SRA Grower Group Innovation Project
Final Report

Sugar Research Australia

Research Funding Unit

SRA project number:	**GGP056**
SRA project title:	A monitoring-based system to enhance canegrub control best management practice for Isis sugarcane growers
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Executive Summary:

- *Issue (what was the industry and/or community issue, what was its relevance, and how did the project address the issue)?*
- *R&D Methodology (explain the methodology, and indicate the extent of collaboration and/or partnerships, especially with end users).*
- *Key results.*
- *The impact of the project findings on the group, the sugar industry and the community.*

The aim of GGP-056 was for growers to experience the effectiveness and practical value of monitoring canegrub risk as the basis for more cost-effective and efficient canegrub management: - taking the most appropriate option, including the most suitable insecticide treatment if and when and where needed, as opposed to current routines that are in the main effective but not as efficient as possible.

At a series of meetings organised through Isis Productivity Limited, the project concept was explained, and offers of assistance made to all who attended. Over the three crop years 2009-2011, 50 growers chose to interact with BSES Limited specialists in grub-monitoring processes, to identify their grub-risk potential and prepare appropriate management plans.

In the project, key at-risk fields were identified in discussion with each grower, and then an evaluation team sampled these fields for canegrubs and/or signs of activity. A total of 218 fields were monitored following grower request. Most growers were able to participate in the monitoring activity. All were given the risk-assessment results, and asked to outline and discuss and develop short- and long-term management options with the specialists, in view of this information.

Monitoring programs successfully detected or confirmed broad categories (general/ light/ or nil) of infestation, and current and future risk. Growers generally were willing to discuss various options in view of the risk-situation. The specialists and growers kept general overview of these fields and farms in years following the consultations. Generally grub damage remained low in the vicinity of monitoring fields for the duration of the project, although several non-participating growers experienced substantial damage. Most important, these follow-ups confirm no major false negatives (under-estimates of grub-damage potential), in the fields surveyed during 2009-2012, although follow-up monitoring detected several infestations regaining intensity from 2012 - 2014.

Isis Productivity Limited (IPL) Board members, many of whom had participated in this activity, considered that the results of grub-risk-monitoring in this format were beneficial to their enterprises. Thus, IPL has provided a letter stating:

> *"The Board of IPL values the outcomes of this SRDC funded project and believes a monitoring-based warning system can give sugarcane growers reasonable confidence in ascertaining whether they will or will not have a canegrub problem later in the season."*
> -- "*canegrubs can have significant constraint on productivity, and as such, the Board will incorporate canegrub monitoring into its core-business activities. However, with only two full-time staff the task of providing more than a sample monitoring program is beyond our capacity. As with RSD, the Board will sample sections of the cane supply each year to obtain an indication of potential damage."*

Further, IPL Board considered monitoring <u>in the format tested</u> may not be a profitable or efficient core-business role. But, IPL Board also considers that with added efficiency of focusing monitoring activity on growth constraint areas through Remote (satellite) Sensing, monitoring to confirm canegrub risk and/or other crop conditions could be profitable and useful.

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"In considering whether or not to implement a full commercial monitoring system, the Board does not anticipate there would be much uptake by the canegrowing community to pay for an annual service."

At the end of this Report there is a Recommendation that the concept of an Integrated Productivity Management program, using Remote Sensing Imagery as the guiding tool, be considered as a Joint Venture involving a range of providers (e.g. SRA, Universities, Institutes, SRA-PEC) and their specialists and generalists, collaborating with IPL. The concept is that if successful such collaboration could become more industry-wide, involving a range of Productivity Services; tailored to focus on locality-specific issues including, in this case, improved canegrub control.

Background:

IPL Board sought to increase the capacity of grub-group members to manage canegrub-control. IPL Board members sought reassurance through demonstration, that monitoring canegrub risk could deliver widespread benefit and opportunity to the grower community? And if so, could IPL incorporate such a program into core-business; perhaps even on a fee-for-service basis?

Regularly, canegrub damage has constrained Isis' production and profitability: $0.5-0.75M / yr sugarcane payment lost to Growers, plus costs to prematurely replace failed crops (@>$1,200/ha); also the lost opportunity for the Mill to produce and sell 2,500-4,000t sugar. Current insecticide options for controlling canegrubs are effective, but cost $100–150/ ha/yr, or $250-375/ha at establishment for 4-year protection. Widespread 'blanket' or 'routine' protection could be deemed uneconomic: - also impractical, unnecessary, and environmentally unsustainable.

In Isis, as elsewhere, general, *reactive* strategies for managing canegrubs prevail amongst 'responsible' growers who attempt to manage these pests. In one scenario, severe outbreaks of damage prompt widespread 'routine prevention' treatments, resulting in a lull in damage. Several seasons later some growers forget the threat and do not protect new crops, and most grow on their older ratoons - now out-of-protection - without awareness of trends in grub populations – and so allow grub populations to escalate and again cause severe damage. Decreasing control and treatment is also frequently driven by economic downturn – low sugar price. In another scenario, growers normally at inherently low-risk do not protect plant or ratoon; then in abnormal situations (e.g. low sugar price years leading to extended ratooning beyond normal cropping-cycles) grub numbers escalate sufficiently to cause damage. Both scenarios are inefficient strategies. Both are due to:

(a) lack of information-systems tuned to growers' annual needs and timetables, leading to
(b) inability to efficiently employ optimum tactics, instead of inefficient general routines.

A significant proportion of grub damage symptom involves 'lackadaisical' growers; with little concern or awareness of grub-management; or refusing to accept (for various reasons) that effective management can be achieved. Unfortunately these seem unaware of the negative consequences of their attitude; for themselves, or for their neighbors impacted by migrating beetles, or of their potential to increase their productivity and profitability as well as that of the sugar-mill. After several failures to progress, we made no further attempts to engage with this category of grower.

In the Isis and Bundaberg region, SRDC-funded research (BSS0266) had highlighted the potential benefit from an efficient, *pro-active,* monitoring-based warning-system. Monitoring during autumn and/or winter giving 80-90% local predictability of grub-activity in subsequent crops, provided adequate 'awareness' and preparation time to plan site-specific grub- and crop-management; and to implement the strategy in spring. Appropriate crop-protection strategy and actions, when and where needed. These include rotation-crop fallowing with a legume crop as a more viable alternative than 'curative' insecticide treatment in spring; and nil (preventive) insecticide treatment in low-risk years or situations; or short-term preventive treatment with insecticide only when risk begins to escalate, to a routine of long-term pre-emptive insecticide protection in high-risk situations.

This Project combined resources and skilled people to role-model using monitoring-based processes to improve outcomes from grub management, on individual and district-wide scales.

Objectives:

1. Validate systems to (a) monitor grub trends, and (b) to use the data in annual grub management planning with efficiency-level not possible without such systems.
2. Train and build capacity of grower & manager members to annually collect relevant information, and to prepare timely, cost-effective, and sustainable canegrub management strategy.
3. Be a pilot scheme, from which the IPL could gauge if, and in what form, to include grub-monitoring in commercial core business.
4. Group members will, by participation, training, and trials, gain skills and confidence in systems to enhance commercial best management of canegrubs.

Methodology:

BSES Limited staff formed a team (an applied crop-protection scientist, (2) trained field technicians, plus trained and skilled field-hands) to perform necessary activities.

At the beginning of 2009, the BSES team was already operating a pilot program supported through SRDC project BSS-0266, to integrate monitoring-based grub management within 'new farming-systems' combining crop rotations, minimum-tillage, and dual-row/wide-row spacing as a strategy to improve soil condition and to minimise soil compaction. Monitoring activities with funding from BSS266 continued until the beginning of GGP056 in January 2010: so monitoring from 2009 is included in this report.

IPL staff convened meetings of interested and grub-affected growers – the Isis Grub Group. In addition, local newspaper reports were used to advertise the new project. Also BSES newsletters to all Bundaberg, Isis, and Maryborough growers outlined the GGP056 activities. At meetings in 2009 and again in 2010, goals and likely benefits from this project were discussed. Offers to collaborate in this Project were made to all attendees. In addition, several growers with obvious grub-problems were offered places in the program. All respondents were visited by the BSES contracted scientist and technician and/or IPL staff. Each grower's specific situation and goals were assessed.

Growers were coached through steps to identify key grub-risk situations on their farm. Using mill record farm maps and details on crop age (Appendix 1), we discussed relevant criteria - including existing and past grub-damage, soil type, crop protection treatment history, future cropping rotations, etc., – to identify key blocks for risk-assessment by grub-monitoring, relevant to the grower's management goals.

Growers (mostly) were able to accompany the assessment team in monitoring key fields and sites. These growers were coached through appropriate sampling plans, sampling for and locating grubs, and to develop skills on recognition of grub-damage to stools, and cane-grub identity, including non-target species (organic feeders (Dynastinae) and minor pests such as Christmas grubs (Rutelinae)). BSES Ltd Information Sheets on some of the above technical details, including IS13037 "Canegrub management in the Bundaberg and Maryborough districts - Survey in Autumn: Plan to Manage Canegrubs in Spring" plus a Southern region canegrub identification sheet (Appendix 2); also IS13035CG "Childers canegrub" (Appendix 2a), and/or IS13101 "Southern one-year canegrub" (Appendix 2b), were given to assist participants' learning.
All participating Growers were given copies of their sampling results (example in Appendix 3) and were engaged in discussions, with reference to relevant fact sheets (e.g. above), of likely risks and

appropriate management strategy relevant to stated goals especially for crop rotation.

During the 2010 season the BSES Limited consultants established four field-scale trials to compare efficacy of a range of management and treatment strategies when combined with grub-monitoring guidance. The sites were monitored annually or biannually for canegrub activity, as appropriate. Treatments compared are outlined in Appendix 4.

Specific information meetings were held on three occasions through the project, to outline broad findings, and enlist further collaborators; in particular we attempted to enlist subsets of growers from several geographic sectors of the mill-district covering cultural practice, soil-type, and canegrub species variables.

Special meetings of IPL Board were called on two occasions to discuss findings; from both technical and grower-member perspectives, and on one occasion to discuss likely future directions for both within and after this project.

Results and Outputs:

Monitoring up to and including early 2009 was conducted with funds from BSS266. IPL staff convened 4 workshop meetings on 11-12 March 2009 (reported in BSS266) at which monitoring was discussed and growers invited to indicate interest. IPL staff convened another four workshop meetings on 23rd and 24th March 2010, attended by about 40 interested and grub-affected growers - at which goals and likely benefits from this continuing project were again discussed. Further progress reports were delivered at shed meetings on 26 May 2011. Discussions of outcomes and future directions were continued at meetings associated with BSS342 in 2012, and at an SRA information update meeting in Childers in May 2013.

Almost all grub-affected attendees chose to participate in the program, and all who responded to offers to participate were included in the program: despite the subset of growers who had initially been selected for Project BSS266 being biased towards those attempting the whole gamut of 'new farming systems'. In addition, several growers with obvious grub-problems were offered places in the program. Others who themselves identified a potential benefit from participation were accommodated in the program as they made themselves known.

Collaborators over the three sampling-years 2009-2012 and the numbers of blocks sampled are listed in Appendix 5. In addition the technical team conducted follow-up monitoring on selected sites during 2012, 2013, and 2014 - also included in Appendix 5.

Over the three crop years 2009-2012, 50 growers chose to interact with grub-monitoring specialists. A total of 218 blocks were identified from key grub-risk criteria, then monitored, and management recommendations appropriate for the results and farm situations discussed and developed in conjunction with these growers.

Objective 1#: Validate systems to (a) monitor grub trends, and (b) to use the data in annual grub management planning with efficiency-level not possible without such systems.

Monitoring as part of a farming systems approach

Monitoring data collected during the 2009-2011 crop-years is given in Appendix 6. It should be emphasized that different sets of fields and/or growers were sampled in each year.

