose for fuel
one with 15 ft. of 1" garden hose for insecticide

12 marker sheets

1 x 44 galls. dieldrin

1 x 44 galls. aviation fuel: 73 Octane

2 galls. aviation oil: X100

D. Transport of Supplies

Each District Officer is to arrange for an engine-drawn pump (e.g. fire fighting pump) to be available at short call to enable quick loading of aircraft spray tanks. These pumps will be used for water only.

He is also to arrange for transport to be available to carry the above supplies and pump to the spraying site.

These arrangements are to be made by all District Officers: NOT only by those District Officers who are in charge of supplies.

If any officer is not able to make the above arrangements, he should notify his Regional Officer.

21/11/55.

A.R. Callaghan
DIRECTOR OF AGRICULTURE

This organisation of Departmental personnel was effected during the third week in November just when the first fliers commenced migrating. Departmental Officers were strategically placed to cover the District Council area which would possibly be in the path of the incoming swarms.

This was effected as outlined in the Director's Circular of 21/11/55 but was commenced a week or so previously in the more northerly districts. Staff dispersed in the above manner involved a Regional Control Officer and an assistant, two Regional Officers and twenty one district Officers stationed in specific areas. The areas selected are shown on plan No. 2

The first aerial spraying took place on 16/11/55 in the Melrose area where the first of the large invading swarms reached the agricultural areas.

This was followed by invasions reaching Caltowie 23/11/55, Peterborough 23/11/55, Burra 23/11/55, Yongala 24/11/55, Robertstown 26/11/55 and Whyte Yarcowie on 27/11/55.

During this period it was found necessary to change the technique of organisation. Except where Officers were permanently stationed and remained to observe any movement that may reach their areas it was found necessary to attach equipment and Departmental personnel to swarms rather than areas. In actual practice this meant that Departmental Officers remained in districts allotted them on the West Coast, Upper Murray and Lower North.

In the Upper North districts it was found necessary to attach two Officers to each plane to secure the degree of efficiency necessary to conduct an aerial spraying campaign.

This meant drawing to the limit on Departmental Officers moving them from areas not invaded to those in which swarms had settled. Throughout the Campaign a

further sixteen Officers had to be called in at various times in order to keep up with the swarms. At various times and for varying periods over forty Departmental Officers were involved in the control campaign.

The plan originally set out for landholders to report to District Council Clerks who in their turn would pass information on to the District Departmental Officers worked up to a point. However the tempo of the campaign was such that orderly step by step methods were most times impossible. Reports reached Departmental Officers and headquarters from a variety of sources but mostly from the landholder to the Departmental Officer direct. Allocation of equipment and personnel was then decided as considered to best advantage. It meant long hours of work and devotion on duty on behalf of all Officers concerned. There is no doubt that the whole-hearted co-operation of the Departmental Officers was one of the main reasons for the success of the campaign.

2. Equipment

The aeroplane supported by ground operated Air Blast Machines, Sand Blast Machines and Boom Sprays comprised the equipment used against the flying locusts.

Aeroplanes were used on the large swarms. Altogether seven Tiger Moth Planes and one Cessna were used during this stage of the campaign. A total of 50,000 acres were sprayed from the air. The following table sets out the date of commencement of spraying and the total acreage sprayed in each locality that planes operated.

Please note: page 54 is tightly bound therefore some text missing when scanned.

Date of Commencement	Locality	Acres	Locality	Acres	Locality	Acres
5/11/55	Koomooloo	140				
5/11/55	Melrose	1000				
10/11/55	Terka	40				
10/11/55	Wirrabara	1704				
11/11/55	Peterborough	1268	Burra	855	Caltowie	2288
11/11/55	Yongala	2926				
11/11/55	Hornsdale	880				
11/11/55	Robertstown	1040				
11/11/55	Whyte Yarcowie	2850	Hallett	1050	Laura	540
11/11/55	Cleve	600				
11/11/55	The Bluff	880	Appila	264		
10/11/55	Jamestown	3402	Yacka	990		
12/55	Mt. Bryan	2288	Pt. Pass	1435	Georgetown	770
12/55	Rochester	990	Ngapala	1640		
12/55	Belalie East	1836	Snowtown	1122		
12/55	Bundaleer	144	Blyth	1350		
12/55	Booborowie	2138	Hampden- Hansborough	540		
12/55	Clare-Mintaro	222	Hampden- Waterloo	660	Hansborough- Anlaby	1120
12/55	Gum Creek	110	Hilltown	1200	Manoora- Apoinga	990
12/55	Hill River	900				
10/12/55	Farrells Flat	540	Mallala	360		
11/12/55	Auburn	1940	Two Wells	1102	Craigies Plain	540
12/55	Saddleworth	840	Riverton	1360		
5/12/55	Mypolonga	910				
6/12/55	Virginia	418				

The aeroplanes were used to very good effect in controlling the winged locusts. When conditions were suitable they covered large acreages in very quick time. The best days spraying by any one plane was 1144 acres. This was accomplished one day when the locusts were settled in during a cold change in the weather. A better picture of the capabilities of this type of plane is presented when the total amount of work is considered.

Between 15/11/55 and 16/12/55 sufficient planes were available to have completed 158 days of flying. They were only able to operate on 116 aircraft-days during this period when they averaged 433 acres per plane day. This amount of work per plane is probably quite as much as could be expected. The planes are limited by weather conditions and behaviour of the locusts. When it is windy the planes are unable to operate. In cold weather provided the locusts have settled in thickly the planes can operate all day, (this happened early in the flying phase). If the weather is hot the flying time per day is limited to a few hours morning and evening. When very hot it is often impossible to use planes in the evening because the locusts continue to fly late or may even fly all night. Although the plane is limited by these factors it is capable of treating large areas quickly. Fences, creeks, crops and similar obstacles to ground operated equipment can be disregarded in plane operations. Planes are much more useful early in the flier stages when temperatures are lower and locusts less active.

Ground Operated Equipment

Contrary to early expectations ground operated equipment proved quite useful in treating winged locusts. Some very useful information was obtained about this type of equipment. Air Blast Machines and Sand Blast Machines were quite effective for the control of settled "fliers". These machines were used extensively in areas not suitable for treatment from the air by plane e.g. in hilly timbered country. They were also very effective in "mopping up" after planes or in areas too small to warrant using a plane.

During the campaign they were looked upon as an adjunct to the plane but it became quite apparent that a sufficient number of the right type of ground equipment would dispense with much of the need for planes.

These machines have several advantages over planes. They can be operated during rougher weather conditions when it is not safe to fly a plane. With the aid of lights they can be operated all night provided the spotting organisation can locate the settling swarms. Boom Spray Units can be operated at night on level country e.g. lucerne paddocks into which locusts have settled.

3. Insecticides

Dieldrin was the most generally used insecticide on flying swarms. It was used for most of the aerial work, by the Sand Blast Machines, for some of the work done by the Air Blast Machines and for the work done with Boom Sprays.

Some B.H.C. (miscible oil No. 7) was used from the planes, in at least one instance when Dieldrin was in short supply, and in the case of the Murray Swamps where it was preferred to Dieldrin because of the hazard to dairy herds. Gammexane dust was used from Air Blast Machines operating in conjunction with planes.

Aldrin was the other insecticide used to some extent with Air Blast Machines and vaporizing units.

Rates of insecticides applied during the flying stage were slightly higher than the rates used against hoppers. In the case of Dieldrin for instance the rate was increased from 2/3 pint to 1 pint per acre.

All of the insecticides used were effective in killing locusts. B.H.C. was much quicker in action than Dieldrin. This was a decided advantage because the locusts did not move far from the sprayed area and results were apparent soon after spraying. Dieldrin on the other hand took much longer to kill.

