# Chapter 3

# Exploring the feasibility of push-pull for use in management of *Eldana saccharina* by small-scale sugarcane growers

## 3.1 Introduction

The push-pull strategy is recommended by the South African Sugarcane Research Institute (SASRI) as part of an Integrated Pest Management (IPM) approach to managing *Eldana saccharina* Walker (Lepidoptera: Pyralidae) (Conlong and Rutherford, 2009; Rutherford and Conlong, 2010). Push-pull is an ecologically-based method of manipulating a pest using attractant and repellent plants to reduce pest damage to crops (Cook *et al.*, 2007) and is currently being implemented in the Midlands North region of KwaZulu-Natal, South Africa (Webster *et al.*, 2005; Webster *et al.*, 2009). Most of this work has however been focused on large-scale sugarcane growers (LSGs). Until now, there has been no explicit attempt at encouraging the implementation of push-pull or IPM for SSGs (Conlong, pers. comm., 2012).

*Eldana saccharina* pest numbers and damage levels are generally lower in small-scale growers' (SSGs) sugarcane fields than on large-scale growers' (LSGs) farms (Way *et al.*, 2003; Goebel *et al.*, 2005). This has been attributed to a number of factors, including smaller field size, younger harvesting age and a higher biodiversity and varied vegetational mosaic in SSG areas (Draper and Conlong, 2000; Westmacott, 2002; Goebel *et al.*, 2005).

In 2011, there were 29 130 registered sugarcane growers in the South African sugar industry. Of these, 27 580 were small-scale growers and in the last milling season 13 871 SSGs delivered sugarcane for milling and contributed 8.6% of the total crop crushed (SASA, 2011). The average sugarcane yield of SSGs is markedly lower than that of LSGs and this has been ascribed to multiple reasons which are discussed by Eweg (2005a), Mahlangu and Lewis (2008), Armitage *et al.* (2009) and Sibiya and Hurly (2011). Of immediate importance to this study is the reason that due primarily to financial and institutional constraints, SSGs are unable, or unwilling, to adopt best management practices (BMPs) to improve their sugarcane farming systems (Eweg, 2005b; Mahlangu and Lewis, 2008). This is despite efforts at setting up an effective extension support network in the South African sugar industry (Owens and Eweg, 2003; Parsons, 2003).

On a global scale, successful implementation of IPM has not been as common as had been hoped (Kogan, 1998; Peshin and Dhawan, 2009) and the same has been found for ecologically-based, knowledge intensive pest management strategies such as push-pull (Cook *et al.*, 2007) and habitat management (Gurr *et al.*, 2004a). Implementation of IPM in sub-Saharan Africa has seen even less success (van Huis and Meerman, 1997; Orr, 2003), and some authors question the suitability of IPM for resource-poor farmers on the continent (Orr, 2003). Could this be a case of putting the horse before the cart: is IPM suited to farmers' conditions and constraints in sub-Saharan Africa? According to Van Huis (2009) this "shows the paradigm problem in which the constraints of the farmer are not taken as a starting point but as a constraint", and it emphasises the importance of understanding farmers' needs and constraints prior to implementing BMPs such as IPM. The importance of understanding farmers' needs in extension has also been recognised within the South African context (Düvel, 2002).

Where IPM implementation has been successful, it has been based on a 'farmer first' approach in which farmers are involved directly in the implementation of IPM and researchers and extension workers have made an effort to gain an understanding of the socio-economic context of farmers and their wider farming systems (Röling and van de Fliert, 1994; Peshin and Dhawan, 2009). Matteson (2000) described the problems of the top-down, hierarchical technology transfer extension paradigm which failed to implement IPM in Asia, and then highlighted the successes of farmer field schools (FFS) in implementing IPM.

The successful implementation of push-pull in maize farming systems in Kenya also stands out as a successful example of adoption of an ecologically-based, knowledge intensive pest management strategy by farmers (Khan *et al.*, 2011). In Kenya, push-pull was implemented using a 'farmer first' approach to extension, including training of farmer teachers and facilitation of FFS (Amudavi *et al.*, 2009b; Murage *et al.*, 2011a).

Taking into consideration the situation of poor BMP adoption by SSGs in South Africa (Eweg, 2005a; Mahlangu and Lewis, 2008; Van den Berg, 2012)and difficulties with implementation of IPM in sub-Saharan Africa, implementation of push-pull as part of an IPM approach for the control of *E.*

*saccharina* in this situation is considered not to be an easy task. The aim of this study was thus to explore the feasibility of implementing push-pull for control of this pest of sugarcane in the SSG community of the Midlands North region by addressing the following objectives:

- understand the role which sugarcane plays in the SSGs livelihoods and their farming systems
- determine the main sugarcane production constraints faced by SSGs
- gauge SSGs' knowledge and perceptions of sugarcane pests and their pest management practices.

This exploratory study will be valuable not only to facilitate the implementation of push-pull for control of *E. saccharina* among SSGs, but also to add to the current understanding of the SSGs' farming systems and needs, which is very limited (Eweg *et al.*, 2009). Based on the outcomes of this study, recommendations will be made on how best to implement push-pull with SSG's in the Midlands North region.

## 3.2 Research design and methods

### *3.2.1 Research setting*

This research was conducted in the Midlands North sugarcane growing region in KwaZulu-Natal, South Africa. SSGs in this region supply sugarcane to the Illovo Sugar (South Africa) Limited mill at Noodsberg (29°21'38.83"S, 30°41'13.37"E) in KwaZulu-Natal, South Africa (Figure 3.1) (SASA, 2011). In the 2010/2011 season, 240 small-scale growers delivered approximately 24 000 tonnes of sugarcane to the Noodsberg mill. From these data it was extrapolated that average yields for the last season were 68 tonnes per hectare per grower (Fanie Horn, pers. comm., 2012).

Multiple stakeholders are involved in the development of SSGs in the Midlands North region (Gillespie *et al.*, 2012). These are represented by the Noodsberg Research, Development & Extension Committee and are listed in Table 3.1. Good co-operation between these numerous stakeholders, and the good track record of SSG sugarcane deliveries in the recent past (Gillespie and Mitchell, 2006; Gillespie *et al.*, 2009b; Gillespie *et al.*, 2012), is one of the main reasons why this region was selected for the implementation of push-pull.

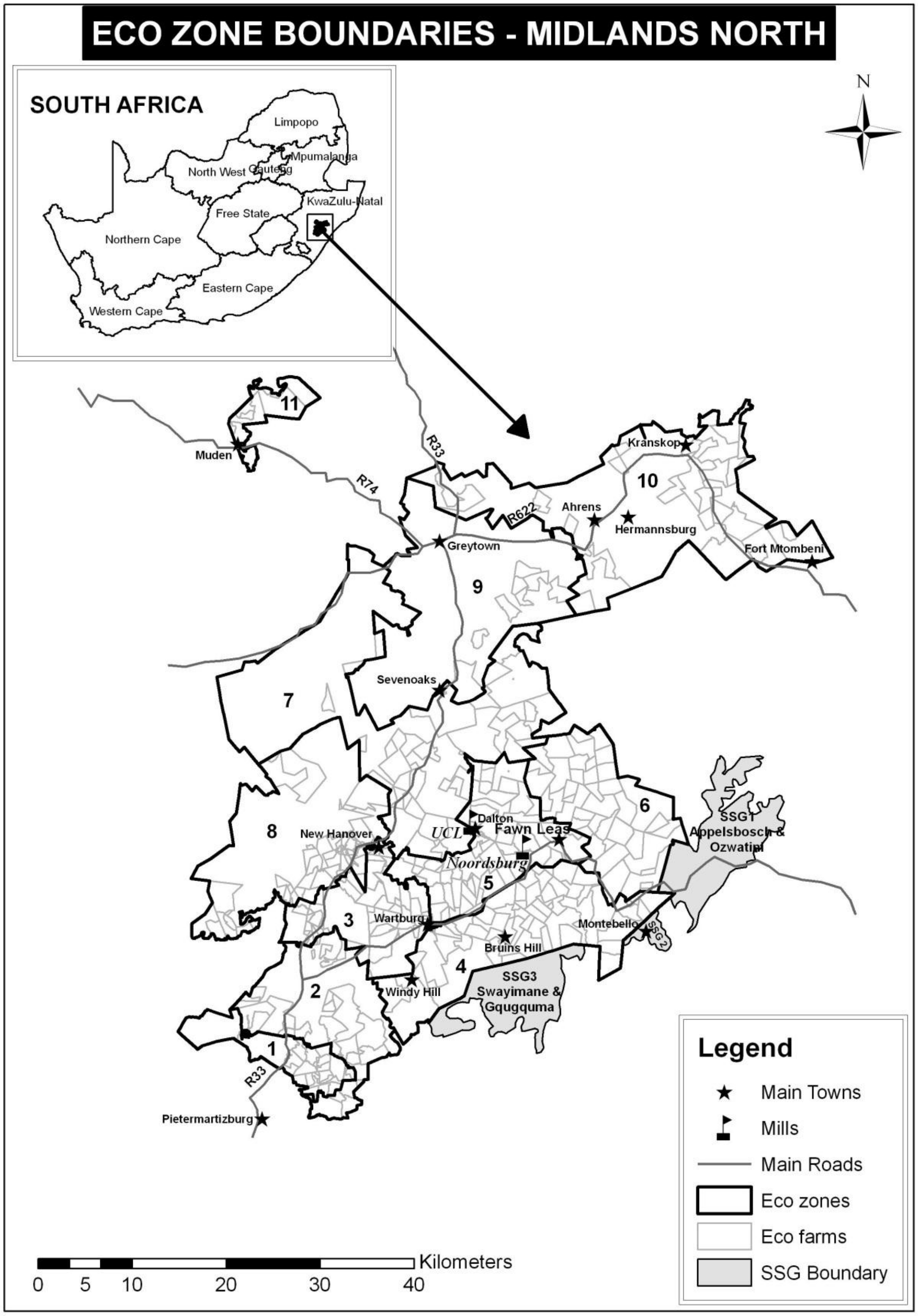



**Figure 3.1** Map of the Midlands North sugarcane farming region. The three small-scale grower sub-regions are shaded grey.

