UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

AN INVENTORY OF AGRICULTURAL CHEMICALS USED BY SMALL-SCALE FARMERS IN SOSHANGUVE : IMPLICATIONS FOR ENVIRONMENTAL MANAGEMENT

By

Cornelia Maria van der Linde

6202729

Submitted in partial fulfilment of the requirements for the degree
M Sc (Env & Soc) of the Department of Geography
in the Faculty of Natural and Agricultural Sciences,
University of Pretoria

October 2000

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

"I declare that the dissertation, which I hereby submit for the degree M Sc (Env & Soc) of the Department of Geography in the Faculty of Natural and Agricultural Sciences at the University of Pretoria, is my own work and has not previously been submitted by me for a degree at another university"

Cornelia Maria van der Linde
(440120 0063 082)
Student number 6202729

Commissioner of Oaths

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

ACKNOWLEDGMENT

This study was financially supported during January to October 2000, by the USAid Tertiary Education Linkages Programme (TELP) - Research Capacity Building (RCB) Project at Technikon Northern Gauteng, Soshanguve, Gauteng.

Mr John Makina, RCB Project Leader, for all the support, advice, and humor during the process of building research capacity.

The RCB team spirit.

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

An inventory of agricultural chemicals used by small-scale farmers in Soshanguve: implications for environmental management

by

Cornelia Maria van der Linde

supervised by

Prof. I Meicklejohn

Mr J F C Friend

in the

Department of Geography

for the degree

M Sc (Env & Soc)

ABSTRACT

Agriculture is a main contributor of the Gross Domestic Product (GDP) of South Africa, currently employing 1,2 million people and contributing 4,5% to the GDP (Ballance and King, 1999). The White Paper on Agriculture (1995) underlines the importance of small-scale farming in the context of food security on national and household level. All farmers should take responsibility of their activities as it is recognized that they are the primary custodians of these resources.

The use of agricultural chemicals was standard practice by farmers in large and small undertakings. Many of these chemicals were handled and disposed of in a manner that did not fulfil basic standards of environmental safety and protection of public health. An inventory of the use of agricultural chemicals by small-scale farmers in Soshanguve, Block L was undertaken. The two main objectives dealt with assessing the types and volumes of hazardous chemicals and the use, storage and disposal practices of hazardous waste by small-scale farmers. Technologies used for soil cultivation, the varieties of crops grown and the role of extension services in the area were also explored. Small-scale farmers living in an informal settlement and who were actively involved in small-scale farming served as the target population. Random selection for participating respondents was done. Structured interviews for completing a set questionnaire were conducted. Frequency distribution analysis of the data from fifty five respondents was done.

Small-scale farmers were too poor to buy agricultural chemicals. Large scale loss of crops due to rat and insect infestation caused broad use of hazardous chemicals like *Doom*, *Blue Death* and *Rattex*; with the main active ingredients of these compounds being organo-phosphates, carbamate derivatives and a blood anti-coagulant. These chemicals are listed as neurotoxins and should be handled and disposed of according to the minimum requirements for the handling, classification and disposal of hazardous waste, regulated by the Department of Water Affairs and Forestry (1998). The majority of the respondents was using no more than 2 kg or 2 litres per household during a three month period.

Chemicals were stored inside the dwellings but care was taken to store hazardous materials away from food and out of reach of children. The original, labeled containers were used for storage of the chemicals in use. Empty chemical containers were mostly disposed of and not utilized for other purposes. In most cases, hazardous waste was mixed with household waste. Burning, burying, discarding in the fields and pouring down toilet facilities have also been cited as general disposal methods.

Small appliances were used for cultivating the land, while either hose-pipes from taps at dwellings or a communal tap were used for crop irrigation. If the land under cultivation was some distance from the dwelling, seasonal rain was the only means of irrigating crops. A wide variety of vegetable crops were grown. Maize, followed by spinach and potatoes were the most popular crops. Peach, mango, banana and apricot trees were the most common fruit trees grown, mostly as single trees in the backyard. Crop output, being the same or less if compared to the previous season were reported by more than half of the respondents in the survey.