Age of the locust and temperatures were two factors which appeared to influence the behaviour of swarms treated with Dieldrin. Early in the campaign against fliers, which was soon after they had reached maturity and when lower mean temperatures prevailed, the numbers of dead locusts found on sprayed areas was very high. Later it was noticeable that Dieldrin killed quicker in hot weather. Many deaths being observed within four hours of spraying. In cooler weather at this stage few dead locusts could be found on sprayed areas unless weather conditions kept them grounded for a considerable period after spraying. They more usually flew away to die and dead locusts were found many miles from the nearest sprayed area. Spraying with Dieldrin did not prevent egg laying and many females died in various stages ovipositing.

The insecticides Dieldrin, B.H.C. and Aldrin used in the concentrations necessary to kill locusts had very little effect upon livestock. Throughout the campaign the only stock reported to be affected were turkeys, pigs and bees. When turkeys consumed locusts poisoned with Dieldrin the mortality was high. Pigs fed lucerne which had been sprayed with Dieldrin became sick for some days. Bees died in very great numbers if aerial spraying with Dieldrin was conducted close to or over the hives. The added complication of moving bees from areas into which

locusts had settled before bringing the plane into action was sometimes impossible. In practice it meant trying to find owners often located great instances from their bees, late in the afternoon, in order that the hives could be removed at night and spraying take place at day-break next morning. This would be additional to the task of organising men, materials and equipment for the aerial spraying.

Bees are an important industry in the district. Aerial operations along the eastern side of the Flinders Range, where bee-keepers concentrate their hives, very quickly demonstrated the difficulties to be overcome. To assist the campaign and contact the bee-keepers an officer of the Department in Mr. J. Masterman was brought into the field. His knowledge of the industry and cordial relationship with the bee-keepers assisted greatly during the remainder of the aerial campaign. The Canowie Belt area, another in which bees were concentrated was excluded from aerial operation. This too assisted in that bee-keepers could move into the section without fear of spraying and subsequent moving of hives.

The toxicity of insecticides to operators was originally considered to be hazardous particularly in the use of Dieldrin and Aldrin. Fortunately this was not so. Not one instance was reported of operators being affected by the insecticides used during the campaign.

4. Technique employed against Adult Locusts

The forward organisation anticipated a technique of spotting swarms by the time they reached the agricultural areas. Aerial spraying was then to take place under the direction of a Departmental Officer stationed in the District Council area concerned. This broke down early in the campaign and a policy of disregarding Council boundaries and following swarms south attacking them when and where possible. The latter proved the most workable policy with the personnel and equipment available. However, the original organisation played a big part in preparing for what was to follow and did not in any way result in mis-directed effort.

The technique which developed was as follows:-

Reports of flying swarms would reach the centre of operations at Jamestown. These would come in a variety of ways. Although designed to go from landholder to District Council Clerk and then to Officer-in-Charge in the district or at Jamestown, this was not always the case. Landholders often phoned in direct and often Departmental Officers after securing some scant information would scout an area and observe the movement of a swarm. Once a swarm was located it was watched in the afternoon and the "settling in" mapped. Often while this was being done

insecticide and equipment was being organised, a plane being moved to the area and spraying would commence that evening if possible. If not it would be to start aerial spraying the following morning.

All aerial operations were aimed at treating locusts when they were settled on the ground.

One of the earlier determinations in relation to aerial attack was the decision to use water and not diesaline as a carrier for the insecticide.

Koomooloo Station trials were made in the use of water and diesaline. Counts of dead locusts the following day showed kills of 8.1 per square foot where water had been used and 9.8 per square foot where diesaline had been used. The decision made as a result of this trial saved 100,000 gallons of diesaline.

At all times it was endeavoured to have two Departmental Officers attached to each plane. They had the job of locating the swarm, mapping its area, alerting the surrounding landholders, organising trucks, tanks, pumps, water supply, insecticide and fuel, as well as selecting a suitable landing strip.

When all was ready the markers (usually the landholders) were taken to their positions and spraying would commence. It was endeavoured to commence operations at the head of the settled swarm and work back. Sometimes the locusts settled in a definite formation but this was not always the case. In practice the dense concentrations at or near the head of the advancing swarm were sprayed. This had the effect of greatly reducing the size of the swarms. Weather conditions at this stage was a determining factor in the efficiency of aerial work. Cool changes which kept the locusts grounded for days as occurred at Peterborough and Yongala allowed spraying throughout the day and really effective killing of large swarms. Fine warm days with cool nights allowed effective spraying morning and evening while a southerly movement of the locusts took place during the day. These conditions allowed fairly effective work but at a much greater cost in effort by the ground crews. This was caused by the movement of air strips and invariably a change in landholder personnel and equipment each day. Hot weather which prevailed towards the end of the campaign caused the locusts to move for such a long period of the day that it made it extremely difficult to keep pace and get a few hours effective aerial spraying each morning.

During the aerial campaign ground operated equipment was kept at work. Air Blast and Sand Blast Machines and the Boom Spray were found to be effective against the grounded fliers. While the plane had

advantages in some ways the ground operated equipment was better suited to some conditions and circumstances. In rough country and in weather too windy for the plane the air and Sand Blast Machines did very effective work. At night, too when fitted with lights these machines could operate longer hours. On flats, particularly those sown to lucerne where locusts often landed in dense numbers the boom spray operated at night with lights proved quite effective.

Ground operated equipment was employed to support aerial attack. It was employed to "mop up" after the planes had dealt with the main swarm, on small swarms, and in country inaccessible to efficient plane operation.

5. Behaviour of Adult Locusts

Development of Swarms

The adult swarms of flying locusts behaved very much as expected, and as outlined in information supplied by Dr. H.G. Andrewartha (page 8 of this Report). Flights of locusts were recorded early in November. On 9/11/55 fliers were moving out of the Hawker-Wilmington area, on 17/11/55 they were reported in the North Eastern pastoral country, and were first reported in the Mambray Creek district on 23/11/55.

The destruction of so many locusts in the hopper stage had two significant effects on the development of fliers. It reduced the over-all numbers to manageable proportions and it pushed the frontier from within the agricultural areas back to the pastoral country. It can be claimed, too, that the excellent clean up of hoppers on the West Coast and West of the Flinders Range virtually relieved the control organisation of two fields which would otherwise have needed additional personnel and equipment. The pastoralists east of Burra had also conducted a wonderful campaign against the hoppers and to them must go the credit of cleaning out another source of fliers.

The pattern of swarm movement clarified with one main swarm following the eastern side of the Flinders Ranges, others coming down each side of the Tarcowie-Pekina hills and two large swarms from the North East into Peterborough-Yongala and Whyte Yarcowie. Fortunately these swarms did not develop simultaneously. The Flinders Range (Melrose-Wirrabara) swarm was destroyed by the time the Peterborough-Yongala concentration had developed. Then followed the huge concentration at Whyte Yarcowie and a few days later at Jamestown.

Weather conditions during this period were favourable for control work. It was possible to get long periods of aerial spraying each day. At times the planes operated all day.

Map No. 2 shows the swarm movements, the locality where aerial spraying took place and the figure alongside each place name represents the date on which spraying commenced. (16/11/55 Melrose to 16/12/55 Virginia).

Movement of Swarms

The general movement of the fliers was southerly, affected to some degree by ranges. The locusts tended to follow the plains between ranges rather than cross them.

Temperature determined the movement of the flying locusts with perhaps an intensification of activity with age. The general pattern of movement was very much as expected from the time the locusts reached maturity until 6/12/56 when the first sustained period of temperatures exceeding 80 degrees was experienced. The locusts would commence flying between 8 and 10 a.m. in the morning depending on temperature and would start "settling in" between 3 and 5 p.m. They did not always settle in the oval shaped concentration with the dense band of locusts at the head of the swarm. Slightly windy conditions appeared to affect this formation. In fact windy weather had the effect of keeping the locusts grounded. If cold conditions kept a swarm grounded for a few days its activity of movement was greatly increased when the temperature rose.