**Table 3.1** Stakeholders involved in the development of small-scale growers in the Midlands North region and which are represented by the Noodsberg Research, Development & Extension Committee.

| **Stakeholder** | **Role** |
|---|---|
| CANEGROWERS | Representing farmers in the sugar industry, training and development. |
| Illovo Sugar (South Africa) Limited | Noodsberg mill: Assist with the development of SSGs in conjunction with the stakeholders to ensure sustainable sugarcane supply by accessing government funding for development. |
| KwaZulu-Natal Department of Agriculture and Environmental Affairs (Provincial Government) (DAEA) | Extension support services and grant funding for establishment of sugarcane. |
| Midlands North Local Pest, Disease & Variety Control Committee (LPD&VCC) | Providing pest & disease monitoring services to farmers and providing extension support related to pest & disease management. |
| Mill Group Board (MGB) | Committee representing SSGs (drawn from local grower groups) at the mill and liaising with contractors for harvesting and haulage activities. |
| Noodsberg Canegrowers Association (NCGA) | Association of large-scale sugarcane growers supplying sugarcane to the Illovo mill: involved in mentoring and development of SSGs. |
| Project Khula | SSG development project supported by WWF and The Coca-Cola Company to promote implementation of BMPs by SSGs and to improve mentorship. |
| South African Sugarcane Research Institute (SASRI) | Research & extension services. |
| Ingomankulu Trust (represented by local chiefs) | Tribal authority responsible for land in the SSG areas. The *Inkosi* (chiefs) and *Induna* (headmen) are responsible for liaison between members of the community and stakeholders involved in sugarcane development activities. |

In this study we purposefully chose to work with SSGs that deliver sugarcane to the mill and who are involved in local grower groups and extension activities. These are likely to be the economically least vulnerable members of these communities. Chambers (2008) noted that vulnerable and marginalised members of communities, such as the poorest and women, are often not addressed in development projects because of different biases. We recognise this, but in our study we purposefully decided to work with the active SSGs as they are likely to be in a position to accept and implement a new pest management technology such as push-pull. We did however make a concerted effort to ensure that women were represented in our sample as it is well-recognised that women play and important role in small-scale sugarcane agriculture in South Africa (Eweg *et al.*, 2009; Thomson, 2010) and that extension services and development of agricultural technology has not always been suitable for women (Hart and Aliber, 2010).

From an agro-ecological perspective, the Midlands North region was identified as a suitable area to begin implementing push-pull for management of *E. saccharina,* since this pest has only recently become a threat to sugarcane production in this region. The range of *E. saccharina* is currently expanding inland (Assefa *et al.*, 2009), and the Midlands North region is suitable to put preventative measures in place against the spread of the pest (Webster *et al.,* 2005; 2009).

### *3.2.2 Entrée and establishing researcher roles*

The main researcher in this study was introduced to the SSGs and stakeholders through attendance at meetings and field days, including the Noodsberg Research, Development & Extension Committee, Mill Group Board meetings and field days for growers hosted by SASRI and the DAEA (Gillespie *et al.*, 2012). The research project was explained by the DAEA extension officer at these meetings. During the individual survey interviews, the researchers identified participants for the survey by going from house-to-house through the community and asking SSGs to introduce the researchers to their neighbours. Through our involvement at field days and these house visits, we feel we gained a good understanding of the SSGs and felt accepted in the community. As one SSG from Ekupholeni commented:

"*You're here again! You're here every day. We should build you a house in our community*."

We took this as a positive sign as we felt that participants were becoming familiar with our presence and would thus engage with us more freely.

### *3.2.3 Sampling*

The research activities were divided into three phases. Participants were from a number of communities in the three SSG sub-regions of the Midlands North region indicated in Figure 3.1. As described in 3.2.1 above, we chose to work with the growers actively delivering sugarcane to the mill and involved in extension activities. These were primarily from the Swayimane area (SSG 3,

Figure 3.1). According to data from the Noodsberg mill, the average number of SSGs delivering sugarcane since 2008 is 232 per annum (Fanie Horn, pers. comm., 2012). The sample numbers for each of the research phases are shown in Table 3.2.

### 3.2.4 Data collection methods

A mixed methods approach was used for data collection. A combination of quantitative, qualitative and participatory approaches to sampling was employed (Mayoux and Chambers, 2005; Creswell, 2009). This approach is well suited to the world view which underpins this particular study, namely pragmatism with some elements of constructivism (Creswell, 2009). Identifying the researcher's world view is recognised as an important aspect in the preparation of a research design in the social sciences (Creswell, 2009; Babbie, 2010).

**Table 3.2** Sample numbers of small-scale grower participants for each phase of research activities (percentages in brackets indicate what proportion of small-scale growers actively delivering cane the sample number represents)

| Research Phase | Activities | Sample numbers |
|---|---|---|
| Phase 1 | **House visits**: Individual survey interviews, participatory sketch mapping and scoring matrix | 35 individuals (15%). (from 9 different communities) |
| Phase 2 | **Reunion Island students' survey**: individual survey interviews carried out by students from Reunion Island | 72 individuals (31%). (from 5 different communities) |
| Phase 3 | **Group meetings**: Focus group discussions (FGDs) and free-listing activities about insects and pest management | 46 Individuals in total (20%). Groups from four different communities of varying numbers of participants: 10, 17, 8, 11. |

In mixed methods research both quantitative and qualitative data are collected, analysed and combined in a single study (Creswell, 2009). Mixed method research provides a better understanding of research problems compared to quantitative or qualitative research methods on their own (Creswell, 2009). Sinzogan *et al.* (2004) conducted a similar study with cotton farmers in Benin and their methodology, which used participatory and mixed methods approaches, provided a useful guideline for this study. The three research phases used for data collection are described in Table 3.2, and the data collection activities, methods and tools in relation to the study objectives are indicated in Table 3.3. All data collection activities were conducted in isiZulu, which is the home language of the SSGs in the study area.

### 3.2.4.1 Data collection Phase 1: House visits

The first phase of the study involved household visits and individual interviews with SSGs. There were three activities during the house visits: participatory sketch mapping, interview questions and participatory matrix scoring. Guidelines for how to run the participatory sketch map and scoring matrix activities were taken from Pretty *et al.* (1995) and Chambers (2002).

**Table 3.3** Survey objectives, data collection activities and methods and tools used for the study.

| **Objectives** | **Activities, methods & tools** | **Information collected** |
|---|---|---|
| Understand the role of sugarcane in livelihoods and farming systems | Individual survey interviews | Reasons for farming cane, income from cane, other income, livelihood challenges and resources, crops which they grow, most important crops. |
| | Participatory sketch maps | Crops which the household grows (sugarcane & other), other agricultural enterprises, most important crops, layout of fields, size of sugarcane fields. |
| | Participatory matrix scoring activity | Most important crops/agricultural enterprises, inputs (costs: money, labour, time) and outputs (incomes: food and income) from top five agricultural enterprises (including sugarcane). |
| Determine the main sugarcane production constraints | Individual survey interviews | Biggest problems with sugarcane production (constraints). |
| | Observations/field notes | Condition of sugarcane crop and fields, overall impressions about the SSGs' sugarcane husbandry and production constraints. |
| Gauge knowledge and perceptions of sugarcane pests and pest management practices | Focus group discussions using the 'insect box'<br><br>Free listing | SSGs' knowledge of insects, sugarcane pests, food crop pests and beneficial insects. SSGs' perceptions about worst insect pests. SSGs' approaches to insect pest management: in sugarcane and food crops. |
| | Individual survey interviews: Reunion Island students' survey | SSGs' knowledge of sugarcane pests and pest management, knowledge and management of diseases and weeds (for comparison). |

Upon arrival at the SSGs' homes, the study was explained to the participants, and they were asked whether they were prepared to participate, and the privacy of their information was guaranteed.

They were asked to start by drawing a map of their farming activities (Fig. 3.2). This was a good way of putting the participant in a position in which they taught the researchers about their farm, rather than passively learning from the outsiders, as is often occurs in rural development (Chambers, 2008). The map allowed a focus for discussion and for questions to be asked about the various agricultural enterprises which the participant was engaged in, including crops and livestock (Figure 3.2 A). The sketch map activity was followed by a semi-structured interview in which further information was collected by asking both open- and closed-ended questions (See Table 3.3 for details). The final activity during the household visits was the participatory matrix scoring. During this activity, the researchers drew a matrix onto a flipchart. The top row of the matrix indicated outputs and inputs of agricultural enterprises (outputs: income, food, inputs: costs, labour, time) and


**Figure 3.2 A:** A small-scale grower from Ekupholeni drawing a sketch map of his household and agricultural activities. **B:** A small-scale grower from Chibini using the scoring matrix to illustrate inputs and outputs of her top five agricultural activities.

in the first column of the matrix the SSG's top five agricultural enterprises were listed. The participants were given a box of 220 matches. They then divided all the matches into the cells across the matrix, indicating their most important crops and livestock and how much each farming enterprise cost them (inputs) and how much food or income it earned them (outputs)(Figure 3.2 B).

For example, a SSG would place a large number of matches in the matrix cell for sugarcane income to indicate that sugarcane made a large contribution to household income. Conversely, to indicate that sugarcane contributed little to household income, he or she would place fewer matches in that cell. Allocating a 'restricted overall score' by allowing a fixed maximum score (in our case 220 matches) in a matrix, allows for more rigorous statistical analysis than allowing participants to choose the scores themselves (Maxwell and Bart, 1995). Using scoring rather than simply ranking of items within a matrix also ensures a more accurate analysis can be made since the 'distance' between ranks is better measured when using restricted overall scoring (Maxwell and Bart, 1995; Abeyasekera, 2001).

The mapping and matrix activities were recorded using photographs. Participants were asked whether they were prepared to have their photographs taken and the purpose of the photographs was explained to them. Field observations and notes about each participant were recorded after the house visits were completed. These notes were captured according to the following topics: general impressions of the SSG and the household, impressions about what sugarcane means to the SSGs and the household and impressions about constraints to cane production, including observations of field conditions. The observations were used as a qualitative validation of the quantitative data collected during the interview and of the findings of the mapping and matrix activities (Creswell, 2009).

### 3.2.4.2 Data collection Phase 2: Reunion Island students' survey

The second research phase was carried out in collaboration with students and teachers from LEGTA St Paul Agricultural College in Reunion Island. A group of students from the college visits the Midlands North small-scale growers annually to carry out agronomic knowledge surveys and to exchange experiences about farming sugarcane. Since both the researchers of our study were involved in facilitating and translating the surveys for the student group, it was agreed that the resulting data would be shared. For this survey, SSGs were asked to gather at a central point where each one was interviewed individually about their sugarcane farming practices and agronomic knowledge. For our study, we only used questions from the crop protection section of the students' survey on pests, diseases and weeds. This survey was a quantitative method (Babbie, 2010). Participants were asked specific questions about their crop protection knowledge and practices and the students scored the participants' answers in a range from zero to two: 0 = no knowledge, 1 = some knowledge, 2 = good knowledge, which is similar to the method used by Midega *et al.* (2012) (See Appendix D for the questionnaire). For our purposes, we used the scores (quantitative data) together with notes made on survey sheets (qualitative data) as a form of validation, since the scoring system may have been interpreted slightly differently by each student and could include some bias or subjectivity. The notes which students made on the data sheets were mostly a record of the SSGs' verbatim answers which each student then interpreted and scored. The notes were written on the survey sheets in French, and a translator was employed to translate these into English.

