PROGRESS OF THE AREA-WIDE INTEGRATED PEST MANAGEMENT PLAN FOR *ELDANA SACCHARINA* WALKER (LEPIDOPTERA: PYRALIDAE) IN THE MIDLANDS NORTH REGION OF KWAZULU-NATAL

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Abstract

In 2005, 14 farms in the Midlands North Extension Region were reported with *Eldana saccharina* Walker (Lepidoptera: Pyralidae). Currently, a further 29 farms in this region are known to have this pest in their sugarcane. It is thus firmly entrenched in the Midlands North Region (MNR), and is spreading. This 207% increase in known localities over three years in this region is disturbing, and highlights the urgent need for growers to implement the IPM plan presented in 2005, on an area wide basis. This paper demonstrates the increased occurrence and spread of *E. saccharina* in ecozones 1-6, 8, 10 and 11 since 2005.

Using already known ecological data on *E. saccharina*, soil characteristics and climatic forecasts, it is evident that ecozone 7 is the next likely area to suffer an increase in *E. saccharina* numbers, should growers continue with the slow implementation of the Integrated Pest Management (IPM) plan and the Environmental Management System (EMS), which are aimed at minimising the threat of *E. saccharina* in their areas.

Keywords: Eldana saccharina, Integrated Pest Management, environmental management, climate change, soils, incursions

Introduction

Historically, sugarcane growing in the Midlands area of KwaZulu-Natal was thought safe from attack by the stalk borer *Eldana saccharina* Walker (Lepidoptera: Pyralidae), because of its higher altitude and thus cooler climate (Atkinson *et al*., 1981). However, in recent years temperatures throughout South Africa have increased, leading to conditions becoming more suitable for *E. saccharina* development, and this insect has been found in areas as diverse as Potchefstroom in the North West Province, and Thohoyandou in Limpopo Province (Assefa *et al.,* 2008). Fortunately, the Midlands North Local Pest, Disease and Variety Control Committee (MNLPD&VCC) was aware of the dangers of *E. saccharina* establishment in their area much earlier on, and in July 2005 presented an Integrated Pest Management (IPM) Plan for its control in the region (Webster *et al.,* 2005).

At the same time, Noodsberg Cane Growers were embarking on an environmental management system for their sugarcane (Maher and Schulz, 2003), which has developed into the 'Sustainable Sugarcane Farm Management System (SuSFarMS^{TM})' - a management

system that includes an audit of farming practices designed to help farmers subscribing to it to manage their farms in an economically, socially and environmentally sustainable manner (Anon, 2008). The IPM system described for *E. saccharina* by Webster *et al.* (2005) thus lent itself well to integration into the development and acceptance of SuSFarMS in the area, as both approaches 'optimise ecosystem functions and processes (such as biotic regulation of harmful organisms), nutrient recycling, water production and biomass accumulation, thus allowing agro-ecosystems to assist and sponsor their own functioning into the future' (Anon, 2008). The focus of both approaches are thus ecosystem based and, as whole ecosystems often encompass many farms, their emphasis has expanded from the better management practices advocated on an individual farm basis, to an Area Wide (AW) approach (Klassen, 2005), where individual farmers work together to develop a holistic AW-IPM approach. Insects do not recognise farm and/or political boundaries; they are components of ecosystems, which have to be studied, and the resultant knowledge used to manage them in an economical but sustainable manner (Conlong and Rutherford, 2009).

With this in mind, the MNLPD&VCC has since 2005 further developed their IPM programme into an AW programme. As this paper will describe, this intervention is timely and of utmost importance, and provides integrated control advice that must be embraced by growers of the whole region to limit the ever increasing spread of *E. saccharina*.

The current situation

The ecozones

The Midlands North Region (MNR) is divided into a number of ecozones (Figure 5), each with its particular range of altitude, temperature and rainfall (Table 1).

Table 1. Altitude and main climatic features of each ecozone in the MNR (from Webster *et al.,* 2005).

Ecozone	Rainfall range (mm)	Altitude range (m)	Maximum Temperature (ºC)	Minimum Temperature (ºC)
1	801-850	451-900	26.7	6.1
2	701-750	451-900	27.5	5.9
3	751-750	451-900	26.8	5.8
4	901-1100	901-1400	25.3	7.0
5	801-850	901-1400	25.7	6.0
6	751-800	451-1400	26.6	6.8
7	851-900	901-1400	25.7	5.3 (frost)
8	901-1100	451-1400	27.1	5.3 (frost)
9	751-850	901-1400	26.1	4.6 (frost)
10	901-1100	901-1400	25.4	6.5
11	651-700	451-900	28.6	4.3 (frost)

Varieties

Twenty varieties are planted throughout the region, of which three (N12, N16 and N31) make up in excess of 80% of the area planted. Variety N12 is planted over 56% of the MNR area (Figure 1).