An example of this occurred at Whyte Yarcowie when fog prevented aerial operation one morning after the locusts had been on the ground for a couple of days. They took to the wing immediately the fog lifted and within ten minutes were recorded by the pilots as being as high as 500 feet.

At this stage and at the temperatures prevailing the locusts did not move very far per day. Although it appeared that they were moving at about 10 m.p.h., observations made, recorded movements of only three to eight miles per day.

The movement pattern changed considerably on the 6th December when a very sharp rise occurred in maximum temperatures. From that date on their movement was very much greater per day. On that particular day swarms were noted flying at great height (500-1000 feet was a pilot's report) over Jamestown, Gladstone and Spalding. That afternoon reports were received of large swarms settling in at Hilltown and Barinia. With this period of higher maximum temperatures the locusts were flying for much longer periods each day and flights were recorded continuing into the night. This greater rate of movement demoralised the organisation of aerial spraying as only a few hours of work could be done each morning.

Size and Density of Swarms

Swarms varied considerably in size from a few hundred acres up to 15 square miles. It was difficult to accurately measure density but reliable estimations of 15-20 per square foot and 30 per square foot were made. These figures refer to average densities. On occasions they were noted in very dense concentration of up to 100 per square foot.

Egg Laying

The adult females commenced laying almost as soon as they started migrating south.

These eggs hatched within a few weeks and millions of freshly hatched hoppers died in the first or second instar stages.

Damage

The adult locusts generally preferred grasses, but were not at all consistent in their preferences for food.

In the pastoral country the spear grass flats suffered severely when the locusts were in the late hopper-early winged stage. Also the watercourse vegetation which was green later than the remainder often supported huge congregations from surrounding areas. Under such circumstances complete denudation of water course vegetation took place. All green plants were devoured and the requirements of the locust at that stage could have been moisture as much as food.

As the locusts migrated south they appeared to prefer grasses to clovers.

Wimmera Rye Grass was a first preference but for other grasses and cereals preferences seemed to depend on circumstances. In different areas ripening wheat, barley and oat crops were damaged. The summer fodder crops of rape and Chou Mollier also suffered. Damage to lucerne stands varied greatly, in some instances the locusts left young lucerne and in others showed a preference for it. Peas and Subterranean Clover did not suffer much damage at all.

Although large swarms entered the fruit and vine growing districts very little damage occurred. Only one instance of vine damage was reported. On another occasion severe damage to a prune tree (Robe De Sargent) occurred while surrounding trees and vines were not touched.

The true picture of food preferences was difficult to obtain because of the spraying campaign which was continually interfering with the locusts normal behaviour. Also availability of green food often determined what was

eaten, as the season closed and some plants reached maturity a change in preference towards other green plants took place.

6. Observations made by Field Officers during the Flying stage of the Control Campaign

(1) Organisation

(a) I think that a considerable proportion of the control work on flying swarms could have been done relatively cheaply if it had been possible for the Department to purchase ground equipment of the Air Blower type to be operated by our own Officers or men employed by the Department.

(b) For night spraying with ground equipment it was found advisable to get the farmer to assist with navigation in his own paddock.

(c) "Mopping up" - spotting for this work was extremely difficult so finally I decided to travel with the dusting or vapour units and wipe out concentrations as we found them. This worked very well and saved a lot of extra travel and time.

(d) Shell Agents and District Councils should be asked to deliver drums of insecticide. The Departmental Officers are busy enough without having to do work like this.

With an Austin A70 Utility and two wheeled trailer 26 drums of Aviation Gas and 29 drums of Dieldrin were delivered in eleven days and 1372 miles.

(e) The district organisation originally made out was successful in alerting District Councils and landholders about the locusts.

The system reverted to a team following each swarm which was the only method. The drawback of this system was lack of men to do the organising. I think it would require three or four Departmental Officers to each aeroplane to:-

1. Keep with the locusts during flight each day.
2. Another Officer to come in when it is fairly well established where the locusts will land and help organise trucks tanks etc.

3. Two men to operate the loading system.
4. One man ahead organising equipment for the next shift.

(f) I think the idea of having teams of Officers attacking each individual swarm and following it south until it was wiped out regardless of District Council boundaries was very satisfactory.

(g) Where there is scope two planes can achieve more by working together from one landing ground than by working separately.

(h) Aerial spraying definitely requires a minimum of two Departmental Officers per plane where planes are working separately.

(i) The organisation of equipment and supply to the plane was difficult; ground crews should be dependent on farmers and local authorities only for water.

(j) The organisation of aerial spraying proved a burden to us all, a feature of the exacting requirements of this equipment.

(k) Aerial spraying of fliers was difficult to organise because of:

1. Difficulty of finding landing strips.
2. Difficulty of securing water supplies.
3. The organisation of markers and general assistants.
4. The difficulty of finding swarms to be sprayed.
5. Shortage of suitable equipment for quick filling of plane tanks.
6. There was no shortage of centrifugal pumps on farms but the fittings were not suitable for the plane.

(l) If a set of equipment could accompany each plane organising would be much simpler and more effective.

(m) Once aircraft landed interest seemed to be stimulated and was more readily available. The hardest part of field organisation was the little time available to get the ground loading system working.

(n) The response of farmers to the call for aid and use of equipment was very good in most cases, particularly when their properties were badly infested with locusts.

(o) For aerial spraying we tried to have two Departmental Officers per plane, three or four for two planes and in one case five men operated three planes on one swarm. We followed the principle used by J.D. McAuliffe or individual teams following individual swarms as they moved south, wherever possible.

(p) Aerial Spraying Routine -

4 a.m. - 9 a.m. Spraying

10 a.m. - 5 p.m. Checking reports
spotting swarms
organising markers
and programme of
spraying.

5.30 - 7.30 Spraying with
plane

(q) I often worked 16 or 17 hours per day, knocked my car about quite a bit, missed a lot of meals but generally quite enjoyed the experience and consider that I did everything that I could.

(r) The possibility of using the firefighting organisation as a spotting service was impracticable.

(s) At the outset of "Operation on Guard" the District Clerk of each Council in my District was advised of the help expected from Council and landholders in the event of an invasion.

(t) Practically no worthwhile information was received from District Councils so position of swarms had to be ascertained by going out and looking for them.

(u) I think the most effective spotting work was done by our own Officers.

(v) I think the system of using District Clerks to collect landholder's reports and forward them on to Departmental Officers was some help, but was, on the whole a failure and that nothing more could have been done to make it satisfactory.

(w) The ground equipment necessary for working a plane against fliers should always travel with that plane. This equipment and ground crew would probably be best supplied by the aviation Company with the aircraft under contract. Departmental Officers could then more adequately supervise and plan the campaign.

(x) One of the big difficulties was getting suitable equipment quickly to a given area, after locating the area, and before the locusts moved on. This was particularly so when aeroplanes were being used.

(2) Equipment

General

(a) Ground units are essential in conjunction with aerial units.

(b) A Wilmist Duster should accompany each plane.

(c) The use of ground machines is limited by small paddocks, channels, bridges etc.

(d) The Sayers Exhaust Sprayers were used unsuccessfully on rough going to deal with winged locusts under cool conditions. Small coverage by the Sayer Spray on each run and the large area of rough going made this method unpracticable.

(e) The Boom Spray was quite effective, and where used at night, some enterprising farmers did an excellent job; 300 acres were sprayed during one night with the use of headlights.

(f) Ground equipment could have been far more effective; less organisation needed; can work in poor weather conditions and at night, good in rough and hilly country, mobile and ideal for both hoppers and fliers. Spraying can commence immediately after 'settling in' instead of just organising for the following morning.

(g) A wind which will ground the planes will be of great assistance to a machine applying B.H.C. dust.

(h) Hoses, able to resist the action of Dieldrin better, should be used.

(i) The inside of garden hose used to pump Dieldrin started to fret. The small lumps of rubber blocked the planes spray jets.