#### 3.2.4.3 Data collection Phase 3: Group meetings

The third research phase involved group meetings including focus group discussions (FGDs) and free-listing activities with small groups of SSGs, ranging in size from eight to 17 SSGs. FGDs are recommended by Peshin *et al.* (2009a) and Litsinger *et al.* (2009) as a means of gathering data on farmers' knowledge and perceptions of pests and their pest management activities. For example, Midega *et al.* (2012) and Sinzogan *et al.* (2004) used FGDs to gather farmers' perceptions and knowledge of cotton pests and pest management. Guidelines for FGDs were taken from Kruger (1998), Morales and Perfecto (2000) and Creswell (2009). The free-listing activities were facilitated according to recommendations from Björnsen Gurung (2003), Quinlan (2005) and Fagbemissi and Price (2008). Free-listing is based on an ethno-biological methodology used in anthropology to quantify people's knowledge within a certain domain (Quinlan, 2005).

Depending on the size of the group, each group was further divided, by gender, into sub-groups. In a pilot survey it was found that men dominated discussions in mixed gender groups and hence it was decided to group people according to gender to ensure better participation by women. These FGDs were repeated four times in different communities. The FGDs were facilitated by the local extension officer from the DAEA together with the researchers from the study. The FGDs were used to answer the following questions:

- Which sugarcane pests do the SSGs know?
- Which food crop pests do they know? (to use for comparison to sugarcane pests)
- Which do they consider to be the worst sugarcane pest/s?
- Do they know about beneficial insects (i.e. do they have any understanding of insect biological control?)
- What do they do to control insect pests: in sugarcane and food crops (for comparison)?

The FGDs were divided into three activities:

1. Free-listing of insects observed in sugarcane, known sugarcane pests and pests of other crops. The respondents were divided into smaller groups and instructed to compile written lists of insects according to the following categories:

- insects which they have seen in sugarcane
- insects which they know are pests of sugarcane
- pest insects which they have seen in their food crops.

2. Identification and naming of insects in the insect box (dried pinned insect specimens) and on photographs (See Appendix E for the insect box and photographs). This activity helped to facilitate discussion about insects and insect pests. Both object (specimens) and graphic (photographs) media were used to ensure that SSGs could identify the insects (Mkize, 2003).

3. Discussion about free-listed insects, specimens in the insect box and on photographs including additional questions for clarification.

The FGDs were recorded for purposes of analysis and data checking. The researchers involved also had a debriefing session after each FGD to discuss pertinent themes and outcomes. This was incorporated into the qualitative analysis.

## *3.2.5 Data analyses*

### 3.2.5.1 Analysis of survey and interview data

Descriptive statistics, such as frequency distributions and percentages, were used to analyse and report responses to questions in individual interviews during house visits and also the students' survey (Fink, 2009). Content analysis was completed on open-ended questions during the individual SSG interviews to identify recurrent themes which could be quantified to determine SSGs' perceptions (Creswell, 2009; Fink, 2009). The answers to these questions were categorised into topics which were divided into further categories. For quantification and analysis, the frequency of mention of each category within a topic was recorded. The topics and categories identified during the interviews are shown along with the results in the pie charts (Figures 3.3, 3.4, 3.5 and 3.9).

### 3.2.5.2 Interpretation of sketch maps

Sketch maps were interpreted subjectively by identifying patterns in the relative size of sugarcane fields compared to other crop fields and as a qualitative data source to complement findings of the other data sources.

### 3.2.5.3 Analysis of scoring matrix data

For analysis of the scoring matrix activity, the total number of matches per cell was counted and captured in a spreadsheet. Since the data were found to be non-parametric, the median number of matches per cell was calculated for each variable to be analysed. The median was used to determine how much sugarcane and other agricultural enterprises contribute to household outputs and inputs. The median scores, i.e. median number of matches, for each variable were represented using box and whisker plots and were analysed using a Wilcoxon signed ranks test to determine whether there was a statistically significant difference between the various variables (Admassu *et al.*, 2004).

The top five agricultural enterprises listed during the matrix scoring activity were analysed using free-listing and the frequency of mention, and a salience index (SI) was calculated for each crop which was included by any SSG in the list (Björnsen Gurung, 2003; Quinlan, 2005). The method for analyzing the free-list activities is described in 3.2.5.5 below.

### 3.2.5.4 Analysis of focus group discussion data

A classical content analysis was used for a qualitative analysis of the focus FGD data (Krueger, 1998; Creswell, 2009; Onwuegbuzie *et al.*, 2009). Onwuegbuzie *et al.* (2009) recommend using a mixed methods content analysis in which the frequency of each code or topic (quantitative information) is supplemented using a rich description of the code (qualitative). A detailed procedure for the content analysis within a mixed methods approach is described by Creswell (2009) and this was used for analyzing these data. A tape-based method was used for the analysis by means of abridged transcripts of the FGDs (Krueger, 1998). The topics and categories within each topic used for the content analysis are shown along with the results in Table 3.6, and the rich description follows the table as a narrative text.

### 3.2.5.5 Analysis of free-listing activities

The free-listing data were analysed according to guidelines from Björnsen Gurung (2003) and Quinlan (2005). The importance of insects listed during the listing activity can be inferred from the frequency of mention across all respondents and also by calculating a free-list salience index (SI). The salience index is a product of the frequency of the insect across all lists, and its average rank across all lists, which is given as a percentile rank (Smith, 1993). The percentage frequency and the average percentile rank are multiplied to give an SI, which can be calculated for all insects mentioned in all lists (Smith, 1993).

## 3.3 Results

### 3.3.1 Role of sugarcane in livelihoods and farming systems

#### 3.3.1.1 Results from interviews

SSGs responses during interviews, drawings of their farming systems in sketch maps and the results of the participatory matrix scoring activity all show that sugarcane plays an important role in the farming system and livelihoods of these households. Farming in general, as well as farming of sugarcane specifically, are seen as a major livelihood resource by the SSGs (note that sugarcane has been abbreviated to ‘cane’ in figures and tables) (Figure 3.3). When SSGs were asked what their main source of income was, almost half of them (46%) stated sugarcane (Figure 3.4). Employment or other business activities are second to sugarcane as a source of income in these communities. When SSGs were asked what they mainly used the income from sugarcane for, most of them indicated food (42%) and education (26%) (Figure 3.5).

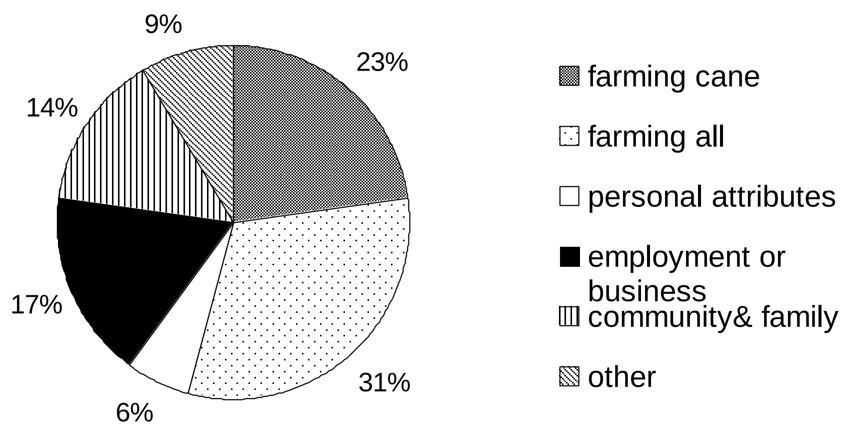



**Figure 3.3.** Small-scale growers’ responses to the question “What allows you and your family to live in this area?” (N = 35).

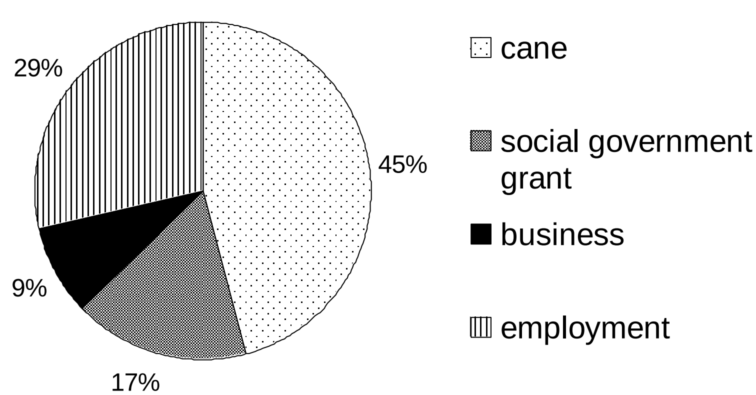



**Figure 3.4.** Small-scale growers’ main source of income, as stated in interviews (N = 35).

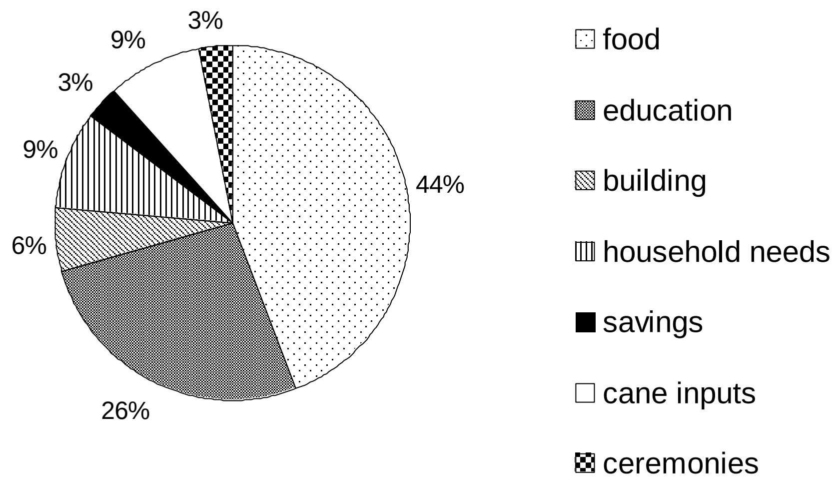



**Figure 3.5** Small-scale growers' main uses for income from sugarcane, as stated in interviews (N = 35).

Verbatim quotes collected during house visits, a form of qualitative data, support the quantitative data in Figures 3.3, 3.4 and 3.5 and indicate the important role which sugarcane plays in the SSGs' livelihoods, as a source of employment and income;

> *"This is my work. I don't need to go to work for a company far away, because sugarcane is my job."* A SSG from Ekupholeni village, Swayimane
>
> *"I don't need to go to the mines to work like other men. This is gold (pointing at the soil), this is where I can earn a living to support my family. Right here." A SSG* from Chibini village, Ozwathini

and as a means of improving their homes and their lifestyles:

> *"I can't do anything big with my pension money. But with the sugarcane money I can. I can buy a cupboard if I want to. Sugarcane is the king of money."* A SSG from Ekupholeni village, Swayimane
>
> *"My neighbours used to call me a fool for growing sugarcane.*
> *But now they see: I got married, I've built a house and I've got running water in my house to wash when I get home in the evenings."* A SSG from Enkululeko village, Swayimane

#### 3.3.1.2 Results from sketch maps

Four sketch maps (Figure 3.6) were specifically selected from the entire sample as visual illustrations of how sugarcane integrates into the farming system. The areas shaded in grey represent sugarcane fields. The sketch maps indicate that most SSGs committed a fairly large portion of their farming land to sugarcane, however this varies between SSGs: in these examples the size of sugarcane fields drawn on the maps is equal to or larger than any other crop fields. In all but one case (D), SSGs have more than one field of sugarcane. The maps also indicate that these SSGs are engaged in multiple agricultural enterprises, including various food crops, livestock, fruit trees and timber.

