

**THE COMPILATION OF INDIGENOUS KNOWLEDGE REGARDING
INSECT PESTS IN SMALL-SCALE FARMING COMMUNITIES IN NORTH
EASTERN SOUTH AFRICA.**

BY

S.R. NETSHIFHEFHE

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FACULTY OF NATURAL AND AGRICULTURAL SCIENCE.

UNIVERSITY OF PRETORIA

PRETORIA

Supervisor: Dr. A.S. Schoeman

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NETSHIFHEFHE, SHANDUKANI RUDOLF

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Table of contents

1. General overview of the study	1
1.1. Introduction	2
1.2. The overall objectives of the study	3
1.3. The role of indigenous knowledge in Africa	4
1.4. Material and methods	8
1.5. Results and discussion	9
1.6. Study areas	11
1.7. Conclusion	13
1.8. References	17
2. Participatory rural appraisal (PRA's): The approach to community participation.	20
2.1. Introduction	20
2.2. Objectives	22
2.3. Literature study	22
2.4. Material and methods	24
2.5. Analysis	29
2.6. Results and discussions	30
2.7. Conclusion	44
2.8. References	53

3. Management of stored grain insects in small scale farming communities	57
3.1. Introduction	57
3.2. Importance of stored grain pests	58
3.3. Kinds of stored grain pests	59
3.4. Literature review	61
3.5. Material and methods	66
3.6. Results and discussions	70
3.7. Storage pests management techniques	74
3.8. Natural crop protectant chemicals	78
3.9. Conclusion	82
3.10. References	85
4. Management of cutworms, <i>Agrotis spp.</i> (Lepidoptera: Noctuidae) by resource poor farmers in Limpopo Province	89
4.1. Introduction	89
4.2. Literature study	90
4.3. Material and methods	95
4.4. Results and discussion	96
4.5. Conclusion	99
4.6. References	107

1. GENERAL OVERVIEW OF THE STUDY

Abstract

Insects are a major factor limiting the successful adoption of cropping technologies throughout the whole of the African continent. They are known to attack (among others) young seedlings, leaves, fruits, seeds and roots in some cases causing up to 100% losses. They attack cash, tree and forestry crops. They are also a major problem in nurseries. The use of insecticides is not only expensive for small-scale farmers but they are environmentally hostile. The use of plant derivatives and indigenous knowledge for insect pest control was common in the tropics before the advent of synthetic pesticides. Some of the very first insecticides – nicotine, pyrethrins and rotenone, were derived from plants.

Key words: Insects, plant derivatives, indigenous knowledge.

1.1. Introduction

Bembridge (1993) defined a small-scale farmer as any farmer who practices agriculture on a small scale. Small-scale farmers usually lack institutional support such as operational agricultural policies, credit, marketing, farming inputs, research, and extension. This decreases their productivity and subsequently lowers Net Farm Income (NFI). Farm Profit (NFP) is therefore affected.

Bembridge (1993) stated that small-scale farmers in southern Africa have certain common features:

- a) There is often inadequate infrastructural development in terms of water supplies.
- b) Local leadership and village organisations are not developed or geared to promoting agriculture.
- c) Organisation of agricultural production is based on simple traditional technology.
- d) Traditional culture and customs sometimes act as constraints to agricultural production.
- e) Small-scale farmers collectively have little say or political influence in agricultural production.
- f) Small-scale farming is subsistence oriented.

Insects are one of the major constraints in terms of yield loss in many small-scale farming communities. Some of the small-scale farmers do not even know how to identify insect pests, and subsequently do not know when the populations of these

insect pests are at the peak, and what is the necessary step to be taken to control these pests.

This problem is experienced in many small-scale farming communities throughout the African continent (Stoll, 2000). This project was undertaken to identify existing indigenous knowledge regarding insect pests in farming communities and to assist these people in monitoring, identification and control of the major pests. The following areas were targeted:

- Mpumalanga (Pilgrim's Rest)
- Limpopo (Northern) Province: (Tshidzini, Tshifudi, Gaba, Tshaulu and Mushiru)
[Greater Vhutswema Transitional Local Council]

1.2. The overall objectives of the study

The main aims of the project were:

- a) To determine the relative seasonal abundance of pests in the study areas
- b) To determine the seasonal abundance of different types of crops grown by small scale farmers
- c) To quantify the importance of different insect pests as well as different crops produced by small scale farmers via Participatory Rural Appraisals (PRA's).

1.3. The role of indigenous knowledge in Africa

We are living in an advanced technological society where information and technology are unequally available to producers due to other reasons such as financial constraints and access to resources. Commercial farmers have more access to new technological innovation when compared to small-scale farmers. An important contributing factor to this phenomenon is that most of the commercial farmers are innovators and early adopters of technology, whereas small-scale farmers tend to follow tradition (Bembridge, 1993).

Insects are man's competitors on earth and to some extent his benefactors. They eat his crops and some of his other possessions. Much emphasis is normally placed on beneficial insects these days. Dung beetles feed exclusively on the dung of cattle and other ungulates (Kumar, 1984). Some of the insects can be used to control other insect pests, e.g. the biological control of red scale, *Aonidiella aurantii* (Maskell) (Hemiptera: Diaspididae), by *Aphytis spp.* (Compere) (Hymenoptera: Aphelinidae) (Bedford, 1998). Pests of crops and their status are likely to vary according to local environmental conditions (Kumar, 1983).

The coffee berry borer, *Hypothenemus hampei* (Ferrari) (Coleoptera: Scolytidae), is a native to Africa and has now become a serious pest of coffee (Kumar, 1983, Vega *et. al*, 1999). In Brazil, this pest has caused major crop losses and remains a serious pest of coffee (Le Pelley, 1973). He further indicated that all over Africa and

elsewhere, a large sum of money is spent in controlling coffee berry borer and other pests.

The grain legumes such as cowpeas (*Vigna unguiculata*), soybeans (*Glycine max*) and pigeon peas (*Cajanus cajan*) provide green leaves, green pods and dry beans which are important sources of palatable high quality protein in many African countries (Kumar, 1984). The Lowveld Agricultural Research Unit in Mpumalanga (Nelspruit) conducted some trials to identify the best suitable variety of pigeon peas and cowpeas in the region. The same trials were also conducted by the Department of Plant Production (University of Venda for Science and Technology) in the year 2000. The main purpose of the trials was to identify the adaptability of various varieties of pigeon peas, i.e. short, medium and long term duration under the leadership of Rudolf Netshifhefhe. Kumar (1984) further stated that one of the greatest limiting factors in the attempt to increase productivity of grain legumes is the wide range of phytophagous insects with which they are associated. More than 130 pest species had been recorded on grain legumes in Africa and they may attack virtually every part of the crop (roots, stems, leaves, flower and pods) (Kumar, 1984).

Cereal crops in Africa are subjected to attack by a variety of insect pests. Walker (1967) estimated that yield losses in Tanzania and Kenya in 1963 were attributed as to stem borer, *Busseola fusca* (Fuller) (Lepidoptera: Noctuidae), at 18% in Kenya

and at 27% in Tanzania. Field losses due to cutworms, *Agrotis ipsilon* (Hufnagel) (Lepidoptera: Noctuidae) were 2% in Kenya and 4% in Tanzania.

Some of the produce retrieved from fields need to be stored. A large number of insects including many species of beetles and moths, attack crops in farmers bins, in mills, warehouses, retail stores and in the home (Kumar, 1984). He further listed 219 species belonging to 56 genera of 11 orders of insects associated with stored products in Nigeria. Hall (1970) stated that in some tropical countries, losses during storage, processing and marketing may be as high as 50%.

Because of the above-mentioned losses that were caused by insects, scientists came up with different ways to control different types of insects encompassing cultural, physical, chemical, genetic, and biological methods.

Small-scale farmers have their own techniques to control different types of pests. Crop rotation is one of the methods which is often used by small scale farmers and it also helps to reduce damage to crops by insects which attack only a few kinds of plants (Njoroge, 1994). For instance, when maize is grown continuously on the same field, the stalk borer becomes a problem (Njoroge, 1994).

Grenier (1998) further stated that, indigenous knowledge refers to the unique, traditional, local knowledge existing within and developed around the specific conditions of women and men indigenous to a particular geographic area. It was further stated that it is acknowledged that indigenous people, in particular people living off the land, have their own indigenous or local knowledge. Stoll (1986) indicated that in southern Togo, traditional maize silos, in which the outer walls are made of maize cobs, are sprayed with goats' dung solution. Probably the strong smell deters insect pests as well as the goats themselves from attempting to eat the stored grains.

It is also found that the application of indigenous knowledge has no health hazards when compared to sophisticated modern and often expensive technology. Indigenous knowledge may help to improve scientific research (Aina, 1996).

Indigenous knowledge that individuals possess differ (Ruddle, 1993). Some of the influencing factors are age, education, gender, social and economic status, daily experiences, outside influences, roles and accountability in home and community, profession, available time, aptitude and intellectual capability, level of curiosity and observation skills, ability to travel and degree of autonomy and control over natural resources.

Indigenous knowledge is stored in peoples' memories and activities and is expressed in stories, songs, folklore, proverbs, dances, myths, cultural values, beliefs, rituals, community laws, local language and taxonomy, agricultural practices, equipment, materials, plant species and animal breeds (Nakashima, 1990). Agricultural extension is the only instrument used by Ministries of Agriculture to promote agricultural development. Extension is equated to rural development, improving productivity and profitability to farmers, and it is viewed as a provider of non-formal community education and agriculturally related continuing education for multiple audiences such as farmers, spouses, youth rural community and urban horticulturists (Zwane, 1999). This paper is focused on the "Identification on indigenous knowledge regarding insect pests in small scale farming communities in north eastern South Africa".

1.4. Materials and methods

The first step (activity) that was taken was to identify and prioritize different crops and their associated pests and diseases via monthly participatory rural appraisals (PRA). Participatory rural appraisals was carried out on a monthly basis for the whole year, i.e. from mid 1998 till mid 1999 in Mpumalanga and also in 2000 in the Limpopo (Northern) province. The participatory rural appraisal was based on two analyses, i.e. verbal and visual.

The second activity include the surveying of insects occurring on crops using various techniques. Some of the techniques used include: exposure of insects by plough, collecting with a net, beating tray or jarring, light trap and yellow card traps.

The last activity was the surveying of indigenous knowledge regarding crop protection. Traditional healers were consulted. What the farmers were doing was also noted.

1.5. Results and discussions

It was found during the first activity, i.e. participatory rural appraisal that verbal analysis is very effective by discussions and observations. It was also discovered that farmer's analysis through discussion and observation could be facilitated in several ways that can also be combined.

Firstly, farmers' groups are used in agricultural extension. In Ashy *et al* (1989), Ashby (1990), and Norman *et al* (1989) indicated that in recent years there have been innovations in group management and gains in understanding. Groups presented both problems and opportunities that were well discussed in these sources. Analysis by groups, rather than individuals has also been a tendency in PRA (Ashby, 1990).

Secondly, sequence has been used in discussion and analysis. Present and past agriculture were compared by asking about problems and difficulties, what has been tried to overcome them and what experience has been gained.

The following criteria were used during the surveys:

Matrix scoring and ranking: these include the types and varieties of crops, vegetables and fruits. Criteria for assessing the items were identified (through straight discussion and listing, through pairwise comparisons, or through asking what is good and what is bad about each) (see chapter 2).

Seasonal analysis: seasonal diagramming has become a standard method in PRA (Ashby, 1990). Crops were divided according to the seasons (See chapter 2) in which they were grown.

Trend analysis: The analysis of change over time is a strong point of entry with farmers. It can be entirely or largely verbal (Gubbel, 1988; Box, 1989). Areas under different land uses, including proportions of different crops and pest incidence were taken into consideration. Questionnaires were also used.

1.6. Study areas and methods

All five rural communities in the Limpopo (Northern) province in the former Venda homeland, namely, Tshidzini, Tshifudi, Gaba, Tshaulu, and Mushiru and one community, namely Pilgrim's Rest in Mpumalanga were initially selected to be surveyed. Interviews were conducted at random.

Pilgrim's Rest

Pilgrim's Rest (Fig. 1) is situated about 90km from Nelspruit and is located in the north west of Mpumalanga. The climate is very different from the Lowveld. During winter, the temperatures drop below freezing point. Frost normally occurs during winter months. Therefore, the area is not suitable for most of the tropical and subtropical crops. The highest temperatures reported in Pilgrim's Rest is 48.8 °C and the lowest reported temperature is - 5.6 °C.

At this area, a community development project, Pilgrim's Rest Permaculture Project was started by the Provincial Department of Environmental Affairs. The main objective of the project was the production of food crops (cash crops or vegetables) for home consumption (owners of gardens and their respective families) and to market vegetables locally to secure income. Particular emphasis was placed on increasing production per unit area. They also indicated that if there is enough income they will send their children to schools and the lower quality vegetables will be used for home consumption.

Tshidzini, Tshifudi, Gaba, Tshaulu and Mushiru (Greater Vhutswema)

All these five communities (Fig. 2) are situated in the north eastern region of the Limpopo (Northern) Province. The climate ranges from tropical to subtropical with the rains, falling from around the middle of October to March, producing a hot humid climate. The temperature varying from 20 - 38°C in summer to 10 - 20°C during winter.

Communications are very poor with gravel roads. Most villages have an electricity supply, except Mushiru, and there are telephone links. Loss of telephone links and power supplies are common. Because of poor access to machinery, farming is almost entirely un-mechanised.