Air Blast Machines

(a) Wilmists are effective in certain localities.

(b) The Wilmist Sprayer operates at a comparatively low cost, approximately 7/- per acre requiring only one operator.

(c) The Wilmist duster is less effected by wind than the plane.

(d) The Wilmist machine was very effective at Yongala, capable of 60 acres per hour.

(e) The Wilmist Dust machine was very inaccurate in measuring the amount of dust to go on each acre. At Virginia 66 bags of dust, enough for 100 acres went on 80 acres.

(f) The Wilmist machine - duster gave good cover and was capable of high acreage per hour 80-90 depending on wind-carry.

(g) The Wilmist Duster put the dust on unevenly through trying to put it through the machine too quickly and driving too far apart.

Sand Blast Machines

(a) Sand Blast Machines are effective in cleaning up odd pockets after aerial spraying.

(b) Sand Blast Machines were effective but were large cumbersome units in small paddocks. Their bag advantage was that they could be used during the night.

(c) Lorries carrying Sand Blast Machines were fitted with spotlights for night work. This proved successful.

Aeroplanes

(a) Aeroplanes were equipped with tanks in front of the cockpit with varying capacities 36, 45 and 60 galls. however, in all cases 44 gallons was the maximum load.

(b) The pump which operated the boom under the wings was driven by a small prop. just below the main prop. Travelling at 75 m.p.h. at the height of from 8-25 ft. depending on obstacles, weather conditions and topography the planes put out approximately 2 gallons per acre. Width of spraying 18-22 yards.

(c) The turn round time depended upon length of runs and efficiency of ground loading staff, at stages only seven minutes, but an average of ten minutes per load was taken.

(d) Plane turn round was as quick as $6\frac{1}{2}$ minutes.

(e) Aircraft have a place in attacking the bigger swarms of fliers only i.e. where fliers settle thickly over more than a couple of square miles.

(f) Greatest efficiency seemed to be obtained with two planes working from one base.

(g) Aerial spraying was the most effective for large swarms where areas had to be covered in a short time.

(h) Under good conditions where ground was level the planes flew down to 8 ft.

(i) It should be possible to equip aircraft with dusters. One Tiger Moth could spray nearly 200 acres per flight.

(j) Tiger Moths are too easily grounded by wind, a slightly heavier but nevertheless manoeuvrable plane would be better.

(k) Plane engines should be better if fitted with screens to prevent locusts from blocking their cooling systems.

(l) When operating from landing grounds infested with locusts plane engines frequently became blocked by dead locusts and had to be cleaned.

(m) Aeroplanes were unable to operate once the wind velocity exceeded approximately 15 m.p.h.

(n) Pilots can do a good job without markers though they prefer to have them.

(o) Aerial spraying requires too great a labour force and can be too easily upset by the vagaries of the weather.

(p) Ground equipment seen for working a plane was generally inadequate. Insecticide pumps were too small, engines on pumps were unreliable, pumps not of the self priming type and often had no means of switching off engine or shutting off delivery. Delivery hoses were too small and often too short.

Two power driven pumps were the best for handling the mixing of insecticide and filling. One to fill the 44 gallon drums and one to pump mixed insecticide into the plane.

(q) Two hand pumps and markers were supplied by the Department. All other equipment was borrowed from District Councils and farmers, mostly the latter.

(r) There was a lack of good power pumps suitable for filling. The two Sassafras pumps used with a $1\frac{1}{2}$ " outlet were ideal. (delivered 1 gall. per second).

(s) Water tanks, pumps and hoses were borrowed from local District Councils, Corporations and landholders.

(t) Mixing of spray in 400 gallon tanks fitted blitz buggy chassis with pumps driven from transmission was ideal (35 galls. in 55 seconds).

(u) Local firefighting unit was used for spray mixing, satisfactory except that day was one of high fire hazard.

(v) Firefighting trucks and pumps were loaned on the understanding that they be taken away if required for firefighting purposes.

(w) Fire fighting equipment seldom available from one source. Pumps were often too slow and hoses too small. When ever the landing strip changed another set of equipment had to be organised.

(x) For loading planes two good power pumps were necessary per plane, especially where large capacity tanks and where insecticide had to be mixed in 44 gallon drums to avoid any chance of overloading.

(3) Insecticides

(a) At Wilmington Dieldrin was aerial sprayed - the following day the kill was in the vicinity of 100 hoppers per square yard.

The signs of death are:-

1. Flight loses direction.
2. Become too weak to keep up with rest of swarm - they drop out.
3. Short flights or hops are made and each time the hoppers nose-dive when they land.
4. Finally appear paralysed, they quiver with wings outstretched and fall on their side. Death soon follows and a red exudate from the mouth is seen.

(b) In spraying with Dieldrin on hot days many locusts died within 4 hours. In cool weather many apparently fly away to die.

(c) The effectiveness of Dieldrin seemed greater in cool weather and late evening spraying when the locusts stayed in the sprayed area for a considerable time. Very few could fly out of the paddock after several hours in contact with the spray. In this way spraying the same swarm was avoided.

(d) Dieldrin killed fliers faster when they were active than in cold weather when movement was restricted.

(e) Dieldrin was not spectacular except on hot days.

(f) Weather played a big part in the time taken for locusts to show the effects of Dieldrin.

(g) Very few dead hoppers can be seen in treated areas (Dieldrin). One per square foot is exceptionally high. Many legs and body parts can be seen suggesting cannibalism but this was not seen.

(h) I saw dead locusts killed by spray quite thick on the ground (say three per square yard) about three miles from the nearest area sprayed.

(i) On December 6th at North Booborowie I saw locusts dying apparently from the effects of Dieldrin in a paddock of Chou Moellier, nine miles from the nearest area of spraying and six days after it.

(j) Many fliers were sprayed twice and perhaps three times because of the slow kill of Dieldrin. A faster killing insecticide such as B.H.C. would have been better as it would enable observers to gauge results more easily and would have eliminated double spraying of the same swarm.

(k) Slow killing of Dieldrin permits egg laying prior to death and treatment of dying hoppers is possible after they move on to another area.

(l) Laying was not always successful and eggs were squirted over the ground instead of being placed in the usual tube bored in the ground.

(m) I saw dead female fliers at Clare near areas which had been aerial sprayed with their ovipositors in the ground but no eggs laid.

(n) Many locusts died before they could complete egg laying but many laid eggs and then died with ovipositors in position.

(o) Locusts mated and laid eggs after treatment (Dieldrin). Locusts died in all stages of egg laying from the first attempts at burrowing to the end of egg laying.

(p) When very thick swarms are being dealt with concentration of Dieldrin could be increased. Also on green paddocks because the locusts seem to swarm to such places.

(q) Type of water affected the concentration that killed. It needed a stronger mixture if using hard or brackish water.

(r) Dieldrin - Manufacturers could well add a defrothing agent. At times owing to the froth it was impossible to fill tanks over half way.

(s) Aircraft spraying was very successful with both Lindane and Dieldrin.

(t) Wilmist Sprayer gave good results with both Lindane and Dieldrin.

(u) Aldrin 40% as used by the Wilmist Air Blast Machine seemed effective and gave a fairly rapid effect where locusts were flying they fell to the ground almost immediately.

(v) Dieldrin was not used to any extent on irrigated pastures as it was feared dairy stock may drop back in production. Lindane or B.H.C. was used for spraying such pasture land.

(w) B.H.C. and Dieldrin - Spraying with these grasshopper poisons appeared to have little effect on stock. Some paddocks in which stock were grazing were given complete spray cover but stock were not affected. Where only parts of the paddock were sprayed it did not appear worthwhile moving the stock.

(4) Techniques Employed against Adult Locusts

(a) Technique was to spot swarms while flying then pick up the head when they settled towards evening.

(b) The best means of locating swarms for spraying is to watch the head of the swarm settling in. Once settled in they are hard to find especially in cool weather.