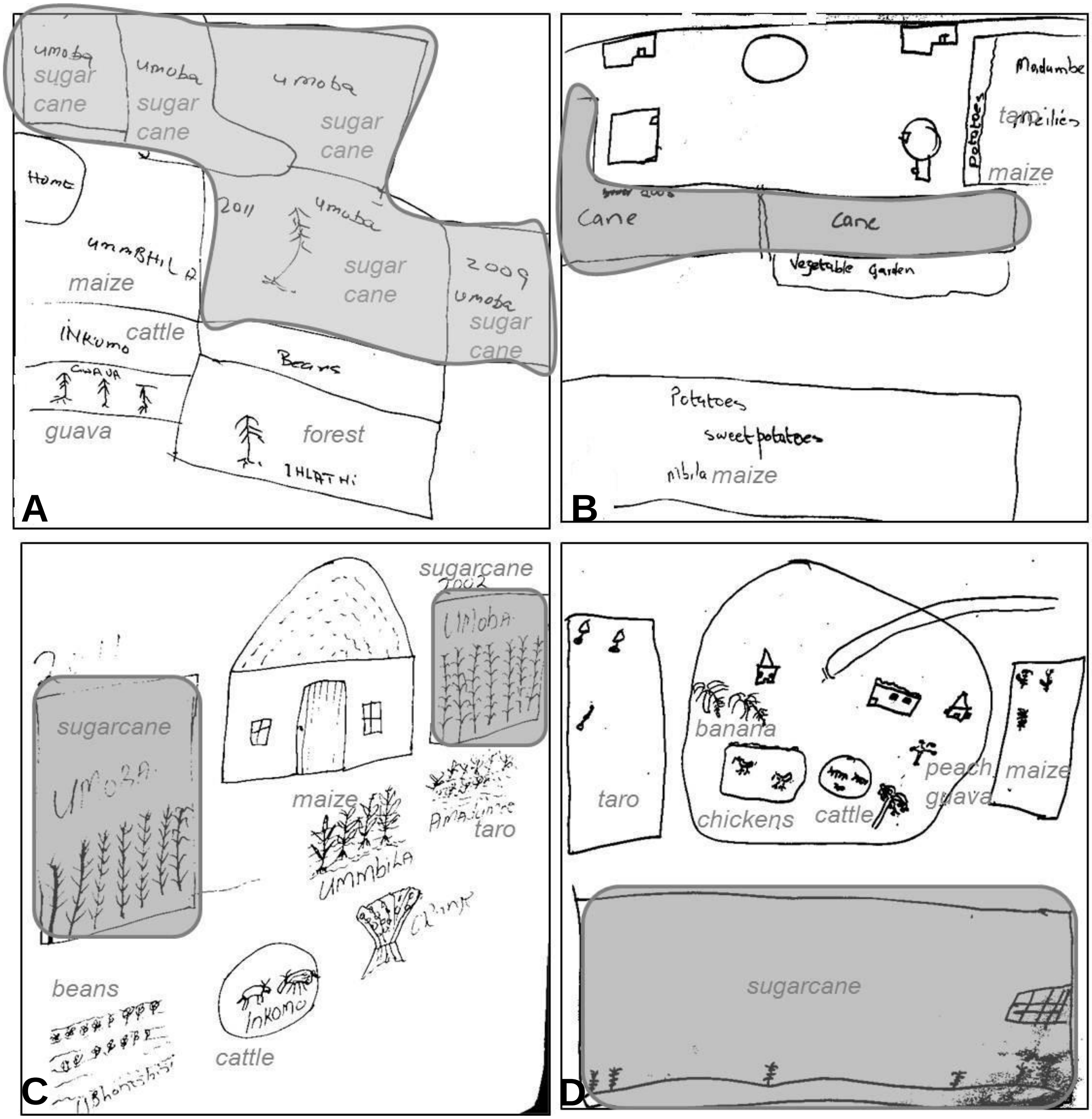



**Figure 3.6** Sketch maps drawn by four different small-scale growers' to illustrate their farming systems (typed labels in English added afterwards).

### 3.3.1.3 Results from participatory matrix scoring activity

Analysis of the participatory matrix scoring confirms the important role which sugarcane plays as a form of income to these households.

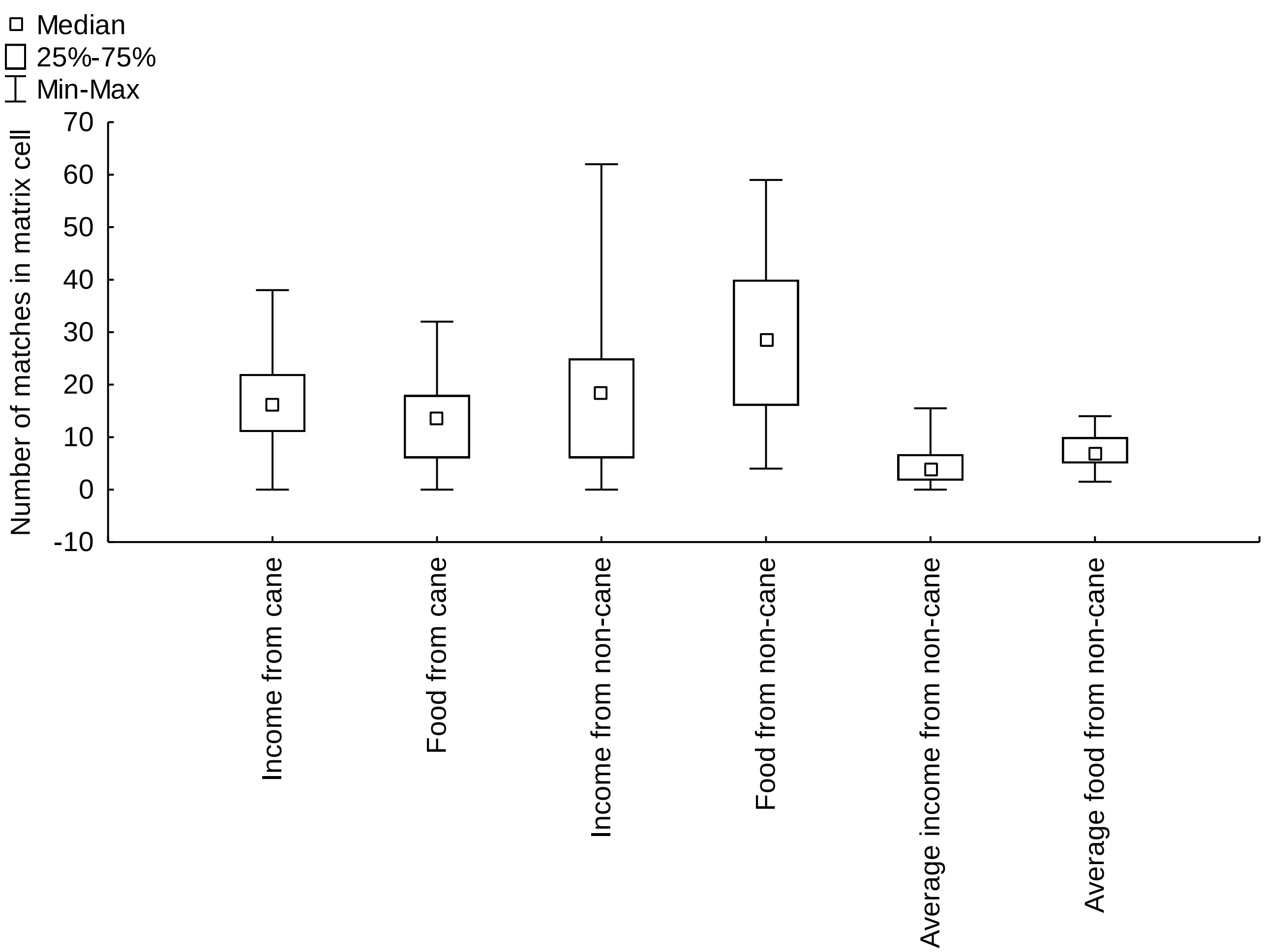



**Figure 3.7.** Box and whisker plot showing median, range and minimum and maximum values (= number of matches) for key variables extracted from the participatory matrix scoring activity (N = 35).

The variables used for this analysis were income from sugarcane, food from sugarcane, income from non-sugarcane agricultural enterprises (total), food from non-sugarcane agricultural enterprises (total), average income from non-sugarcane agricultural enterprises and average food from non-sugarcane enterprises (Figure 3.7 and Table 3.4). The results of the Wilcoxon signed ranks test carried out on these variables (Table 3.4), indicate that the income from sugarcane, although higher (Figure 3.7), is not significantly more so than the total income from non-sugarcane agricultural enterprises. The income from sugarcane is however significantly larger than the average income per non-sugarcane enterprise. Sugarcane generates more income than any other non-sugarcane enterprise on its own. Similarly, although the total food from non-sugarcane enterprises is significantly more than that brought in by sugarcane, when the food from non-sugarcane enterprises is averaged, then it is significantly less than the food brought in by sugarcane. The matrix scoring analysis furthermore shows the variety of agricultural enterprises which these SSGs are engaged in.

**Table 3.4** Variables from participatory matrix scoring activity subjected to a Wilcoxon signed ranks test.

| **Variables being compared** | **Statistics** | |
|---|---|---|
| | ***Z*-statistic** | ***p*-value** |
| income from cane < total income from non-cane enterprises | 0.536 | 0.592 |
| income from cane > average income per non-cane enterprise | 4.813 | 0.000 |
| food from cane < total food from non-cane enterprises* | 4.342 | 0.000 |
| food from cane > average food per non-cane enterprise* | 3.254 | 0.001 |

*Significant *p*-values at the 5% level

The free-listing analysis of crops showed that sugarcane was indeed the most important crop grown by the SSGs. It was mentioned most frequently of all crops, and was mentioned most often as first in the list of top five crops. It therefore had the highest salience index (SI) of 98.6 out of a possible maximum of 100 (Figure 3.8). The second most important crop was maize, with a SI of 30.4, almost a third of the SI of sugarcane. Taro (*amadumbe*) (SI = 23.4), beans (SI = 21.4), potatoes (SI = 13.1) and sweet potatoes (SI = 6.7) were the other top vegetable crops mentioned (Figure 3.8). The most important livestock listed was cattle which, compared to that of the top food crops and sugarcane, had a very low SI of 1.94.