Draught animals are used for cultivation. All farms are entirely rain-fed, which limits crop production levels. Farms are large, generally more than 7 hectares. Government of Himachal Pradesh (1990) Statistical Outline uses the categories: small: 1-2 hectares, medium: 2-5 hectares and large: 5 hectares or more (Fig. 3). Maize, groundnuts, green beans, okra and pumpkins are the major crops. Some of the people in these villages keep several cattle for meat (slaughter and to sell locally), milk, draught and dung (for fertilization). Other animals such as goats and sheep are also kept by some people. Cattle, goats and draught animals are looked after during summer-time. Indigenous vanda chickens were reported to have been

found in almost all the villages. Pigs are often kept in stalls for some or all the year, and at this time green fodder and rotten porridge are carried to them.

1.7. Conclusion

This particular project compiles the indigenous knowledge regarding insect pests in small-scale farming communities in North eastern South Africa (See chapter 2, 3 and 4).

Source: <http://mpumalanga.mpu.gov.za/index.html>: Mpumalanga Province



Fig 1. Mpumalanga Province of South Africa showing the location of Pilgrim's Rest relative to all the main towns.

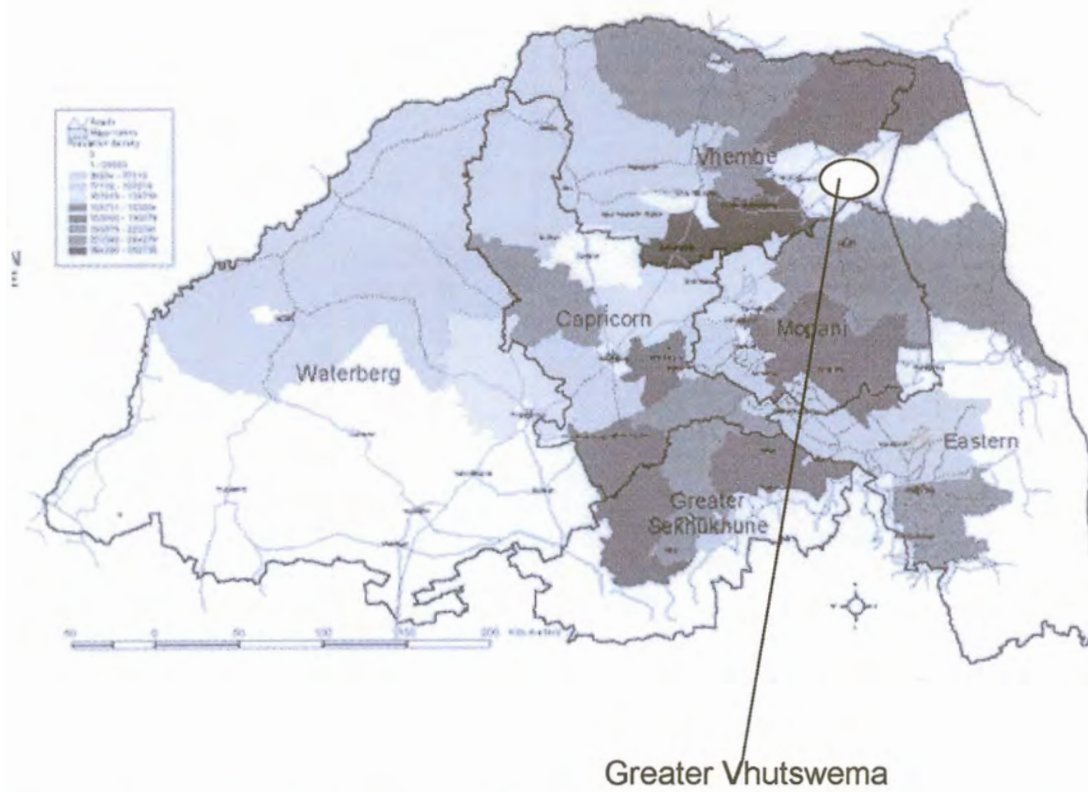


Figure 2. Greater Vhutswema (Tshifudi, Tshidzini, Tshifudi, Gaba, Tshaulu and Mushiru)

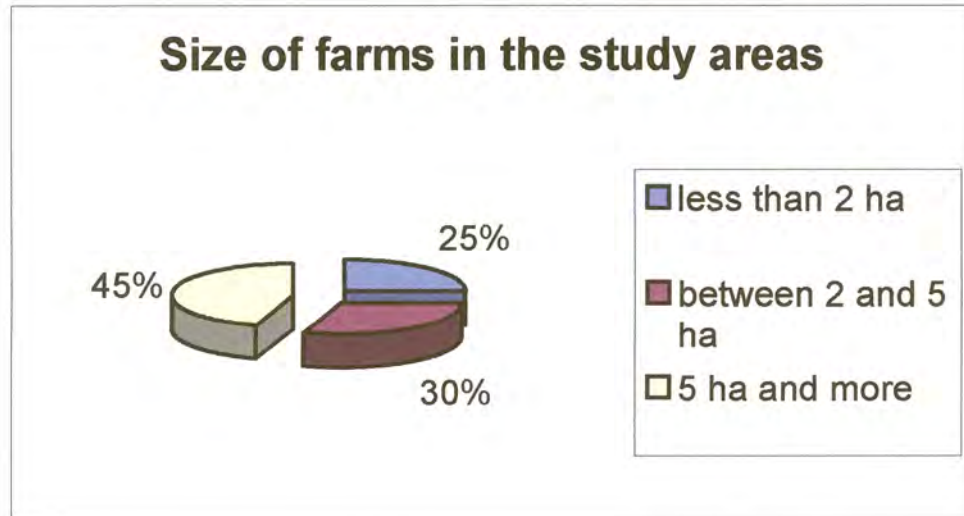


Figure 3: Size of farms in the study areas

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2. PARTICIPATORY RURAL APPRAISALS (PRA'S): THE APPROACH TO COMMUNITY PARTICIPATION

Abstract

Rural development planners for the past years did their work generally without community consultation. When they included consultation, they used quantitative surveys and did not communicate the results back to people who had shared their knowledge. Two approaches namely: rapid and participatory research approach were used.

Key words: Rural development, community, consultation, surveys, knowledge, rapid research, participatory research.

2.1. Introduction

Recently, there have been an increasing number of analyses of development projects showing that 'participation' by farmers is one of the critical components of success in irrigation, livestock, health, water, sanitation and agriculture projects (Kottak, 1991; Montgomery, 1983; Pretty and Sandbrook, 1991; Pretty, 1995 and USAID, 1987).

2.1.1. What is PRA?

PRA is a field-based methodology that mobilises communities. Participatory rural appraisal (PRA) entails techniques for learning about rural life and conditions from, with, and by rural people (Chambers, 1992, cited in Wickham 1993). It enhances the direct participation of communities, with rural people themselves becoming the dominant investigators and analysts.

Rural development is the participation of people in a mutual learning experience involving themselves, their local resources, external change agents and outside resources (Zwane, 1999). Zwane (1999) further said, people cannot be developed, they can only develop themselves by participation in decision and co-operative activities.

The agricultural research process has a provision of involvement of both extension and farmers in both planning and implementation of innovation (Rolling, 1988). According to Rolling (1988), one of the functions of the agricultural knowledge and information system is to ensure that all intended categories of clients are being served. Farming systems research (FSR) is the most potent tool for creating participation between researchers and farmers (Beck, 1999).

Various names have been given to this type of agricultural knowledge systems, namely, Farming System Development (FSD) (FAO, 1991), On Farm Research (Ewell, 1990; Arnon, 1989). Some call it Farming Systems Research and Extension (FSR-E) (Schmick, Poats and Spring, 1988), Participatory Research (PR) (Ashby, 1987), New Farming Systems Development (NFSD) (Spedding, 1988), Farming Systems Perspective (FSP), Adaptive Research Planning Team (ARPT) and On-Farm Orientated Research (OFOR) (Ewell, 1990).

2.2. Objectives

- ❖ To determine the relative seasonal abundance of insect pests in the study areas.
- ❖ To determine the seasonal abundance of the different types of crops grown by small-scale farmers.
- ❖ To quantify the importance of the different insect pests as well as different crops produced by small-scale farmers via monthly participatory rural appraisals.

2.3. Literature study

Participatory rural appraisal is a people centred development model in the tradition of human ecology (Grenier, 1998).

Participation is a complex phenomenon and cannot be presented in a universally acceptable form (Zwane, 1999). He further said that the interpretation is also dynamic. In developing countries, participation is seen as implying voluntary or other forms of contributions by rural people to predetermined programmes and projects (Oakley, 1991).

Organisation goes hand in hand with participation (Van Heck, 1988). Farmers groups have for long been used in agricultural extension (Norman *et al.* 1989, Ashby *et al.* 1989, Ashby 1990). It was further stated that analysis by groups rather than individuals have also been a tendency during participatory rural appraisals. Zwane (1999) said that it could be argued that the tendency of development workers to suggest and structure organisations for rural people is sometimes uncontrollable.

There are some negative factors that are accounted to inhibit the participation of people or rural people (Zwane, 1999). These factors are grouped into three, namely: structural obstacle, administrative obstacle, and social obstacle.

First obstacle, structural: participation would be restricted in a country whose ideology does not inspire openness of citizen's remarks but prefers to affirm direction and controls decision making body (Oakley, 1991).

As far as administrative obstacles are concerned, it has been noted that administrators who are used to centralised government systems tended to have a negative attitude to towards the notion of people's participation (Curtis, 1982).

The third obstacle is the social obstacle. It is significant that efforts seeking to stimulate participation by rural people should first acknowledge economic and social

differentiation that characterises people (Elliot, 1975). He further stated said that it has been demonstrated that in many rural areas different groups compete for available resources, and have different access to development activities.

2.4. Materials and methods

Surveys: Before starting the main survey, a pilot survey was conducted, with the aid of a translator, to investigate question formulation in relation to farmer response. This also provided an opportunity to discuss with some farmers the nature of the farming system. About 196 farmers were interviewed [Pilgrim's Rest (40), Tshidzini (34), Tshifudi (38) Gaba (17), Tshaulu (52) and Mushiru (15)]. All the interviews were analysed. The survey was conducted during October 1998 to June 2000. The questions were asked in the local languages (Tshivenda and Swazi), by translators (students from the Lowveld Agricultural College and the extension officers from Limpopo province) who first had the questions explained to them in full. A questionnaire (Annexure 1) having 66 questions was used during the survey for gathering information from farmers in the study areas.

Several people from the farm usually came to listen in on the interview and provide advice or additional information where the informant was unsure of the answer. The questions included exploring people's science: an outline for agricultural extension 'feed-back survey', facilities and raw materials, social and political organisation and

local skills, production constraints (Fig 1) (insect pests and pest damage) on agronomical and vegetable crops and in stored produce.

Transect walks: Three transect walks with local people comprised a group of two men and one woman in Pilgrim's Rest community. The teams were chosen for their interest in the environment and their strong commitment to the development of an area and also their long-term residence in the village. The transect walk was used to gather basic evaluation of the environment. The features such as soil type, trees, land use and vegetation were noted.

I learnt during transect walks that I could not find suitable words in the local dialect of my childhood to explain key research concepts, such as 'environment', 'sustainable management' and 'conservation'. Fortunately, explain to them what those terms meant.

Field visits: Field visits were carried out twice every month in all study areas. It was discovered during the field visits that the residents had little access to formal education and agricultural extension services. Subsistence crops produced are cabbage, tomato, carrots, beetroot, okra, spinach, maize, pumpkin, onion, green beans, groundnuts, potato, and cauliflower. Some of the households had few avocado trees near their homes. Comparisons between visual analysis and verbal analysis are indicated in Annexure 2.

Questionnaire: Questionnaires and personal interviews were used during the participatory rural appraisals (See Annexure 1). Conditions were optimised during interviews because the interviews and all the questionnaires were done in the local language, to accommodate old people who do not understand English. Interviews were conducted in gardens (Fig. 2).



Figure 2. Tompi Seleka Agricultural College student trainee doing interviews at Pilgrim's Rest Community gardens

The following techniques were used during the surveying of insects occurring on crops in small scale farming communities:

Collecting with a net: Aerial insects were collected with a light net. The advantages of using a net are its simplicity and speed, high returns for a small cost and it will collect comparatively sparsely dispersed species.

Beating tray or jarring: This method encompasses that a tree is hit sharply with a stick, alternatively branches can be vigorously shaken. Insects were then collected by beating tray that is basically a cloth held by a frame. The tray is flat or slightly sloping towards the centre, and is large enough to collect a representative sample of pests that drop off the tree (Southwood, 1978). This type of technique was used to collect green vegetable stinkbug, *Nezara viridula* (L) (Hemiptera: Pentatomidae); yellow edge stinkbugs (Hemiptera: Pentatomidae), *Nezara pallidoconspersa* (L) (Hemiptera: Pentatomidae) and two spotted stinkbugs (Fig. 3), *Bathycoelia natalicola* (L) (Hemiptera: Pentatomidae).

Exposure by plough: This type of method was used to survey the cutworms, *Agrotis ipsilon* (Hufnagel) (Lepidoptera: Noctuidae). Cutworms were collected by ploughing a transect across grassland and counting those insects exposed in the furrow or on overturned turf.

Yellow card traps: Fly-tac glue was smeared on yellow cards. From there, yellow cards hung in trees. Fruit flies, potato ladybird beetle, *Solanophila dregei* (Mulsant)

(Coleoptera: Coccinellidae) and pumpkin beetles, *Aulacophora abdominalis* (Coleoptera: Chrysomelidae) were stuck to the surface. Glad wrap was used to cover the yellow card traps to enable us to count the trapped insects.