(c) We consider that fliers had to be sprayed on the ground.

(d) Markers were placed up to one mile apart. Runs were made in the longest possible direction with a maximum length of three miles.

(f) Three markers were usually necessary and these moved 22 yards each time or 18 yards in the case of the aircraft with the smaller spray width. Where ever possible spraying was started on the southern side of the swarm or at the head of the swarm and then worked back towards the tail.

(g) Markers were started at and across the head of the swarm so that the thickest portion was knocked out first.

(h) Spraying from one side of a swarm, gradually working across the swarm instead of working from the face and towards the tail allowed hoppers to escape.

(i) If the forward movement of the swarm is not stopped by hitting the head of the swarm first then most of the effort is wasted.

(j) It is important to pick a landing field outside the area of the swarm and preferably in front of its expected line of flight.

(k) Aerial spraying of grounded swarms was done too meticulously. Wider runs with more concentrated insecticide dropped from higher than recommended crop spraying height would greatly increase the number of locusts killed in any one day.

(l) On one job we widened our width of runs to two chains to cover more ground as the swarm would soon be on the move.

(m) On occasions awkward little areas where settled fliers were very thickly gathered (a hilly area with several steep valleys and ridges and where there were rows of trees, gardens, sheds, plantations etc.) we increased the strength of the insecticide and told the pilots to spray from a fair height (100 ft.) in a rough pattern of runs without markers allowing wind drift to even the cover.

(n) Time of aerial spraying - Early in the morning and during the evening. Usually it was impossible to effectively spray after 9 a.m. and on really hot days 8.00 - 8.30 a.m. was the limit. It was possible to start at 5 a.m. most mornings. On hot days practically no spraying was done at night as the hoppers did not seem to settle until it was almost dark.

(o) Boom Spraying - was done paddock by paddock in straight 50 ft. strips and wherever the pests became thin the spray was turned off.

(p) Where Boom Spray was using Dieldrin on the Murray Swamps one paddock per farm, or enough feed for one week was untreated to prevent any upsets in grazing stock.

(q) Air Blast Machines - Use was made of a breeze to carry the insecticide and in this way we got kills 150 yards away. To get the most effective drift we found it necessary to point the machine so that the first blast hit the ground about 10 ft. from the vehicle and not level with the ground or into the air. The insecticide, whether dust or water-mixed would then roll on with the breeze and thoroughly saturate the foliage.

(r) The Wilmist used Gammexane dust to clean up the concentrations left from aerial spraying. The best way, was to travel with the machine and dust the locusts as we found them.

(s) In the case of the Wilmist duster an Officer of the Department of Agriculture pin pointed the swarms and the duster crew did the rest.

(t) Sand Blast Machines - would work from the leeward side of the paddock in parrallel lines across the paddock to the windward side with about 25 ft. between each track as this was the maximum coverage one could expect with a small wind.

(u) Where locusts were sprayed from the windward side of a paddock across to the leeward side the noise of the spray equipment and the slight drift of insecticide disturbed the locusts and the majority would leave the paddock flying with the wind before they were sprayed.

(v) We also found that the best method for the hose operator to manipulate the hose varied with the wind. A vertical movement with the wind to the broadside of the jet gave better cover in windy conditions.

(w) Night spraying using a spotlight on a truck proved successful giving a good kill of hoppers and giving greater acreage per day than usually possible.

(x) Night spraying was more effective since there is practically no movement of hoppers as the Machines approached. An advantage of night spraying was that the locusts, not always dead in the morning were incapacitated sufficiently to stop them flying.

(y) It is advisable for the farmer to travel with the spray crew to direct them at night.

(z) A cool change gave the ground equipment a chance to cover larger acreage than usual while planes were often grounded due to high winds.

(5) Behaviour of Locusts

General

(a) The work done before the locusts reached the flying stage was valuable in preventing swarms from becoming so large as to be uncontrollable.

(b) There was definite need for Field Officers to have some measure of adults swarm size. Perhaps some rule of thumb measurement could be devised or the difficulty overcome by having a trained entomologist in the field with us.

(c) Farmers reports are an unreliable guide to seriousness of situation - need to check all reports.

(d) Investigations should be made into the areas from which these locusts swarm.

(e) The campaign against flying locusts was successful largely due to the fact that the cool weather, which interspersed the hot allowed the locusts to mass into swarms on hot days and then on the cool days they "stayed put" for spraying.

Experience indicated that locusts could fly all night when weather is hot. If this occurred often (as it could in some seasons) very little opportunity to spray would then exist.

(f) Many could have been knocked down while in flight using aircraft over the top even if up to 3,000 ft.

(g) Spraying in this district delayed hoppers from reaching the winged stage in large numbers by at least a fortnight.

(h) The small winged formation of locusts seen in the Murat Bay district at the end of November disappeared in early December. Nothing is known of their migration as they disappeared over night.

(i) Locust swarms which settle as a result of normal evening temperature drop after a hot day are generally far denser and therefore a better target than locusts which are grounded because of cold weather.

(j) Locusts were very sensitive to noise on warm days. Air craft disturbed them.

(k) Laying commenced near Pt. Pirie during the last week of November. In the Clare hills it was delayed until the second week in December.

(l) It was very fortunate that the main swarms of this plague entered the agricultural areas at different points in time and not in a wide front across the whole of the Upper North simultaneously. (The Wilmington-Melrose-Wirrabara swarm was just about cleaned up before the Peterborough-Yongala swarm became serious, etc.)

(m) Tons of locusts were washed up along the shores of St. Vincent's Gulf during the months of December and January.

Development of Fliers

(a) The first fliers were sighted on 17/11/55 on the Newicke water course. At the same time and place adults were mating.

(b) The first adults were reported on the 23rd October at Mambray Creek.

(c) The first main flight of locusts I saw was on November 9th in the country between Hawker and Wilmington.

(d) At Curnamona Station locusts were on the wing on 26/11/56.

Movement of Swarms

(a) The first adults were reported on 23rd October at Mambray Creek. A co-ordinated flight occurred six days later. The swarm flew south along the foothills and S.W. to Butlers Bridge.

(b) The flying swarms moved in a definite S.W. direction unless a range of hills and high winds prevented them from doing so.

(c) During the hot weather locusts travelled at a steady 10-12 m.p.h. covering up to 20 miles in a day. An instance of this occurred on 7th December 1955 when a head of a swarm moved from 5 miles N. of Blyth to several miles south of Hayleton in a day.

(d) With the temperatures over 80 degrees F. the fliers move on each day, on the other hand during the cool weather one large swarm at Rochester stayed 'put' for 5 or 6 days.

(e) On 8/12/55 a stream of locusts near Clare were observed to concentrate and fly through a definite gap in some trees rather than fly over them.

(f) It was a general rule everywhere that swarms were active very early after a few days on the ground because of low temperatures or wind.

(g) I think that flight is controlled almost entirely by temperature and wind, and is affected little by feed supply. Swarms would fly out of excellent lucerne as soon as the temperature was high enough.

(h) Flying swarms tended to follow the north south valleys generally, but did on occasions cross the ranges of hills, When this occurred it was always from east to west.

(i) I think that the big high level flight which was observed at Jamestown on December 6th was the only such flight of any magnitude that occurred and that these locusts landed on the evening of December 6th in the area bounded by Andrews, North Booborowie, Farrells Flat and Clare. I think that this swarm came from Orroroo, Johnburg, Belton country where spraying of hoppers was not very thorough.

(j) Locusts flew most strongly on hot calm days, on these days in undulating Lower North country swarms moved about 5 miles per day.

On hot days locusts rose about 8-9 a.m. They spread out moving steadily S.W. Towards evening their movements became more haphazard; from 5-6.30 p.m. they came together and settled thickly on chosen paddocks.

(k) They displayed no preference for settling in depressions or on hills or green feed or for soft or hard ground except for laying.