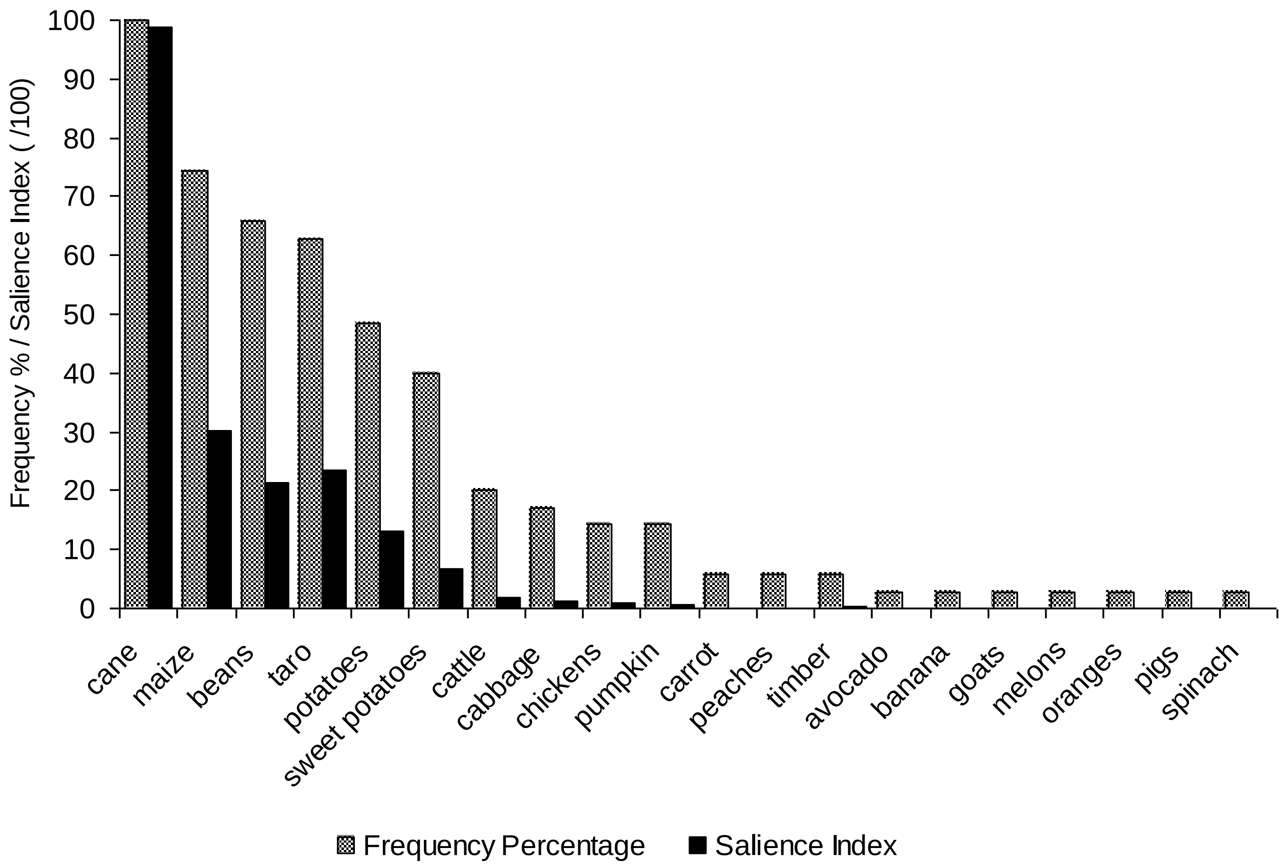



**Figure 3.8.** Frequency of mention (% respondents) and salience index (out of a maximum of 100) of all crops mentioned for the matrix scoring analysis.

### *3.3.2 Sugarcane production constraints*

The most important production constraint mentioned by SSGs were weeds (48%) followed by high input costs (20%) (Figure 3.9). The following quote from a SSG confirms that input costs are a serious constraint for SSGs:

*"Growing sugarcane takes a lot of expenses and the income is not that much. But half a loaf of bread is better than no bread."* A SSG from Gcwensa village, Bhamshela

This was confirmed by field observations, in which it was noted that the majority of SSGs did not control weeds effectively in their sugarcane fields. In most cases they were using herbicides but applying them incorrectly. Weeds were found to be a problem in young sugarcane (recently planted or ratooning/re-growing after harvest) as well as in older, more established sugarcane. During household visits SSGs were often busy with weed control activities (hoeing or application of herbicides) and this provided us with the opportunity to discuss these practices with them. In these informal discussions it was found that the majority of SSGs used Velpar® K3.0 on young sugarcane as the primary herbicide. It was also observed that they applied this herbicide at rates higher than recommended and too late in the growing cycle of weeds and sugarcane. The product was applied indiscriminately on plant and ratoon cane, despite the fact that it is recommended for ratoon cane only and high rates can have damaging effects on sugarcane growth (SASRI, 2010). Their practices for measuring and mixing the herbicide product with water were also not according to recommendations and resulted in over-application of product in most cases.

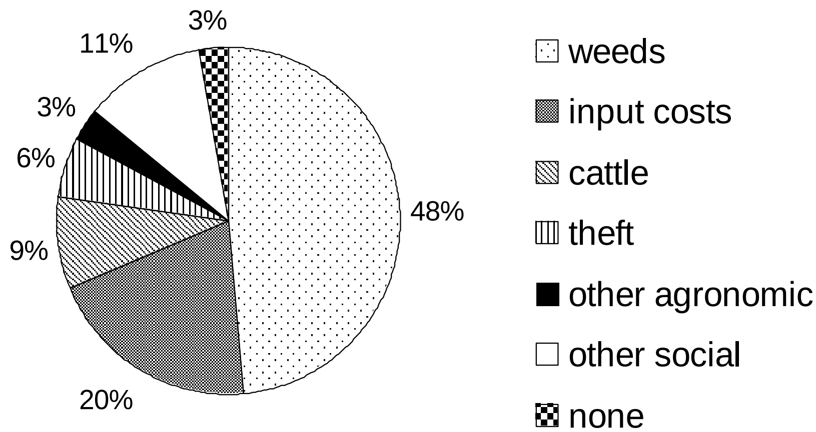



**Figure 3.9.** Main sugarcane production constraints of small-scale growers', as stated in interviews (N = 35).

**Table 3.5** Three different lists of insects generated from free-listing activities.

| Invertebrates which the SSGs have seen in sugarcane | Insects which the SSGs know are pests of sugarcane | Invertebrates which the SSGs have experienced as pests in their food crops |
|---|---|---|
| adult moth or butterfly | stem borer | cutworm |
| adult moth/butterfly (other) | termite | beetle |
| stem borer | beetle grub | termite |
| termite | grasshopper | grasshopper |
| grasshopper | adult moths / butterfly | stem borer |
| beetle grub | bladder locust | aphid |
| hairy caterpillar | hairy caterpillar | caterpillar (looper) |
| hairless caterpillar | hairless caterpillar | brown locust |
| brown locust | beetle | adult moth / butterfly (other) |
| red ant | | ant |
| ant | | millipede |
| bee | | snail |
| snail | | |
| earthworm | | |
| millipede | | |
| cutworm | | |
| beetle | | |

## 3.3.3 Knowledge and perceptions of insect pests and pest management practices

### 3.3.3.1 Results from free-listing activities

The insects listed by SSGs in the three free-listing activities are shown in Table 3.5. SSGs mostly listed invertebrates which are not necessarily pests, as occurring in sugarcane. Some of these invertebrates do however have pest status. Only a few sugarcane pest species were listed and included stem borers, termites, beetle grubs (white grub) and grasshoppers, which are also recognised as pest insects by researchers (Campbell *et al.*, 2009).

The pest insects of sugarcane and food crops listed during free listing activities were further analysed by calculating the frequency of mention and the SI, shown in Figures 3.10 and 3.11.

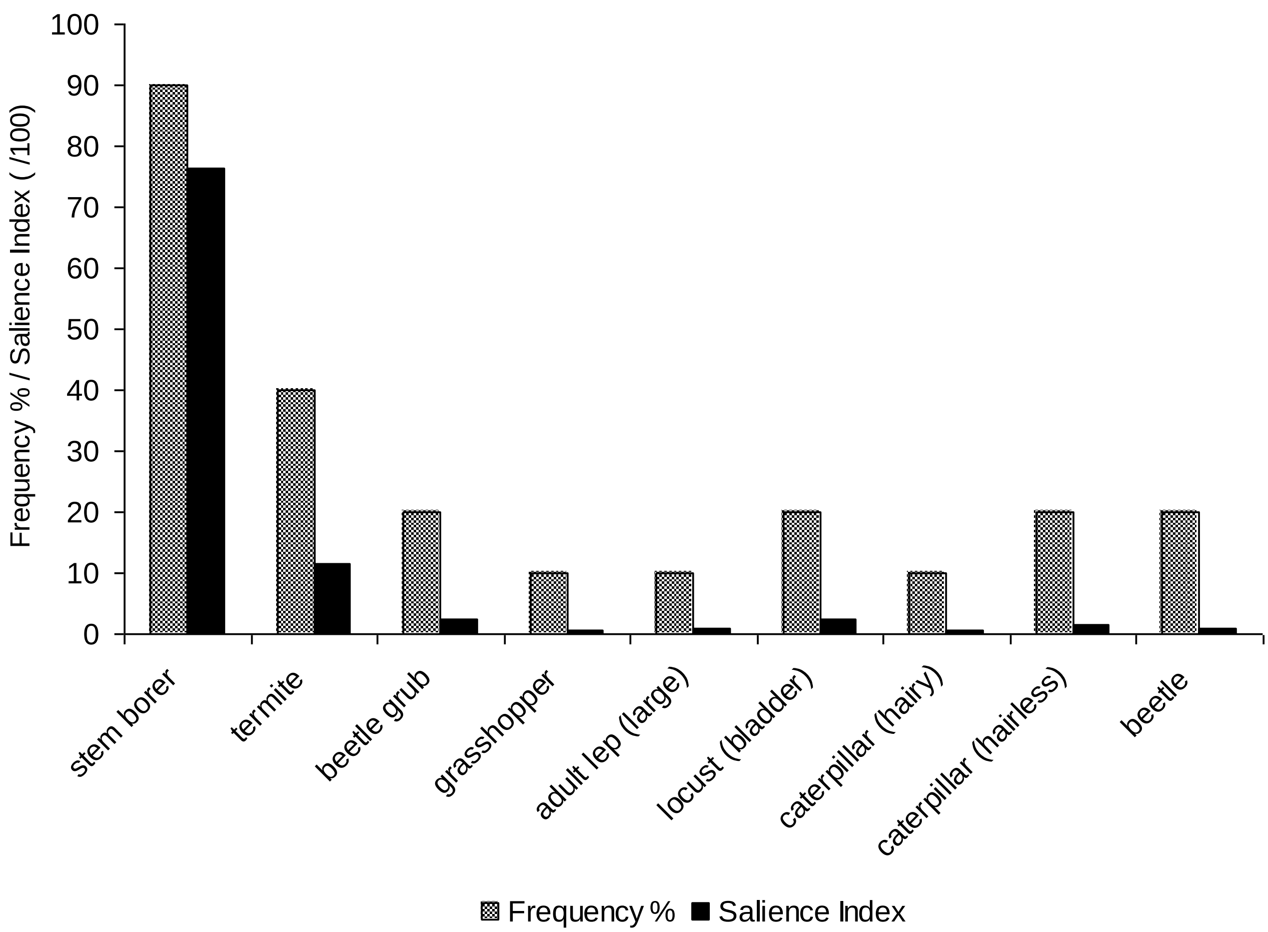



**Figure 3.10.** Frequency of mention (% respondents) and salience index (out of a maximum of 100) of insect pests of sugarcane.