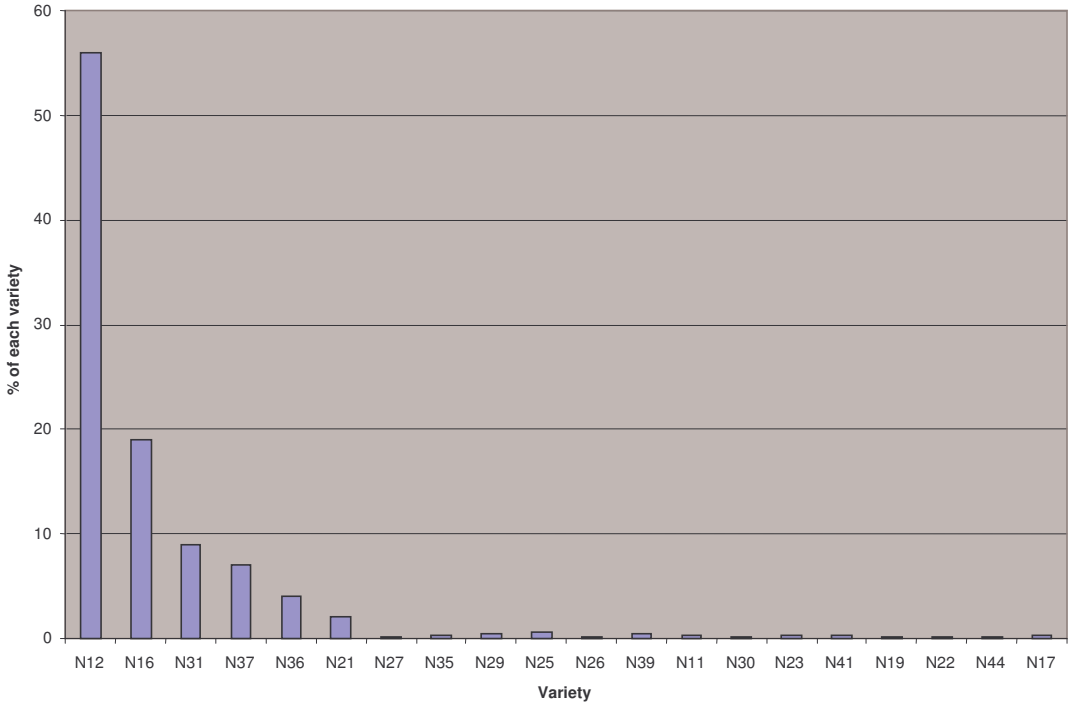

Figure 1. Variety disposition in all ecozones of the MNR in 2008.

The varieties of the area are still chosen for their agronomic properties rather than their resistance to *E. saccharina*. For example, the resistant variety N21 is planted in only about 5% of the area available (Figure 1), and two of the three major varieties, N12 and N31, are only moderately resistant, while N16 is susceptible. This is a concern, as *E. saccharina* now occurs in 21% of the farms of the area (Figure 2). In addition, a field recently planted to N35 (a susceptible variety) was found to harbour 65 *E. saccharina* per 100 stalks. In addition to the cane being 24 months old (older cane is usually more heavily infested by *E. saccharina* (Carnegie, 1981)), the choice of this variety in this ecozone on the shallow soil it was planted on was a poor one (See Table 3).

Eldana saccharina

Since 2005, *E. saccharina* levels have increased dramatically in the MNR, with 50 farms positively identified as having *E. saccharina* present in their sugarcane in 2008, compared to fewer than 20 in 2004 (Figure 2). In addition, prior to 2004, it was recorded in only six ecozones (1-4, 6 and 8). In 2005 it was found on a farm in ecozone 10, by 2006 it had spread into two more ecozones (5 and 7), and in 2007 ecozone 11 had its first positive farm. Only ecozone 9 now has no farms with *E. saccharina* (Table 2).

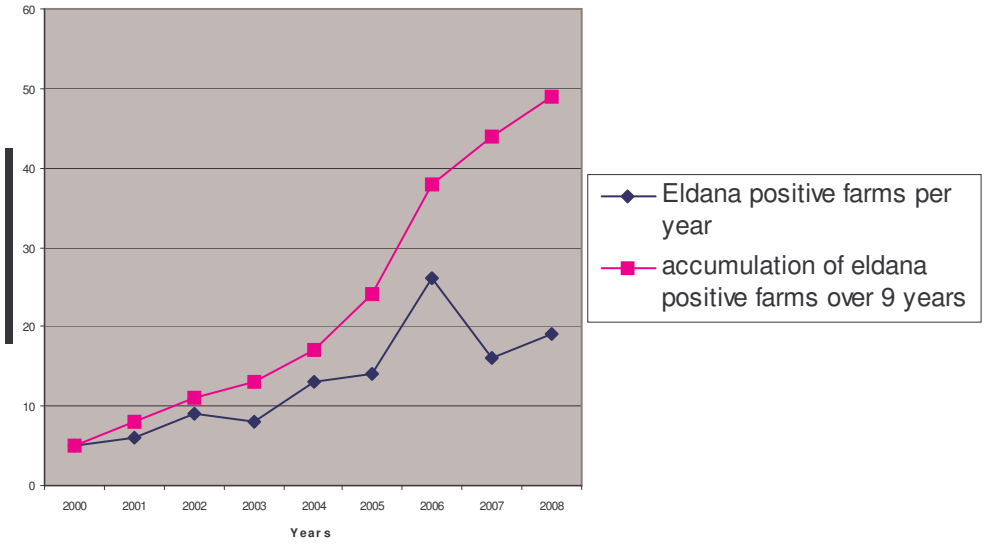

Figure 2. Increase in *E. saccharina* levels in the MNR in terms of number of farms infested per year and accumulated increase in farms infested since the first record in 2000.