(l) The swarms preferred to fly round a hill rather than over it, this often led to splitting of swarms some going one side and some the other.

(m) I followed one swarm from Clare Race Course over the Clare Hills to Kybinga to Hoyleton. By 5.30 p.m. the swarm was still flying S.S.W. and later that evening was reported at Balaklava. It had covered 25 miles. It was about 50 yards wide 15 feet off the ground and about 20 feet deep. Various groups branched off it and came into it during its course.

(n) It seems fantastic that these swarms which were reaching hundreds of feet high at times and seemed to travel up to 7-10 m.p.h. in many cases only moved 6 or 7 miles in a day.

(o) On several occasions I heard reports of night flights by small swarms.

(p) In really hot weather they moved much greater distances in a day.

(q) There was little movement during cool periods as during the night. Since this period of little activity was always at best 12 hours each night it seemed an opportunity missed since there was little night spraying. Where it was done it was successful and the 12 hour period allowed considerable acreage to be ground sprayed.

(r) On windy days there was little locust activity and it was a pity that we had not a little more ground equipment to cover large acreages during these periods when air craft could not be used.

(s) Swarms of fliers are definitely held up by belts of timber such as along some water courses. It seems as though they will congregate in such places for up to several days before they finally find a way through the timber.

(t) I saw some bands of fliers moving north and northeast in and around Clare for several days after the big high-level flight from the north on December 6th. Even so, the general movement was still southwards. It was as though this very big swarm had been broken up, on landing, into smaller swarms by the belts of timber, and ranges of hills in the Clare district, and these had lost their sense of direction or were trying to reform. These bands stayed in the Clare - Watervale Hills for over a week, but once clear of the hills rapid migration was again resumed in a definite S. or S.W. direction.

(u) Locusts on the Murray swamps appeared to come from Cambrai, Sedan and Nildottie areas where extensive breeding took place.

(v) Hoppers flying west to south-west over plain from Robertstown would alight at foot of ranges during the afternoon and if conditions were right next morning they would fly to table land on top and alight.

(w) The thickest and largest swarms came from the North East and were attacked at Yongala, Burra, Tarcowie and Booborowie.

(x) At Jamestown on December 6th I saw a mass movement of locusts flying due south at 0 to 1000 feet high (checked by aeroplane). This mass movement continued for several hours at least, on a front of several miles at least, and at quite a considerable speed, perhaps 10 to 15 m.p.h. This was the only mass high-level movement which I saw at any time.

(y) I think that the big high level flight which was observed at Jamestown on December 6th came from the Orroroo-Johnburgh-Belton country and landed in the area bounded by Andrews, North Booborowie, Farrells Flat and Clare.

(z) During the whole of the plague I saw six main swarms of fliers at Melrose, Yongala, Caltowie, Whyte Yarcowie, Jamestown and Hill River. Only on two days at Whyte Yarcowie did any of these swarms settle into anything like an oval or crescent shaped area. At Melrose and Hill River the swarms were banked up behind rows of trees. The rest of the swarms assumed no definite shape on settling, and in some cases were not even continuous, but were in thick patches of 100 or so acres spread over several square miles.

Extent, Size and Density of Swarms

(a) The first main flight of locusts which I saw was on November 9th in the country stretching from Hawker to Wilmington. On this date there were very few fliers at Carrieton, but I drove through fliers all the way from Hawker to Wilmington via Quorn. The general line of flight was S.S.W. There was no tendency towards distinct swarms but concentrations were somewhat thicker in some places than in others. None of these concentrations were thick enough to consider spraying at this stage. Between Quorn and Wilmington along the main road there was a distinct tendency for fliers to be densest immediately north of Richman's, Mt. Brown, Mimbadoggie, Yarpoona and Beautiful Valley Creeks and in the township of Wilmington for strips about one quarter of a mile wide. Immediately south of these creeks strips of up to a mile wide were practically free of locusts.

(b) The largest swarm of fliers which I saw was Whyte Yarcowie on November 27th. This settled on about 9 square miles in two main areas to the S.E. and N.W. of the town. The area was not oval shaped or anything like it. This appeared to be the meeting point of two swarms, coming in from the East over the ranges, and down from the North (from Ucolta etc.)

Three planes sprayed here on November 27th and 28th, covering perhaps 2,000 acres. November 28th was foggy early in the morning and locusts started to fly within ten minutes of the fog lifting. (It was a general rule everywhere that swarms were active very early after a few days on the ground because of low temperature or wind). One hour after the fog's lifting locusts were flying south at approximately 10 m.p.h. (tail wind).

On the way back to Jamestown on the morning of the 28th we saw dead locusts killed by spray, quite thick on the ground (say three per square yard) about three miles (roughly) from the nearest area sprayed. At 4.00 p.m. on November 28th this swarm was located and plotted in on a county map only eight miles S.S.W. of Whyte Yarcowie. A series of telephone calls had confirmed that this swarm could not possibly have moved any further than this. The front of this swarm now assumed a perfect parabola shape with the thickest concentrations in the nose, and along both wings of the parabola. Locusts were thick enough to spray on about three square miles, but scattered fliers were present in the body of the parabola right back well through Whyte Yarcowie.

On the morning of the 29th of November we sprayed approximately two square miles with three planes, starting right at the head of the swarm with two planes and on one of the wings with the third. 'Stream-off' occurred

at about 9.00 a.m. and spraying was stopped. Once again the swarm appeared to be moving south at an estimated 12 to 14 m.p.h., and yet was located at 5.00 p.m. settling in with the head of the swarm exactly three miles south of where it had been that morning. How this happened beats me!

We thought that the main flight must be in a leap-frog fashion with each locust flying for half a mile (say) and then resting for an hour (say). Again the head of the swarm assumed a parabolic shape with thick concentrations of locusts in the nose and along both wings.

(c) Concentrations were thick enough for spraying on 1,000 acres only, but scattered fliers were encountered for many miles north in the body of the parabola, and at 9.00 p.m. on November 29th locusts were still flying South through Whyte Yarcowie by moonlight. Two planes sprayed the 1,000 acres of the swarm on the morning of November 30th, on the evening of the 30th November I heard that 100 acres only of very thick locusts settled in less than half a mile South of where the morning's spraying had taken place. This was not sprayed. I saw very few dead hoppers during the whole of this four day campaign.

(d) At Whyte Yarcowie the fliers came in from the north on the 25th and 26th October and covered an area of approximately 5 miles by 3 miles. The cold weather on the 26th forced them down over this area and they did not settle in the normal manner i.e. largest concentrations in the front of the swarm. But the hoppers were reasonably thick in the whole area. The 27th and 28th November were cool days and a big area of the swarm was sprayed by three air craft. The 29th opened with a dense fog which cleared at about 8.00 - 8.30 a.m. and ten minutes later the hoppers were on the move and reached a height of 500 feet or more. However they only travelled 6-8 miles to the Bluff where they formed the anticipated crescent shape swarm and were very concentrated at the head of the swarm, up to approximately 75 to the square foot in the thickest places. These were sprayed heavily and the swarm at this stage was reduced to about 2,000.

The next day they landed 5 miles south and the final area of approximately 700-1,000 acres were sprayed.

(e) On 6th December the remainder of the swarm from the north-east poured in down the gullies on to the Booborowie plain. These hoppers formed a dense blue mist as they followed the gullies down. These were the greatest concentration of hoppers I saw during the whole campaign.

When the air-craft came into land 3-4 miles north of Booborowie a blanket of hoppers rose, and the pilots were unable to see the ground.

This was the only time during the whole campaign that I have seen the hoppers so thick as to blanket out buildings 100 yards away, and then it only for a moment.