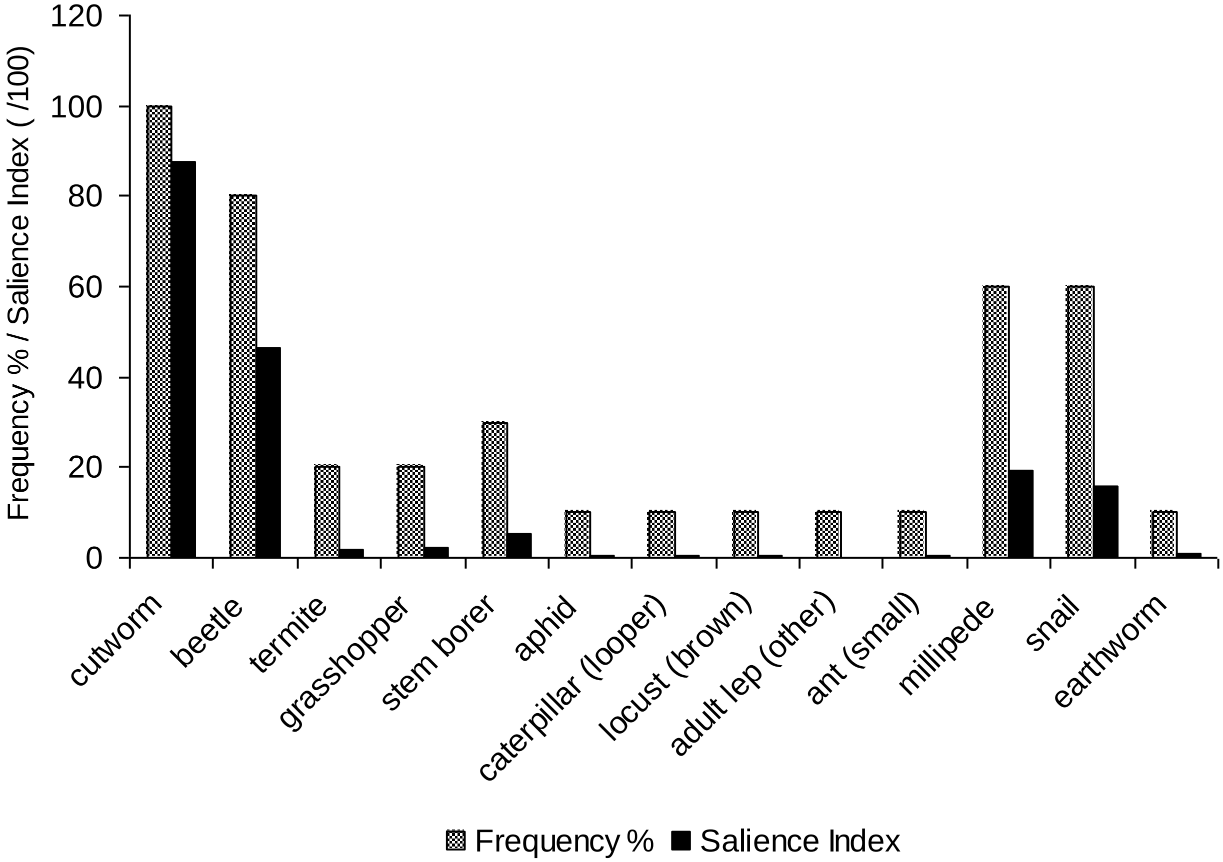



**Figure 3.11.** Frequency of mention (% respondents) and salience index (out of a maximum of 100) of insect pests of food crops.

The SI for insect pests indicates that SSGs recognise stem borers as the most important pest of sugarcane (SI = 76.5) (Figure 3.10). Termites were the second most important sugarcane pest (SI = 11.5) (Figure 3.10). The most important vegetable pest listed was cutworm (SI = 87.5) (Figure 3.11), which has a higher SI than stem borers as a sugarcane pest (Figure 3.10). Beetles were considered to be the second most important pest of food crops (SI = 46.4) (Figure 3.11).

### 3.3.3.2 Results from students' survey

Results from the Reunion Island students' survey on sugarcane SSGs' crop protection knowledge are presented in Figures 3.12 and 3.13. The mean scores per knowledge category indicate that of the three domains of crop protection (pests, diseases and weeds), disease and pest control knowledge had the lowest mean scores of 0.43 and 0.51 respectively, out of a possible maximum of 2 (Figure 3.12). While SSGs scored an average score of 0.68 for identifying at least two sugarcane pests correctly, the highest mean score, in contrast, was for weed control (1.78). SSGs were expected to mention both hand weeding and herbicide application as methods of weed control to achieve a score of 2.

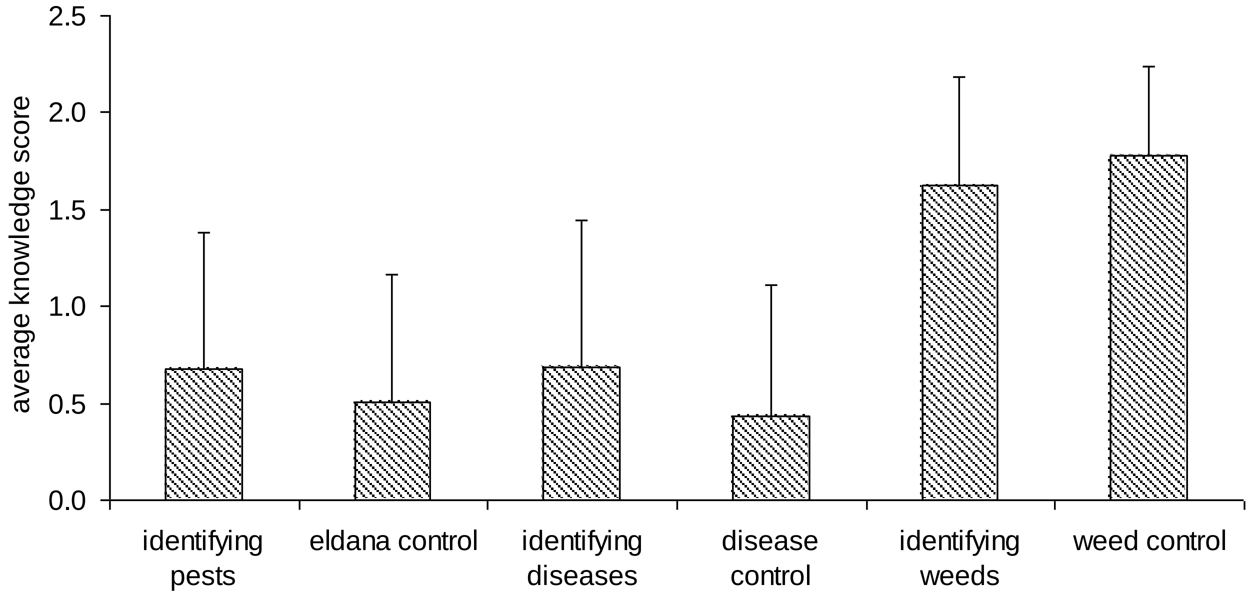



**Figure 3.12.** Mean scores per knowledge category of pests, weeds and their control (minimum score = 0, maximum score = 2). Bars indicate standard deviation (N = 72).