Table 2. Percentage increase in fields infested with *E. saccharina* in all ecozones since the first infestation in 1998.

Incidences of *E. saccharina* found					Eldana Risk Category expressed as % AUC		
Ecozone	**1998 to 2004**	**2005 to 2008**	**Combined Total**	**% increase for 2005-2008**	**High**	**Medium**	**Low**
1	39	144	183	369	2.9		
2	23	26	49	113	7.6		
3	28	18	46	64	8.2		
4	12	34	46	283		26.3	
5	0	5	5	~		18.6	
6	4	38	42	950	11.1		
7	0	4	4	~			11.3
8	17	16	33	94		7.0	
9	0	0	0	~			1.1
10	0	1	1	~		4.5	
11	0	3	3	~		1.4	
Total	123	289	412	235	29.8	57.8	12.4
Farms	17	32	49	188	Total MN Area Risk Categories		

A prediction of ecozone susceptibility or risk to *E. saccharina* is given as a function of the percentage of the ecozone area compared to the total area under cane for the MNR. Risk is a function of cane age (normally 24 months), effective rainfall, average temperatures, average total available moisture, nematodes, variety and crop nutrition management, N mineralising potential, threat from neighbours, and degraded natural habitat.

Table 2 shows that 29.8% of the mill supply area in the MNR is situated in ecozones with a 'High Eldana Risk'. Similiarly, 57.8% of the mill supply area faces a 'Medium Eldana Risk'. This knowledge allows the MNLPD&VCC to prioritise its efforts to contain *E. saccharina*.

Table 3. 'On farm' prioritisation of *E. saccharina* risk as a guide to AW-IPM recommendations.

Farm risk of serious eldana losses		Category of farm		
Category of ecozone	**% AUC in P&D area**	**High risk farm**	**Medium risk farm**	**Low risk farm**
High risk Ecozone	29.8%	Problem!	High risk	Medium risk
Medium risk Ecozone	57.8%	High risk	Medium risk	Low risk
Low risk Ecozone	12.4%	Medium risk	Low risk	No problem

Risk is a function of cane age (normally 24 months), effective rainfall, average temperatures, average TAM, nematodes, variety and crop nutrition management, N mineralising potential, threat from neighbours, and degraded natural habitat.

Table 3 uses the same parameters as Table 2, but at a farm level. It allows the extension specialist and P&D manager to refine their variety management recommendations. For example, a farm situated in a 'High Risk Ecozone', but with soils deeper than average, a micro-climate with above average rainfall and with a high level of farm management, will be deemed to be a 'Low Risk Farm'. However, because it is situated in a 'High Risk Ecozone', overall it will be treated as a 'Medium Risk Farm'. This is because of the threat of *E. saccharina* incursions from neighbouring farms, and thus illustrates the need for AW-IPM.

Current status of IPM

However, through the proactiveness of the MNLPD&VCC, AW-IPM measures using the knowledge based approach advocated by Conlong and Rutherford (2009), are available and are being implemented in the region. The implementation, driven by the MNLPD&VCC, is multifaceted, and integration is assured by supervision of the process by the P&D manager. The importance of the threat of *E. saccharina* to the area has been realised by the MNLPD&VCC, in that they already have employed an additional field team to help monitor the *E. saccharina* levels on an AW basis. This in no way detracts from the need for individual farmers to employ their own P&D scouts, to allow them to stay on top of potential P&D problems (especially outbreaks of *E. saccharina*) on their own farms.

Community participation in development of the area-wide strategy

The buy-in of the community is an integral part of AW-IPM (Klassen, 2005). To this end, the MNLPD&VCC have initiated regular ecozone meetings to publicise the IPM concepts within all the ecozones throughout the region. In order to create AW-IPM awareness, the MNLPD&VCC has developed a questionnaire in the form of an audit for farmers to complete to assess their readiness to manage *E. saccharina* outbreaks (Table 4). It is clear from the questions posed in the questionnaire that knowledge of many biotic and abiotic aspects of farms is most important for efficient AW-IPM.

Healthy sugarcane

Soil and variety interaction for healthy sugarcane

Healthy sugarcane plants are less prone to pests and diseases than are plants that are stressed in some way. Sugarcane is no exception, and even in its early years as a sugarcane pest, this relationship was established between *E. saccharina* and sugarcane (Atkinson and Nuss, 1989; Carnegie, 1974, 1981).