(f) Density of Locusts in Flying Stage

We found it very hard to estimate the absolute density of locusts at any place. On the thickest swarm that I saw G. Webber and I made counts on estimated one square foot areas from a distance of about 15 feet. We made counts of 40, 70, and 100 per square foot. Those figures would be above average for the swarm because we picked out the thick patches. An overall figure of thirty per square foot would be a fair enough figure for what we were calling 'very thick'. During the early morning when grounded locusts were unable to move at all, one tended to under-estimate the density of the swarm. When locusts were very active, and especially when on the wing the tendency was to grossly over-estimate the density of a swarm. It was very difficult to get accurate reports from landholders.

(g) Single swarms of up to 2,000 acres in extent, average density 15-20 fliers per square foot (when at rest). Such swarms seen at Gladstone on 29/11/55 and at Rochester on 30/11/55.

(h) The largest and densest swarm was seen at Hilltown on 8/12/55. Locusts at rest settled on fence posts and wires and telegraph poles so thickly that the posts themselves were often covered completely. When disturbed by aerial spraying the air had the appearance almost like a fog as the fliers rose from the ground. In spite of the great number of locusts in this swarm very little damage occurred to the crops and pastures in which the locusts landed for one night. (I would guess that this swarm had a density of 30 per square foot).

Damage

(a) Adults preferred grasses and weeds to legumes. At Hallett they camped for three days in a young stand of spring sown lucerne with a very light cover crop of barley. The barley was practically eaten out but the lucerne untouched except up near the head of the swarm where numbers forced them to eat everything.

(b) The adults in the Baroota area disregarded young peas and cleaned out self sown barley and oat crops.

(c) The only case of vine damage was where an undergrowth of couch grass was the prime attraction. Vine damage followed eating out of couch.

(d) Fliers camped in lucerne, Wimmera Rye Grass stand, cleaned out the semi-dry Wimmera Rye Grass but did not unduly worry the lucerne.

(e) The worst damage seen would not have amounted to a loss of any more than 20% of the crops or pastures.

(f) When locusts moved in over orchards and vineyards in Clare and Baroota only one instance of damage to fruit trees or vines was heard of at Roseworthy College one variety of prune tree (Robe De Sargent) was completely defoliated. Other trees and vines were not damaged.

(g) Most locust damage was done either late in the evenings or on cold wet days when the locusts were grounded. Little damage was done on warm days when locusts were grounded.

(h) Once the hoppers reached green pastures they showed little inclination to move on. In many cases they remained in the one area for 7-10 days.

(i) Most damage was caused to green oat crops, young lucerne paddocks and in some cases fairly severe damage to barley and wheat crops.

(j) Green fodder crops were often badly damaged in particular - Rape.

(k) Chou Mollier seed crops at Wirrabara were damaged by locusts.

(l) Heavy invasions of winged locusts from December 5th to December 23rd approximately destroyed all green fodder in the Lower North area. There was just as great destruction of green fodders, lucerne and gardens in the 1955 plague in the Lower North as in any previous plague. Crops were saved because of the control of locusts in the area in the hopper stage.

(m) Locusts usually settled thickly on higher slopes but nature of vegetation often modified this. The nature of preferences were:-

Oats or barley
 Re-growth on hay stubble
 Cluster Clover - Rye Grass
 Green Wheat
 Green Lucerne, especially if not too thick

(n) In cereals locusts ate heads and stripped or cut off heads, depending on degree of crops maturity. They trimmed leaves off lucerne and other pasture plants. Cluster Clover, Rye Grass and Phalaris were favourites but Subterranean Clovers were rarely damaged. Degree of damage varied greatly but generally 25% in crops and pastures.

(o) Locusts prefer young wheat, barley and rye and prefer these cereals to oats. Lucerne is attractive and Wimmera Rye Grass appears more palatable than either Burr or Barrel Medic.

(p) Crop preferences were:-

Green and dry Rye Grass
Couch Grass
Freshly cut lucerne with short regrowth
(tall regrowth of lucerne avoided).
Oats
Wheat - barley

(q) Locusts did not eat Subterranean Clover readily.

(r) Rye Grass was a favourite feed of the locusts. They tended to avoid tall growth. Lucerne paddocks recently cut were popular settling grounds as were stubbles on which the straw had been cut low or pastures which had been grazed.

(6) Locust Spraying, and its effects on Bees

The following report was made by Mr. J. Masterman, Inspector of Apiaries who assisted Beekeepers during the aerial campaign.

" In every case where a comparison could be made, it was found that spraying by plane was more harmful to bees than dusting, boom-spraying etc.

This is probably due to:-

- i. The non-selective nature of plane spraying within the area sprayed.
- ii. The greater extent of plane spraying.
- iii. The greater height of application from a plane.
- iv. The speed of application.

Serious losses of bees occurred as long as two weeks after spraying, and in some cases bees one mile away suffered as much as those only 200 yards away. This is probably because all were working on the same crop which was included in the spraying.

In some cases dead bees could be shovelled up in front of the hives. Each side of a red gum creek near Melrose, was sprayed by planes and a colony of bees in the centre was practically wiped out. A few days later only five live bees could be seen going in or out in about five minutes.

It would be impossible to state the actual loss sustained by beekeepers because it varied from a negligible loss of field bees to about 50% of the field force, or even more. The bulk of the bees died in the field, so losses were difficult to assess, except where apiaries were seen before and after spraying.

The loss in honey is not so difficult to estimate where apiaries were moved off a flow as at Jamestown the loss would be about one 'take' of honey, i.e. 30 lbs. per colony or 50 tins for a 100 colony apiary, this at £3 per tin is £150, less the cost of taking it and the cost of the tins.

The cost of moving bees should also be considered.

During the recent hopper spraying campaign the aim was to warn beekeepers who had apiaries in an area to be sprayed.

In many cases this worked well, but the difficulty was to give them enough warning. Owing to last minute decisions or altered plans, due to hopper movements, there were times when there was too little warning, or none at all.

The practice was to warn apiarists between 6 and 10 p.m. that spraying would start at daylight, and there was good co-operation between the spraying people and the beekeepers, the latter working through most of the night at times to get the apiaries out in time.

Difficulties arose when:-

- i. The weather was too hot to risk moving bees at night.
- ii. When beekeepers could not be contacted owing to absence.
- iii. When they lived 60-80 miles away and were not on the phone.

The plan developed was to scout through a district ahead of the hoppers, learn where the bees were, alert the owners, and arrange for one or two of them to pass on any spray warning from the Department to all the other local beekeepers.

This system encouraged them to help one another to move their apiaries, and left the Department to warn the outside beekeepers as far as possible.

To reduce losses to beekeepers in the event of another hopper plague, it is suggested that:-

- i. The hoppers be attacked more vigorously before they get down into the beekeeping country.
- ii. Leave unsprayed certain defined areas, where the heaviest concentration of bees are, and notify the beekeepers accordingly, so that they can move bees into these safe zones, without fear of having to move them again or having their aparies sprayed."

VII. Press, Radio and Public Relations

It is pleasing to report that throughout the whole campaign the Press and Radio were sympathetic towards the efforts being made to bring the plague under control.

My personal experience was one of being able to convey accurate accounts of the position to the public and at the same time use the reports to disseminate vital information.

This close liaison between Press and Radio and Regional control was a valuable asset. It met a requirement so very necessary to the success of the Campaign.

From the Regional Control Officer, therefore, a very sincere thanks is extended to the Press and Radio for the excellent manner in which they publicised the Campaign.

The Senior Information Officer, Mr. D.J. Kilpatrick has summarized Press liaison and publicity as follows:-

Press Liaison and Publicity

"Continuous liaison with the press was maintained during the whole of the Campaign and effective publicity was given to it.

Commencing the last week in September, news reporters of the A.B.C., the Advertiser, the News, the Sunday Mail and Sunday Advertiser contacted Mr. J.D. McAuliffe direct by phone at Jamestown.

This situation held until the 19th October when the Director released the following statements to the Press.