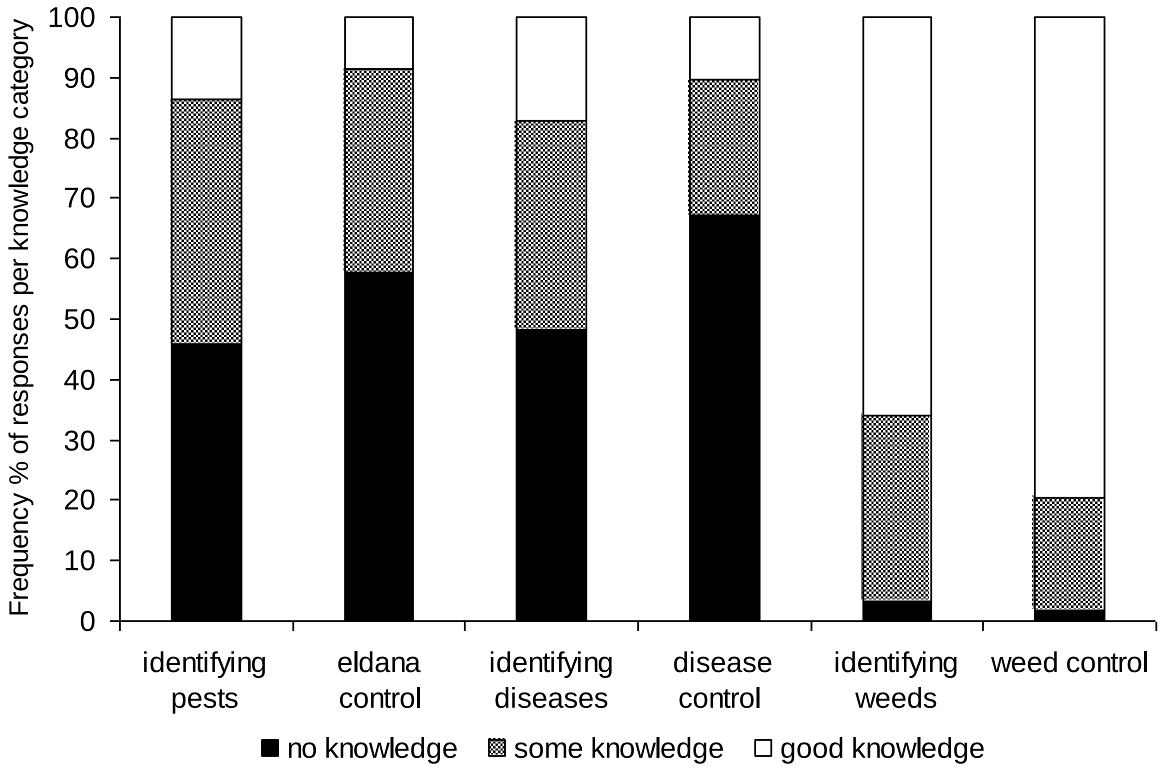
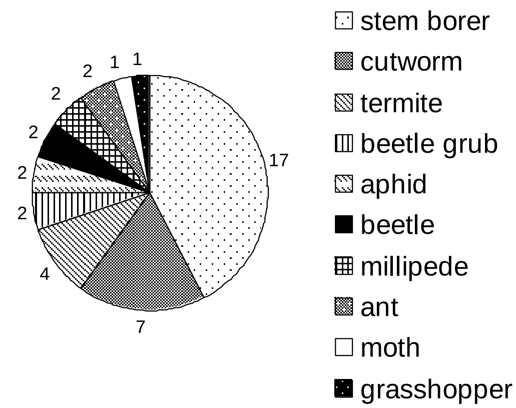
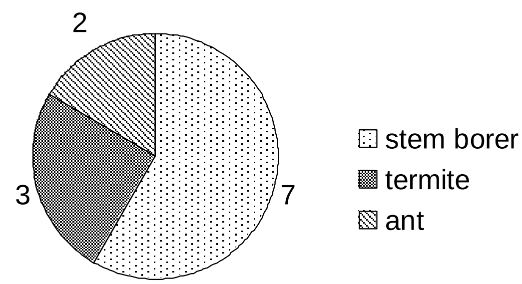
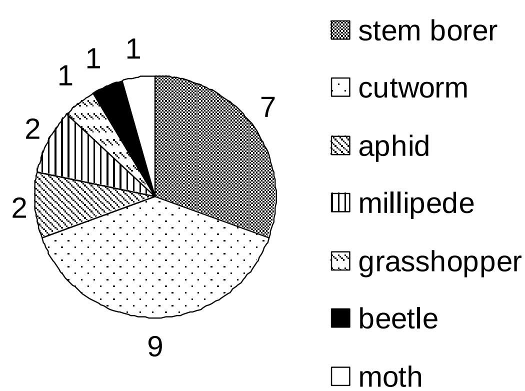
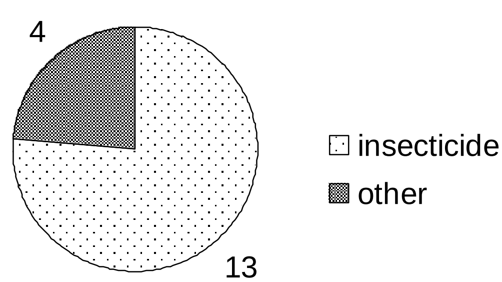
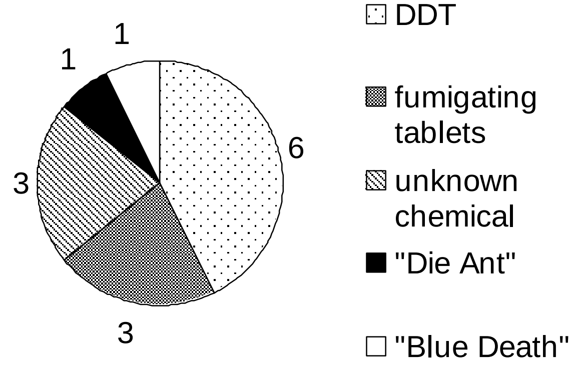
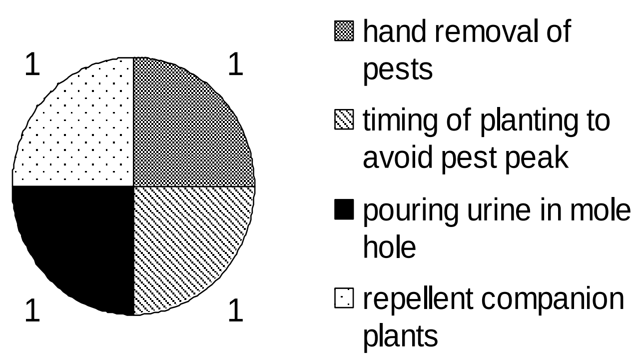
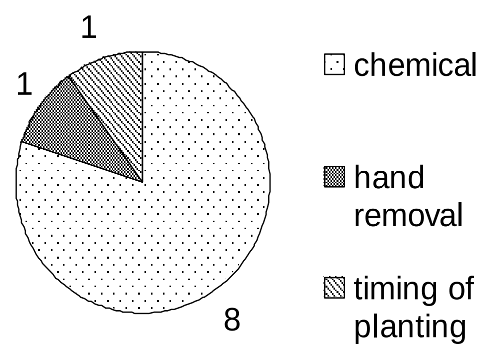
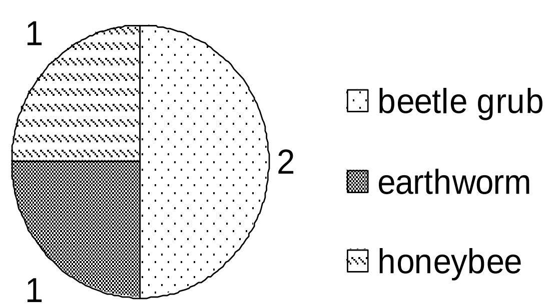



**Figure 3.13.** Frequency of respondents per knowledge category: no knowledge (score = 0), some knowledge (score = 1), good knowledge (score = 2) (N = 72).

**Table 3.6** Summary of quantitative content analysis of focus group discussions on insects.

| **Topic** | **Summary of findings** | **Pie chart to illustrate frequency of mention of categories within each topic** |
|---|---|---|
| General pests | Top pests named: stem borer and cutworm. |   |
| Sugarcane pests | Top sugarcane pest named: stem borer. Eldana only named twice using the specific English name. Total frequency of mention: 12. |   |
| Food crop pests | Top food crop pest named: cutworm. Food crop pests easier to list/name because there are more of them. Total frequency of mention: 23. |   |
| General pest control | Pest control was discussed mostly for food crop pests, very strong emphasis on chemical control using insecticides. |   |

| | | |
|---|---|---|
| Chemical control | DDT was mentioned often for chemical control, more than any other measure. |  |
| Non-chemical control | Some cultural control measures were mentioned. |  |
| Control of sugarcane pests | There was virtually no mention of pest control for sugarcane pests, except for termites, which were controlled using an insecticide ("Die Ant"). | |
| Control of food crop pests | Most control measures for food crop pests are chemical.<br>Total frequency of mention: 10 |  |
| Beneficial insects | There are hardly any helpful insects. Those which are mentioned are not predators. |  |

The biggest knowledge gaps (i.e. no knowledge = black section of bars) identified were for pests and diseases (Figure 3.13). Most respondents had some or good knowledge of weeds and weed control. Very few SSGs could identify insects, pests and diseases and had knowledge of methods of control. A brief analysis of the additional notes on the survey sheets (where verbatim answers from SSGs were recorded) indicated that the scores they had allocated to the participants answers were accurate. Examples of some of the comments recorded when a score of 0 was allocated are given below:

*"She forgot the names of the pests and doesn't know anything about how to control them."*

*"She would call the extension officer to ask for advice on how to control the pest."*

*"She can recognise the pest but she can't put a name to it."*

### 3.3.3.3 Results from focus group discussions about insects

The FGDs proved that these SSGs were aware of insect pests, both in their sugarcane and food crops. The most often mentioned sugarcane pest insect during the discussion was the stem borer, and three isiZulu names used for it: *inhlava*, *inhlakava* and *isihlava*. Such variations in the names of plants and animals in isiZulu are well known (Koopman, 2002). In all four FGDs, only one SSG mentioned *E. saccharina* by its specific English name 'eldana'. The insect mentioned most often as a vegetable pest was the cutworm. The top four insect pests mentioned, for both sugarcane and food crops were stem borers, cutworms, termites and beetle grubs. SSGs found it easier to list and discuss vegetable pests. This is evidenced by the SSGs free lists of vegetable pests which were almost always longer than those of sugarcane pests (Table 3.5). SSGs were first asked to list sugarcane pests and then asked to list vegetable pests. One of the SSGs, when asked to list vegetable pests, after sugarcane pests, said

*"Oh, that's easy. There are lots of those."*

Vegetable pests seemed more common and a greater problem than sugarcane pests. The frequency of mentions of vegetable pests (23) during discussions was much higher than the frequency of mention of sugarcane pests (12) (Table 3.6). The same pattern emerged when pest control was discussed. The frequency of mention of measures to control sugarcane pests was 1, whereas the frequency of mention of measures to control food crop pests was 10 (Table 3.6).

According to Krueger (1998), the frequency of comments should not be over-emphasized, but the extensiveness, intensity and specificity of comments should also be considered. Specific responses based on experiences merit greater attention. The following are quotes of specific examples of control measures used for food crops:

*"In the food crops, there is this thing, the cutworm. There is this medicine/chemical, DDT, which you add to water and then put into a sprayer, then these insects won't be able to stay there."*

(Note: the respondents' use of the term DDT (Dichlorodiphenyltrichloroethane) may be a misnomer, and is likely being used as a general term for all insecticides)

*"'When you have the stalk borer [in maize], it's best if you buy certified seed and plant later in the season, like in November. Around November the stalk borer is busy. If you plant in August, then the maize will be older in November and get damaged, so it's better to plant it later."*

It is also useful to consider what was not said in a FGD, alongside what was said frequently (Krueger, 1998). The fact that there was almost no mention or discussion of control of sugarcane pests certainly is an indicator that the SSGs are not particularly concerned about pests and that they are not engaged in any control measures for these pests.

When control measures were discussed, there was a strong emphasis on chemical control. In all control measures mentioned, for all types of pests and crops, chemical control was mentioned 13 out of 17 times (Table 3.6). The other four control measures mentioned were hand removal of pests, timing of planting, pouring urine down mole holes and planting pest-repellent plants around the crop. SSGs appeared to enjoy sharing their experiences of pest control with the group and some gave detailed accounts of how they applied the control measures. One example (as quoted above) is where a SSG described the importance of timing of maize planting to avoid stem borers. Another comment was as follows:

*"At night you can pour urine down the mole hole, then [the mole] runs away. I did this at home, the mole left and didn't come back. Urine really works. These are the ways of our people."*

To explore the SSGs' understanding of biological control by predators, they were asked whether there were any beneficial insects among those listed or whether all insects are problematic. The immediate response to this question by multiple participants within all four groups, was that all insects are a problem. Upon further probing and questioning, some participants conceded that some insects are beneficial (grubs, earthworms and bees) while others are neutral, i.e. neither beneficial nor harmful (grubs, pupae). For example:

*"There is the grub, the grub helps. The grub goes into the soil, it digs, and allows air into the soil."*

SSGs did mention some beneficial vertebrates such as birds (including crows), frogs and lizards. This indicated that some SSGs do have an understanding of the role of predation on pest control in the crop environment. As an indication of the SSGs' knowledge of insect biology it must be noted that on two occasions the topic of lepidopteran pupae as part of the insect life cycle was discussed by the SSGs. In the first case, a female SSG mentioned a pupa as a harmless insect but a male SSG then explained that the pupa hatches into a moth which lays a destructive stem borer onto the crops. On another occasion, a woman told the story of how pupae are used to help find lost cattle: they allowed it to wiggle on the hand and the direction the abdomen pointed indicated the direction of the lost cattle. A male participant in this group, who was in fact a retired teacher, also explained that a pupa can hatch into a moth or butterfly. The fact that there was some confusion about the pupa suggests that the SSGs' knowledge of insect biology is rudimentary.