Table 5, although lengthy, is a very relevant and important document in the hands of growers in the MNR. It outlines the soil types in each ecozone in the region, the sugarcane varieties most suited for the regions in terms of these soils, their depth, and whether irrigated or rainfed. Provided that growers select and plant varieties as recommended in Table 5, the growers, and the ecozones in general, will have healthy sugarcane, which is the first defence against pest infestation. Soil parent material maps produced by SASRI for each ecozone in the MNR complement this.

Seedcane schemes

Healthy, pest and disease free seedcane to plant in the correct soils (as indicated in Table 5) is a further arm of the AW-IPM arsenal. The MNLPD&VCC has decided that the use of hot water treatment tanks to treat cane stalks destined for planting (Bailey and McFarlane, 1999) is the route to follow. To this end, four seedcane schemes have been set up, with hot water treatment tanks and resultant pest and disease free seedcane nurseries. The sitings of these and the areas they will serve are shown in Figure 3.

Table 4. The AW-IPM awareness questionnaire presented to farmers attending ecozone meetings held by the MNLPD&VCC throughout the region, and the results of completed questionnaires.

IMPLEMENTATION OF IPM : MIDLANDS NORTH

	Ecozones												
AUDIT QUESTIONS	**E/Z 1**	**E/Z 2**	**E/Z 3**	**E/Z 4**	**E/Z 5**	**E/Z 6**	**E/Z 7**	**E/Z 8**	**E/Z 9**	**E/Z 10**	**E/Z 11**	**% FOR ECO ZONES SURVEYED**	**% FOR TOTAL AREA**
Have you got an IPM brochure - 2008?													
Have you got a 1st stage nursery?													
Have you got a 2nd stage nursery?													
Are you taking soil samples for crop nutrition?													
Are you taking leaf samples for silicon levels?													
Are you satisfied with your variety selection?													
Are you doing your own Eldana surveys?													
Are you planting melinis grasses on contours?													
Have you got a green manure programme in action?													
Are you aware of "natural host" sedges, and protecting them?													
Are you able to cut betwweeen 55% to 60% of cane fields each season?													
Do you carry out field hygene where Eldana is found?													
AVERAGE PER QUESTION													
No of Farms in Eco Zone	14	23	29	41	34	25	29	19	5	8	5	232	
Turn out for 2008													
% Turnout for 2008													

Total farms	**232**
Turnout	
% Turnout	

Table 5. The main soil groups of each ecozone in the MNR, and the suggested varieties to be planted in different toposequences, microclimates, soil depths and irrigation sequences found within each ecozone. Varieties in bold and italic fonts relate to the toposequences in bold and italic fonts.

Soil group	Toposequence	Representative soil form	Deep enough	Not deep enough	Irrigation	Ecozones
BROWN HUMIC SANDY LOAMS TO CLAY LOAMS AND ORGANICS Natal Group Sandstone, Dolerite and Vryheid Sediments	**crest to midslope *(long cycle)***	Nomanci, Inanda, Kranskop, Magwa, Lusiki	**N16, N37,** *N41, N48*	**N12,** *N39*	**N36,** N37, *N40, N41, N43, N48, N49*	2, 4, 8, 10
	footslope *(frost prone)*	Sweetwater	**N35, N36, N37,** *N39, N41*	**N35, N36, N37,** *N39, N41*		
	valley	Champagne	**NO CANE**			
BLACK BLOCKY CLAYS Dolerite and Pietermaritzburg Shales	**crest to midslope (long cycle)**	Arcadia, Mayo,Milkwood, Bonheim (red)	**N12,** *N39, N41, N42*	**N12, N31**	**N25, N36,** *N40, N41, N43, N49*	1, 2, 11
	footslope to valley *(frost prone)*	Bonheim (non-red), Inhoek, Willowbrook, Rensburg	**N35, N36,** *N41, N42*	**N21, N31**		
RED LOAMY SANDS TO CLAYS Wide range of Parent Materials	**crest to midslope *(long cycle)***	Hutton, Oakleaf (red), Bonheim (red), Swartland (red), Shortlands	**N37,** *N39, N41, N48*	**N12,** *N31, N47*	**N36,** *N40, N41, N43, N49*	ALL
	footslope (*frost prone)*	Bainsvlei, Bloemdal, Shepstone	**N35, N36, N37,** *N39, N41*	**N21**		
YELLOW-BROWN LOAMY SANDS TO CLAYS Natal Group Sandstone, Dwyka Tillite and Vryheid Sediments	**crest to midslope *(long cycle)***	Clovelly, Griffin,	**N37,** *N39, N41, N48*	**N12,** *N31, N47*	**N36,** *N40, N41, N43, N49*	ALL
	footslope *(frost prone)*	Avalon, Glencoe, Constantia, Pinedene	**N35, N36, N37,** *N39, N41*	**N21**		
GREY SANDS TO SANDY CLAY LOAMS Natal Group Sandstone and Granite	**crest to midslope *(short cycle)***	Mispah, Glenrosa	N/A	*N21*, **N31**	**N35, N36,** *N41, N49*	3, 4, 5, 6
	midslope *(long cycle)*	Cartref, Oakleaf, Swartland	**N12,** *N39, N47, N50*	**N12**		

	footslope ***(frost prone)***	Valsrivier, Klapmuts, Sepane, Longlands, Westleigh, Wasbank, Sterkspruit, Estcourt	**N35, N36**, *N39, N41*	**N31**		
	valley bottom ***(frost prone)***	Kroonstad, Katspruit	**N35,** *N39, N41*	**NO CANE**		
	recent deposits ***(long cycle)***	Oakleaf, Vilafontes, Tukulu, Fernwood, Dundee, Witbank	**N12,** *N39, N41*	**N31**		