In summary:

- During 2009, only 2 of the 50 fields sampled had zero grubs; with infestation density averages from 0.3 – 14.0 per stool, and a median population of 2.5/stool:- reflective of relatively high-risk situations and of working with those at most risk.
- During 2010, 38 of the 144 fields sampled had 0 grubs, with infestation density averages from 0.1 – 22.0 / stool, and a median density of 0.6/stool.
- During 2011, 18 of the 40 fields sampled had 0 grubs, with infestation density averages from 0.2 – 5.5 / stool, and a median density of 0.2 grubs/stool.
- During 2012, infestation increased at several observation areas and symptoms increased district-wide, suggesting resurging risk.
- During 2013 and 2014 further resurgence occurred in or near specific observation sites, and symptoms increased district-wide.

Conclusions: Reducing proportions of target fields with infestation during 2010 and 2011, and reducing median infestation, perhaps reflect:

(a) lessening risk and lower populations than when the program began before 2009.

(b) working with a high proportion of the more risk-averse growers who were already taking effective action to control grubs.

(c) reduced overall infestation pressure at the different locations, due to participants having been encouraged to adopt strategy appropriate to higher-risk scenarios.

These findings could support the concepts (and project Aim) that, with relatively minor monitoring input it is possible to:

(a) predict grub trends at Isis on both farm-specific and district-wide scales, and to;

(b) use grub-pest-trend data to encourage and enhance effective grub management strategy.

Some generalities may also support the above concept:-

1. Damage levels at Isis during 2009-2012 were lower than for many years previously; even though the current highly effective insecticide treatments have been available since 2005-2006. Were outcomes enhanced through the monitoring-based management process, including a number who had minimal direct involvement with the project?
2. Could increasing levels of southern one-year grub activity in 2013 and 2014 be a direct consequence of the relatively minor level of monitoring throughout the Isis district in 2012 as this project 'wound down' and regular reminders to growers ceased?
3. It appeared that within the same Bundaberg-region transects, Bundaberg Sugar Ltd supply farms showed greater levels of grub-damage than Isis Sugar Ltd supply farms, and was that a consequence of the (Bundaberg) growers NOT having had the benefit of a monitoring project or meetings at which they are prompted on canegrub management issues?

Objective 2#: Train and build capacity of grower & manager members to annually collect relevant grub-incidence data, and to prepare timely, cost-effective, and sustainable canegrub management strategy.

A diverse range of crop-situations, risk-profiles, and grower preferences were encountered during the monitoring program: these factors were included in site-specific (tailored) planning.

In summary, by participating, each Grower was afforded the opportunity of coaching, if needed, to apply the information contained in Appendices 2, 2a, or 2b. Each could either (a) decide management Strategy routines according to Preference, and/or (b) develop Strategy outlines appropriate for their risk-profile.

- A high proportion of Growers held to their Preferred Strategy for Routine Preventive treatment – regardless of the single (temporal) monitoring result; as stated in Appendix 8 – which is a copy of Table 65 in the BSS266 final report. Many of these grower decisions were based on their past experience of damage in those fields. Such judgement does reflect scientific findings in this project and in the existing GrubPlan Model, that inherent high-risk status is one of the more significant predictors of grub-risk, and as such may outweigh a single set of low-risk observations.

- A smaller proportion chose to learn monitoring skills and began monitoring independently to assess risk as a basis for decision-making after the 2009 coaching; but showed little immediate intention of changing their established routines. These included J. Russo, Cram, Johnson, Kelly, and Wessel. By 2011, additional independent monitoring was indicated by Plath, Bundesen, Garrard, J. Kingston, Pickup, L. Zunker, Muller, and several Isis Productivity Services Managers (De Pappi, Cardiff, and Pedley).

- Several growers indicated a preference to have someone available as a contractor to monitor populations in specific situations; including N. Kingston, B. Peterson, P. McLennan, and P. Cross (managing a corporate farm).

- A small proportion seemed to have sufficient confidence by year 3 that monitoring was reliable and could be used to break from routine and to select varied options as appropriate. One grower (Chapman) chose not to use long-term control treatments. His alternative strategy was to lower populations as much as possible through cultural routines; including planting sugarcane after fallow-cropping rotation to remove infestation, and to monitor thereafter and to only treat with a short-term insecticide control option if infestation developed. He expressed a need to avoid insecticide treatment if at all (safely) possible; particularly where cane-cropping is in rotation with horticulture.

- Of those offered assistance (as distinct from volunteering), several declined. Others participated in the monitoring but seemed disinterested in Strategy development, so were not followed up.

- But over all categories of attitude, about 50% could be assessed as having at least considered the potential benefit of monitoring as a basis for their grub control.

Features of the program that were well-received were:

- ✓ Individual coaching in grub identification skill and process was a significant confidence-booster for almost all participants.

- ✓ The relative ease of sampling to enable reliable choice between relatively few options.
- ✓ Relative reliability of the autumn/winter sampling routine, relative to likely outcomes and choices for spring and subsequent years, as discussed in the Final Report for BSS0266.
- ✓ Further confirmation of the experience from BSS0266 in this project, demonstrating that 5-10 samples are an adequate indicator of risk in a field; as distinct from more intensive sampling practiced for scientific population estimates, requiring at least 20 samples.
- ✓ That there have not been major underestimates of grub-problem status over the breadth of this project - more than 200 fields - convincing numerous growers and IPL members of the merit of this monitoring-based approach to canegrub management. This was outlined by IPL in a Statement dated 7th June 2012 (Appendix 7).

Discussion

As a result of this project, a much wider group has developed some confidence that through monitoring grub-threat they could improve grub-related management choices and profit. Optimism and positive feeling towards monitoring, as expressed by growers determined to manage their problems efficiently and set out in Appendix 8 (Table 65 in the Final Report to BSS0266), has grown.

Unfortunately the full potential benefit of the monitoring in this project has, for some, been limited by their decisions to implement blanket preventive treatments (risk-averse management) regardless of current assessments. Though, on a positive note these growers are now aware of the capacity to make better decisions; and have had an opportunity to develop confidence in this approach.

A purpose for this project has been to use the full range of variables included in the GrubPlan Model for predicting risk of grub-infestation, to offer choice and flexible process to achieve efficient and cost-effective canegrub control. So, as has happened in this project, historical risk alone may not justify always employing the highest level of grub-prevention tactics in particular fields or areas. Likewise other single-factor judgement or decision-making criteria should not restrict growers' choices or options.

So regular (annual or biennial) monitoring, combined with other observations - such as infestation status in surrounding fields, which is the highest-value predictor-variable in the GrubPlan Model - into the decision process, should facilitate better outcomes than existing single-variable considerations for deciding current tactics.

Objective 3#: Be a pilot scheme, from which the IPL could gauge if, and in what form, to include grub-monitoring in commercial core business.

Isis Productivity Limited (IPL) Board members, many of whom had participated in this activity, considered that the results of grub-risk-monitoring in this format were beneficial to their enterprises. Thus, IPL has provided a letter (Appendix 7) stating:

> *"The Board of IPL values the outcomes of this SRDC funded project and believes a monitoring-based warning system can give sugarcane growers reasonable confidence in ascertaining whether they will or will not have a canegrub problem later in the season."*
> -- *"canegrubs can have significant constraint on productivity, and as such, the Board will incorporate canegrub monitoring into its core-business activities. However, with only two full-time staff the task of providing more than a sample monitoring program is beyond our capacity. As with RSD, the Board will sample sections of the cane supply each year to obtain an indication of potential damage."*

"In considering whether or not to implement a full commercial monitoring system, the Board does not anticipate there would be much uptake by the canegrowing community to pay for an annual service."

So, IPL considers monitoring in the format tested may not be a profitable or efficient core-business role. But, IPL also considers that with the added efficiency of identifying growth constraint areas through Remote (satellite) Sensing, monitoring to confirm canegrub risk and/or other crop conditions may be more profitable and useful. To quote (see Appendix 7):

"Remote (satellite) sensing technologies
The SRDC funded project (BSS342) commenced after GGP056 and early findings indicate this (remote sensing) *project will be a valuable tool in helping --- to identify those areas with poor or irregular growth that may be where canegrub monitoring should be undertaken."*

The relative efficiency of remote sensing for detecting and quantifying canegrub activity at Childers can also be gauged with an extract from Milestone report #6 for BSS342, which compares numbers of detections for the Isis region in 2013 using (a) a (May 2013) remote sensing image, requiring relatively minor input for validation over several days and (b) detections by conventional ground-based observations by a number of people over 4 months (Jan – April 2013).

- **"***Detection of canegrub activity was considerably improved through using remote-sensing imagery. A much larger sample of the current grub-activity in the district (involving 25 grower holdings and 50 separate infestations) was detected early (with remote-sensing assistance), than by conventional ground-based observations which produced only 13 infestations on 8 farming entities over a 4-month period*."

The overall impression for researchers and growers is that the cost-effectiveness and efficiency and timeliness of (grub) monitoring can be vastly improved through combining remote-sensing-based monitoring with ground-based validation. In addition to canegrubs, remote sensing detects symptoms of numerous other productivity constraints, awareness of which can only help a targeted approach to improving production and profitability.

This illustration of the potential to expand the purpose for monitoring (i.e. not just to detect canegrubs but to quantify productivity constraints generally) has been made to growers and the IPL Board at several of the information meetings for BSS342.

Objective 4: Building skills and Confidence in systems to enhance management of canegrubs: Group members will increase their capability through participation, training, and observing trials and developing situations.

Participation and training has been described above, as a conduit to build confidence in the concept of monitoring to guide flexible and responsive grub-control programs:- rather than grub-control programs that either maintain an inflexible treatment routine or programs that ignore the possibility of damage until a crisis as damage expresses fully.

(a) Building confidence through Observations from structured field-trials
Results from various treatment options at 4 demonstration sites with moderate risk profiles are discussed below. These were a further initiative to build confidence in monitoring as a useful tool and to explore practical strategy considerations. We compared infestation and damage scenarios

for the various strategies. Unfortunately grub-infestation at these sites did not develop until after the formal project was completed, but results collected by SRA staff in 2013 and 2014 are quoted below, along with learnings applicable to grub control in the Isis district.

In the demonstration field-trial program we aimed to :
(a) to monitor untreated (control) areas, to objectively assess the actual risk of infestation in the modern context, and
(b) to assess relative cost-effectiveness of the (a) long-term and (b) short-term preventive insecticide Treatment Strategy options. These equate to applying CR granule formulation to the planting furrow for protection including third ratoon, or applying SC liquid formulation either into the planting furrow or into ratoons for protection for at least one crop-cycle.

Five treatment regimes were compared, commencing in 2010. Basic treatments options are outlined below, and also in Appendix 4;

1. Do nothing (controls)
2. Pre-emptive preventive treatment for 4 year's protection – suSCon Maxi CR insecticide
3. Pre-emptive insecticide treatment for 1-2 years protection – Confidor or other liquid imidacloprid formulation.
4. Nil pre-emptive treatment, with monitoring to detect infestation trend, followed by treatment (as in #3) as infestation threshold develops.
5. Pre-emptive treatment with the liquid formulation applied at-planting (as in #3) plus in another year when risk rises (as in #4).

Population Monitoring in field-demonstration plots is outlined below (and detailed in Appendix 4).

- For the 2011 (plant) crop;
  - Sites 'a', 'b', and 'd' were not infested.
  - Site 'c' became lightly (0.4 / stool; Appendix 4) infested, but not symptomatic; no treatment was applied as risk was still very low.
- For the 2012 crop:
  - Sites 'a' 'b' were not infested.
  - Site (c) Infestation increased (1.4/stool) but was not symptomatic to ground or remote-sensing observation. No treatment was applied owing to logistic difficulty in spring.
  - Site (d) developed light infestation (0.66 / stool), which was non-symptomatic to ground observation, but no further treatment options were applied because of logistic difficulties. However some of the neighbouring fields did develop overt symptoms of infestation.
- For the 2013 crop,
  - Sites 'a' 'b' were not infested, and no preventive ratoon treatment was applied.
  - At (c) infestation intensified - (2.1/stool) - but plots were not obviously symptomatic by remote sensing (satellite) or ground observation. The ratoon treatment was not applied due to logistic difficulties, although the building population indicated it ought to have been.
  - At (d) infestation intensified (3.1 / stool) and was symptomatic to both satellite and ground-based observation. Treatments #4 and #5 with liquid (SC) imidacloprid were applied to suitable areas in plots after harvest in 2013.
- For the 2014 (third ratoon) crop, in March 2014;
  - Site 'a' was significantly infested (>9.0 grubs/untreated stool), with obvious damage and poorer growth in control plots.
  - Site 'b' was very lightly infested (<0.25/ untreated stool).
  - Site 'c' was markedly infested with 4.9 southern one-year grubs/ untreated stool and

showed signs of crop-growth effect by April 2014: plus it had 0.75±0.3/ stool of the young stages of a new generation of *negatoria* canegrubs, sufficient to cause further severe damage in late winter and spring 2014. Grub numbers were reduced by 72% in plots protected with suSCon Maxi, which also had better growth.