Summary of interpretations and lessons learnt from insect FGDs:

- SSGs do not perceive sugarcane pests, including *E. saccharina*, to be a serious constraint
- SSGs know about stem borers as important pests of sugarcane
- SSGs have problems with insect pests on food crops
- In controlling pests in food crops, SSGs rely primarily on chemical control measures
- SSGs perceive insects negatively, and do not know about beneficial insect predators and parasitoids
- SSGs recognise that vertebrate predators can play a role in minimising pest damage.

## 3.4 Discussion

The discussion below is sub-divided into three sections which report on the findings for each of the three objectives of the study, as outlined in the introduction (3.1).

### *3.4.1 Role of sugarcane in livelihoods and farming systems*

The multiple methods used in this study all support the finding that sugarcane is an important part of the livelihoods of the small-scale growers in the Midlands North region. The descriptive statistics from interview data indicate that for many SSGs, sugarcane is a primary livelihood resource (Figure 3.3). While sugarcane is perceived as the main source of income it is supplemented by other employment, business activities and social government grants (Figure 3.4). SSGs indicated that they use the income from sugarcane to pay for food and education (Figure 3.5). Sugarcane as a cash crop, therefore makes an important contribution to food security in these households and allows for children to be educated. The relatively large areas dedicated to sugarcane as shown on the sketch maps (Figure 3.6) and the verbatim quotes from the growers (both forms of qualitative data), support the quantitative data and confirm the importance of sugarcane to these families. The participatory matrix scoring activity showed that although food and income derived from all other agricultural enterprises together is larger than that from sugarcane, none of the other agricultural enterprises on their own contributed as much to household income and food as sugarcane (Figure 3.7, Table 3.4). Compared to all other agricultural enterprises which these SSGs engage in, sugarcane is viewed as the most important and it is listed as the most important crop most frequently (Figure 3.8).

The importance of sugarcane for rural households is recognised elsewhere in the literature (Armitage *et al.*, 2009; Eweg *et al.*, 2009; Sibiya and Hurly, 2011), but this is the first time a detailed study, using participatory, mixed methods approaches has been conducted with SSG's in KwaZulu-Natal. It is an important contribution to understanding how sugarcane supports rural livelihoods and is part of an integrated farming system, and therefore merits continued effort to improve support services from multiple stakeholders (Armitage *et al.*, 2009). Since these households grow sugarcane together with other crops and livestock, there is the potential for farmers to be subject to multiple and conflicting messages from extension and support stakeholders involved in the various agricultural enterprises. This has been the case elsewhere, for example in Lesotho (Molomo, 2012). It is therefore important that extension and support stakeholders in this area communicate effectively and work together, and that good linkages are developed between these different stakeholders (Düvel, 2005) so that the SSGs' constraints, such as high input costs and weed control as identified in this study, can be addressed effectively.

### *3.4.2 Sugarcane production constraints*

Declining yields of SSGs is a concern of the South African sugar industry (Parsons, 2003; Eweg *et al.*, 2009; Thomson, 2010; Sibiya and Hurly, 2011). Although reduced yields have been ascribed to a number of factors no study has been conducted to identify specific crop husbandry or agronomic production constraints as perceived by SSGs. A preliminary report on a survey conducted in Mauritius and South Africa (Eweg *et al.*, 2009; Canegrowers, 2011) indicated that poor re-plant rates may contribute to reduced yields, along with low levels of education which contribute to poor crop husbandry practices among SSGs (Canegrowers, 2011). Our finding that SSGs perceive weeds as the top agronomic constraint is the first record of such a perception. In the recent past, there have been numerous publications on improving weed management practices amongst emerging farmers (both SSGs and new freehold growers) in the South African sugar industry, which indicates a recognition of weeds as a major constraint and a need for research and extension to continue addressing crop protection practices amongst SSGs (Campbell *et al.*, 2009; Campbell *et al.*, 2010; Conlong and Campbell, 2010). The results of the students' survey reported here (Figure 3.12 & 3.13) also indicated the importance of weeds for SSGs. The SSGs have good knowledge regarding weeds and weed control practices, however whether this knowledge is applied correctly needs further investigation. Weed management should therefore be prioritized as an extension topic for the SSGs in the Midlands North region. This can be achieved by incorporating it into the demonstration plot programme of work which is currently being used for extension in the Midlands North region (Gillespie *et al.*, 2009a; Gillespie *et al.*, 2012). SSGs also identified high input costs as an important constraint. This finding is supported by other studies (Armitage *et al.*, 2009; Thomson, 2010). According to Eweg (2005a) high costs of fertilizers may be one of the major constraints on SSG yields which implies that SSGs do not apply enough fertiliser.

The use of *Melinis minutiflora* P. Beauv. (Cyperales: Cyperaceae), the repellent grass used in the push-pull strategy, for both weed and insect management by SSGs warrants further investigation. This grass has multiple benefits and it could potentially integrate well with the SSGs' farming system, which has been shown in this chapter to be composed of multiple crop and livestock elements (Figure 3.6, 3.8). It is known to be a good fodder grass and possesses tick repellent properties (Mwangi *et al.*, 1995). Not only is it known to repel both *E. saccharina* (Kasl, 2004; Barker *et al.*, 2006), and the exotic maze stem borer *Chilo partellus* Swinhoe (Lepidoptera: Pyralidae) (Khan *et al.*, 1997b), but it has also been shown to reduce infestations of weedy creeping grasses into sugarcane fields (Conlong and Campbell, 2010).

The SSGs in this study did not perceive pests as a major constraint. This was seen both in interviews during which constraints were discussed (Figure 3.9) and also in the group discussions on insect pests (Table 3.6). The SSGs did however recognise that stem borers are a pest of sugarcane (Table 3.6). The SSGs' poor knowledge of sugarcane pests and their control also indicate that pests are not considered an important constraint, particularly when compared to weeds. It is notable that to date, no study has identified pests as a major production constraint for SSGs, ours included. Furthermore, Way *et al.* (2003) and Goebel *et al.* (2005) reported that pest numbers and damage levels in SSG fields are lower than those in large-scale or commercial fields in the same area. Pest surveys by the LPD&VCC in the Midlands North for *E. saccharina* in SSG areas generally show much lower population and damage levels than those in LSG areas (Webster, pers. comm., 2012). According to Orr (2003), crop losses due to insect pests in sub-Saharan Africa are often over estimated by research and extension institutes. Assefa *et al.* (2008) found that sugarcane farmers in Ethiopia were aware of stem borers as pests of sugarcane but only 15% applied any control measures, which indicated that they were not considered a major constraint. Since extension and implementation of improved agricultural practices, for example push-pull and IPM, must to be relevant to the needs of farmers (Röling *et al.*, 2004), the results of this study indicate that push-pull and IPM should not be prioritised for SSGs at this time. *E. saccharina* is not a major production constraint for SSGs in the Midlands North region and thus attempts to implement pest management practices at this time are unlikely to succeed.

### *3.4.3 Knowledge and perceptions of insect pests and pest management practices*

The fact that stem borers are not considered a serious pest and sugarcane production constraint may explain why the SSGs did not have a particularly good knowledge of sugarcane pests. Despite the fact that participants in the FGDs listed most of the major pests of sugarcane (Figure 3.10), individual survey interviews showed that the SSGs mostly could not name the most important pests of sugarcane correctly (Figure 3.12 & 3.13). The better knowledge results from the group discussions compared to individual interviews confirm that group settings can result in a sharing of knowledge and learning. Group meetings and discussions are recognised as a useful tool in extension, as they can promote an active exchange of knowledge between farmers, learning and opinion change (Leeuwis, 2004).

The participants seemed to consider pests of their food crops a greater constraint than sugarcane pests. Not only did they list more food crop pests than sugarcane pests (Table 3.5), but the SI of the top three food crop pests was higher than the SI of the top three sugarcane pests (Figures 3.10 & 3.11). During all four FGDs, only one mention was made of controlling sugarcane pests. The students' survey also confirmed that the SSGs had poor knowledge of sugarcane pest control practices. Comments recorded on the data sheets indicate that the SSGs are aware of the presence of pests but remain reliant on the extension officers for help with controlling pests. The SSG survey reported by Eweg *et al.* (2009) found that 77% of SSGs indicated they would do nothing if they found a disease in their sugarcane fields, while only 6% said they would call an extension officer. This is similar to our findings on pest control. Similarly, a study on cabbage pest management in the Eastern Cape province found that farmers in rural areas relied on extension officers for pest control decisions (Mkize, 2003).

The poor pest and pest management knowledge of the SSGs in this region may be an indication of the level of knowledge elsewhere in the sugar industry. It is recommended that a study is carried out in areas where *E. saccharina* is a more serious threat, i.e. the coastal sugarcane growing areas (Goebel *et al.*, 2005), to determine not only SSGs' production constraints, but also their pest and pest management knowledge and identify gaps in knowledge. It should also aim to determine whether there is a need to implement push-pull and IPM, as has for example been done with cotton farmers in western Kenya (Midega *et al.*, 2012). There it was found that farmers were aware of pests and identified them as a major constraint, but were not controlling them effectively and that there was a 'vacuum in the area of IPM' in the region which required targeted research and extension (Midega *et al.*, 2012).

## 3.5 Conclusion and recommendations

This study has shown that sugarcane plays an important role in the livelihoods of SSGs in the Midlands North region as it contributes to household food security and provides money for education. Sugarcane is the most important crop within a complex of crops and livestock which are farmed in an integrated system. Weeds and high input costs are perceived as the biggest constraints to sugarcane production by the SSGs in the Midlands North area, and not insect pests. Since insect pests in general, and *E. saccharina* specifically, are not currently a major production constraint for these SSGs, continued investment of resources in implementing push-pull and IPM among these SSGs presently appears unwarranted. Considering the increasing threat of *E. saccharina* however (Webster *et al.*, 2005; Webster *et al.*, 2009; Singels *et al.*, 2012) it is crucial that *E. saccharina* levels in SSG fields in the Midlands North continue to be monitored and that SSGs are continue to made aware of the potential threat of this pest. The potential benefits of *M. minutiflora* for use by SSGs in their farming systems to address both pest and weed management needs to be investigated further.

It is recommended that extension activities in the Midlands North region prioritise weed management for SSGs and that efforts to reduce SSGs' input costs and improve their business skills continue. The important role which sugarcane plays in the livelihoods of these SSGs means that improvements in yields will not only benefit millers, but will have a direct positive impact on household income and food security.