Climatic impacts

Even though ecozones may eventually have the right disposition of sugarcane on the correct soil types, climate could still impact on the sugarcane causing stress either from lack of rainfall, or high rainfall and waterlogging. There has recently been much debate on climate change, although it is generally accepted that the following climate vagaries will impact adversely on crop production:

- Longer dry spells stressing young plant cane and ratoon cane
- Intense daytime heat causing cane to stress
- Intense thunderstorms causing soil erosion and hail damage
- Extremes of weather affecting labour and mechanical performance
- Cane left in the field for too long because of weather conditions.

Climate change can also have an impact on soil attributes. Soils with high organic and clay content are able to mineralise about 60 to 100 kg N per ha per annum (personal communication[1]) The mineralised N is mainly available to the plant after a dry spell is broken by sufficient rains. This presents the danger of an oversupply of N to the plant and, if the soil has a low TAM (ie shallow), then the soil profile itself will not hold enough water and the plant will suffer moisture stress. The combination of excess N and moisture stress is lethal. Ecozones 1, 2 and parts of 8 are particularly prone to this phenomenon.

Most of the leaf analyses in the MNR on Natal Group Sandstone derived soils show a low silicon (Si) level (<0.5% Si), which may cause low plant resistance to *E. saccharina* (Keeping and Meyer, 2002). If this low level of Si is taken into account with the high N in the plant, then *E. saccharina* incursions will occur more easily (Meyer and Keeping, 2005).

Increasing Si to the required level in Si-deficient soils has helped to increase resistance in sugarcane to *E. saccharina* (Keeping and Meyer, 2002). The measurement of the Si:N ratio in sugarcane leaves thus becomes important (Meyer and Keeping, 2005). Growers should add regular leaf sampling to their IPM armoury so that residual silicon levels can be analysed and field applications made if necessary.

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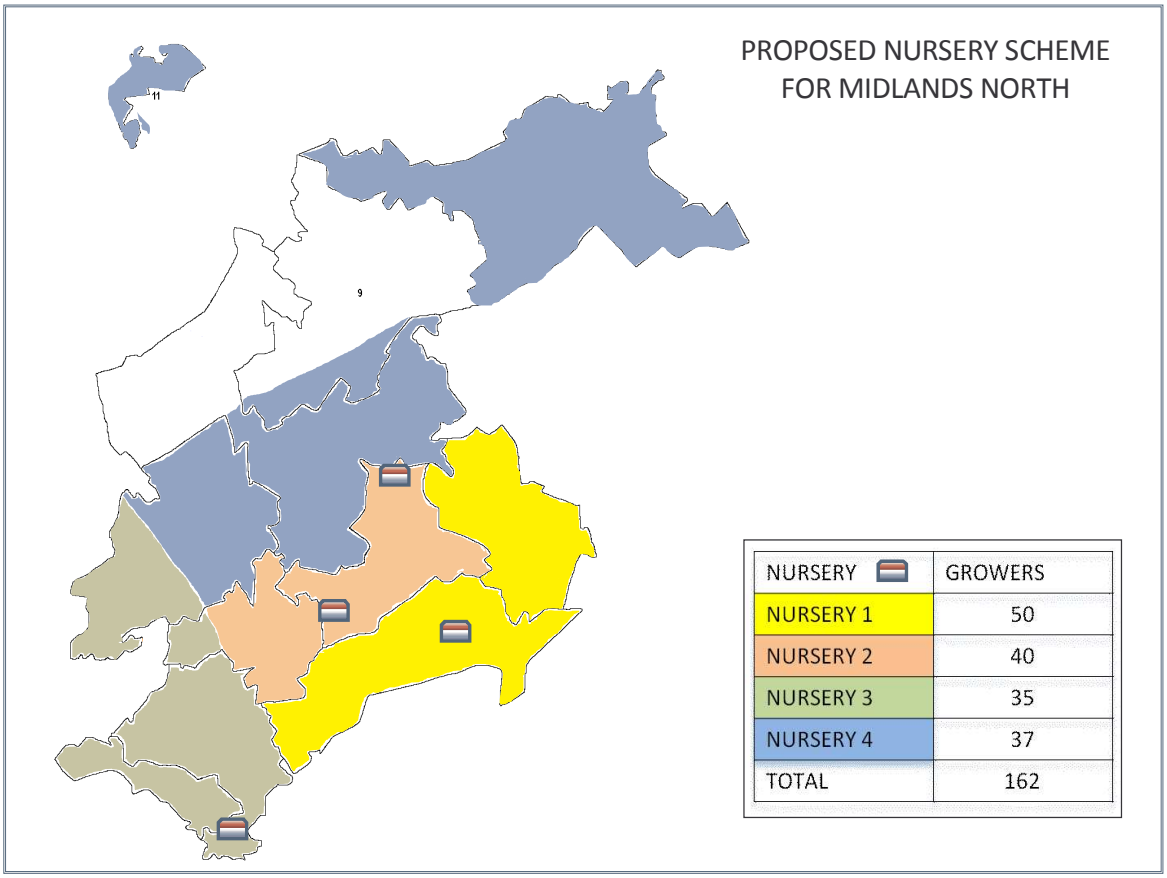