The sensus fly trap: A synthetic sex pheromone (attractant) was used to attract males of the Natal and Mediterranean fruit flies (Fig. 4). The attractant known as Capilure was mixed with the insecticide dichlorvos EC at the ration of 23:1 respectively and 4 ml of mixture was used per trap.



Figure 3: The two spotted stinkbugs. The one on the left is exposed to *Beauvaria bassiana*.

A home made trap from a 2 litre plastic bottle: This method was used to monitor fruit flies which were not attracted to Capilure. The two litre plastic bottle has four

openings on the sides to accommodate a volume of approximately 250 ml at the bottom. A protein attractant such as Hym lure at the rate of 8 ml/1 litre water was mixed with the insecticide trichlorfon SP at 0.5 g/1 l water per trap.



Figure 4: Fruit fly, *Ceratitis sp.*

2.5. Analysis

All information concerning seasonal abundance of different crops grown (planting times), seasonal abundance of insect pests and demographic characteristics were summarised and analysed using the statistical non-parametric tests. Dunn's multiple comparison tests were also used to isolate the groups or determine groups that differ from one another.

2.6. Results and discussions

2.6.1. Demographic characteristics

Most of the plots were owed by women in Pilgrim's Rest. Ninety percent (90%) of all the plots were owed by females who are 45 and 60 years old. Eighty five (85%) of all these farmers in Pilgrim's Rest are literate. Christianity is the most dominant religion in this community. Only about 10% of the people do not belong to any church.

About 60% of all the interviewed farmers in Greater Vhutswema (Tshidzini, Tshifudi, Gaba, Tshaulu, and Mushiru) are pensioners and they are more than 60 years old. Those who are literate contribute only 10 percent. Most of the farmers receive the income in the form of a monthly government grant of R620. Most of the interviewed farmers said that they inherited farming from their parents.

In the Pilgrim's Rest community, farmers were growing vegetable crops with the intention of selling them to the local hotels in the future so that they could get extra income to send their children to school and for home consumption. In the Greater Vhutswema, agronomical crops are produced for subsistence purpose and also selling locally.

2.6.2. Seasonal abundance of different crops grown

Table 1 indicates the different crops that were grown in the study areas and their recommended sowing time. It was discovered in the survey that cabbage, spinach,

maize and potato were the most important crops whereas carrots, lettuce, cauliflower and beetroot were least important crops (Fig. 5).

During the study, some farmers asked where and when some of the crops they are growing originated. The centres of origin of major crops grown by farmers in the study areas are shown on table 2. Classification of different crops according to temperature requirement is indicated on table 3. Table 4 indicates the classification of crops according to accepted use or groupings. Table 5 shows classification of vegetable crops.

Table 1. GENERAL SOWING AND PLANTING GUIDE IN NORTHERN PROVINCE (GREATER VHUTSWEMA) AND MPUMALANGA (PILGRIM'S REST)

Crop	Region	
	Northern (Limpopo) Province	Mpumalanga Province
Beans, broad	April – May	April - May
Beans, dwarf	August – January	February - September
Beans, runner	August – December	February - August
Beetroot	August – October March	February - July
Cabbages	October – November July – March	February - June
Carrots	August – October January – March	February - August
Cauliflowers (early)	November – December	October-November
Cauliflowers (main crop)	December – February	February - March
Cauliflowers (late)	March	March
Groundnuts	November – January	November - January
Maize	July October – December	October - December
Melons, sweet	September – January	January - August
Okra	November – January	November - January
Onions	February – March	February - March
Potatoes	March – September October – December	October - December
Pumpkins	September – December	February - August
Spinach	August – April	February - June
Sweet potato	October – December	October - December
Swiss chard	February – August	February - August
Tomatoes	March – July August – November	January - July

Table 2. Centers of origin of major crops and estimates of domestication

Region	Species	Date
Chinese Center	Cucumber, <i>Cucumis sativus</i>	3000-4000 B.C. (also India)
Central Asiatic Center (Punjab, Kashmir, Afghanistan)	Onion, <i>Pisum sativum</i>	5000-6000 B.C.
	Spinach, <i>Spinacia oleracea</i>	700 A.D.
	Carrot, <i>Daucus carota</i>	500-800 A.D.
Mediterranean Center	Cabbage, <i>Brassica oleracea capitata</i>	2500 B.C. (also N.E. Africa)
	Cauliflower, <i>Brassica oleracea Botrytis</i>	1500 A.D.
Abyssinian Center	Watermelon, <i>Citrullus lanatus</i>	Antiquity
	Okra, <i>Hibiscus esculentus</i>	Antiquity
Mexico and Central America Center	Maize, <i>Zea mays</i>	5000-3000 B.C. (possibly 45, 000 years earlier)
	Bean, <i>Phaseolus vulgaris</i>	5000 B.C. (also S. America)
	Sweet potato, <i>Ipomoea batatas</i>	Antiquity
South American Centers	Tomato, <i>Lycopersicon esculentum</i>	Antiquity
	Potato, <i>Solanum tuberosum</i>	6000 B.C. (Peru, Bolivia, Ecuador, Chile)
	Pumpkin, <i>Cucurbita maxima</i>	2000 B.C. (also Chile)

Source: Yamaguchi, 1983

Table 3. Crops separated according to temperature requirements

Very hardy cool season	Less hardy cool season	Crops adapted to wide range of temperature and frost tolerance	Crops adapted to a wide range of conditions but not frost tolerant	Warm region crops
<ul style="list-style-type: none"> • Beetroot • Cabbage • Spinach • Swiss chard 	<ul style="list-style-type: none"> • Carrots • Cauliflower • Lettuce • Potato 	<ul style="list-style-type: none"> • Onion 	<ul style="list-style-type: none"> • Beans • Cucumber • Pumpkin • Tomato • Sweet corn/maize 	<ul style="list-style-type: none"> • Sweet potato • Watermelon • Groundnuts

Table 4. Classification of crops according to accepted use or groupings

Cole crops	Solanum crops	Legume	Bulb & root crops
Cabbage	Potato	Beans	Onions
Cauliflower	Tomato	Groundnut	Carrot
			Beetroot
Cereal	Vine crops	leafy crops	Herbs
Maize	Cucumber	Lettuce	Okra
		Spinach	
		Swiss chard	

Source: Yamaguchi, 1983

Table 5. Vegetable crops classified as hardy, half-hardy, tender and very tender

Hardy	Half-hardy	Tender	Very Tender
Cabbage	Carrot	Sweet corn	Cucumber
Onion	Cauliflower	Tomato	Okra
Spinach	Lettuce		Pumpkin
	Beetroot		Sweet potato
			Watermelon

2.6.3. Seasonal abundance of different insect pests

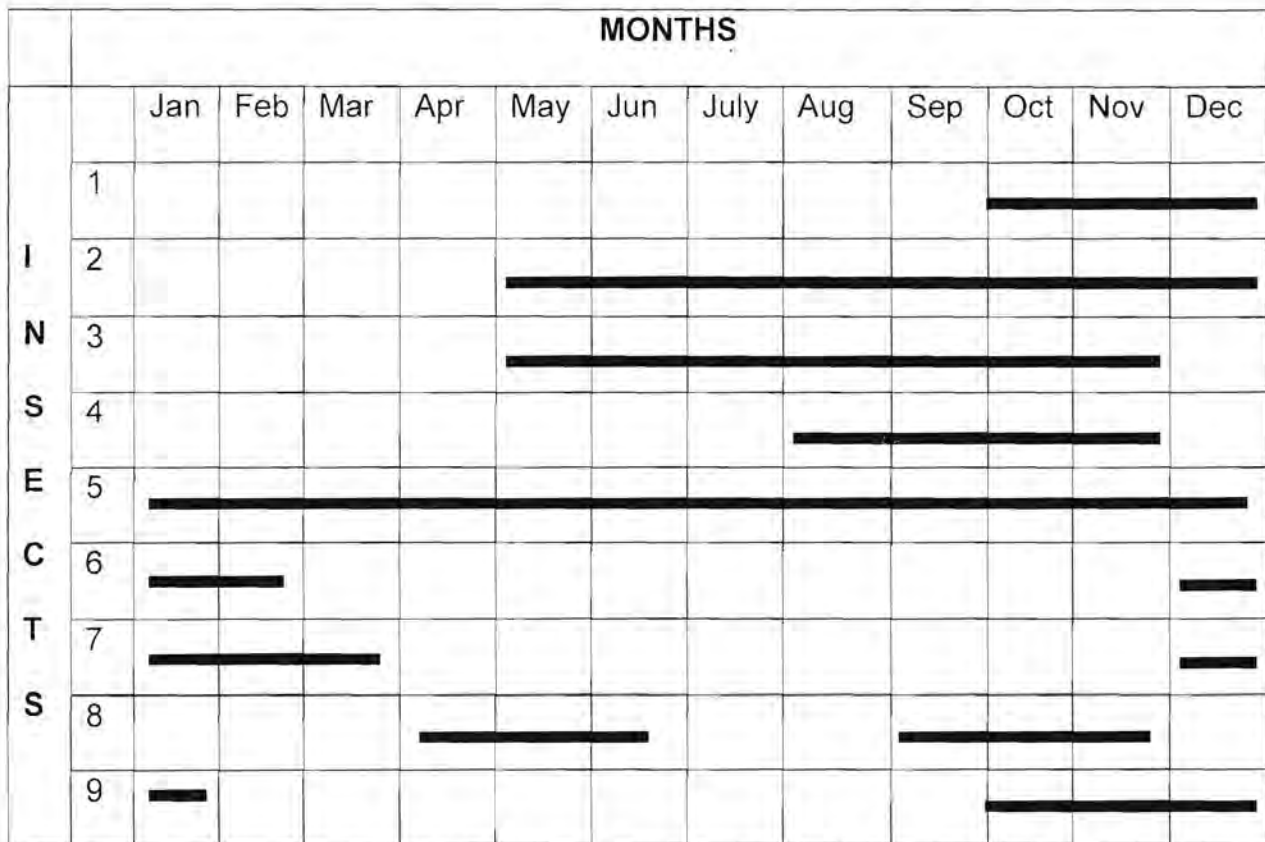
Insects were one of the major constraints in terms of yield loss in many small-scale farming communities in all the study areas. The major constraints affecting agricultural production in the study areas is indicated on figure 1 and 6. Table 3 indicates the different insect pests that were recorded in all the study areas.

Cutworms, *Agrotis spp* (Hufnagel) (Lepidoptera: Noctuidae) and grain weevils, *Sitophilus granarius* (Linnaeus) (Coleoptera: Curculionidae) were reported to have caused decline in yield (see chapter 3 and chapter 4). About 95% of all the interviewed farmers rate grain weevils and cutworms as the major insects that results in the decline in yields in many small-scale farming communities. The identification of these two insects was easy, i.e. farmers were requested to collect all insects they see as destroying their crops. They found cabbage semi-looper, *Trichoplusia ni* (Fabricius) (Lepidoptera: Noctuidae), green vegetable stink bug, *Nezara viridula* (L.) (Hemiptera: Pentatomidae), two spotted stinkbug (Hemiptera: Pentatomidae), American bollworm, *H. armigera* (Hubner) (Lepidoptera: Noctuidae) and pumpkin beetle, *Aulacophora abdominalis* (Fabricius) (Coleoptera: Chrysomelidae). *Ceratitis sp* (Wiedemann) (Diptera: Tephritidae) were also reported to have attacked mangoes, and guavas by those who have a few guava trees around their homes. Table 6 shows different types of insects recorded during the survey. Figure 8 and 9 indicates the seasonal abundance of insects in all study areas.