- Site 'd' was moderately infested (1.6±0.4 / untreated stool) with southern one-year canegrubs. Plots treated with suSCon Maxi granules or liquid imidacloprid (Confidor) ratoon-applied in 2013 had lower numbers (0.4-0.7/stool) and indications of better growth. Plots treated with liquid imidacloprid (Senator) applied at planting in 2010 were not as well protected as the other treatments.

Conclusions:

Site 'a'

- The fact that site (a) had not become infested through 2011-2013 is a positive demonstration to the grower that despite previous severe infestations in 2009, rotation-cropping in 2009-10 had lowered immediate risk. Also that preventive treatment applied to neighbouring fields kept risk low in the short-term at this site. Also that monitoring had correctly predicted low risk for three successive crops.
- However, at site (a), despite three years of nil infestation, and so no preventive treatment considered during late 2013, in the fourth year (March 2014) a severe infestation (12.0±1.9 grubs / untreated stool) developed. So obviously monitoring of individual fields (alone) is not a singular reliable predictor of risk. In this case, sudden infestation is probably due to forced migration of beetles into this field following plough-out of adjacent older ratoons, which is also consistent with criteria used in predicting risk under GrubPlan.
- Treatment with Option (b) –CR granules applied at planting - strongly protected treated sections of this field, further demonstrating the practical advantage of this option.

Site 'b'

- Site (b) has not become infested, despite a natural high-risk status. So, a history of infestation is not an absolute indicator of immediate risk.
- Nil infestation detected each year in the untreated areas of the trial field has so far proven a positive demonstration that monitoring has correctly predicted low risk for three successive crops. But, in view of events at Site 'a', to rely absolutely on such a conclusion from limited sampling is risky.
- (Probably), the role of preventive treatment applied to all neighbouring fields has kept risk low at this site; but it must be remembered that as these neighbouring fields age and protection status declines their risk-status will again escalate, as at Site 'a'.

Site 'c'

- Site (c) was predictably at light risk in 2010, due to adjacent, lightly-infested older ratoons without any preventive treatment. This is borne out by the light and increasing infestation (but not visible) from 2011 and 2012.
- By 2013 the grower had noticed increasing symptoms in adjacent fields and fallowed those fields in late 2013 with rotation cropping.
- Also the grower had expressed concern that preventive treatment should be applied to the trial site in line with the increasing populations. But logistic difficulty prevented this happening, and significant infestation and damage has developed in untreated areas.
- So, a risk of logistically not being able to treat as needed is an inherent disadvantage of the optional ratoon-treatment strategy #4. Conversely, reliable, long-term protection with treatment option #2 also offers an inherent practical advantage of freedom from such logistic risks.

Site (d)

- Prediction of relatively low risk at the trial site (owing to widespread rotation-crop fallowing of previously damaged blocks at and around the Site in 2009-10) vindicated by zero population in untreated plots for the 2011 crop.
- Prediction of increasing risk (based on damage to nearby unprotected fields in 2012, plus light infestation (0.66 / untreated stool) in the trial plots) proved correct; in 2013 the population rose to 3.1 / unprotected stool in the trial and infestation was locality-wide in unprotected crops.
- Logistic problems prevented treatment Options #4 & #5 being applied in 2012 as originally intended once developing infestation was detected; and subsequent grub-damage highlighted this error.
- Treatment of the trial-site and surrounding fields in late 2013 with Confidor as in Options #4 and #5 appears justifiable; relative to damage symptoms expressed in the untreated controls during autumn 2014.
- In 2014, plots treated as per Options #2 (Maxi CR-granules), and as per Options #4 and #5 applied in 2013 appeared healthy; with 55-75% population reduction relative to untreated plots (1.6±0.4 – 2.8±0.5 grubs / untreated stool). Treatment Option #3 was less effective.

(b) Building confidence through independent follow-ups on monitoring sites

The technical team maintained a watching-brief on a number of fields (indicated * in Appendix 5) to gauge for obvious errors in judgement - (false negative assessments), or weakness in variable, pro-active management strategy.

- In one case, fields deemed in 2010 as "low immediate-risk, pre-emptive treatment not needed for the plant crop" were not treated in 2010 due to the grower's wish to cut establishment costs, and did not suffer any damage or infestation (as determined by project monitoring team) in 2011. But this grower did not monitor or apply protective treatments late in 2012, despite some evidence of damage developing about neighbouring farms. By 2013, general light-moderate infestation with Southern One-year canegrub had developed.
- At another site 500m away from the above and under a slightly higher initial risk profile including older unprotected ratoons, symptoms of infestation progressed from light in 2012 to moderate by 2013. Monitoring at site (d) – see Appendix 4 -, had detected this infestation commencing in 2012 and increasing in 2013-14.
- At another moderate initial-risk trial-site (c), infestation of untreated plots commenced in the first crop-year after establishment, confirming the risk from the presence of low-level reservoir populations in neighbouring fields. By 2012 the untreated fields surrounding this trial site were showing damage-symptoms commensurate with the populations in the trial-site. These surrounding fields were fallowed after the 2013 harvest, and significantly increased infestation in the trial-site confirms the validity of this decision to fallow the surrounding fields.

(c) Building skills through learnings from Incidence of 'mistakes':

- Overall there were no gross (short-term) errors of judgement from using monitoring data to decide appropriate control strategy (i.e. no false negatives).
- The major lesson from these observations is that, to make effective decisions growers need to re-assess infestation-levels and risk annually or not less than every 2 crop-years. We monitored re-infestation at three trial sites and in several fields; most re-infestation was after 2-3 years, but in one case re-infestation was quantifiable in the following year. Common experience, as in GrubPlan rules, is that in high-risk scenarios (e.g. ploughout-replant, or planting next to a damaged site) re-infestation will occur within 1 crop-year.

Grub-risk is a dynamic condition that must be estimated having account for individual circumstances; i.e. it cannot be reliably predicted through generalities (e.g. "any older than second ratoon").

- Conditions, activities, and infestation in neighbouring fields had more influence on dynamics of re-infestation than (estimated) population densities within several of the observation and trials sites. Severe and sudden re-infestation seemed a result of removal (fallowing) of cane from neighbouring fields, thus forcing beetles to emigrate to adjacent sugarcane crops and/or concentrate in more suitable portions of those fields.
- So, probably the greatest 'risk of mistaken assessment' for an individual field lies in the need to also monitor and/or consider activities and conditions in surrounding fields, in the decision-process. Conditions and activity in adjacent property is a significant portion of risk-assessment; in such situations, services of an impartial operator (e.g. a Productivity Service person aware of management styles and plans of both sets of owners or managers), is invaluable.

(d) Sampling size and the cost:benefit of return on effort

- In this experience of Monitoring to determine risk-assessment, the need for precise population estimates was not especially relevant. Relatively minor sampling intensity up to a maximum of 10 stools per field (as in Appendix 2, Information Sheet IS13037) was adequate to determine the presence or absence and structure (identity, generation development) of infestation.
- Also the need to check adjacent fields was illustrated by sudden population developments at Trial sites 'a' and to a lesser extents 'c' and 'd' (above).
- Not-especially-practiced persons usually completed 5 holes in about 30 minutes in sandy soil, and about 45 minutes in clay-loam soil.
- Pricing for monitoring and treatment are variable (done by grower, or employees, or contractors), so are not 'analysed' in detail. But, potential loss (5-15 t/ha cane) of income due to grub damage on 2-4ha of cane over several crop cycles, plus ongoing grub-problems in nearby fields, and/or unnecessary expense of at least $120/ha for insecticide treatment in low-risk years, far outweigh the relatively minor input of several hour's work to objectively assess grub-risks through monitoring, either annually or biennially (once every 2 crop-years).

For example, costs / ha could be:	
Loss of income from not treating when needed =10 t/ha*$40/t*2years	=$800/ha
Cost of unnecessary treatment to "protect" (including application)	= $120/ha

Intellectual Property and Confidentiality:

There is no protected Project Technology.

Farm-specific pest status and management preferences need to be treated with respect; but none of the growers involved requested confidentiality or anonymity.

Possible conclusions about insecticide efficacy, particularly in relation to the period of protection from grub-damage afforded by treatment with the products Confidor® or Senator® cannot be treated as recommendations; to do so would contravene their registration with Australian Pesticides and Veterinary Medicines Authority (APVMA).

Capacity Building:

The Group's capacity to better incorporate improved canegrub management within farming systems was considerably enhanced as a result of this collaboration, particularly as this project began under the scope of BSS266.

The Group's appreciation and understanding of R&D has been materially improved as a result of this Project. There were numerous positive learning experiences for members as outlined for Objective #2; and doubtless the shared experience allowed many participants to visualize the concept of achieving effective canegrub control without directly equating that objective with increased expense and greater insecticide use: achieving more with less.

But the "Group's capacity to conduct R&D" has not, in this writer's opinion, materially enhanced as a result of this Project. Nor was such an objective considered at the outset. Such an outcome would require time and resources and skills and levels of enquiry (as distinct from want or need of research outcomes) that are beyond the current scope of the Group members, and of IPL as the current staff are fully committed to existing programs. However the Project has given a guide to how much extra resource could be needed to materially increase IPL's capacity in this regard.

Environmental and Social Impacts:

The potential for expected beneficial environmental impacts such as minimizing (unnecessary) insecticide use has been well explored, and the relatively few innovators have acted as described.

Beneficial social impacts developed between most of the growers, and productivity service operators and the Board of Isis Productivity Limited and contract researchers, as a result of collaboration: particularly, mutual respect and understanding has increased as a result of discussion and enhanced understanding and collective experience.

Economic benefits have probably flowed as a result of enhanced grub control during the years of this collaboration,: as suggested by the relatively low level grub damage during the project period.

No adverse environmental or social impacts were recognized.

Outcomes:

Economic benefit: For the duration the participants and district enjoyed the lowest level of grub damage for many years. This could justify adopting a similar but perhaps more efficient system as a productivity service role.

Environmental benefit: As outcomes of farming system and soybean production initiatives, rotation fallow-cropping as a means to lower grub populations in fields has become common practice, rather than persistence with infested ratoons, or weedy fallows that merely perpetuate the grub-problem and give much lesser returns and outcomes. Outputs from monitoring are compatible with deciding need and extent for fallowing; plus risk and need for further protection when re-establishing sugarcane.

Social benefit: Pro-active growers and the Productivity Service seem far more confident of the potential to improve outcomes of grub management, through a process of monitoring to guide control tactics and strategy. Although the original monitoring system used in this demonstration project has been deemed (probably) non-viable as a stand-alone service to growers (too labour-intensive and time-consuming), the potential to use remote-sensing to focus activities into high-risk areas has become evident.

What more has to happen to get the full benefit from the project?
Further validation is underway in BSS342 of the principle for using remote sensing imagery as a tool to make monitoring more efficient.

Both the IPL and the industry need to discuss if, and the mechanics of how, IPL (and e.g. SRA, universities?) might provide skills and input for remote sensing to monitor canegrub activity, and to alert and empower growers to use the information to minimize constraint due to grub.

Also, as remote-sensing locates restricted growth due to multiple factors, with manual differentiation currently the only reliable means to distinguish grubs or other causes, then ideally this same remote image can be used to direct other programs to minimize production constraint or maximize yield, where possible. If so, then who would participate could also be included in the above discussion.