Figure 3. The proposed sitings of the seedcane nurseries and the ecozones they will serve in the Midlands North Region.

Eldana saccharina management

Stimulo-deterrent diversion

The development and use of stimulo-deterrent diversion (SDD) or 'push-pull' as it relates to *E. saccharina* is summarised by Conlong and Rutherford (2009). *Eldana saccharina* is an African insect, living in four different families of indigenous plants (Conlong, 2001), and as such will never be eradicated from sugarcane, which is an alien introduction into *E. saccharina's* habitat (Conlong *et al.,* 2007). Non-conventional strategies thus have to be developed for its management in sugarcane to below economic thresholds, which will complement the cultural and management controls (Carnegie, 1981) already in place, and the use of resistant varieties (Keeping 2006).

One method which fits into the AW-IPM concept very easily, is to manipulate the behaviour of *E. saccharina* so that it is repelled from sugarcane and remains in its natural habitat. Conlong *et al.* (2007) have shown that *E. saccharina* females have a hierarchical preference for their indigenous sedge host plants, over grasses, with sugarcane least preferred for oviposition. In addition, the neonate larvae actively seek out their indigenous sedge host plant material over that of sugarcane (Kasl, 2004; Conlong *et al.,* 2007). More recent work by Keeping *et al.* (2007) showed that *E saccharina* females preferred tasselling maize to sugarcane for oviposition. Further impetus to repel *E. saccharina* comes from the work of

Barker *et al.* (2006), who demonstrated a 50% reduction in *E. saccharina* levels and damage in cane plots with the grass *Melinis minutiflora* planted in drainage and/or irrigation lines.

The MNLPD&VCC have included habitat management for *E. saccharina* in their AW-IPM approach. To hasten its adoption, when ecozone meetings are held the P&D manager brings rootstock of *Cyperus dives* (Cyperaceae), one of the indigenous host plants of *E. saccharina,* for farmers to take back and plant in their waterways and water courses. At the meetings farmers are encouraged to clear their waterways of alien vegetation and plant this sedge as a first step to rehabilitating their wetlands, to provide indigenous habitat for *E. saccharina.* Figure 4 shows where *C. dives* occurs naturally and where it has been redistributed since the adoption of this approach in the MNR.

An added and very significant benefit of this approach to keep *E. saccharina* in its indigenous sedge habitat is that there are nine different natural enemies effectively attacking *E. saccharina* immature life stages in such a way that the natural enemy populations are maintained, while keeping *E. saccharina* at low levels in this habitat (Conlong, 1990). Genetically engineered maize incorporating the Bt gene from the entomopathogen *Bacillus thuringiensis* is also used as a 'pull' crop (Keeping *et al.,* 2007). Once the neonate larva feeds on the leaves, or bores into the stalk of this maize, it ingests the Bt toxin, which kills it. Thus, from both habitats, there is little chance of *E. saccharina* moving back into sugarcane due to population pressure.