Table 6: Insect pests recorded during the 1999-2000 field-based pest survey at all the sites in the study areas

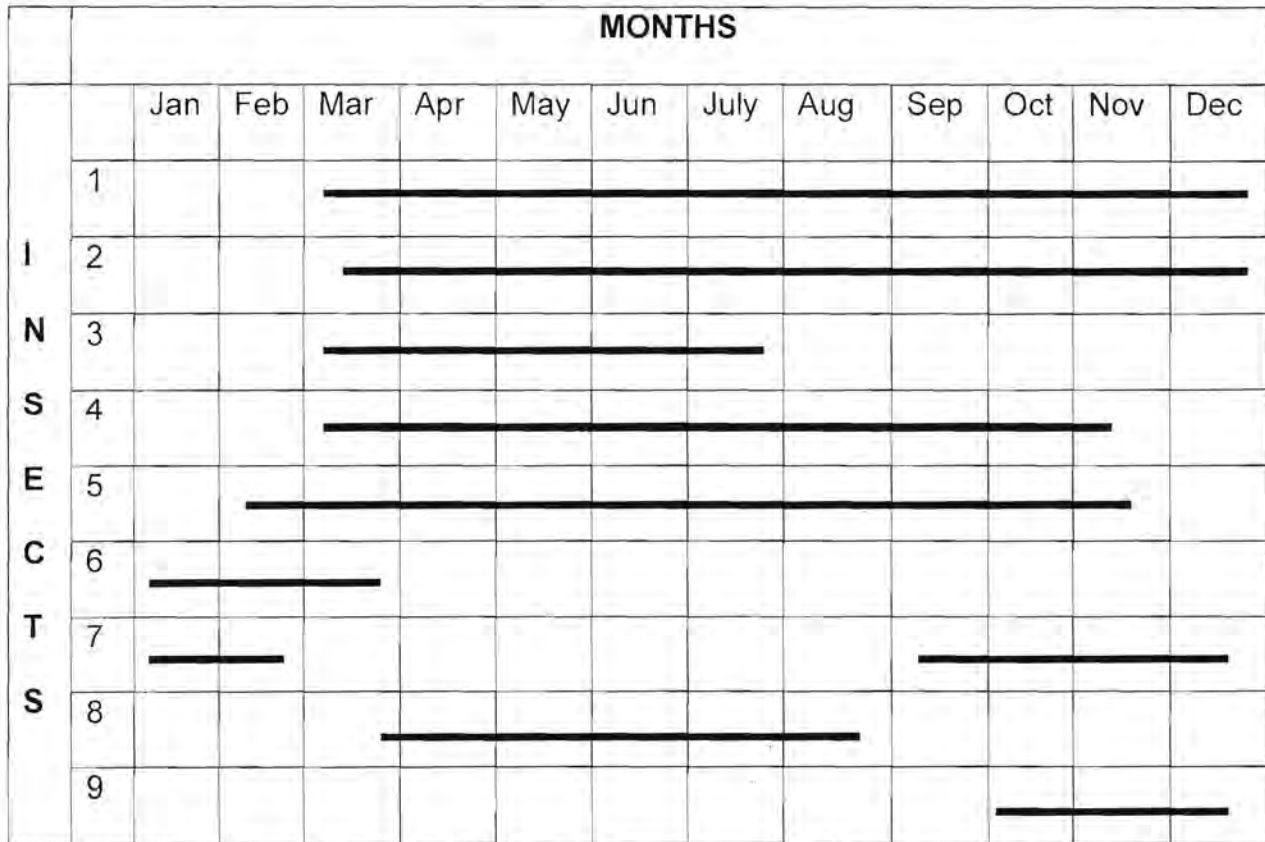
Common names	Scientific names	Author	Order: Family
Cutworms (black)	<i>Agrotis ipsilon</i>	Hufnagel	Lepidoptera: Noctuidae
Cutworms (brown)	<i>A. longidentifera</i>	Hampson	Lepidoptera: Noctuidae
Cutworms (common)	<i>A. segetum</i>	Denis & Schiffermuller	Lepidoptera: Noctuidae
Cutworms (grey)	<i>A. sulbaba</i>	Walker	Lepidoptera: Noctuidae
Grain weevils	<i>Sitophilus granarius</i>	Linnaeus	Coleoptera: Curculionidae
Cabbage semi-looper	<i>Trichoplusia orichalcea</i>	Fabricius	Lepidoptera: Noctuidae
Green stink bug	<i>Nezara viridula</i>	Linnaeus	Hemiptera: Pentatomidae
American bollworm	<i>Helicoverpa armigera</i>	Hubner	Lepidoptera: Noctuidae
Pumpkin beetle	<i>Aulacophora abdominalis</i>	Fabricius	Coleoptera: Chrysomelidae
Fruit flies	<i>Ceratitis sp</i>	Wiedemann	Diptera: Tephritidae
Diamondback moth	<i>Plutella xylostella</i>	Linnaeus	Lepidoptera: Plutellidae
Potato ladybird	<i>Solanophila dregei</i>	Mulsant	Coleoptera: Coccinellidae

Table 7. Seasonal abundance of different insect pests in (Pilgrim's Rest) Mpumalanga Province (Including high and lowveld regions)



- | | | |
|------------------------|----------------------|------------------------|
| 1. Cutworms | 2. Grain weevils | 3. Cabbage semi-looper |
| 4. Green vegetable bug | 5. American bollworm | 6. Pumpkin beetle |
| 7. Fruit flies | 8. Diamond back moth | 9. Potato ladybird |

Table 8. Seasonal abundance of different insect pests in Greater Vhutswema (Tshidzini, Tshifudī, Gaba, Tshaulu & Mushiru) (Limpopo/Northern Province)



- | | | |
|------------------------|----------------------|------------------------|
| 1. Cutworms | 2. Grain weevils | 3. Cabbage semi-looper |
| 4. Green vegetable bug | 5. American bollworm | 6. Pumpkin beetle |
| 7. Fruit flies | 8. Diamond backmoth | 9. Potato ladybird |

It was also found during interviews and discussions women felt comfortable among other women. Oduol (1996) said that to encourage spontaneity and to minimise inhibitions caused by codes of expected behaviour, the researcher should identify discussion groups on the basis of gender, age, educational status, interests and ethnicity.

Questions about the grain shortage

Is grain sold?

Answers given	Frequency	Percent
Yes	68	34.70
No, but home consumption	126	64.30
No, for animal feed	2	1.00
	-----	-----
	196	100.00

Farmers who said they did not plant maize were asked “why not?”

Of those who answered this question (196 respondents)

- About 56% indicated that they already had enough maize on their other fields.

- 32% indicated their decision was due to lack of resources (farms, water, fertilizers, pesticides, tractors, etc.).
- 3 % indicated their decision was based on a choice of how to invest resources, We are not interested (3), We are more interested in growing cash crops (2), Most interested in growing fruits (1)
- 7% indicated a lack of knowledge of tree planting was putting them off doing. [Lack of knowledge 13, If we plant them ourselves they won't grow.

Over 60% of farmers indicated that they have enough grains for their needs and some even said they could sell to their neighbours if they are prepared to pay.

“What do you do when the insect attack is severe”?

When insect attack is severe, most farmers only those who can be able to buy insecticides can buy, only 2%, whereas the rest they just leave the crops. The rest try some various methods.

“Do you think it is worth spending money to control the insects”?

Out of 196 farmers interviewed who gave an answers (other than 'don't know'), 74% said it was worth to control the insects whereas 21% said they thought it was not worth it, and 5% said it was only worth it under 'certain conditions (3 farmers said only if the Government helps).

“Do you take any action to control the insects?”. “If so, what action do you take?”

About 175 farmers who answered said they took no action. Twenty (21) farmers said yes (they cultural and natural pest control).

“If you take no action to control the insects, why not?”

Eighty five percent (85%) of the 175 farmers who answered this question gave lack of resources (or especially money, time, manpower) as the reason (or part of the reason) for not controlling the insects. Ten percent (10%) said the reason was lack of knowledge, two percent (2%) said it was not worth controlling the insects as they had little insect attack and three percent (3%) said that control measures would not be beneficial. Many farmers in the study areas expressed the dislikes of chemical pesticides on the ground of that they would poison the environment.

Summary of the answers

	Numbers	Percent
Lack of resources	45	25.7
Shortage of money	35	20
Lack of time	14	8
Shortage of cash &/or time &/or manpower &/or knowledge	54	30.9
Lack of knowledge	18	10.2
No need	4	2.3
Not beneficial	5	2.9
TOTAL	175	100.0

2.7. Conclusion

It was found that to obtain information from the rural people, a researcher must work hand in hand with the rural people. It was further found that farmers maintained agricultural production levels, sufficient to meet local needs. They used their own knowledge of resources and ecological processes to make rational socio-economic decisions and they used cultural mechanism to prevent excessive resource use.

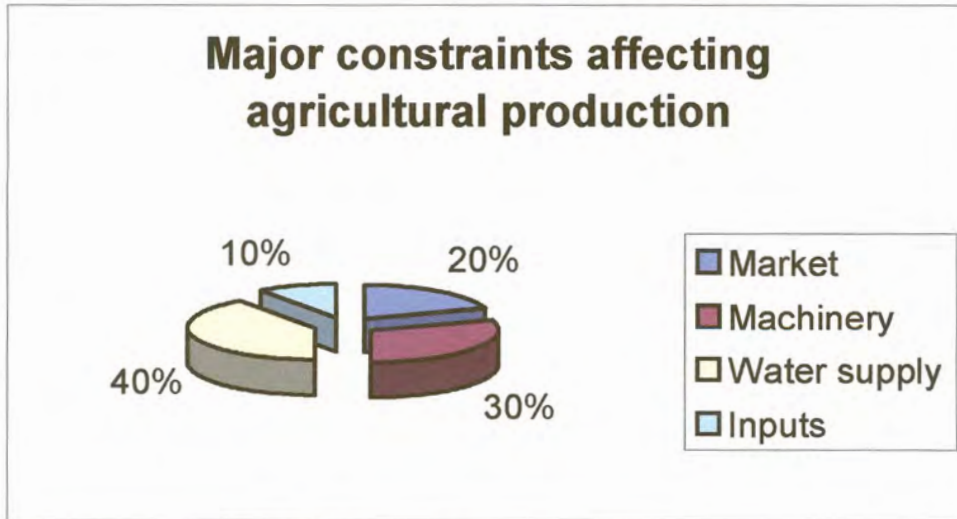


Figure 1: Major constraints affecting agricultural production

Annexure 1: Questionnaire

QUESTIONNAIRE

A. Title: Exploring people's science: an outline for agricultural extension 'feedback survey'

1. Name of person
2. Occupation
3. What do village people produce?
 - farm crops
 - what crops they are growing
 - which crops they consider most important
 - which crops are least important
 - animal products
 - produce for hunting and gathering: e.g. honey, meat, fire-wood, timber, etc.
 - manufacturing and processing: food processing, brewing, brick making, pottery, crafts
 - Services: local medical specialities, midwifery , ritual expertise, music, carving
4. Who produces what?
 - Men activities
 - Women activities

- Are there any activities which might reasonably be undertaken by each household from those requiring the services of specialists
- Are there any activities that are the special province of the poor, the very young or old, e.g. gleaning, water gathering, and spinning?

5. Access to productive resources?

- What is needed to start up each of the productive activities listed?
- How do individuals qualify for rights to land or hunting and gathering opportunities?
- Distinguish between men and women (can women claim land in their own right)?
- Is land bought or sold, leased?
- If inheritance is the main mode of access to land, is this through the father (patrilineal) or through the mother's brother (matrilineal)?
- How are craft workers and other specialists established?
- What kind of apprenticeship is needed (what are the fees of entry to apprenticeship and to professional guilds)?
- What capital resources and equipment are needed for the activities in question?

6. What happens to the product?

- Items produced on a household subsistence basis
- Products and services entering into local exchange?
- Exports to the national and international economy?

- Who controls the distribution of products? e.g. which farm crops belong to women and which to men?
- Which products are intended for the household as a group, which belong to individuals?
- What rights do dependents-youths assisting on the farm, apprentices have to share of the proceeds?
- How is the harvest divided among those who have taken part?

B. Title: Local skills

1. Describe the main farming systems for both field and tree crops?
2. List vegetation and soil management skills?
3. Detail pest control techniques?
 - Are some of the crops damaged by insects?
 - When do they control insects?
 - What methods do they use to control insects?
 - Intercropping to minimize pest damage
 - Bird scaring
 - Fencing and trapping against rodents
 - Storing techniques designed to minimize pest damage
 - Are there local techniques for dealing with insects e.g. local insecticidal/olfactory/fumigational techniques for dealing with the insects?

- Do farmers routinely identify and destroy nests and egg laying sites of potential insect pests (e.g. variegated grasshoppers)?
4. What are the procedures for selecting planting materials?
 5. Are conscious attempts made to improve planting materials?
 6. What characteristics are farmers looking for?
 7. Are such selections undertaken by specialists or is there a wide spread understanding of the principles involved?
 8. Are particular groups sometimes thought to be especially experts in making such selections?
 9. Literacy, numeracy and commercial skills
 - What is the level of literacy in the village?
 - Which groups are literate?
 - What is literacy used for?

C. Facilities, equipment and raw materials

1. Transport? -How does the local transport operate (wet and dry season)
 - Describe procedures/costs for exporting farm produce?
 - Main methods for transporting loads.
2. Water supply?
 - Main water sources in the village?

- How is water obtained for cooking and drinking when farm work is undertaken?
- Is water needed for food processing activities?
- What kinds of vessels are used for carrying or storing water?
- Does the village employ specialist well diggers?
- Are wells privately owned or are they village facilities?
- Who is responsible for their upkeep?

D. Social and political organisation

1. Organization of labour

- What is the pattern of labour?