How do the expected benefits compare with those predicted at the start of the project,

- The experience of this project shows monitoring improves the outcomes of grub-management programs; at the full range of levels – field, farm, locality, and mill-area.
- Monitoring for canegrub has not translated to a commercial service; i.e. one requested and directly supported (fee-for-service) through grower subscription.
- However augmentation with Remote Sensing imagery has the potential to make Monitoring much more cost- and time- effective, timely (at the critical early stage), and efficient for detecting canegrub infestation, than the (relatively) resource-poor, ground-based, guess-work, entirely-manual procedure we trialed.
- Plus, our experience shows the remote (satellite) imagery has significant additional value in allowing us to quantify the extent and cause of other growth constraints. This information could allow growers to be alerted and perhaps facilitate dealing with the issue.
- Imagery can also be used by the sugar-mill to estimate crop yield.

This combination of capabilities and possibilities suggests an Integrated Productivity Maintenance

program, as a new Service initiative provided through an (expanded) role for the Productivity Service. (*See 'Recommendation'*)

Communication and Adoption of Outputs:

Communications have been through Shed and Information meetings and IPL Board-meetings.
SRA / SRDC contributions have been acknowledged in all meetings and handouts.

Recommendations:

Where to from here?
At the end of this Project and in view of experience in the current (Remote Sensing) Project BSSS342, the concept of an Integrated Productivity Maintenance program, a new Service initiative directed through an (expanded) role for the Productivity Service, could Role-model the future efficient management of not only canegrub control, but also a wide range of Productivity Constraints afflicting the Isis region.
Such a Service would require a wider range of capacities than are currently provided through IPL. To address this issue, there is potential to integrate specialist and generalist skills from other providers (e.g. SRA, university) into the program, behind an IPL service to operate within and deliver some or all of the outputs.

For example:
Specialists in : Remote Sensing imagery and processing; nutrition-agronomists; crop-protection pathologists and entomologists, harvester and agricultural specialists.
Generalists in: 'problem' (constraint) definition, information dissemination (PEC?).

Such collaboration could prove the practical training ground for generalists to become industry 'agronomist' specialists; whether as independent contractors or staff or SRA-FU operatives; and for specialists to develop and hone skills and knowledge directly related to practical issues within the industry.

Publications:

Nil at present

Acknowledgements:

Isis Productivity Limited

SRDC

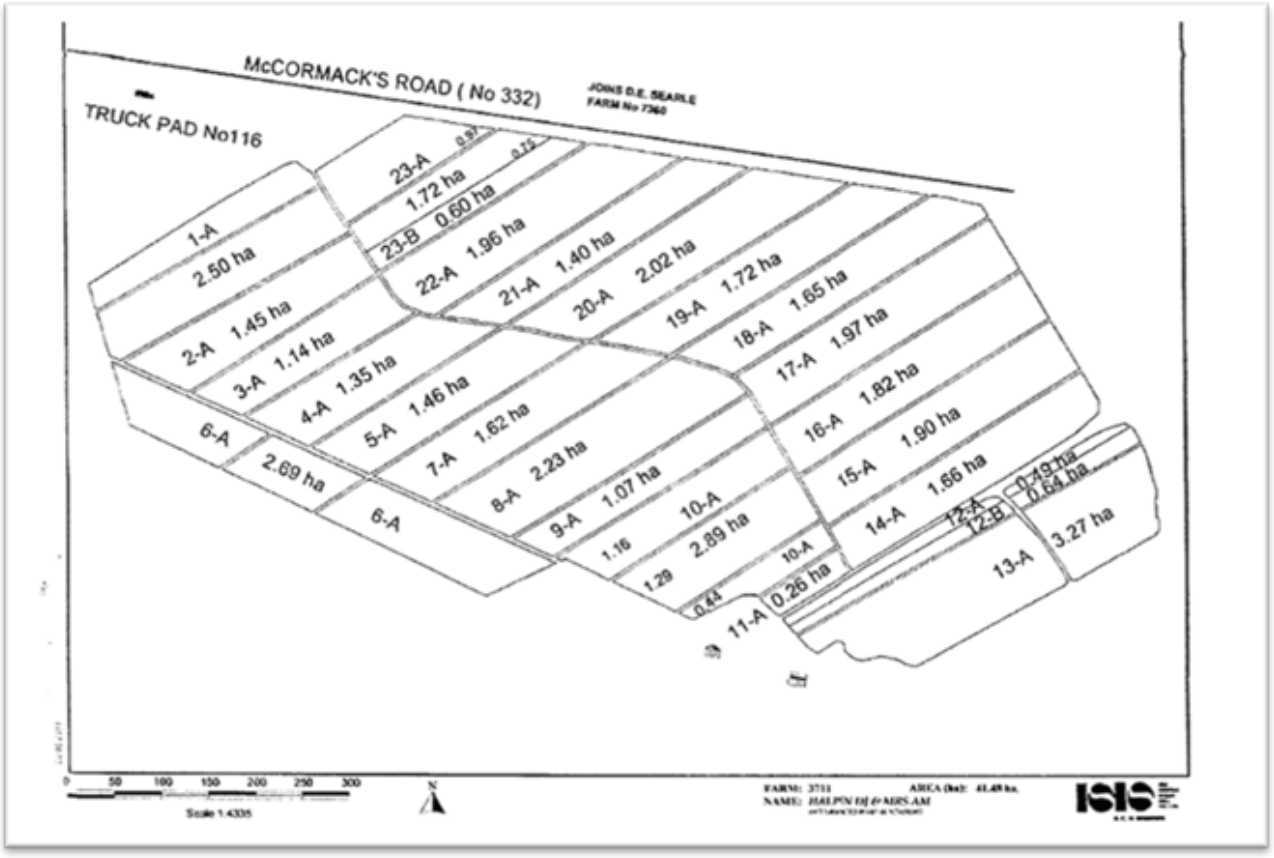
BSES Limited / SRA

Crop Care Australia; Bayer CropScience.

Photos:
(Include photographs or images related to your project they may be useful for future publicity or promotion).

See Appendices

APPENDIX 1: Mill-record farm map and block details (example)



ISIS PRODUCTIVITY LIMITED — *Tuesday, June 14, 2011*

2011 HARVEST FIELDBOOK

Phone No: Mobile No

Farm N 3711 Grower HALPIN D.J. & MRS A.M. Contractor Contractor's No Assigned Area Cane Inspecto Jeff Geaney

Block	Sub Block	Variety	Class	Area	2011 Planting Ft N:LRB	GRUBS LOSS	NEM: LOSS	S/J LOSS	RHYPARIDA LOSS	SUCTION APP:MET:AREA	TEMIK APP:MET:ARE	CONFIDOR APP:MET:ARE
009	A	Fallow	Fallow	1.07								
005	A	Fallow	Fallow	1.40								
019	A	Fallow	Fallow	1.72								
015	A	Fallow	Fallow	1.90								
017	A	Fallow	Fallow	1.97								
018	A	Fallow	Fallow	1.65								
020	A	Fallow	Fallow	2.02								
014	A	Fallow	Fallow	1.66								
007	A	KQ228	AUT PL	1.62								
008	A	Q256	AUT PL	2.23								
021	A	KQ232	AUT PL	1.40								
015	A	Q256	SP	1.82								
022	A	Q256	SP	1.96								
003	A	Q208	1ST RA	1.14								
011	A	Q232	1ST RA	0.26								
012	A	Q256	1ST RA	0.49								
010	A	Q232	1ST RA	2.89								
004	A	KQ228	1ST RA	1.35								
002	A	Q232	1ST RA	1.45								
006	A	Q256	2ND RA	2.69								
001	A	Q256	2ND RA	2.50								
023	B	Q200	2ND RA	0.60								
013	A	Q232	2ND RA	3.27								
025	A	Q256	2ND RA	1.72								
012	B	Q232	2ND RA	0.64								

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APPENDIX 2 – INFORMATION SHEET IS13037; SAMPLING, IDENTITY, AND MANAGEMENT

BSES
Sugarcane for the future

Information Sheet IS13037

Canegrub management in the Bundaberg and Maryborough districts

Survey in Autumn: Plan to manage canegrubs in spring

Autumn is the time to plan grub management for the next crop. Monitor it now so that you can cost-effectively combine grub-management plans with other crop routines in spring.

Do you want value-for-money from water, fertiliser, and weed-control inputs without unexpected hindrance by canegrubs? Do you want to *limit* the costs for canegrub control to only the 'at risk' fields? Would you prefer maximum control by treating early in the spring, rather than treating late in spring after most of the damage is already done? Do you want to plan your harvesting and other operations and prepare for the most suitable cropping option, for example a soybean rotation, rather than ratooning grub-infested cane?

If so, by monitoring for canegrubs during autumn you can make *informed* decisions. Rather than guessing, you can *plan* canegrub management at the ideal time in spring.

For those who want to 'have a go' at monitoring, the steps outlined here may be easier and quicker than you think. It is recommended that you talk to BSES and/or your Productivity Services staff for some simple tips and coaching.

Monitoring canegrubs and risk of damage

Assess risk of damage to a crop (plus its next ratoon) primarily from grub numbers in the field *and/or* in adjacent fields during autumn. Be aware that beetles can move to new fields nearby, especially if you plough out their original home at the end of the year.

One-year cycle canegrub numbers and damage in autumn usually increases for the next crop. With two-year cycle canegrubs, those developing in autumn will damage in spring the same year; but matured canegrubs will become beetles by spring and start another larger generation, to damage young ratoons in the next crop.

How do I go about monitoring?

Dig out sugarcane plants and create holes 40 cm x 40 cm x approximately 40 cm deep. Shake most of the soil off the roots and from between stalks, and collect the 'grubs'.

(Replant stool as deep as possible and pack the soil). The chart will help you identify true canegrubs – those with a pattern of darker hairs underneath at the rear end – from organic-feeder and Christmas grubs with no pattern. A 3-5 X-power hand-lens will help. Write down the number of canegrubs *for each stool*.

How many holes (per 2-4 ha bed or field)?

Dig 5 holes – for example, 1 near each corner and the middle.

- If 4 of 5 holes have one or more canegrubs (total = 7 or more), the infestation may require action in spring. Cease digging.
- If nil canegrubs in 5 holes, there is little immediate risk. Cease digging.
- If few or scattered canegrubs (1-3 holes with one or more, total less than 7), dig at least 5 more holes around the field. If concentrated in one location (for example, soil type?), then dig 4-5 more holes in that section.

How many canegrubs cause damage?

Calculate canegrubs/stool for the field or section. Population averages and risk thresholds where treatment with a liquid imidacloprid product next spring *may be* justifiable are:

Southern one-year canegrubs | Populations 1-1.5/stool or more usually become damaging (more than 3/stool) next year.

Developing two-year canegrubs | About 3 Childers or Bundaberg, or 1.5 negatoria canegrubs per stool, will noticeably damage the ratoon next spring.

Fully developed two-year canegrubs | Around 1-2 mature canegrubs in autumn (= pupae = beetles in spring) usually pre-empt damage in 15-18 months; which can also be prevented by treating with a liquid imidacloprid product next spring.

Remember: In deciding strategy for 'at risk' fields, always check nearby 'risk' fields (for example, old infested? ratoons) also; sample the same way as above.

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Common canegrubs: Bundaberg-Maryborough

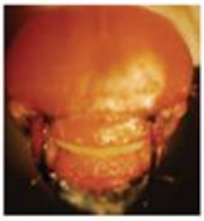
Southern one-year canegrub

Sandy forest soils

Pattern of two curved single rows of 19-31 thick hairs each side

No scales on back, slight pattern of dimples

Canegrub head



Smooth, tan coloured, no wrinkles or stipples

Negatoria canegrub

Forest loam, light clay soils

Pattern pear-shaped, about 50 long hairs each side

Round white scales on back. Bands on belly

Bundaberg canegrub

Sandy soils, red volcanic soils and forest loam

Pattern of two close parallel rows of about 15 short hairs each side

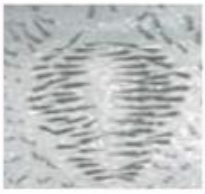
Small elongate white scales on back

Canegrub rear-end

Pattern of hairs in hair-field in front of anus

Childers canegrub

Red volcanic soil

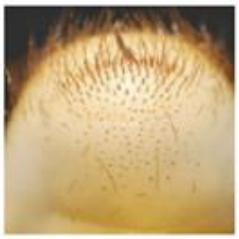


Pattern oval-shaped, about 35 long hairs each side

Glossy 2-tone back. No scales

Non canegrub species

Christmas grub and adult beetle

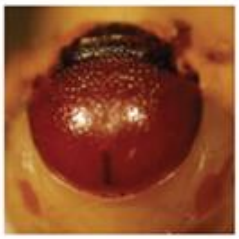


No pattern in hair-field

Stippled, crinkled gold/ light tan head

Golden, irridescent

Red headed grub and adult black beetle



Cherry red or black stippled head

No pattern in hair-field

Lines of pits on back. Glossy brown or black.