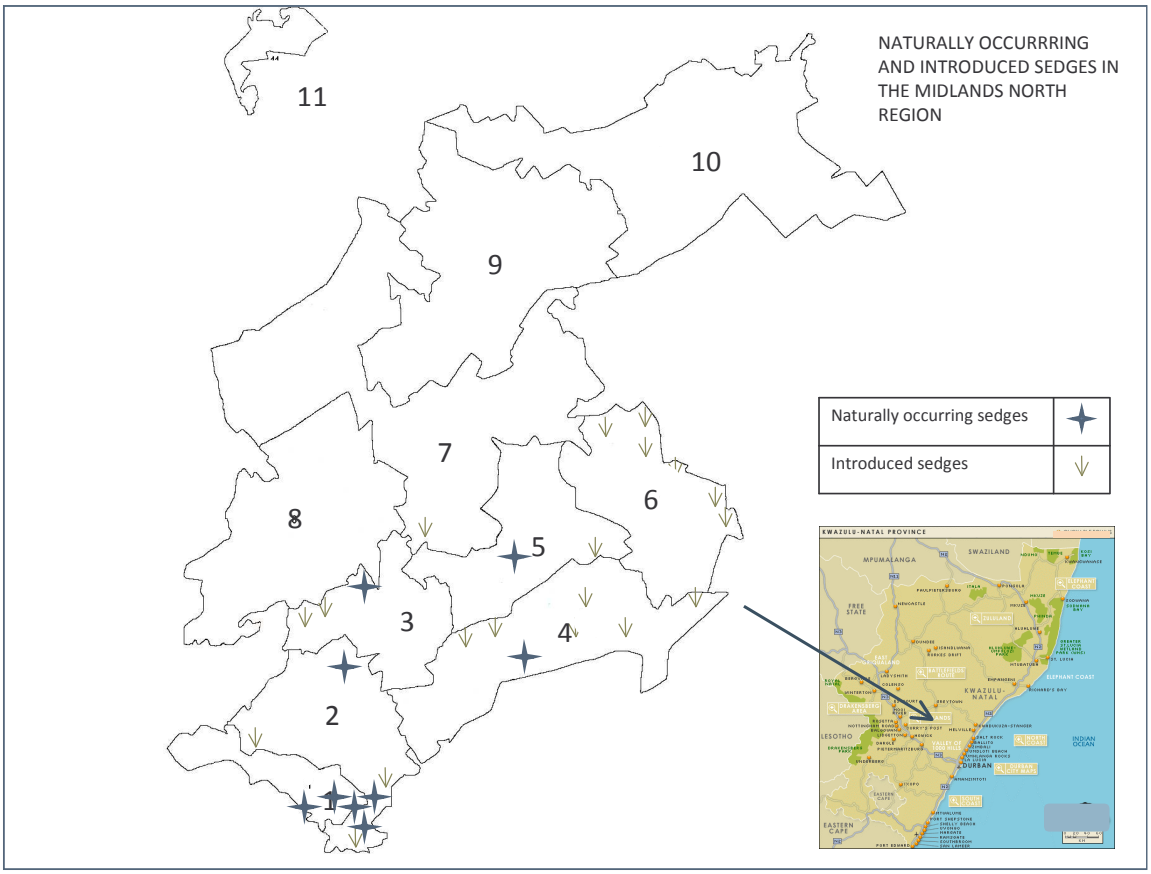

Figure 4. The natural occurrence and redistribution of *Cyperus dives* in the Midlands North Region ecozones (Sedges = *Cyperus dives*; 1-11 = different ecozones).

Regulation

AW-IPM, because of its magnitude, requires multiyear forward planning and an organisation dedicated exclusively to its implementation, whereas conventional pest management involves minimal forward planning, tends to be reactive, and is implemented independently by individual producers, businesses or households (Klassen, 2005). It is encouraging that MNLPD&VCC have thus taken on the mantle of the organisation developing and implementing the AW-IPM approach to control *E. saccharina* in their region. An example of their forward planning is given in Appendix 1.

Conclusion

The protection of the Midlands North sugarcane-growing region against insect pests and diseases is the prime function of their MNLPD&VCC. The pro-active, knowledgeable and ecologically based way in which they have approached the management of the ever-increasing threat of *E. saccharina* on an area-wide basis is clearly illustrated in this paper. It now depends on the co-operation of the farmers in the affected regions to adopt the plan proposed, so that *E. saccharina* remains in its indigenous habitats, under the control of its own natural enemies.

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APPENDIX 1

AREA-WIDE INTEGRATED PEST MANAGEMENT STRATEGY FOR IMPLEMENTATION IN THE MILANDS NORTH REGION

IPM COMPONENTS	Action and Responsibilities	
	Grower	**Other**
Development of the Strategy		
Community Involvement • Define scope. • Set goal, targets and responsibilities. • Responsible people must be actioned. • Monitor progress of AW-IPM on all *E. saccharina* affected farms in the region. • Workshops for a better understanding of the course of action required regarding *E. saccharina* control. • Records: Records of *E. saccharina* infestation including field number, age of cane, variety, *E. saccharina* numbers and damage should be kept. • An IPM Roadshow will be arranged in 2008/09. Planning and production of materials for this roadshow.		
Management measures		
Production management programme		
Soil Health • Green manure: An appropriate green manure crop should be planted after plough-out. The field should be out of cane production for at least six months.		
Crop nutrition • Soil and leaf samples are taken and sent to SASRI Fertiliser Advisory Service (FAS) to determine silicon levels and correct N levels. • Develop recommendations for organic fertilizer use. • Nutrition. The SASRI FAS recommendations should be used regarding rates for N application. Where *E. saccharina* is a problem, the applied N should be reduced by between 20-30 kg N/ha. Leaf samples should be collected and sent to SASRI FAS for analysis to determine N and Si levels. Use should be made of the N:Si ratio on the leaf analysis sheet to determine the likely risk of *E. saccharina* infestation. If Si levels are low apply the required amount of Si as determined by FAS. The application of organics should be very carefully monitored and application rates should not exceed FAS recommendations.		