Annexure 2: OBSERVATION MADE DURING THE INTERVIEW PROCESS
(COMPARISON BETWEEN VERBAL AND VISUAL ANALYSIS)

Comparing verbal and visual	Verbal (Interviews, Conversation)	Visual Field inspection (survey)
What the Researcher did.	The community was asked few questions. Questionnaires were used.	Crops grown by the community were noted down every month. Traps were used to collect insects
What the community did. Community	Reactive respondent	Creative analyst and presenter
Aim	Extracting information from the community	Generating local analysis
Local people's awareness of investigators	High	Low
Degree of eye contact	High	Low
The medium and materials chosen by:	Investigator	Local people
Information flow	Sequential	Cumulative
Accessibility and stability of information to others	Low and brief	High and semi-permanent
Ownership of information	Appropriated by the community	Shared

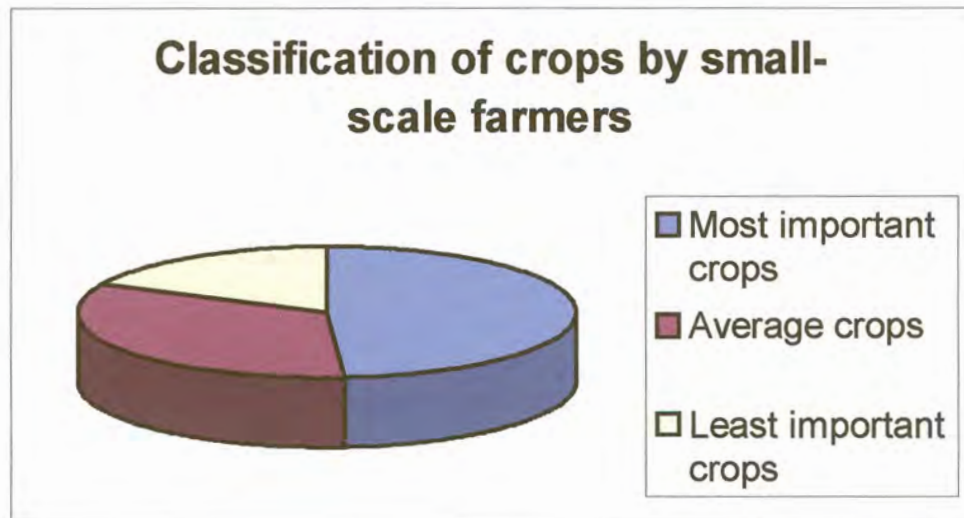


Figure 5: Classification of crops by small-scale farmers

Most important crops: Maize, Cabbage, Tomato and potato

Average: Green beans, Onions, Groundnuts and Pumpkin

Least important: Carrots, Okra, Beetroot and Cauliflower

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3. MANAGEMENT OF STORED GRAIN INSECTS IN SMALL SCALE FARMING COMMUNITIES

Abstract

Postharvest losses are often more significant than crop losses in the field. Small-scale farmers have numerous problems associated with conserving grain safely on the farm. Their main purpose in storing grain is to ensure food supplies for consumption. During the past years, some of the countries in which small-scale farmers suffered heavy postharvest losses due to insect infestations have attempted to counteract these losses through research and training to increase food production.

Keywords: Postharvest, small-scale farmers, grain, storage, insect losses.

3.1. Introduction

Grain quality cannot be improved during storage, which means that the highest level of quality has actually been determined when the grain is first removed from the field at harvest (Higgins & Lippert, 1987). Grain is placed in storage as a massive collection of living kernels- all of which face possible deterioration as one of the unavoidable 'facts of life'.

Maize is one of the major grain crop grown by many small-scale farmers in north eastern South Africa. Between one quarter and one third of the world grain crop is

lost each year during storage (ARC-PPRI: Biennial Report, 1998/99). Maize is very susceptible to storage pests, which take a heavy toll. Grain that is not lost is severely reduced in quality by insect damage. Many grain pests preferentially eat out grain embryos, thereby reducing the protein content of feed grain and lowering the percentage of seeds which germinate (Agriculture in Western Australia, 1998).

Granary weevil, *Sitophilus granarius* (Linnaeus) (Coleoptera: Curculionidae) (also called the grain weevil) is one of the serious pests of stored cereal grains on many small scale farms in the Northern Province, more especially in the Far North, i.e. around Venda (Netshifhefhe, 2001). They attack whole seeds and they are pests of stored grains (Charles, 1998). The adults burrow into the maize grains (Higgins & Lippert, 1987).

3.2. Importance of stored grain pests

The climate in Limpopo Province (Greater Vhutsiwema) is very warm and hot (humid and dry), and this particular climate is conducive to grain storage problems. Economic losses caused by stored grain insects can be measured in several ways (Brown, 1994). He further said more importantly, infested grain results in dissatisfied customers and poor reputation in marketing channels.

The reduced nutritional value of feed and a lower percent germination are also the results of insect damaged grain. Infestations also cause contamination, odor, mold,

and heat-damage problems that reduce the quality of the grain and may make it unfit for processing into food for humans or animals (Hagstrum *et. al*, 1995)

Farmers must also consider the loss of time and money it took to initially produce the grain. In other words, farmers must try to balance the management of field insects and storage pest. Storage losses are often equal to or greater than field losses.

3.3. Kinds of stored grain insects

Several species of insects may infest grain in storage (Anonymous, 1986). Adult and larval stages of beetles and larval stages of moth are the principal insect pests that cause damage. Stored grain insects can be grouped into four major groups, namely, internal feeders, external feeders, scavengers and secondary pests (Brown, 1994).

- Internal feeders: They enter the kernel as very young larvae and spend most of their life cycle inside the kernel (Brown, 1994). They cause an obvious hole in damaged kernels where the adult insect exits the kernel to mate and begin the next generation. The granary weevil, rice weevil, *Sitophilus oryzae* (Linnaeus) (Coleoptera: Curculionidae), lesser grain borer, *Rhyzopertha dominica* (Fabricius) (Coleoptera: Bostrichidae) and larvae of the Angoumois grain moth, *Sitotroga cerealla* (Olivier) (Lepidoptera: Gelechiidae) are examples of internal feeders.
- External feeders: The external feeders are also referred to as bran bugs. They feed on grain dusts and cracked kernels and grain debris without entering the

kernel. In other words, they feed from the outside of the grain, even though the internal seed embryo may often be the tissue upon which they prefer to feed (Brown, 1994). Examples of external feeders include, Indian-meal moth, *Plodia interpunctella* (Hübner) (Lepidoptera: Pyralidae), sawtoothed grain beetle, *Oryzaephilus surinamensis* (Linnaeus) (Coleoptera: Silvanidae) and cadelle, *Tenebroides mauritanicus* (Linnaeus) (Coleoptera: Trogossitidae). Other species, such as the foreign grain beetle, *Ahasverus advena* (Waltl) (Coleoptera: Silvanidae) and hairy fungus beetle, *Typhaea stercorea* (Linnaeus) (Coleoptera: Mycetophagidae) that feeds on molds or fungi growing on grain stored at extensive moisture levels (Noyes *et al.*, 1995).

- Scavengers: This particular group of insects feed on grain only after the seed coat has been broken, either mechanically or by another insect. They are the primary pests in milled products such as flour or meal. Examples of scavengers are the red flour beetle, *Tribolium castaneum* (Herbst) (Coleoptera: Tenebrionidae), confused flour beetle, *Tribolium confusum* (Jacquelin du Val) (Coleoptera: Tenebrionidae) and sawtoothed grain beetle.
- Secondary pests: They are associated with poor quality grain that is often high in moisture content and moldy. The hairy fungus beetle and yellow mealworm *Tenebrio molitor* (Linnaeus) (Coleoptera: Tenebrionidae) are examples of secondary pests.

Grain weevils were discovered and regarded as one of the major stored grain stored insect in the Limpopo Province. About 60% of the stored grain in rural areas of the Limpopo Province were lost due to damage by grain weevils.

3.4. Literature review

3.4.1. Description

Grain weevils belong to the order "Coleoptera" (sheath-wings) and the family Curculionidae (Scholtz & Holm, 1996).

Weevils are characterised, generally, by having a snout. In some members, the snout is used to feed on seeds, or to create sites for oviposition (egg-laying) (BugPeople.org, 1998). Members (weevils) are diverse biologically and may include root-feeding, leaf-mining forms and stored products infesting (Heirichs & Miller, 1991).

Weevils are insects with cylindrical bodies and a pronounced rostrum (snout) equipped with mouthparts which are used by females as a boring tool. They also have elbowed, clubbed antennae set on the rostrum and four segmented tarsi (Charles, 1998).

3.4.2. Distribution

Grain weevils are distributed throughout the tropics and subtropics (Stoll, 2000). They are also encountered in all temperate and warm-temperate climates and are widely distributed in grain stores throughout Venda. Infestations arise as a result of the exchange of maize seeds between neighbours.

3.4.3. Significance

The grain weevils are important pests of stored grains. They are frequently regarded as primary pests of grain since they are able to infest otherwise undamaged grain. The following damage may be caused by the grain weevils (www.blackpool.net/sbwalsh/weevils.htm):

- ❖ Reduction in weight and quality of grain as a result of the larvae feeding on the endosperm. The germ is not always attacked so germination may take place, producing a weak seedling which is vulnerable to attack by moulds, bacteria and other insects. Both larvae and adults will feed upon grains.
- ❖ Tainting with white, dusty excreta which contaminate the product as well as rendering it unpalatable.

3.4.4. Host plants

Grain weevils are primarily pests of stored grain (Stoll, 1986). Wheat, maize, oats, barley, sorghum, buckwheat, rye, rice, stored cotton, table beans, cashew nuts and macaroni are some of the food stuffs attacked by the grain weevil (Charles, 1998). Other crops such as grapes, apples and pears were reported to be attacked by adult grain weevils that burrow into the seeds (Charles, 1998).

3.4.5. Life cycle

Adult grain weevils (Fig. 1) are small, chestnut brown to dark brown, strongly built beetles, about 3 mm long with elongated snouts (Myburgh, 1989). The mouthparts are at the tip of the snout. The weevils do not have wings under the wing covers and the thorax is well marked with longitudinal punctures. They have functional wings and four light-coloured patches on the wing covers. Their larvae are soft, white, fleshy and legless. The pupae are naked, white and soft, also within the kernel.

The females bore a small hole in the grain in which to lay their oval white eggs which is closed with a mucilaginous plug of saliva (secretion) (Stoll, 1986). At about 18°C to 20°C, the eggs hatch in 8 to 11 days to give small, white, legless larvae which feed on the endosperm of the grain (www.blackpool.net/sbwalsh/weevils.htm). The larvae hatch and make their way to the germ of the grain where they develop further until they are about 4 mm long (Stoll, 2000). One larva develops in small grains such as wheat and rice but large grains such as maize will support the development of

several weevils. The larvae develop entirely within the grain. They moult four times and finally pupate within the grain after 6 to 8 weeks. The adults emerge after 5 to 16 days and will live for about 9 months. Small 'windows' in the grain are characteristic of infestation. After pupation, the weevils emerge through the prepared exit holes.

3.4.6. Damage

The grain weevils are the most destructive pests of stored grains (Fig. 2) in the world, frequently almost completely destroying grain in elevators, bins, ships and anywhere else where physical conditions for growth are favourable and the grain is left undisturbed for some time (Charles, 1998).



Fig. 2. Maize grains damaged by granary weevils

Both the larvae and the adults feed on all kinds of cereal grains. Damage is caused by the larvae feeding on the grain and often leaving it completely hollow (Stoll, 2000). The larvae can only feed on the inside whereas the adults on the outside (Fig. 3).

The larva spends its entire life within a single grain kernel (Myburgh, 1989). He further indicated that when the adults emerge from pupae, they eat their way out, leaving the grain through a pinhead-sized hole and they then continue feeding on the outside.

Charles (1998) noted that the adults may also feed on flour and other milled cereals. He further said, these individuals are probably migratory, and will not lay eggs, since the larvae need whole kernels in which to develop (Charles, 1998). Hardcaked flour may, however, encourage egg laying.



Fig. 3. Adults granary weevils feeding on the outside of the kernels or grains
(Source: Myburgh, 1989)

3.5. Material and Methods

When choosing quantitative research, it is important to note that the researcher functions independently of the subjects with little or no interactions or interference. Data collection tools used in quantitative research include experiments, interviews and questionnaires. For the purposes of this study the following methods were used for data collection: literature review, questionnaires and interviews.

Sampling: Infestations can only be detected and evaluated through a sound-sampling program. Remember those areas within the grain mass that show a 10°F or greater difference from the average bin-wide temperature should be intensively sampled.

Stored insects can be sampled in many ways namely, grain triers, bullet or torpedo, vacuum probes, screens and sieves, plastic grain probe or pitfall traps and sticky traps baited with pheromones (volatile chemical sex attractants) (Lippert & Higgins, 1989).

Three major types of sampling devices were used during the survey namely, probes, traps, sieves and screens (Hagstrum *et al.*, 1995).

- Probes: They are called bullet or torpedo probes, and sometimes called deep bin cups. They consist of a short hollow tube or container that collects a small amount of grain (about one pint is typical). This device is inserted into the grain mass manually. A quick upward pull opens the sampling chamber so it can fill with grain from one narrow layer.
- Traps: plastic grain probe traps are elaborate pitfall traps. The plastic tube may contain many small holes, through which insects (mainly beetles) fall as they move about in the grain. These traps contain a vial and funnel device to retain the insects entering them. The traps may also be baited with an appropriate pheromone to increase the capture of selected insect species.

- Sieves and screens (Fig. 4): This particular method was a common practice by small scale farmers in the Limpopo Province to sample stored grain pests, especially grain weevils.



Fig. 4. Traditional way of sieving grain weevils

Figure 4 shows how to separate grain weevils and maize grains.

Sampling tips

Lippert & Higgins (1989) said that the following are the tips for successful grain storage:

- Grain in storage should be sampled at least once a month when the average grain temperature is above 50 degrees and in-bin conditions are relatively stable.
- Bi-weekly or even more frequent sampling is justified in situations where problems have been detected and before conditions stabilize just after binning.
- Check the grain thoroughly if pockets of high moisture, high temperature and beginning signs of insect infestation are detected.
- Be alert if any of the following are detected:
 - Grain mass smells musty or has other unnatural odors associated with it.
 - Temperature variations approach or exceed 10 degrees F.
 - Water vapour is visible.
 - Signs of sprouting are found.
 - Snow is melting off the bin faster than from other unheated building roofs.

The traditional healers or the inyangas (nanga: a Venda word) who are living in close proximity to the targeted communities were consulted. Some of the visited inyangas include: Mrs Annah Tshivhandekano from Mangondi and Mr Wilson Nkhumeleni from Mukula, Mr Tshamudavhini Munyai from Mutale, Mrs Marium Tshikhudo from Mbahe and Mr Thari from Sibasa (Miluwani) (both in the Northern Province in the

former Venda Homeland). They were asked of different types of indigenous trees they use to control insects, most importantly grain weevils.