Males with 'horn' >

Need help to identify canegrubs and decide options?

Drop some or all of the grubs into a container of water with a squirt of detergent. Later, rinse out the dirty water and refill with 60-70% methylated spirit. Take specimens to your Productivity Service to confirm their identity, and to discuss your options, treatments, fallow or rotation-crop. Remember, bring numbers for individual stools.

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APPENDIX 2A ; CHILDERS CANEGRUB INFORMATION SHEET IS1305CG; BIOLOGY, MANAGEMENT, AND REGISTERED INSECTICIDE CONTROLS

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Information Sheet IS13035CG

Childers canegrub

(Antitrogus parvulus)

Introduction

Childers canegrub is native to southeastern Queensland and is the most damaging pest of sugarcane in this area. It occurs on the heavy clay soils of the Bundaberg, Isis and Bauple areas, especially on the red volcanic soils.

Description

Adults are 18-23 mm long, yellowish brown to almost black (Photo 1). Adults do not have the white scales some other grub beetles have. Males are very large, with seven segmented clubs on the ends of their antennae. Childers canegrub larvae have a pear-shaped patch of hairs on the undersurface of the rear end of the grub. Each side of this patch has about 35 hairs in three to four distinct rows (Photo 2).

Photo 1: Adult Childers canegrub.

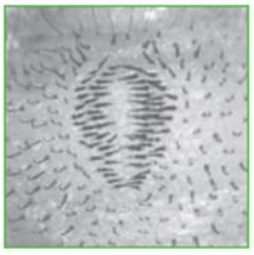

Photo 2:

Pear-shaped patch of hairs on the undersurface of the rear end of the Childers canegrub.

Childers canegrub can be confused with Negatoria and French's canegrubs. The main differences are: the Childers canegrub central naked area within the hair pattern is oval as opposed to having straight sides, and it is blocked off by a number of hairs at each end. Larvae also tend to be smaller than the other species.

Biology

Childers canegrubs have a two-year life cycle (Figure 1). Adults emerge after good rains in November to January. Females are poor fliers. They emit a pheromone to attract males, and mate on the soil surface. Only males are attracted to lights.

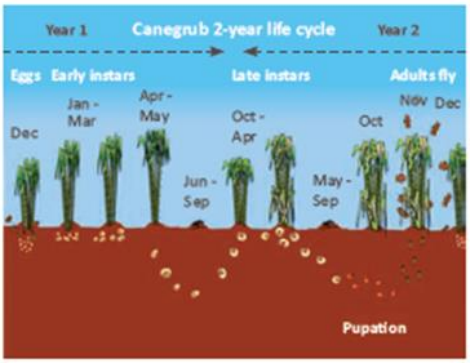

Figure 1: Childers canegrub life cycle.

Eggs hatch after about two weeks, with egg laying usually finished by January. First-stage grubs (first instars) feed mainly on organic matter in the soil for about two months and cause little damage to cane roots. Second-stage grubs (second instars) tend to congregate under the cane stools, and most continue to feed through the first winter of their life. In early spring, the grubs change to the third stage (third instars).

These grubs feed heavily on the roots and stools, and grow rapidly until about January.

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APPENDIX 2A (Childers canegrub - continued)

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Sugarcane for the future

Information Sheet IS13035CG

This is when most damage and yield loss will occur. Feeding decreases after this, but the grubs do not pupate until the second winter or early spring.

Pupae form deeper in the soil. Beetles develop in about four to six weeks after the pupae form, but remain in a chamber in the soil until suitable weather conditions trigger their emergence. At any one time, there may be two populations of Childers grubs, separated by twelve months of age, in any one field. For example, during February there may be fully-fed third-stage grubs (14-15 months old) and first stage grubs (2-3 months old).

Damage

Feeding Childers canegrub larvae prune roots from newly ratooning sugarcane during spring and early summer. Ratoons grow poorly, leaves turn yellow, and, in severe cases, the stools will die. If the damage is not too severe, plants may recover during later summer and early autumn. An average of about three grubs per stool will cause economic losses. Damage usually occurs in patches within fields.

Management

Blocks at risk of infestation should be monitored in autumn so that a decision whether to treat blocks in the next spring can be made early.

Information Sheet IS13037: Canegrub management in the Bundaberg and Maryborough districts – survey in autumn: plan to manage canegrubs in spring, provides information on monitoring and grub thresholds.

Second- or early third-instar Childers canegrubs, or of other 2-year canegrubs, found during monitoring in autumn will be the same larvae causing damage in the next spring, after harvest.

Generally, treatment in the next spring is warranted at the following thesholds:

- If 2 or more ratoons are expected, then an average of more than 1 canegrub (any species) per stool.
- If 1 more ratoon is expected, then an average of 3 or more second instar Childers canegrubs.

Additional useful information

Information Sheet IS13037CG. *Canegrub management in the Bundaberg and Maryborough districts – survey in autumn: plan to manage canegrubs in spring.* BSES Limited.

Samson, P. Chandler, K. Sallam, N. 2010. *Canegrub management and new farming systems.* Technical Publication MN10005. BSES Limited.

Information Sheet IS13108CG. *French's and Negatoria canegrub.* BSES Limited.

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APPENDIX 2A: CHILDERS CANEGRUB continued – INSECTICIDE CONTROLS

BSES
Sugarcane for the future

Information Sheet IS13035CG

Registered controls and rates for control of Childers canegrub			
Product (active constituent)	**Dual row, 1.8 m or greater row spacing**	**Single row – all row spacings**	**Length of control**
Plant			
suSCon® Maxi (imidacloprid)	225 g/100 m of bed	150 g/100 m of row	3 years
Confidor® Guard (imidacloprid)		11-16 mL/100 m of row	1 year
Senator® 700WG Nuprid®700 WG (imidacloprid)		5.5-8 g/100 m of row	1 year
Rugby® (cadusafos)		300-375 g/100 m of row	One crop (for knock-down of grubs present)
suSCon® Blue (chlorpyrifos)		315 g/100 m of row	3 years
Ratoons			
Confidor® Guard (imidacloprid)		11-16 mL/100 m of row	1 year
Senator® 350 SC Nuprid® 350 SC (imidacloprid)		11-16 mL/100 m of row	1 year
Senator® 700WG Nuprid®700 WG (imidacloprid)		5.5-8 g/100 m of row	1 year
Impress 350 & other generic products (imidacloprid)		11-16 mL/100 m of row	1 year
Rugby® (cadusafos)		300-375 g/100 m of row	One crop (for knock-down of grubs present)

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APPENDIX 2B: INFORMATION SHEET – SOUTHERN ONE-YEAR CANEGRUB

BSES
Sugarcane for the future

Information Sheet IS13101CG

Southern one-year canegrub

(Antitrogus consanguineus)

Introduction

Southern one-year canegrub is a major canegrub species in the Bundaberg, Isis and Maryborough areas. It prefers sands, loams and light clay soils, particularly in wallum country.

In the Bundaberg – Isis area, southern one-year canegrub often occurs in mixed infestations with other species of canegrubs (Bundaberg, negatoria, and noxia canegrubs). In the Maryborough area it often occurs with negatoria canegrub in loams and light clays.

Childers canegrub is native to southeastern Queensland and is the most damaging pest of sugarcane in this area. It occurs on the heavy clay soils of the Bundaberg, Isis and Bauple areas, especially on the red volcanic soils.

Photo 1: Adult Adult male of southern one-year canegrub (large antennal clubs).

Photo 2:

Raster of southern one-year canegrub.

Description

Adults of southern one-year canegrub are bright red-brown, without scales but with short hairs on the upper surface (Photo 1). The antennae have large clubs on the end.

The raster of southern one-year canegrub has two single convex rows of 23-26 (range 19-31) stout hairs (Photo 2). Grubs and adult beetles are superficially similar to those of Nambour canegrub (*Antitrogus rugulosis*) but that species is not found north of the Moreton district.

Biology

Southern one-year canegrubs have a 1-year lifecycle (Figure 1) with three instars (grub stages) before pupating. Beetles emerge from the soil after rain, usually in September – October. Beetle flights occur after dusk. After mating, the females return to the soil to lay their eggs. Larvae feed on cane roots and develop through to the damaging third instar by late December, and may continue feeding as late as May. Fully fed third instars then burrow to about 25-40 cm depth where they pupate in late winter. Beetles remain in their underground chambers until rainfall triggers their emergence.

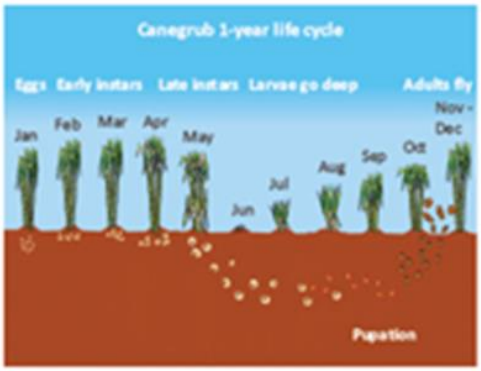

Figure 1: Southern one-year canegrub life cycle.

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Information Sheet IS13101CG

Damage

Damage is caused by the larvae eating sugarcane roots and stubble. Water and nutrient uptake is impaired with subsequent crop stress and yield loss (Photo 3). Stools are susceptible to tipping and lodging due to the lack of roots to provide anchorage (Photo 4). Heavily infested stools may die. Moderately infested stools are often pulled out by the harvester, as evidenced by gaps in young ratoons after harvest (Photo 5).

Photo 3: Severely pruned root system from canegrub feeding.

Photo 4: Reduced root mass results in stool tipping.

Photo 5: Stool death from severe canegrub attack results in gappy ratoons.

Crop damage is usually visible around March, in semi-mature or mature cane, but if beetle flights were early in September then symptoms can commence in January.

Management

Cane blocks most at risk from southern one-year canegrubs are those on old wallum country or sandy soils. Blocks at risk of infestation should be monitored in autumn so that a decision whether to treat blocks in the next spring can be made early. **Information Sheet IS13037: Canegrub management in the Bundaberg and Maryborough districts – survey in autumn: plan to manage canegrubs in spring,** provides information on monitoring and grub thresholds.

Generally, if monitoring shows an average of 1 or more southern one-year canegrubs per stool, then treatment in the next spring could be warranted. Registered treatments are listed below. No insecticides are registered for dual rows, but trial results indicate that Confidor® Guard at 16 mL per 100 m of dual-row bed would be effective for 1-year control in plant crops and ratoons.

Registered controls and rates for control of southern one-year canegrub

Product (active constituent)	Single row - all row spacings	Length of control
Plant		
suSCon® Maxi (imidacloprid)	150 g/ 100 m of row	3 years
Confidor® Guard (imidacloprid)	11-16 mL/ 100 m of row	1 year
Rugby® (cadusafos)	300 g/ 100 m of row	One crop for knock-down of grubs present
suSCon® Blue (chlorpyrifos)	315 g/ 100 m of row	3 years
Ratoons		
Confidor® Guard (imidacloprid)	11-16 mL/ 100 m of row	1 year
Rugby® (cadusafos)	300 g/ 100 m of row	One crop for knock-down of grubs present

Product labels describe the correct methods of application.

suSCon® Maxi and Confidor® Guard have largely replaced suSCon® Blue and Rugby® for the control of southern one-year canegrubs.

Additional useful information

Samson P, Sallam N, Chandler K. 2013 Pests of Australian Sugarcane – Field Guide. BSES Limited.

Samson P, Chandler K, Sallam N. 2010. Canegrub management and new farming systems. BSES Technical Publication MN10005.

Canegrub management in the Bundaberg and Maryborough districts – survey in autumn: plan to manage canegrubs in spring: Information Sheet IS13037. BSES Limited.