Variety Selection and Management
• A seedcane nursery has been developed on the farm.
• Only clean seedcane is used.
• *E. saccharina* susceptible varieties are not planted if this pest is present.
• Frost trial:
  o Continue with the frost trial introduced through SASRI Agronomy. Identification of frost tolerant varieties.
  o Better management of frost prone areas.
• Varieties resistant to *E. saccharina* should be planted especially in problem areas and near natural host plants. Susceptible varieties should not be planted on farms with *E. saccharina* and intermediate varieties should be carefully selected and placed away from trouble spots. The following table gives a breakdown of the gazetted varieties for the Midlands North region and their susceptibility rating.		

Gazetted varieties and their rating for **Eldana saccharina** *resistance in the Midlands North region*

Resistance category	Gazetted variety	*Degazetted variety*
Resistant	N21, N39, N42	
Intermediate-resistant	N12, N25, N41, N47	*N17, N29 (rust)*
Intermediate	N23, N31, N37, N40, N44, N45, N46, N48	*N24*
Intermediate-susceptible	N36, N43	*N22*
Susceptible	N16, N27, N35	
Highly susceptible	N26	*N11, N30*

Seedcane Scheme

- Assist the P&D manager drive a seedcane initiative, which should lead to the establishment of a formal seedcane scheme.
- Produce variety recommendations for the MNR P&D area, based on soil types.
- Eighty percent of the annual replant area planted to the most appropriate varieties in respect of soils and growing conditions as well as timing of harvest and response to ripeners. This will be done by promoting the local seedcane schemes in each Ecozone, by visiting all growers to discuss the characteristics of gazetted varieties, and by recording their seedcane orders.
- Variety and Seedcane field days will be held.
- Ensure that certified nurseries conform to the required standards. To this end promote Best Management Practices (BMP) such as green manure crops as well as the value of a fallow period through visits to growers.

Crop Hygiene

- Field hygiene is practiced if *E. saccharina* is present.
- Fields repeatedly infested or with 5e/100 *E. saccharina* are replanted.
- Loading zones are kept clean.
- Where possible pre-trashing is practised.
- Clean seedcane:
  Clean, *E. saccharina* free seedcane must be selected, preferably off the farm initially. The seedcane must be 'hot water' treated for 30 mins at 50ºC and dipped as setts in a phoxim solution of 2 ml/L water for 15 mins prior to planting. A seedcane nursery should be developed on the farm to ensure a good supply of clean seed. No seedcane should be taken from fields within a 500 m radius of fields found with *E. saccharina.*
- Field hygiene:
  Stalk residues and stubble in the field should be removed after harvest if the previous crop was heavily infested with *E. saccharina.* Leave and scatter the burnt tops in the field as *E. saccharina* is a lower stalk borer in South Africa and does not infest tops.
- Replanting:
  Fields that have been repeatedly infested with *E. saccharina* three times and more should be replanted, especially in the case of fields with high infestation levels. Fields with infestation levels of 5 e/100 stalks and more should be ploughed out.
- Loading zones:
  Loading zones should be kept clean and free of cane stalks. Avoid dumping cane from *E. saccharina* infested fields onto loading zones in *E. saccharina* free areas.
- Pre-trashing:
  Where possible, pre-trashing should be carried out especially during August to October, and in the older fields.
- The frequency of the P&D surveys may not be sufficient, so it is important that growers carry out frequent small surveys. Existing fields should be rated for *E. saccharina* hazard. Fields with a high score have a higher *E. saccharina* hazard

rating and should be monitored closely. This information should be passed on to the P&D officer.		
Environmental Management Plan		
• Biological control: Wetland sedges such as *Cyperus dives* and *C. papyrus,* as well as Napier fodder and wild sorghum attract *E. saccharina* moths away from cane, whilst *Melinis minutiflora* discourages *E. saccharina* infestation. This type of vegetation should be encouraged in and around sugarcane fields, especially on contour banks, breaks and wetlands. Where possible encourage predators such as earwigs, spiders and ants by trashing cane instead of burning. • Natural hosts: Natural hosts such as sedges should not be removed from rivers, streams and wetlands. Sugarcane should not be planted too close to the natural hosts; leave a break of at least 10 meters between the cane and the natural hosts.		
<u>Chemical control</u> • Insecticides: The use of the insecticide alpha-cypermethrin would be considered as a last resort and requires very careful consideration. Only the registered method of application should be used. Selected carry-over fields with susceptible varieties on poor soils should be targeted with a maximum of 5 e/100 stalks or a maximum of 2.5% stalk length red.		
Regulations		
• Carry-over cane: Mature cane should not be carried over at all in an *E. saccharina* affected area. All cane that will be 22 months and more in November should be milled in *E. saccharina* affected areas. In non-affected areas it is important to ensure that all mature cane is harvested before the close of the season. • Age at harvest: All *E. saccharina* prone fields should be harvested at a younger age. The more susceptible the variety the younger it should be cut. Susceptible varieties should be cut at 12 months of age, intermediate at 16-18 months and resistant at 18-22 months.		
All operations listed in the management strategy above, apart from the application of insecticides, should be completed; there are no options or exceptions.		