What farmers were practicing in both study areas to control storage pests were also noted.

3.6. Results and discussions

In order to come to a more objective conclusion, the researcher chose an exploratory descriptive research design based on a cross-sectional survey method. Exploratory descriptive research design of a quantitative nature was chosen because of its ability to capture the information needed to answer questions about storage grain pests, especially the grain weevils and their control in the study areas. It is important to note that the aim of exploratory research is to look for patterns, ideas or hypotheses, rather than testing or confirming a hypothesis and that a descriptive research describes phenomena as they exist, (Hussey & Hussey, 1997). Quantitative research is preferred because it is objective in nature and concentrates on measuring phenomena. Thus quantitative studies are mainly concerned with the degree to which a phenomenon possesses certain characteristics, similarities, and differences unlike qualitative studies that are concerned with understanding human behavior from the participant's own frame of reference. Again, the design is suitable for measuring reactions of many respondents on a given set of questions, at a given point in time, facilitating comparison and statistical aggregation of a vast amount of

data. This allows for broad and generalizable findings (Rubin & Habie, 1989). In overall, the descriptive survey is the method of research that looks with intense accuracy at the phenomena of the moment and then describes precisely what the researcher sees.

It was discovered during the survey that Muonze (Venda)/ Tambotie (Afrikaans)/ Morekuri (Northern Sotho)/ umThomboti (Zulu), *Spirostachys africanus* (Fig. 5) is used for the control of grain weevil. *Spirostachys africanus* bark was removed from a tree and put inside the traditional silo (dulu) (Fig. 6).

Some of the interviewed farmers also mentioned the use of ashes, goat dung and cow dung for control of the grain weevils.

Grain weevils were collected and put in two separate traditional grain silos. The first one was a control and in the second one, *Spirostachys africanus* bark was put inside. Five hundred grams of wet bark was placed in a box containing fifty grain weevils. Nothing was done to the bark. Shelled grains were put inside the box and two unshelled cobs.

The tree was identified by the Department of Botany of the University of Venda for Science and Technology by Mr M.P. Tshisikhawe and Mr Mabogo.



Fig. 5. Tambotie tree, *Spirostachys africanus*

Brief description of *Spirostachys africanus*

Common name: Muonze (Venda), Tambotie (Afrikaans), Morekuri (Northern Sotho), umThomboti (Zulu) and Tamboti (English).

Botanical name: *Spirostachys africanus* (Fanie & Venter, 1996). This is a semi deciduous to deciduous tree up to 18 m tall. All parts of the tree exudes a toxic milky substance.

Uses

The milky latex is very toxic and can cause blisters on the skin and severe pain and/or damage to the eyes (Fanie & Venter, 1996). Latex can also be used to poison fish. The wood is unsuitable for fuel or for roasting meat. They also stated that the milky latex is extremely toxic when heated, resulting in severe diarrhea if meat roasted on coals from its wood is eaten. In severe cases, death may result.



Figure 6. Traditional grain silo (Dulu in local language) used for storing maize grains

Mr Nkhumeleni and Mrs Tshivhandekano stated that you could also use the same tree to:

- Heal wounds
- Stop bleeding
- Stop head ache

It was found that *Spirotachys africanus* has got some insecticidal properties through the small experiment that was done in two of the selected traditional grain silos. It was found that in one of the silo for experiment, 115 weevils were dead out of 250 where as in the control, only 57 weevils out of 250 were reported dead after five weeks.

The other methods of getting rid of grain weevils by indigenous people of Venda is by sieving (u fhefhera).

3.7. Storage pests management techniques

- **Preparing the storage bin**

Grain residues from previously stored grains should be removed from the bin walls, floors and ceiling (Brown, 1994). Silos must be prepared prior to harvest. Small farmers in the study areas usually cleanup their traditional silos before storing the new grains. All the silo base openings were sealed with cow dung. This helps in

restricting insect access to the top of the structure where it can be more easily monitored. Clean insect free-free storage environment is essential to effective insect management.

The following should be used two or more weeks before grain is placed in bins (<http://www.entm.purdue.edu/entomology/ext/targets/publicat.htm>):

- Brush, sweep out and/or vacuum the combine, truck beds, transport wagons, grain dumps, augers, and elevator buckets to remove insect-infested grain and debris.
- In empty bins, thoroughly sweep or brush down walls, ceilings, ledges, rafters, braces, and handling equipment, and remove debris from bins.
- Remove all debris from fans, exhaust, and aeration ducts (also from beneath slotted floors, when possible).
- Remove all debris from storage site and dispose of it properly according to area, state, and/or federal guidelines (this debris usually contains insect eggs, larvae, pupae, and/or adults, all ready to infest the new grain).
- Remove all debris and vegetation growing within ten feet of the bins (preferably the whole storage area).
- Examine area to determine if rodent bait stations are require, and use if needed. Be sure to follow all label directions.
- Spray cleaned area around bins with residual herbicide to remove all undesirable weedy plants.

- If the grain is expected to remain in the bins for at least a year, fumigate the area beneath the slotted (drying) floors with a formulation of Chloropicrin according to label directions (only certified applicators may purchase and apply)
- If newly harvested grain and/or insect free grain must be added to grain already in storage, the latter must be fumigated with either aluminum phosphide or methyl bromide.

- **Preparing the grains**

Before storing the grains, all foreign materials are removed. Small farmers usually dry their seeds before storing using the sun. Brown (1994) said that the grains should be properly dried before storage. Grain with excess moisture is very attractive to insects.

Maximum moisture content for storage of aerated grain	
Grain type and storage time	Maximum moisture content
Shelled maize and sorghum	
Sold as #2 grain by spring	14%
Stored 6 to 12 months	13%
Stored more than 1 year	12%
Values for good quality, clean grain in aerated storage	
<p>Note: Reduce moisture content by 1% for poor quality grain such as grain damaged by blight, drought, etc. Reduce moisture content by 2% for non-aerated storage</p>	

Source: Brown, 1994

Stored grain insects cannot live on extremely dry grain (less than 10 percent), however, it is impractical to reduce grain moisture much below minimum moisture levels necessary for long term storage. Insect activity and reproduction are favoured by high grain moisture (14 percent or more), especially when condensation and molds occur, and fermentation raises temperature in the grain mass (Keith, 1999).

- **Sanitation**

This is used to limit the rate of insect migration into stored grains from infestation sites in bin bottoms, nearby stored grain, or other places where grain, grain dust, or

grain based materials accumulate (Reed *et. al*, 1995). Combine and other harvesters, transportation equipment, conveying equipment, and storage structures should be clean and existing insect infestations eliminated before new grain is stored. Inspect feed production and feed ingredient storage areas often especially in warm weather.

- **Temperature manipulation**

The grain storage temperature must be maintained as low as possible to reduce insect reproduction (Hedges & Lacey, 1996). Condensation of moisture in the grain mass is prevented by slowly reducing the gradient between the grain mass temperature and the outside (ambient) temperature.

- **Rotation**

Grain stocks may be rotated, or moved and a grain protectant applied at the time of turning.

- **Trapping**

Grain stored insects can be monitored with special traps.

3.8. Natural crop protectant chemicals

The use of plant derivatives for insect pest control was common in tropics before the advent of synthetic pesticides (<http://ippc.orst.edu/ipmafrica/elements/ncpp.html>). It

was further stated that the very earliest insecticides- nicotine, pyrethrins and rotenone, were derived from plants (1987). Many of these products have been discovered and utilised because they were locally available, which is often a serious constraint with synthetic crop protection chemicals.

Natural products (Table 1) used for post harvest problems have been classified under three categories; plant materials, admixtures of inert materials, and heat and smoke (Stoll, 2000). DNCPC broke their list of materials used as protectants of stored products into; whole plants or parts of plant, plant extracts, oils, ashes, minerals, and miscellaneous materials. Another method of classification could be based on mode of action, e.g. antifeedent, repellent, hormonal effects, attractants, defensive chemicals, etc. The following list, and text material was collected from literature reports, non-published reports and surveys, and personal communication with farmers, extension officers and crop protection specialists throughout sub-Saharan Africa.

Table 1: Natural products used, with potential use, for crop pest control in Sub-Saharan Africa

Scientific name	Common name	Product use
<i>Allium sativum</i>	Garlic	Field Pests
<i>Anacardium occidentale</i>	Cashew	Storage
<i>Allium cepa</i>	Onion	Field Pests, Storage
<i>Anona sp.</i>	Custard apple	Field pests
<i>Azadirachta indica A. Juss</i>	Neem	Field, Storage
<i>Calendula officinalis</i>	African marigold	Field
<i>Capsicum frutescens</i>	Hot peppers, Chillies, Bird's Eye Chillies	Storage
<i>Chenopodium opalifolium</i>	Lamb's quarters	Storage
<i>Chrysanthemum (Pyrethrum) cineariaefolium Vis.</i>	Pyrethrum	Storage
<i>Citronella rhamil</i>	Citronella	Storage
<i>Colophospermum mopane</i>	Mopani	Storage
<i>Cupressus lusitanica</i>	Cyprus hedge	Storage
<i>Derris elliptica and D. trifoliata</i>	Derris, Rotenone, tuba root	Field
Dung	Manure	Field and Storage
<i>Eleusine indica</i>	Millet husks	Storage
<i>Eucalyptus spp.</i>	Blue gum	Storage
<i>Kniphofia snowdenii</i>	Red Hot Poker	Field
<i>Lantana camara</i>	Lantana	Storage
<i>Lonchocarpus bussei</i>	Rotenone, Derris, Cube	Field and storage
<i>Lycopersicon lycopericum</i>	Tomato	Field

<i>Melia azadarach</i>	Persian lilac, syringa, chinabery	Storage
<i>Musa sapientium</i>	Banana juice	Storage
<i>Nicotiana tabacum</i>	Tobacco, Foja	Field and storage
<i>Ocimum suave</i> Willd.	Basil	Storage
<i>Ocimum basilicum</i>	Sweet basil	Storage
Paraffin	Kerosene	Field and storage
<i>Phaseols spp.</i>	Bean Chaff	Storage
<i>Picrasma quassiodie</i>	Quassia chips	Field
<i>Piper nigrum, Piper spp.</i>	Black Pepper	Storage
<i>Rheum raphonticum</i>	Rhubarb	Field
<i>Ricinus communis</i>	Castor bean	Field and storage
<i>Spirostachys africana</i>	Tamboti	Field and storage
<i>Syzygium aromaticum</i>	Cloves	Storage
<i>Tagetes minuta</i>	Mexican marigold, Black jack	Field
<i>Tamarindus indicus</i>	Tamarind	Field
<i>Urtica sp.</i>	Stinging nettle	Field
<i>Zingiber officinale</i>	Ginger	Storage

Source: Stoll, 2000

Goat dung has also proved to be useful in plant protection mostly in the control of stored grain pests. Traditional maize silos, in which the outer walls are made of

maize cobs, are sprayed with goat dung solution. Probably the strong smell deters insect pests as well as the goats themselves from attempting to eat the stored grain (Stoll, 2000).

Cow dung was also proved to be repelling grain weevils. Two to three cow dung patches were mixed with ten litres of water in a bucket and stirred daily for fourteen days. Stone and clay dust can be sprinkled into the bucket if smell becomes unpleasantly strong (Stoll, 1986). After two weeks the mixture is sprayed around the traditional grain silos.

The other indigenous method is by burning the dried cow dung and there after, spread the ashes where the maize is stored or in the traditional grain silos.

3.9. Conclusion

Stored grain pests are the most pressing constraints to the crop production in the small-scale farming communities in Venda. They can cause losses of 10 to 50% and damage of 23 to 80% after 2 to 4 months of storage (Rowland, 1993). On the other hand, maize is the staple food in all parts of Venda. The grain weevil, *Sitophilus granarius* is one of the most important storage pests of maize.

The control measures start with proper storage. Cool and well ventilated storage conditions provide an unfavourable environment for these and many other pests of stored grains. Stores must be free from weevils and only clean seeds should be stored. Maize varieties with unexposed ears are likely to escape infestation in the field, minimizing the chances of infestation in storage.

The use of *Spirostachys africanus*, muonze or a tamboti tree was among other indigenous practices used by small-scale farmers around Venda (Northern Province). The other methods include: removing the weevils by means of sieving (u fhefhera).

Turning of storage sacks was among the methods used by small-scale farmers in controlling grain weevils in some parts of Venda. The principle behind this practice is that moving the sacks, the grains inside are also moved and thus prevent the young larvae of the pest from penetrating into the interior of the grains. The sacks are normally turned twice a day, i.e. in the morning and evening. Drying is an important procedure in storage protection. It prevents the germination of seeds, growth of bacteria and fungi. A moisture content of not more than 12-13% is essential before seeds are safely stored (Purseglove, 1992). A prolonged exposure of stored grain pests to temperatures greater than 35°C is fatal (Songa and Rono, 1998). Most of the small-scale farmers around the Venda area are exposing their maize grains to

the sun (Fig. 3.8). Maize may also be dried by hanging it over a traditional kitchen 'tshitangani' fire.

Tobacco, *Nicotiana tabacum* leaves and stalks are the plant parts used in crop protection (Watt & Brandwijk, 1962). Nicotine is one of the most toxic organic poisons. Tobacco sprays are more effective when they are used at temperatures above 30°C (Lal, 1955). Nicotine spray can be prepared by soaking 1 kg of bruised tobacco stalks and leaves in 15 litres of water for one day. A small handful of soap is added as adhesive agent. The spray is applied to the stored maize grains in the traditional silos.