Childers canegrub: Information Sheet IS13035. BSES Limited.

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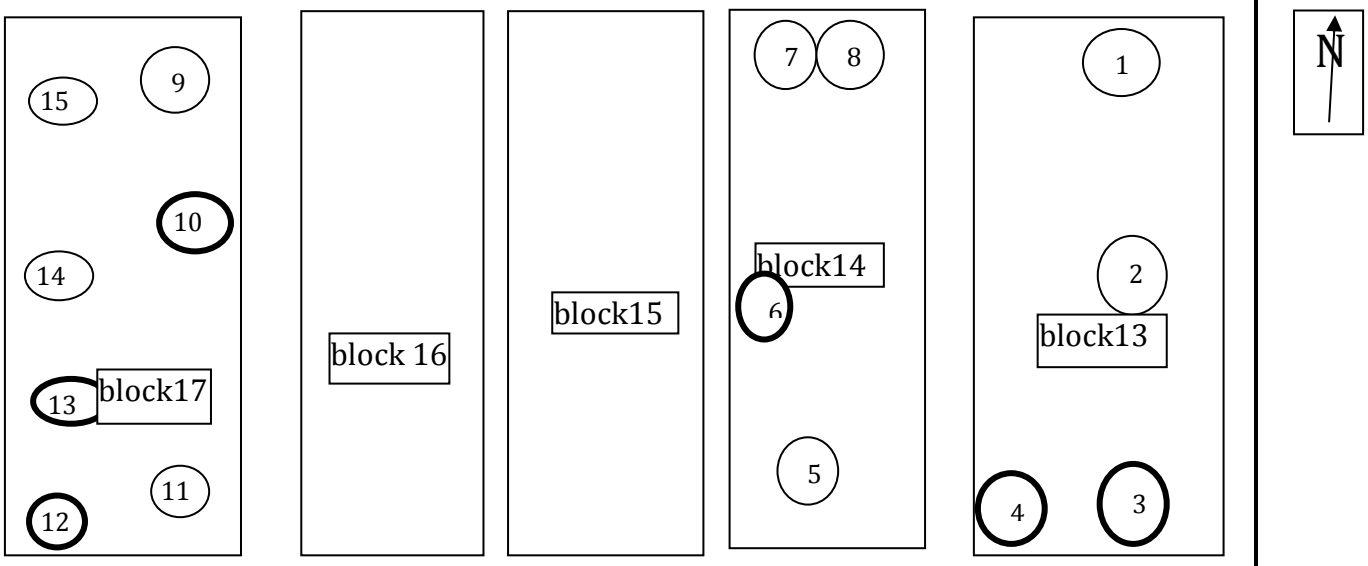
APPENDIX 3. EXAMPLE GRUB-SAMPLING RESULT SHEET

Grower	JIM SMITH	Block	13,14 ,17			
Location	Isis district	Date(dmy	26	5	2010	Autumn/



	Southern 1 Year				Negatoria			Notes
Hole #	I	II	Year III's	Old III's	II	Year III's	Old III's	Beetles? M/F? Pupa? Parasites? Other Specie Metarhizium?
1								
2								
3			1					
4			1					
5								2 Christmas grub
6			1					
7								1 Christmas grub
8								
9								
10							1	5 Christmas grub
11								
12			2				1	2 Christmas grub
13			1					
14								
15								
16								
17								
18	-	-	-	-	-	-	-	
19	-	-	-	-	-	-	-	
20	-	-	-	-	-	-	-	

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APPENDIX 4

SRDC PROJECT GGP-056 - ISIS GROWER-GROUP

SUMMARY OF GRUB CONTROL STRATEGY COMPARISONS ESTABLISHED 2010

Treatments:

	Details	(a) Hansen	(b) Kingston	(c) Chapman	(d) Garrard
	Code	ES10-05	ES10-06	ES10-08	ES10-07
	Date established – plant cane	21/10/2010	2/11/2010	26/11/2010	11/11/2010
	untreated	strip X 1r ✓	30m X 4r ✓	strips X4r ✓	strips X6r✓
	suSCon Maxi at plant	12.5kg/ha✓	12.5kg/ha✓	15kg/ha✓	12.5kg/ha✓
	Senator at plant / in furrow	1.2L/ha ✓	0.7L, 0.95 L/ha in furrow ✓	nil	0.85L/ha✓
	Senator in ratoons if infested	not treated.	no provision	not treated.	treated 2013*

* first significant infestation detected 3/2013. Slight signs 3/2012, not treated.

Sampling Results: canegrubs/stool at various crop-years

	year	Treatments	(a) Hansen ES10-05	(b) Kingston ES10-06	(c) Chapman ES10-08	(d) Garrard ES10-07
grub population ± std error (mean) / stool	2011	untreated	0 (8/6/2011)	0 (31/3/2011)	0.44 (27/5/11)	0 (8/6/2011)
	2012	untreated ;	0 (15/2/2012)	0 (28/3/2012)	1.4 (1/8/2012	0.66 (15/2/2012)
		Maxi at plant:	ns	ns	0.1 (1/8/2012)	ns
	2013	untreated ;	0.3 (11/4/2013)	0 (11/4/2013)	2.08 (21/2/2013)	3.12 (5/4/2013)
		Maxi at plant ;	ns	ns	ns	2.66 (5/4/2013)
		Senator in planting furrow; 2010	0.2 (11/4/2013)	0.55 (11/4/2013)	na	4.4 (5/4/2013)
	2014	untreated ; 2014	12.0±1.9 (2/2014)	0 (3/2014)	6.3±0.9 (17/4/2014)	1.6±0.4 (17/04/2014)
		Maxi at plant ;2014	2.0±0.5	-	1.8±0.6	0.75±0.4
		Senator in planting furrow; 2010	2.9±0.6	-	na	1.4±0.4
		Confidor applied to ratoon 2013	na	-	na	0.4±0.4
		Senator2010+ Confidor 2013	na	na	na	0.7±0.5

ns= not sampled *na=not applicable*

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Appendix 5 – Grower contacts and holdings, plus numbers of blocks sampled, over three project years 2009-2011.

Grower #	Surname	First name	farm #	No. of Blocks	≤2008	2009	2010	2011	≥2012
1	ALGEO	Simon	1060	3		x			
2	ANDERSON	Norm	1252	1	*	x			
3	ANDREOLI	Simon	1300	5			x		x
4	ATTARD	Tony	1131	4				x	
5	BAILEY	Ross	12116	4		x			
6	BAKER	John	1400	3			x		
7	BUNDERSON	Glen	1750	5	*		x	*	
8	CARDIFF (ISIS)		2150	3			x		
9	CHAPMAN	Tony	2190	8	*	x	*	*	x
	CHAPMAN	Tony	2190	5			x		
	CHAPMAN	Tony	2190	2				x	
10	COCCO	Gil	2365 (BSL)	4				x	*
11	CRAM	Bruce	4270	3		x			
	CRAM	Bruce	4270	4			x		
12	Lagoon Farms	Peter Cross	3841	3			x	x	*
	Lagoon Farms	Peter Cross	3841	2				x	
13	DE PAPPI	F	2402	3			x		
	DE PAPPI	F	2410	3			x		
14	FINLAY	John	2990	7	*		x		
15	FLANDERS	Gavin	3022	4			x		
16	GALEA	Andrew	3140	2	*			x	
17	GARRAD	Russell	3130	3			x	*	x
18	HALPIN	Don	3711	3				x	*
19	HANSEN	Jamie	2350	4			x		x
20	HODGITTS	Noel	3811	7			x	*	
21	JOHNSON	Noel	4320	4		x			
22	KELLY	Peter	4481	2	*	x		*	x
23	KINGSTON	Neil	4582	1	*	x	*	*	x
24	KINGSTON	John	4443	3	*		x		x
25	KRIEGER	Steve	4592	3	*			x	*
26	La ROCCA	Angelo	4651	2	*	x	*		*
27	MAMMINO	Mark	5581	2	*			x	*
28	MARTENS	Mick	5390	2		x			
29	MCLENNAN	Peter	5612	5	*		x		x
30	MOLLER	Rodney	5760	6			x		
31	MULLER	John	5850	8			x		
32	PAPE	Alan	6230	5	*			x	

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Grower #	Surname	First name	farm #	No. of Blocks	≤2008	2009	2010	2011	≥2012
33	PEDLEY (ISIS)		6281	5			x		
34	PEIRSON TRUST		6301	2				x	x
35	PETERSON	John	6350	5	*	x	*	*	*
	PETERSON	John	6350	1			x		
36	PETERSON	Bruce	1100	1	*		x		
	PETERSON	Bruce	6361	2			x		
	PETERSON	Bruce	6362	2			x		
37	PICKUP	Ron	4831	5	*		x	*	
	PICKUP	Ron	4832	3			x	*	
38	PLATH	Jeff	2801	2	*		x	*	
	PLATH	Jeff	2802	2			x	*	
39	RANDELL	Des	6760	3				x	*
40	RASMUSSEN	Ian	2010 (BSL)	3			x	*	
41	RUSSO	John	7117	1		x			
	RUSSO	John	7122	1		x	x	x	
	RUSSO	John	7152	1			x	x	*
42	SEE	Ken & C	7401	4			x		
	SEE	Ken & C	7402	3			x		
43	SKOPP	Greg	0481(BSL)	2				x	
	SKOPP	Greg	0481 (BSL)	2			x		*
44	TANNER	John	7740	1	*	x	*		
45	UNIFACT	Pty Ltd	8051	2		x	x	x	
46	WEBB	Graham	8361	3	*	x		*	*
	WEBB	Graham	8362	1	*	x		x	*
47	WESSEL	Armin	4003	3			x	x	
48	ZUNKER	Errol	8750	4			x		
49	ZUNKER	Lindsey	8800	6	*		x		
50	ZUNKER	Russell	8770	4			x	*	*
	ZUNKER	Russell	8780	6			x		
Holdings sampled / monitored in high-risk areas					21	17	41	28	22
50	50 growers		63 holdings	218 blocks		44	134	40	8

BSL = Bundaberg Sugar Ltd supplier x=sampled

* = follow-up monitoring by BSES Ltd independent of grower contact

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APPENDIX 6: Summary of monitoring results for growers, blocks, and years.

2009

Date	Grower		Farm#	Block	holes	Average Grubs	Lowest grubs/hole	Highest grubs/hole
18/06/2009	RUSSO	John	7117	4A	8	3.1	0	7
	RUSSO	John	7122	12A	4	14	6	23
18/06/2009	CRAM	Bruce	4270	10B	9	3	0	7
	CRAM	Bruce	4270	11				
18/06/2009	CRAM	Bruce	4270	8A	5	6.6	0	13
17/06/2009	JOHNSON	Noel	4320	7A	2	2.5	2	3
	JOHNSON	Noel	4320	6A	6	1.5	0	3
	JOHNSON	Noel	4320	11A	5	0.2	0	1
	JOHNSON	Noel	4320	12C	2	0	0	0
7/09/2009	TANNER	John	7740	5A	18	2.2	0	9
31/87/09	TANNER	John	7740	5A	8	3.4	1	8
30/07/2009	ALGEO	Simon	1060	13A+B	8	2	0	5
	ALGEO	Simon	1060	2A	10	3.8	0	12
	ALGEO	Simon	1060	7A	10	3.9	0	7
6/03/2009	MARTENS		5390	16A	3	1.3	0	4
	MARTENS		5390	15B	3	2.7	0	8
29/07/2009	ANDERSON	Norm	1252	10A	10	0.4	0	4
28/07/2009	KINGSTON	Neil	4582	7A	10	4.1	0	9
30/07/2009	BAILEY	Ross	12116	17A+B	4	3.5	0	8
	BAILEY	Ross	12116	17C	3	4.7	0	10
	BAILEY	Ross	12116	17D	5	0.4	0	2
	BAILEY	Ross	12116	21A	1	0	0	0
9/07/2009	WEBB	Graham	8361	15	6	4.1	0	20
	WEBB	Graham	8361	6A	4	1.75	0	3
	WEBB	Graham	8361	7A+B+C	4	12.5	7	17
	WEBB	Graham	8362	17B+C+D	6	0.3	0	1
8/07/2009	UNIFACT		8051	30	6	3.7	1	7
	UNIFACT		8051	31	5	1	0	2
17/06/2009	CHAPMAN	Tony	2190	7A	4	1.5	1	3
	CHAPMAN	Tony	2190	5A	5	4.6	2	7
	CHAPMAN	Tony	2190	4A	2	13.5	10	17
	CHAPMAN	Tony	2190	40	5	2.2	1	4
	CHAPMAN	Tony	2190	20A	2	0.5	0	1
	CHAPMAN	Tony	2190	21A	2	0.5	0	1
	CHAPMAN	Tony	2190	23A	2	5	4	6
30/06/2009	PETERSON	John	6350	4	10	0.5	0	1
	PETERSON	John	6350	5	6	1.5	0	3
	PETERSON	John	6350	16A	6	2.5	0	5
	PETERSON	John	6350	14	6	3.8	1	8
	PETERSON	John	6350	20	6	0.66	0	3
8/07/2009	KELLY	Peter	4481	4A	7	1.4	0	6
	KELLY	Peter	4481	9A	6	0.5	0	1
1/06/2009	La ROCCA	Angelo	4651	37	8	5.1	0	11
	La ROCCA	Angelo	4651	9A	4	6	0	13
number blocks						43		
median grub population (grubs/stool)						2.5		