" In order to prevent interruptions to Officers in the field, the Director of Agriculture, (Dr. A.R. Callaghan), has arranged for a full statement to be issued in Adelaide each day at noon covering developments from all areas concerned with the control campaign. It is hoped as a result of this that the press will no longer seek direct information from Officers in the field."

Press bulletins prepared from information phoned to the Adelaide Office from control centres about 10 a.m. each day were then issued daily.

This arrangement continued until the 15th December when it became clear that the swarms were virtually cleaned up and only mopping up operations remained to be carried out.

The city press and the A.B.C. reported the progress of the campaign daily from the bulletins and observed the Director's request to refrain from phoning Officers in the field.

The "News" in particular made use of the daily releases in their entirety.

At the conclusion of this phase, the following letter indicating the appreciation of the Press of the daily releases was received by Dr. Callaghan from the Associate Editor and Chief of Staff of the "News".

"NEWS LIMITED"

19th Dec., 1955.

Dr. A.R. Callaghan,
Director of Agriculture
Agriculture Building
Gawler Place
ADELAIDE

Dear Dr. Callaghan,

We thought it only just that we should write you now that the daily bulletins on the grasshopper plague have ceased. We have felt for a long time that these bulletins have been issued with a consistency and skill that have made them unique in the relations between press and your Department. They have always been excellently compiled and presented in a manner which has been helpful to our readers, the general public and the State itself. It has been a service which we have greatly appreciated and for which we know we owe a great deal, firstly to yourself and partly to Officers of your Department.

The fact that the grasshopper plague was checked and the damage limited was undoubtedly due to the action of your Department. We would like to add our praise for the work your Department has done in this way.

This is an opportunity also to tell you how much we appreciate the weekly press bulletins issued by your Department. These are always most helpful and very much

appreciated. We know that their real news value has improved materially from the time you took charge of the Department.

Since that time the relations between the Department and the press have been exceedingly good. This is something we have appreciated indeed and we would like to take this opportunity of thanking you personally for your co-operation and friendly contact with us at all times.

Yours faithfully,

(Signed): Murray W. James

Associated Editor & Chief
of Staff."

Fortunately it can also be reported that Public Relations were cordial throughout the whole Campaign. Early, some passive resistance from landholders who believed the task impossible, did exist. However as the campaign progressed this attitude changed considerably and finally it was generally conceded that under the circumstances control efforts were very good.

Landholders benefited greatly from the experience of engaging in efforts to control a plague. They were generally pleased with the result because of their own participation, because of the Departmental effort and because Government gave so much assistance.

The Campaign imposed additional work on District Councils, particularly the District Clerks. For the most part these men assisted in every way possible. At the conclusion it was the general opinion of District Clerks that a central depot of insecticide from which they could all draw supplies would have assisted them greatly but in other respects were satisfied with the manner in which the Campaign was conducted.

One District Council submitted the following report; on the organisation of the Campaign.

"It is the opinion of my Council that the organisation of the Campaign to control the grasshopper plague reflects great credit on all concerned including our late Minister of Agriculture, his Officers in the Agricultural Department, the Councils and their Officers, the suppliers of insecticides, the landholders and those who worked so well in the field during the aerial spraying in the flying stage. The organisation of this latter part of the Campaign calls for congratulations to the Northern Regional Officer, Mr. J.D. McAuliffe and the Departmental Officers who worked with him. Their efforts brought glowing tributes from those in a position to know just what a great job they did.

District clerk, Jamestown"

VIII. Cost of Control Campaign

It is not possible to submit a complete cost of the Campaign because labour except where included in contracts has not been recorded. Landholders, District Clerks, Army Personnel and Officers of the Department of Agriculture spent a great deal of time in organising and carrying out the control campaign. As labour would probably be secured in a similar manner in the event of another plague, and as it does not represent an additional direct cost to Government its omission from the Summary of Expenditure does not affect the value of this record.

SUMMARY OF EXPENDITURELOCUST CONTROL CAMPAIGN 1955-56

<u>Insecticides</u> distributed by Local Governing bodies	£93,475 - 5 - 7
<u>Insecticides</u> Aerial Campaign	24,799 - 2 - 11
<u>Aerial Spraying</u> Plane Hire	26,931 - 17 - 9
<u>Ground Operated Equipment</u>	
Sand Blast Ltd. Hire of equipment	3,549 - 2 - 1
Research Indus. Hire of equipment and supply of Insecticide	15,115 - 6 - 10
Army Jeeps	3,001 - 6 - 10
<u>Travelling Expenses</u> (Departmental Officers)	
Telephone Charges and Sundries	5,436 - 17 - 1
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	£172,308 - 19 - 1
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IX. Suggestions for the Future1. Assess Magnitude of Plague

It is important to know as nearly as possible the size and extent of the invasion because plans for the control depends on this information. This was most difficult in the last Campaign because the Noxious Insects Act was not thoroughly understood by landholders.

In the case of any future invasion of adult locusts in the Autumn a publicity Campaign should take place immediately i.e. during March and April. This publicity attended by extension Meetings where ever possible should concentrate on securing accurate and complete reports of egg laying. At the same time as reporting egg beds landholders should be asked to supply details of the type of

equipment on hand to deal with the situation.

If such information could be collected a Campaign could be planned during the Winter months. The plan would include determining the extent of the plague purchasing or hiring equipment for use in areas where suitable equipment was inadequate and organising supplies of insecticides.

2. Design Campaign to control Plague in the Hopper Stage

The 1955 Campaign proved that the best time to destroy locusts was during the 'hopper' stage. Any future Campaign should be designed to completely control the locusts in this stage. To achieve this it would be necessary to:-

(1) Conduct an intense publicity and extension Campaign. This should commence in August before Spring hatchings take place. The aims of this Campaign should be to create public interest and to educate landholders in control methods.

(2) The above drive should culminate in the placement of Departmental staff throughout the infested area. In a plague the size of the 1955 one this would require twenty four Departmental Officers. It is suggested that one Officer could be centred on each of the following Council areas:- Hawker, Kanyaka, Carrieton, Wilmington, Orroroo, Pt. Germein, Pt. Pirie, Peterborough, Laura-Gladstone-Georgetown, Hallett, Burra, Robertstown, Morgan-Waikerie, Eudunda-Truro, Loxton, Franklin Harbour, Cleve, Kimba. In addition five men should be allocated to the pastoral areas, to the North and the North-East. At a regional headquarters two Officers would be necessary to co-ordinate field operations and act as the channel for directions from Departmental headquarters.

(3) The most suitable equipment for use in a Campaign will vary with locality and conditions. Based on our present knowledge and experience a machinery pool created for the purpose of supplementing farmer owned equipment should contain Sayer Spray Units, Boom Sprays and Air Blast Machines. These should be allocated to districts and be directed by the Departmental Officers. They should be loaned or hired to the landholder.

(4) In suggesting above, that, District Council areas be the basis for placement of Departmental Officers, consideration has been given to the distribution of Insecticide, District Councils constitute an ideal organisation for handling Insecticide. The method used in 1955 could be improved by Departmental purchase of insecticide in large quantities and forwarding on demand to Councils for distribution.

3. Treatment of Flying Locusts

It is considered that a properly conducted Campaign in the 'hopper' stage would prevent adult locusts developing.

However if some locusts did reach the flying stage a somewhat similar approach as for the 1955 plague would have to be made. Planes of the Tiger Moth type are quite satisfactory under our conditions. The basis of contracting planes should be altered. The Aero. Companies should be contracted to:- Furnish their own ground crews for supplies of insecticide and fuel and landholders be asked to provide water and markers. This would relieve the Departmental Officers of long hours of manual work and allow them the time necessary for efficient spotting of swarms.

It was learned during the 1955 Campaign that very efficient control of fliers is possible with ground operated equipment. Boom Sprays and Air Blast Machines can be operated for long hours with the aid of lights.

In the event of fliers developing in any future plague more use could be made of ground operated machines.