Nicotine solution is also effective against caterpillars, beetles, stem bores, leaf miners, aphids, thrips and creatures which pass some stage of their life cycle in the soil, like cutworms (Conacher, 1980).

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4. MANAGEMENT OF CUTWORMS, *AGROTIS SPP.* (LEPIDOPTERA: NOCTUIDAE) BY RESOURCE POOR FARMERS IN LIMPOPO PROVINCE

Abstract

Insects are one of the major constraints in terms of yield loss in many small scales farming communities in Africa. Some of the small scale farmers do not even know how to identify major insect pests, and subsequently do not know when the populations of these insects are at the peak, and what is the necessary step to be taken to control these major pests. Cutworms are among the major insect pests that cause reduction in yield in small scale farming operations.

Key words: Cutworms, *Agrotis spp.*, resource poor farming, insects, control.

4.1. INTRODUCTION

Cutworms (Figs. 1 and 2) are the larvae of several species of night-flying moths (Myburgh, 1989). They are very serious pests of most vegetables and also of many other plants (Walters *et. al*, 1988). There are many species of cutworms. Many are smooth, soft-bodied, plump caterpillars. Cutworms are solitary feeders found in the soil, however some species occasionally attack the foliage and/or fruit of some vegetable crops. They vary from brown or tan to pink, or grey and black. They are all one colour, others spotted or striped. They larvae are dull, others appear glossy.

4.2 LITERATURE STUDY

◆ Description

Cutworms are classified into four or 'many' species, i.e. common cutworms (*Agrotis segetum*), black cutworm (*Agrotis ipsilon*), grey cutworm (*Agrotis subalba*) and brown cutworm (*Agrotis longidentifera*) (Walters *et al.* 1988). Common cutworm is widely distributed in Africa, Europe, and Asia whereas black cutworm is found in all continents but grey cutworm is found in sandy areas of western and south-western Cape and the brown cutworm is found in Transvaal (Walters *et al.* 1988). The pale western cutworm (*Agrotis orthogonia*) destroys considerable wheat in the dryland section of Montana, North Dakota, Kansas and other states (Martin *et al.*, 1976)

Cutworms are usually found 2-5 cm under the soil surface, near "felled" seedling. They are active during the night and eat through the stems of seedlings, either just above or just below the soil surface. Moths (Fig. 3) have greyish or brownish forewings in appearance that have dark brown or black markings (Annecke & Moran, 1982). Eggs are laid during the night (Daiber and Coertze, 1997). Eggs are laid in autumn and winter.

◆ Distribution

Cutworms are widely distributed in Africa, Europe, and Asia (Stoll, 1986). It is a serious pest in America too (Stoll, 1986). They occur mostly after the first summer rainfalls. The common cutworm, *A. segetum* is the most abundant species in South

Africa with *A. ipsilon* probably in the second place (Annecke & Moran, 1982). The brown cutworm, *A. longidenifera* is not infrequent in Transvaal while in the Western Cape the grey cutworm, *A. subalba* is often locally very plentiful especially in coastal sandy areas.

◆ Host plants

Attacked plants are attacked in the seedling stage. Cotton and certain vegetables sometimes have stand reductions. Climbing cutworms can be serious foliage feeders on some crops such as peanuts (Roberts *et al.* 1999). Their primary host plants are vegetables and roots whereas maize, tobacco and coffee are the secondary host plants (Stoll, 1986). They are general feeders and attack almost any kind of succulent young plant and even grass. The caterpillar is a world-wide pest, attacking leaves, stems, and roots of many agricultural crops listed on table 1. Among the above mentioned crops, cutworms also attack beans, pumpkin, beet, broccoli, cabbage, peas, pepper, onion, rhubarb, carrots, cauliflower, cucumber, lettuce, melon, spinach, tomato, potato, wheat, barley, and rice (Hemy, 1984). An extensive listing of hosts of cutworm may be found in Rings *et al.* (1975).

◆ Damage

There are many species of cutworms. They all feed on plants by chewing. They destroy more of the plant than they eat. Cutworms injure plants in four ways (Nielsen, 1998):

- Solitary surface cutworms cut off young plants just at, or slightly above or below the soil line (Fig. 4), sometimes dropping the severed plants into their burrows.
- Climbing cutworms (Fig. 5), usually variegated, *Peridom saucia* Hubner (Lepidoptera: Noctuidae) and spotted ones, *Amanthes c-nigrum* Hubner (Lepidoptera: Noctuidae), climb stem of trees, shrubs, vines and crops and eat the leaves, buds and fruit.
- Subterranean cutworms such as sandhill cutworm, *Euxoa detersa* Walker (Lepidoptera: Noctuidae) which is pale in colour and glassy, *Crymodes devastator* Brace (Lepidoptera: Noctuidae) remain in the soil and feed upon roots and underground parts.
- Army cutworms occur in great numbers, consuming the tops of plants and then marching on to other fields.

◆ Life cycle

Life cycles vary among the different species (Roberts *et al.*, 1999). The life cycle from egg to adult is completed in 32 - 67 days (Kessing & Mau, 1991). The duration of the life cycle is governed by temperature. Kessing and Mau (1991) said in temperate regions, the larvae overwinter and pupate in the late spring.

Eggs: Adult females of *A. segetum* lay 1 000 or more eggs while *A. ipsilon* lay 2 000 or more eggs (Annecke & Moran, 1982). Eggs are laid singly or in small clusters primarily on leaves and hatch in 2 - 9 days. They are often found in the soil or on the lower parts of the plants. Eggs of *A. segetum* hatch after one week, i.e. 4-14,5 days and those of *A. ipsilon* hatch in 3 to 13 days. The creamy white eggs are globular with a ribbed surface and are approximately 12.5 mm in diameter (Hill, 1983).

Larvae: Newly hatch caterpillars are 6.25 mm long and the mature larvae are 500mm long (Kessing & Mau, 1991). Cutworms pass through six larval stages at the temperature ranging from 15°C to 33°C. The larvae are thin, cylindrical and dark brown to greasy in colour with faint lighter stripes running laterally on each side of the body. The mature larvae of *A. ipsilon* are blackish in colour and up to 35 mm in length while those of *A. segetum* are of the same size but brownish in colour. The head is brown with two white spots. Larval development takes from 28-34 days (Hill, 1993). The larvae overwinter in soil, especially in grassy or weedy situations (Drinkwater *et al.*, 1998).

The larvae emerge and remain in the ground, unprotected or in earthen cells, until the end of winter. They rely on winter weeds as their food source. After the eggs are hatched, they move into the ground where they settle close by a host plant. They are 20-50 mm long when fully grown.

Pupae: The pupation takes place in the ground (Stoll, 1986). He further stated that pupation lasts 10-30 days. Pupae are dark brown and are about 18.75 mm in length.

Adults: After pupation, a turnip moth with a wing span of 30-40 mm and the forewings which are grey-brown with dark brown or black kidney-shaped markings emerge (Stoll, 1986). Hind wings are almost white except for dark fringe at tips and are folded under the forewing when adult is inactive (Hill, 1993). The body is grey. The light grey larvae hatch out in the spring (Martin *et al.*, 1976). Several generations may occur each year, but overwintering larvae and the first generation in the spring are the most damaging.

The caterpillars are the most troublesome. They are very dangerous particularly to transplanted seedlings as well as young plants of field-sown crops (Stoll, 1986). He continued by saying that the caterpillars remain in the ground during the day where they feed on the roots of the host plants. During the night, they emerge and feed on the stems of young plants that fall over as a result and entire rows can be destroyed. Roots and tuber crops are also damaged. They work in the upper soil surface and chew seedling stems at or just below the soil level (Hemy, 1984). The most damage occurs in spring (Cedara Agricultural Development Institute, 1993). Cutworms curl up (Fig. 1) when disturbed (Vermeulen *et al.*, 1992).

4.3. MATERIALS AND METHODS

Small-scale farmers were interviewed individually during field visits and survey in the greater Vhutswema area to identify the most important insect pest that attacks their major crops.

Plants were monitored for cutworm injury by walking throughout the field during the seedling stage. Special attention was paid to field edges and any low or weedy areas.

Cutworms were detected by visible damage to crop plants. For surface-feeding cutworms, the number of severed plants per meter of row should be determined.

Cutworms that feed below ground were sampled before planting, especially in areas with a history of subterranean species. The soil was exposed by ploughing using draught animals and hand hoes. The main reason of ploughing the soil was to survey the distribution of cutworms.

The moths were monitored using pheromone and light traps. They were placed strategically in vegetable growing areas in Tshidzini, Pilgrim's Rest, Tshaulu, Tshifudi, Gaba and Mushiru.

4.4. RESULTS AND DISCUSSIONS

It was found during the survey in rural areas of Limpopo Province that small scale farmers use the cultural practices in trying to control cutworms in their farms. Cultural practices is defined as a broad set of management techniques or options, which may be manipulated by agricultural producers to achieve crop production goals (Ferro, 1996) or the manipulation of the environment to improve crop production. Cultural control on the other hand is the deliberate alteration of the production system, either the cropping system itself or specific crop production practices, to reduce pest populations or avoid pest injury from crops. The following are among the cultural practices that are used by small farmers in the Limpopo Province:

- Ploughing, hoeing and basin preparation: All these influenced the survival of the soil inhabiting pests. It involves the destruction of the fully-grown larvae or of the pupae in the soil during the winter by ploughing. It exposes soil inhabiting insect, pests and other arthropods and nematodes to harsh weather and other natural predators. Birds like the king crow, the myna, the starling, etc. pick up not only the exposed pupae of cutworms, but even other soil inhabiting pests following these cultural operations. Farmers in the study areas usually use draught animals such as donkeys to plough their lands. Some insects such as grasshoppers, crickets, mole-crickets and borers lay their eggs in the upper layers of the soil. Their eggs are exposed during soil preparation and subsequently disintegrate. Deep ploughing during winter helps in reducing the overwintering populations of several species. The ploughing should be done at least six weeks before planting. The

larvae and the pupae are then crushed or brought to the surface where they are killed by frost or eaten by birds. Of many farms in South Africa, winter ploughing reduces cutworm damage.

- Hand picking of pests: This is the other method of pest control. Right from picking lice from human hair, clothes and even animals to the manual separation of pests from stored grain. Nocturnal insects such as cutworms were collected using this method using a light trap. This method was found to be efficient in eliminating tobacco stem borer, *Scrobipalpa heliopa* (Lower) (Lepidoptera: Gelechiidae) caterpillar, hairy pine caterpillar, *Nadiasa concolor* (Walker) (Lepidoptera: Lasiocampidae), sugarcane borer, *Eldana saccharina* (Walker) (Lepidoptera: Pyralidae) grain ladybird, *Epilachna similis* (Thunberg) Coleoptera: Coccinellidae) etc. Hand picking demands alertness, patience and keen observation. The collected pests are destroyed burying them deep in the soil. Cutworms were also hand picked at night after the soil was watered with a solution of water and insecticidal soap (1 spoonful of soap, i.e. liquid soap to a watering can full of water). After an hour, the worms crawled to the surface to escape irrigating soap solution. The worms were then crushed between the thumb and forefinger and some were picked and buried deep into the soil.
- Destruction of alternate hosts or volunteer plants: Young cutworm larvae feed on seedling until fourth instar when they cause serious damage by cutting or drilling the plants. Small farmers in the study areas use hand hoes and others herbicides to control weeds that serve as alternate hosts of cutworms.

- Crop rotation or maintenance of a host-free season: Crop rotation interrupts the normal life cycle of insect pests by placing the insects in a non-host habitat (Hertzog & Funderburk, 1986). Some farmers were rotating maize with sweet potatoes, pigeon peas, cassava, etc.
- Time of planting: Alterations in planting date and harvest date can frequently result in plants escaping from damaging pest infestations (Ferro, 1996). Maize farmers in the study areas plant maize around the 15th of October and this helps crops to escape some of the insect attacks. Vegetables are usually planted in many hectares during the cold season to avoid the cutworm damage.
- The use of physical barriers: The use of sticks of about the size of the third finger of a human being or nails were also used by poor resource farmers in controlling cutworms. Small sticks are cut and placed around the young seedlings. Sticks or nails prevent cutworms from curling around the plant to feed.
- Starvation method: The sanitation method involves keeping the weeds down in the spring by ploughing and systematic cultivation. Small-scale farmers used hand hoes to cut down the weeds. The ploughing should be done about six weeks before transplanting or sowing in order to turn the caterpillars or pupae up to the surface where they shrivel in the sun or are eaten by birds.

Stoll (1986) mentioned that where the above methods are not feasible, cutworms are known to be perennial pest, baits may be applied before plant emergence. Moisten 20kg maize meal or bran mixture with 20 to 30 litre water to soft porridge consistency

and distribute the bait thinly in the late afternoon (spread in rows), so that it remains damp as long as possible for the cutworms to feed on at night.

Treatment of seeds with wood ash or a mixture of wood ash and chalk is also recommended for the control of cutworms (Stoll, 1986). Light traps may also be introduced. Tobacco, derris and pyrethrum sprays should be used on young plants and directed particularly at the point where they emerge from the ground (Stoll, 2000). Attract beneficial insects, birds, spiders and predator insect prey on cutworms in the farm. Improve the soil by adding organic matter so lots spiders and ants can survive there and eat cutworm eggs. Insects such as braconid and trichogramma wasps, ground beetles, firefly larvae, soldier beetles, stinkbugs and tachinid flies all prey on cutworms in their various life stages (www.yardener.com).