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2010

Date	Grower	Farm#	Block	holes	Average Grubs	Lowest No grubs/hole	Highest No grubs/hole
19/05/2010	Hansen J	2350	11	2	4	2	6
19/05/2010	Hansen J	2350	12	2	2	2	2
19/05/2010	Hansen J	2350	13	2	2.5	2	3
19/05/2010	Hansen J	2360	37	5	1.2	0	3
19/05/2010	Plath J	2801	2A	8	0.6	0	2
19/05/2010	Plath J	2801	9 A+B	4	0	0	0
19/05/2010	Plath J	2802	7C	2	0	0	0
19/05/2010	Plath J	2802	8A	4	0	0	0
19/05/2010	Cram B	4270	6	8	0.1	0	1
19/05/2010	Cram B	4270	10A	4	0.25	0	1
19/05/2010	Cram B	4280	13	4	0	0	0
20/05/2010	Andreoli S	1300	3 B	3	0.3	0	1
20/05/2010	Andreoli S	1300	4A	6	0.2	0	1
20/05/2010	Andreoli S	1300	13	1	0	0	0
20/05/2010	Andreoli S	1300	14 A	2	0	0	0
20/05/2010	Andreoli S	1300	14 B	7	0.3	0	1
20/05/2010	Chapman T		26	5	2.4	1	3
20/05/2010	Chapman T		38 B	6	0.2	0	1
20/05/2010	Chapman T		49	8	1.4	0	3
20/05/2010	Chapman T		51	5	1.6	0	6
20/05/2010	Chapman T		52	3	0.3	0	1
26/05/2010	Bundesen G	1750	10 B	3	0.3	0	1
26/05/2010	Bundesen G	1750	13	4	0.5	0	1
26/05/2010	Bundesen G	1750	14	4	0.25	0	1
26/05/2010	Bundesen G	1750	15	3	0	0	0
26/05/2010	Bundesen G	1750	17	8	0.6	0	3
28/05/2010	Garrard R	3130	9	7	1	0	2
28/05/2010	Garrard R	3130	26	5	1	0	2
28/05/2010	Garrard R	3130	27	7	1.3	0	5
28/05/2010	Kingston J	4443	2	8	0.1	0	1
28/05/2010	Kingston J	4443	6A	6	0.7	0	2
28/05/2010	Kingston J	4443	11	5	0.4	0	1
1/06/2010	Pickup R	4831	6A	2	0	0	0
1/06/2010	Pickup R	4831	7B	2	0	0	0
1/06/2010	Pickup R	4831	10 B	5	0.4	0	1
1/06/2010	Pickup R	4831	11A	3	0	0	0
1/06/2010	Pickup R	4831	14 B	2	1	0	2
1/06/2010	Pickup R	4832	22	7	0	0	0
1/06/2010	Pickup R	4832	23	2	0	0	0
1/06/2010	Pickup R	4832	24	2	0	0	0
1/06/2010	Zunker L	8800	2B	3	0	0	0
1/06/2010	Zunker L	8800	2C	3	0.3	0	1
2/06/2010	Zunker L	8800	12D	8	0.4	0	2
1/06/2010	Zunker L	8800	13B	6	0.7	0	2
1/06/2010	Zunker L	8800	13C	3	0	0	0
2/06/2010	Zunker L	8800	15	10	0	0	0
2/06/2010	Hodgets N	3811	1	2	7	3	11
2/06/2010	Hodgets N	3811	2A	5	7.4	2	14
2/06/2010	Hodgets N	3811	2B	3	7.7	6	11
2/06/2010	Hodgets N	3811	4A	5	2	1	4
2/06/2010	Hodgets N	3811	5A	1	8		8
2/06/2010	Hodgets N	3811	7A	2	2	0	4
2/06/2010	Hodgets N	3811	7B	2	0.5	0	1

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Date	Grower	Farm#	Block	holes	Average Grubs	Lowest No grubs/hole	Highest No grubs/hole
17/06/2010	Cardiff (Isis)	2150	8A	3	0	0	0
17/06/2010	Cardiff (Isis)	2150	9A	5	0.2	0	1
17/06/2010	Cardiff (Isis)	2150	10A	3	0	0	0
17/06/2010	De Pappi F	2402	4	7	2	0	7
17/06/2010	De Pappi F	2402	10A	2	1.5	1	2
17/06/2010	De Pappi F	2402	11	3	0.3	0	1
17/06/2010	De Pappi F	2410	11	5	0	0	0
17/06/2010	De Pappi F	2410	12	6	0	0	0
17/06/2010	De Pappi F	2410	13	5	0	0	0
17/06/2010	Pedley (Isis)	6281	2A	3	0	0	0
17/06/2010	Pedley (Isis)	6281	3	2	0	0	0
17/06/2010	Pedley (Isis)	6281	4	1	1		1
17/06/2010	Pedley (Isis)	6281	5A	2	0	0	0
17/06/2010	Pedley (Isis)	6281	10A	6	0	0	0
18/06/2010	Zunker E	8750	3A	8	0.25	0	2
18/06/2010	Zunker E	8750	11A	4	0	0	0
18/06/2010	Zunker E	8750	17A	1	1		1
18/06/2010	Zunker E	8750	22B	2	0.5	0	1
18/06/2010	Zunker R	8770	8	5	3	1	8
18/06/2010	Zunker R	8770	9	6	0.6	0	2
18/06/2010	Zunker R	8770	10	4	3.75	0	11
18/06/2010	Zunker R	8770	12	6	3.3	1	8
18/06/2010	Zunker R	8780	1A	3	6.7	5	8
18/06/2010	Zunker R	8780	6A	4	0	0	0
18/06/2010	Zunker R	8780	7B	2	3	1	5
18/06/2010	Zunker R	8780	7C	2	1	0	2
18/06/2010	Zunker R	8780	8A	5	2	0	7
18/06/2010	Zunker R	8780	12A	3	5.3	0	16
24/06/2010	Peterson B	6361	11B+C	7	0	0	0
24/06/2010	Peterson B	6362	3A	6	3	0	8
24/06/2010	Peterson B	1100	4A	9	0.4	0	2
24/06/2010	Muller J	5850	1A	4	3.25	0	7
24/06/2010	Muller J	5850	2A	4	1	0	2
24/06/2010	Muller J	5850	3C	3	0	0	0
24/06/2010	Muller J	5850	4A	5	0.6	0	2
24/06/2010	Muller J	5850	4B	6	0	0	0
24/06/2010	Muller J	5850	4C	6	2.5	0	7
24/06/2010	Muller J	5850	5A	5	0.8	0	3
24/06/2010	Muller J	5850	5B	3	0.3	0	1
25/06/2010	Peterson J	6350	6	4	1.75	1	3
25/06/2010	Skopp G	0481	1B	4	3.5	2	7
25/06/2010	Skopp G	0481	6A	3	8.3	4	14
29/06/2010	Baker J	1400	2A+B	10	1.5	0	9
29/06/2010	Baker J	1400	5	2	3	3	3
29/06/2010	Baker J	1400	12A	2	3	2	4
29/06/2010	See K&C	7401	6A	4	1.25	0	3
29/06/2010	See K&C	7401	19	3	1	0	2
29/06/2010	See K&C	7401	20	3	0	0	0
29/06/2010	See K&C	7401	21B	4	5.25	1	10
29/06/2010	See K&C	7402	22	2	0	0	0
29/06/2010	See K&C	7402	23	2	0	0	0
29/06/2010	See K&C	7402	24	6	0	0	0
15/07/2010	Finlay J	2990	15	6	1.7	0	3
15/07/2010	Finlay J	3010	1A	6	0.8	0	4

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Date	Grower	Farm#	Block	holes	Average Grubs	Lowest No grubs/hole	Highest No grubs/hole
15/07/2010	Finlay J	3010	4A	7	1	0	3
15/07/2010	Finlay J	3010	9A	2	0	0	0
15/07/2010	Finlay J	3010	10A	5	0.2	0	1
15/07/2010	Finlay J	3010	18A	3	0.3	0	1
15/07/2010	Finlay J	3010	19A	4	0	0	0
16/07/2010	Cross P	3841	1 +18	10	0.1	0	1
16/07/2010	Cross P	3841	3	8	0.9	0	7
16/07/2010	McLennan P	5612	1	14	1	0	4
16/07/2010	McLennan P	5612	5	3	1	0	3
16/07/2010	McLennan P	5612	6	1	0	0	0
21/07/2010	Moller R	5760	1B	8	1	0	2
21/07/2010	Moller R	5760	2B	5	1.8	0	4
21/07/2010	Moller R	5760	5A	8	1.4	0	4
21/07/2010	Moller R	5760	20A	4	0	0	0
21/07/2010	Moller R	5760	20C+D	12	2.5	1	6
21/07/2010	Moller R	5760	21	2	2.5	2	3
27/07/2010	Flanders G	3022	2A	11	0.4	0	1
27/07/2010	Flanders G	3022	3	6	1.7	0	6
27/07/2010	Flanders G	3022	12	13	0.4	0	2
27/07/2010	Flanders G	3022	19	9	1.25	0	4
30/07/2010	Rasmussen I	2010	8A	3	4	0	10
30/07/2010	Rasmussen I	2010	9A	1	8		8
30/07/2010	Rasmussen I	2010	10A	2	22	10	34
10/09/2010	Wessel A	4003	2A	6	0.5	0	2
10/09/2010	Wessel A	4003	3A	3	1	0	2
10/09/2010	Wessel A	4003	5A	6	0.8	0	4
number blocks 2010					133		
Median population (grubs/stool) 2010					0.6		

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2011

Date	Grower	Farm#	Block	holes	Average Grubs	Lowest grubs/ hole	Highest grubs/ hole
20/05/2011	COCCO	22365 (BS)	1A	6	0.3	0	1
	COCCO	22365 (BS)	2A	4	0.75	0	2
	COCCO	22365 (BS)	3A	4	2.75	1	4
	COCCO	22365 (BS)	4B	2	5	1	9
7/07/2011	SKOPP	00481(BS)	2A	11	3.5	0	11
	SKOPP	00481(BS)	4	6	5.5	0	19
25/07/2011	RUSSO	7152	9A	4	1	0	3
5/07/2011	MCLENNAN	5612	1	7	0	0	0
	MCLENNAN	5612	2	6	3	0	4
5/07/2011	CROSS		22	5	0	0	0
	CROSS		21	4	0	0	0
3/08/2011	ATTARD	1131	8A	5	0	0	0
	ATTARD	1131	2A	7	0	0	0
	ATTARD	1132	15B	3	0	0	0
	ATTARD	1132	13A	2	0	0	0
16/06/2011	CHAPMAN	2190	27	8	0	0	0
	CHAPMAN	2190	39	8	0.4	0	3
13/07/2011	GALEA	3140	1A	6	0.2	0	1
	GALEA	3140	15	8	0.25	0	2
13/07/2011	PAPE	6230	6A	6	0.3	0	1
	PAPE	6230	14	2	0	0	0
	PAPE	6230	15	2	0.5	0	1
	PAPE	6230	34A	2	0	0	0
	PAPE	6230	36A	4	0	0	0
8/07/2011	HALPIN	3711	1A	5	1.8	1	3
	HALPIN	3711	13A	5	0.2	0	1
	HALPIN	3711	16A	3	0	0	0
14/07/2011	MAMMINO	5581	3	5	0.2	0	1
	MAMMINO	5581	4	5	1.6	0	4
14/07/2011	PEIRSON	6301	2C+D	3	0	0	0
	PEIRSON	6301	17	7	0	0	0
3/08/2011	RANDELL	6760	6A	5	0	0	0
	RANDELL	6760	15	2	1.5	0	3
	RANDELL	6760	16	1	1	1	1
10/06/2011	PETERSON	6361	1	9	0.6	0	4
	PETERSON	6362	3	6	0.2	0	1
10/06/2011	KRIEGER	4592	1A	4	0	0	0
	KRIEGER	4592	2A	4	0	0	0
	KRIEGER	4592	3A	1	0	0	0
number blocks sampled					39		
median population (grubs/ stool)					0.2		
number fields with nil					18		