4.5. CONCLUSION

Cutworm is a major vegetable pest in most production small-scale farming areas in Venda. Cutworms are group of caterpillars that vary in feeding behavior and life history. They typically feed at night, and do most of their damage early in the season on young plants.

Monitoring of this pest is very important. It is not practical to sample for eggs because they are too difficult to find among the weeds. Instead, monitor for damage, presence of larvae or adults. Feeding damage: look for damage seedlings.

Eliminating weeds removes eggs-laying sites and their preferred food. Mowing of grasses discourages egg laying and encourages predation. It also exposes eggs so they dry out and do not hatch. Insecticides such as endosulfan and trichlorfon are also used to control cutworms. The use of the methods by small-scale farmers such as wood ash, tobacco; pyrethrum & derris sprays, hand picking, stick, light traps and attraction of beneficial insects can also control cutworms.

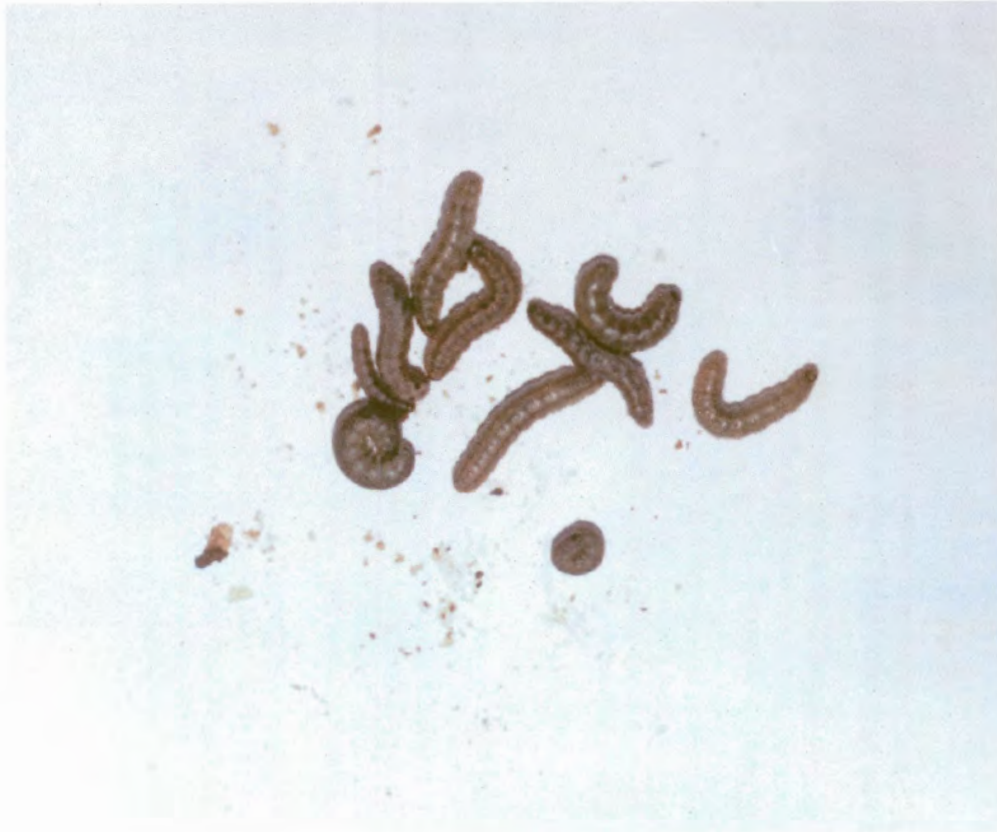


Figure 1: Cutworm, *Agrotis* spp.



Figure 2: Cutworms

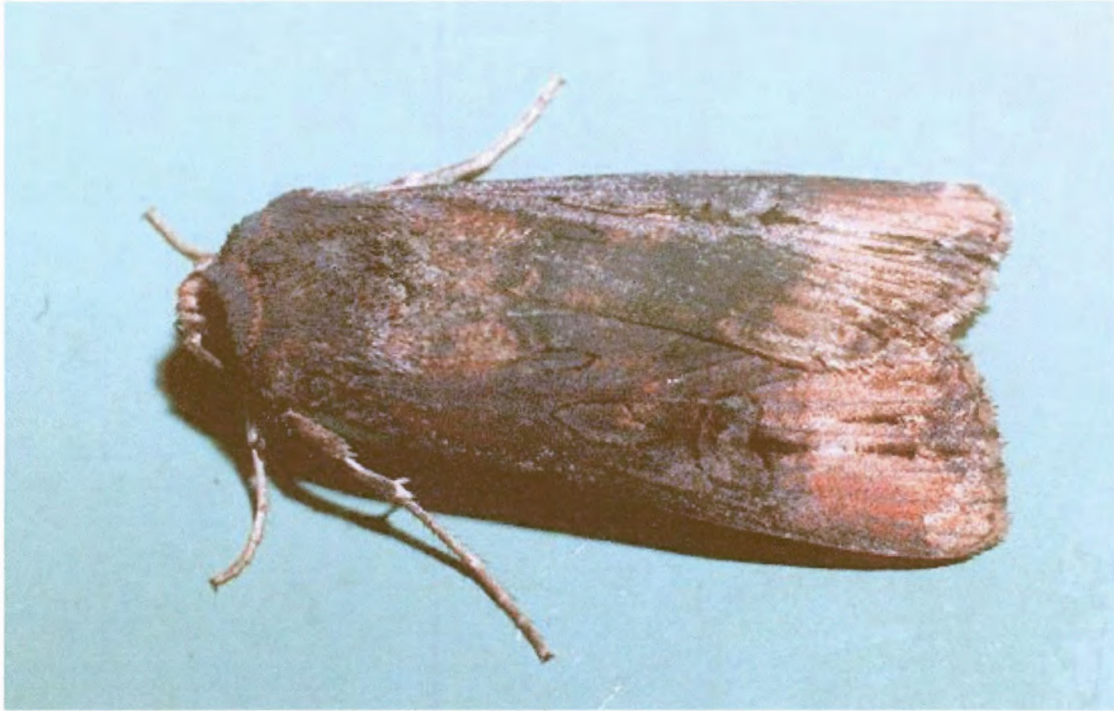


Figure 3: Cutworm moth

Table 1: Different crops that are attacked by cutworms

Common name	Scientific name	Family
Cabbage	<i>Brassica oleracea capitata</i> L.	Brassicaceae or Cruciferae
Beans	<i>Phaseolus vulgaris</i> L.	Fabaceae
Potato	<i>Solanum tuberosum</i> L.	Solanaceae
Soybean	<i>Glycine max</i> L.	Fabaceae
Tomato	<i>Lycopersicum esculentum</i> (L) Merr.	Solanaceae
Maize	<i>Zea mays</i> L.	Poaceae
Cauliflower	<i>Brassica oleraceae</i> L.	Brassicaceae or Cruciferae
Cotton	<i>Gossypium hirsutum</i> L.	Malvaceae
Tobacco	<i>Nicotiana tabacum</i> L.	Solanaceae
Coffee	<i>Coffea arabica</i> L.	Rubiaceae
Pumpkin	<i>Cucurbita pepo</i> L.	Cucurbitaceae
Beet	<i>Beta vulgaris</i> L.	Chenopodiaceae
Broccoli	<i>Brassica olearaceae</i> L. var. <i>botrytis</i> L.	Brassicaceae or Cruciferae
Peas	<i>Pisum sativum</i> L.	Legumiosae or Fabaceae
Pepper	<i>Piper nigrum</i> L.	Piperaceae
Onion	<i>Allium cepa</i> L.	Amaryllidaceae
Rhubarb	<i>Rheum rhaponticum</i> L.	Polygonaceae
Carrots	<i>Daucus caota</i> var. <i>sativus</i> L.	Apiacea or Umbelliferae

Cucumber	<i>Cucumis sativus</i> L.	Cucurbitaceae
Lettuce	<i>Lactuca spp.</i> L.	Compositae or Asteraceae
Watermelon	<i>Citrullus lanatus</i> (Thunb) Matsum & Nakai	Cucurbitaceae
Spinach	<i>Spinacia oleracea</i> L.	Chenopodiaceae
Wheat	<i>Triticum aestivum</i> L.	Poaceae or Graminae
Barley	<i>Hordeum vulgare</i> L.	Poaceae
Rice	<i>Oryza sativa</i> L.	Poaceae or Graminae
Grape vine	<i>Vitis vinifera</i> L.	Vitaceae
Strawberry	<i>Fragaria virginiana</i> (Duchense)	Rosaceae

Source: Hemy, 1984

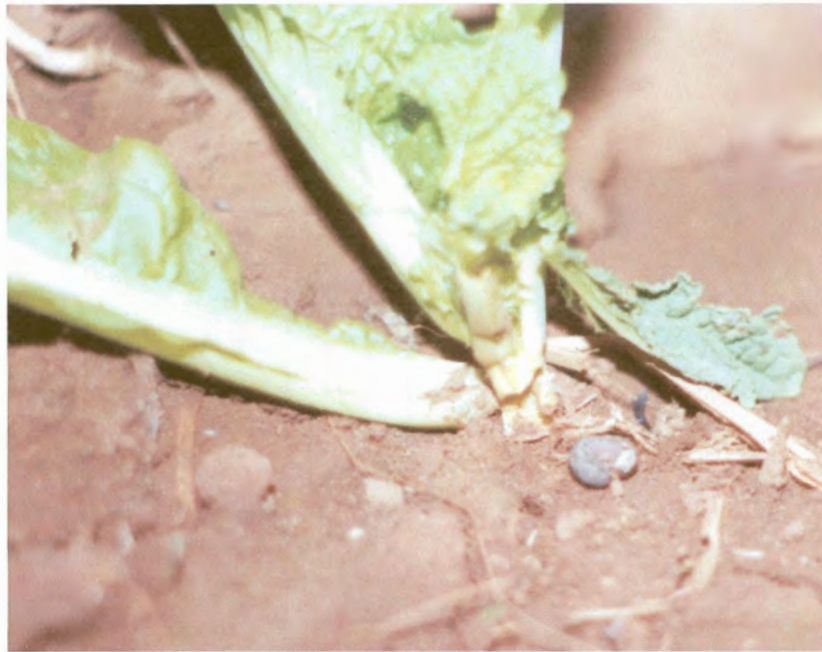


Figure 4: Cutworm above the soil surface near a felled seedling



Figure 5: Climbing cutworm damage

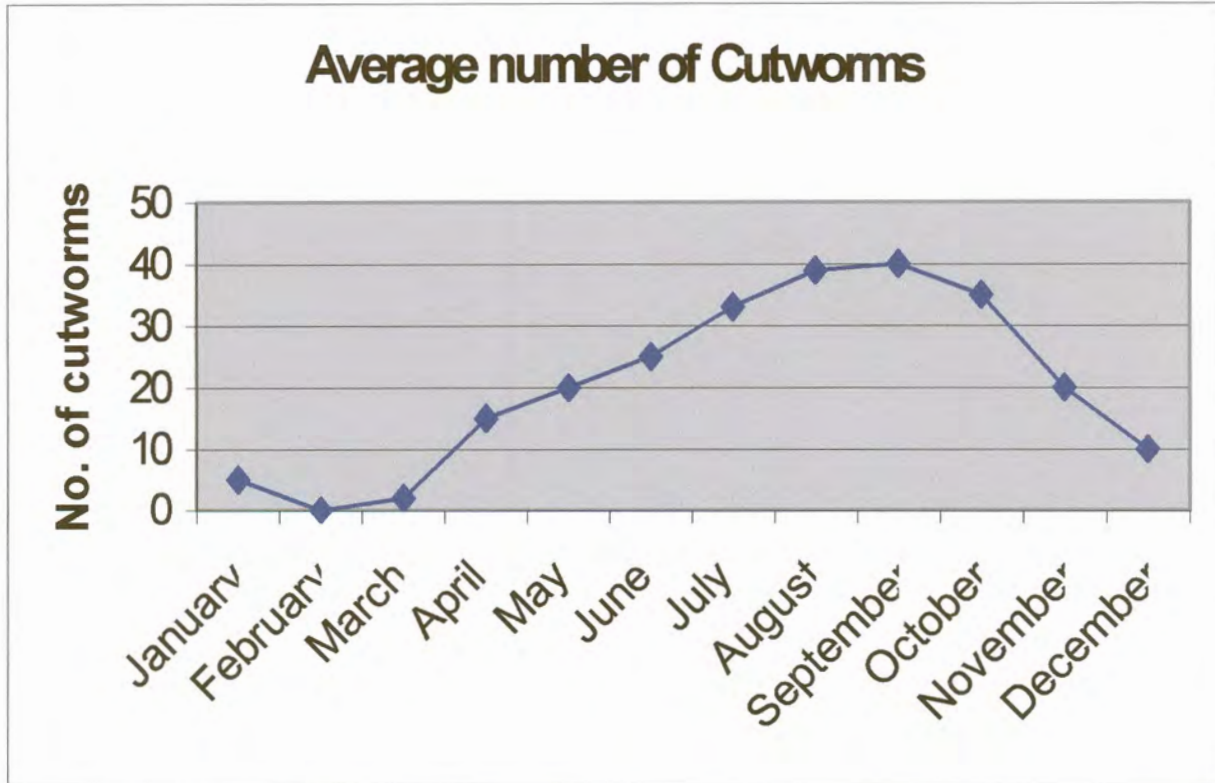


Figure 6: Distribution of cutworms (Source: Survey done in Pilgrim's Rest in the year 2000)

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