BS = Bundaberg Sugar Ltd

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APPENDIX 7 – Statement of support for Project outcome from Isis Productivity Limited

ISIS Productivity Limited

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7 June 2012

STATEMENT OF INTENT

SRDC Project number GGP056
Project title: Evolve a Monitoring-based System to enhance Canegrub Control Best Management Practice for Isis Sugarcane Growers

The Board of Isis Productivity Limited values the outcomes of this SRDC funded project and believes that a monitoring based warning system can give sugarcane growers reasonable confidence in ascertaining whether they will or will not have a canegrub problem later in the season.

The project's objectives of –

- validating systems to monitor grub trends;
- use of data in annual grub management planning;
- train and build capacity of grower & manager members to annually collect relevant information and to prepare timely, cost-effective, and sustainable canegrub management strategies; and
- to build confidence in systems to enhance commercial best management practice,

have been achieved and will continue to be supported by Isis Productivity Limited.

The project has delivered a good learning experience for the grower group members. Many of the members will continue to monitor crops in the February to April period as a pre-emptive measure; some will continue to apply residual chemicals at planting time; and some will ignore the teachings of this project and will consequently apply knockdown chemicals in a reactive measure after canegrub damage is evident.

Grub-monitoring in commercial core business

The Board of Isis Productivity Limited classes canegrubs in the same category as Ratoon Stunting Disease. Both problems (canegrubs and RSD) can have significant impacts on productivity and as such, the Board will incorporate canegrub monitoring into its core business activities.

However, with only two full-time staff the task of providing more than a sample monitoring program is beyond our capacity. As with RSD, the Board will sample sections of the cane supply area each year to obtain an indication of potential damage.

In considering whether or not to implement a full commercial canegrub monitoring system, the Board does not anticipate that there would be much uptake by the canegrowing community to pay for an annual service. The Board bases this

assumption on a similar experience when the local sugar industry offered a bug-checking service for soybeans grown in a cane rotation on a fee for service basis.

If only a small number of growers participated then the benefits of the commercial service would be no more valuable than the Board's staff doing sample monitoring within core activities.

The Board will however, continue to promote the benefits of canegrub monitoring to growers so that they can do their own monitoring to allow themselves time to plan site specific canegrub and cropping management strategies.

Remote (satellite) sensing technologies

The SRDC funded project (BSS342) commenced after GGP056 and early findings indicate that this project will be a valuable tool in helping Isis Productivity Limited to identify those areas with poor or irregular growth that may be areas where canegrub monitoring should be undertaken.

Isis Productivity Limited is very interested in collaborating with this project to gain access to the aerial photography of farms in the Isis cane supply area. Isis Central Mill is considering providing the Isis farm maps so that the farm boundaries can be overlayed over the aerial photographs to assist in identifying the farms.

The value of remote sensing will provide Productivity Service Companies, such as Isis Productivity Limited, with valuable information, not limited to only canegrubs, so that our staff are able to ground-truth the data identified through satellite sensing technologies.

Conclusion

In conclusion, Isis Productivity Limited acknowledges the success of GGP056, in that the anticipated outcomes of the project have been demonstrated and proven. A canegrub early monitoring-based warning system, where fields are monitored in the February to April period, can reasonably predict future canegrub damage. The results of the monitoring system will allow growers adequate time and 'awareness' to plan site specific grub and crop management strategies to treat or not in spring.

The Board recognises the value and benefits to be gained by adopting the information to be gathered through the use of the Remote (satellite) sensing technologies in targeting the areas of the Isis cane supply area where monitoring (digging) should be undertaken.

Isis Productivity Limited will incorporate monitoring in its core-business activities and will encourage canegrowers, particularly those growers with a history of grub damage, to monitor during the February – April period.

Clearly, there are economic, environmental and social benefits from adopting the findings of the SRDC funded Grower Group Innovation Project GGP056 "Evolve a Monitoring-based System to enhance Canegrub Control Best Management Practice for Isis sugarcane growers.

W M Stanley

Wayne Stanley
COMPANY SECRETARY

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APPENDIX 8 Summary of grower attitudes and preferences and copy of 2008 questionnaire used to judge opinions (Source Final Report BSS266)

Table 65 - Summary of grower attitudes, preferences and comments regarding monitoring and decision processes

Grower	Attitude to grub management	Attitude to new strategy	Preference	Comments on limitations
John Kingston	Determined. Consistently treats most plant crops owing to previous consistent (2-3 yrs) damage.	Supportive; Believes improvement in efficiency always possible; but questions cost-effectiveness and time-constraint of a monitoring-based strategy (vs a routine).	Currently believes routine approach to grub management most effective and least bother: "treat all plant cane & 3rd ratoons". But in 2008 became "sick of buying Confidor®" and was satisfied to believe 'low-risk' prognoses for less-productive fields, and not treat.	Reliability of monitoring only question constraining greater adoption of monitoring-driven strategies. Identifies pathways to getting Isis Productivity Ltd / Target 100 to engage in a monitoring project. Also Bruce Quinn as their "gatekeeper". .
Neil Kingston	Determined etc (as above)	Supportive; keen to see continuation. Wants monitoring approach to tell him how long after Maxi expires before grub numbers likely to rise to problem levels? [Inference? Neil would then factor this into a routine?]	Will stick to routine treatment of plant crops; happy to base ratoon planning on monitoring. Can see need for commercial service to help this happen in some cases.	Believes autumn monitoring (for Childers grub) is "on the money" for decision-making and forward-planning. Reasonably satisfied with reliability of sampling as a warning tool.
Steve Kreiger	Positive: Was complacent but now recognizes severity of problem due to recent damage experience. Relatively recently took over farm. Looking to improve outcome over whole farm system, & grubs a major disruptor.	Supportive: Keen to avoid unnecessary treatment. IPM for melons leaves him comfortable with merit of monitoring grubs. Took our advice on 2 blocks and put out a 6-row strip to test the validity of our prognosis.	Steve said "Maxi at planting (routine) is still the best option", and he "will take some convincing otherwise". Also, he "will review (his current) strategy in 2-3 years". Keen for monitoring in ratoons.	Accurate identification of grub species is major constraint to farmer's willingness to monitor.
Bruce & Gavin Peterson	Increasingly Positive: Recognises problem; has been complacent but now proactive due to better options available. Identifies soybean rotation as a valuable management tool for various reasons, including grub management. "Good" sugar price for 2-3 years is reason to minimize grub risk, & "only (adopts) change if there is a good reason".	Supportive: Gavin says he is "supportive of any program to improve outcomes". Believes positive experience with IPM for soybeans will ease any reluctance by canegrowers to factor monitoring into improving grub management.	Gavin volunteered "Can imagine finding the time to monitor the relatively few vulnerable ratoons that may (or may not) need additional protection". Otherwise protect plant & 2 ratoons with Maxi (routine) then plough out older ratoons if grubs appear - (rather than treat ratoons).	"Monitoring would need to be extremely reliable for (Bruce) to not routinely treat plant cane". Both agreed the merit of being aware of grub risk in ratoons, for planning rotations, fertilizing, watering, etc.
Paul & Col Taylor	Relatively complacent: "Grubs not a major consideration, at present". Recognises certain parts of farm as susceptible and routinely treats plant cane on these.	Positive; improvement possible. New products good. Monitoring in 2008 "helped a bit".	Routine treatment of 'trouble' fields. Commercial monitoring service would be most suitable in order to free time for other tasks of the mixed cane / horticulture / farm / tourism enterprise.	Comfortable with monitoring (experience with IPM in horticulture) and does not believe that doubt about its reliability is a valid reason to constrain its adoption for grub management.
Daryl Rapley	Determined: Previously waited until grub problem arose before managing or applying controls, but "Not any more". Now always treats most plant crops owing to previous consistent (2-3 yrs) damage, and confidence from better results with	Positive: Currently waits to see damage before treating ratoons, but acknowledges the limitations to this approach and sees that early monitoring and treatment prior to damage expression will improve the outcomes.	Currently believes routine approach to grub management is most effective: treat all plant cane & 2nd or 3rd ratoons	Daryl is not unsupportive of what this program is attempting; but for the present (and considering his farm risk) will continue 'as is' and will continue to advise others of his approach, if asked.

Appendix 8 (contd)

	new products.			
Graham Webb	Positive: Recognises a consistent "problem" at Cordalba. "No problem" elsewhere; except for recent minor damage? (And "noticed heavy (negatoria) beetle flights in 2008-09?").	Supportive: prepared to give change a go. Greater confidence in modern options and products – "better off now than 5 - 10 years ago". Convinced monitoring can identify trends and when strategy needs to change.	Since new CR product became available, now treats plant cane at Cordalba as routine, but generally not ratoons. Not treating other farms (unless damage situation changes)	No caution comments offered – probably preferring to see and assess outcomes.
Bundaberg Sugar Ltd	Supportive: Previously no faith in ability of suSCon® Blue to control grubs, so chose not to use it and to tolerate damage, which was becoming excessive.	Willing; especially with a business-oriented approach to monitoring, and service to industry. Willing to pay 'fee-for-service' or include this service as a significant part of a service agreement.	Routine treatment at planting is easiest for managing workforce and scale of operations. Monitoring older ratoons as basis for decisions on treatment, or alternative options (eg peanuts) is attractive.	BSL would need to do too much training and have insufficient labour available to be able to do its own monitoring. How could a commercial service be physically capable of effectively delivering, on time?

These questions are to identify grower beliefs and needs, to enable BSES Limited and others to identify new services for growers. Note:- BSES Limited will maintain confidentiality and not name individuals in survey results

Date…Feb 2009 Mill-

Location: Farm #……..

Name (optional) Phone……

(please circle or tick one or more of following options)

DO YOU (NOW OR IN THE PAST) HAVE GRUB DAMAGE ON YOUR FARM?

Often? (1 in 2-3 years) sometimes? (5-10 years) less often no

IF SO, WHAT TYPE OF GRUB?

Childers grub? Sthn 1-year (mussoni)? Other? Unknown?

DO YOU FACTOR CANEGRUB RISK AND/OR CONTROL INTO CROP MANAGEMENT PLANS?
(eg. control treatments, harvest date, ratooning decisions, irrigation needs, fertilising?)

controls on most fields consider selected fields? sometimes (eg. treat after damage) no?

GIVEN NEW & BETTER PRODUCTS, AND SYSTEMS, IS BETTER GRUB-CONTROL POSSIBLE?

yes probably maybe, but not worth my effort no

DO YOU AGREE ANY OF THESE LIMIT INTEREST IN TRYING TO IMPROVE GRUB CONTROL?

It's OK as is; 'why fiddle if it aint broke'?
Not confident in new chemicals.
Not convinced anyone can monitor and predict grubs with sufficient reliability.
Grubs are a minor problem not worth extra effort.
I'll wait until I see a problem before I do something different.

ANY RELEVANT COMMENTS?

Figure 31 Questionnaire about grub management; beliefs, preferences, and needs