Extension services and advice were rendered to only a few respondents who took the initiative upon themselves to get into contact with Agricultural Research Council (ARC) Roodeplaat. Small-scale farmers depended on suppliers, friends and family for information and support for their farming activities.

Soil sample analysis indicated imbalances in plant nutrients and an overall tendency to attenuate cations, resulting in plants being deficient in necessary ions even in the case of sufficient nutrient levels found in the soil. Compost preparation was not done on a large scale and, coupled with soil qualities insufficient irrigation and good soil cultivation procedures, crop output resulted in most small-scale farmers not being able to farm sufficiently productive.

It is recommended that inventories of small-scale farmer use of hazardous chemicals are conducted in Soshanguve, this being in line with the need from authorities to set up national inventories to prioritize problem areas in the management of hazardous substances. A public-private cooperation between academia, the private sector and small-scale farmers need to be initiated to transfer information about appropriate technology and impart business and managerial skills.

KEYWORDS

small-scale farmers
agricultural chemicals
household chemicals
inventory
storage
approximate amounts
disposal
handling practices
crops
land use
environmental management

1. INTRODUCTION AND BACKGROUND

Agriculture is a major contributor of the Gross Domestic Product (GDP) of South Africa, currently employing 1,2 million people and contributing 4,5% to the GDP (Ballance and King,1999). Almost all agricultural produce is delivered by white commercial farmers who, according to the Farmers Support Services Working Group (FSSWG) in the past, had the benefits and incentives of subsidies, guaranteed price structures and research and development support (FSSWG,1997; Van Staden[2], 1999). Under the democratically elected government, special efforts to bring the previously disadvantaged into the mainstream of the agricultural economy are being made. The White Paper on Agriculture 1995 underlines the importance of small-scale farming within the context of food security on national and household level. The vision of the White Paper foresees a highly efficient and economically feasible market-directed farming sector, which will be characterised by a wide range of farm sizes (de Lange and Crosby, 1995). Four basic groups of farmers, namely the commercial group, the emerging or small farmers (including land reform beneficiaries), individual households farming for food security, both in deep rural and peri-urban areas; and the farm workers are identified. The household group who are mostly small vegetable and/or poultry farmers are the largest group involved in agriculture.

A profusion of services are provided to commercial farmers by the private sector in terms of grains, staples, red meat and by supplying information on fertilizers, pesticides, herbicides and insecticides. These services are presumably not easily available to small-scale rural and peri-urban farming activities. Van Staden[2] (1999) indicated that technology transfer to the small-scale rural and peri-urban agricultural sector, needs to be facilitated by the Agricultural Research Council (ARC).

Most small-scale farming take place in community gardens that are based in areas with a high concentration of people and consequently offer opportunities to sell surplus production. Community gardens are found in small villages in rural areas, rural towns or urban settlements. Small backyard gardens produce food and fulfill a very important role in food security.

2. LITERATURE REVIEW

Agricultural and hazardous household chemicals, the use and administering thereof, but most of all the manner in which these chemicals are disposed of, not only have a huge influence on the environment and natural resources, but also impact on public health.

2.1 Effects of agricultural activities on natural resources

The survival and well being of a nation depends on the sustainable management of natural resources (Arnon, n.d.; Laker, 1997; Hugo *et al*, 1998; Ballance and King, 1999). Over the years increasing demand on natural resources and the environment brought about unsettling impacts which are becoming noticeable in intensifying dimensions. The major part of South Africa is covered with very poor quality and shallow soils. Low and inefficient rainfall limits soil formation and if not managed properly will degrade agricultural resources and the environment irreversibly (Laker, 1997). For many decades, soil productivity was merely manipulated by additions of essential plant nutrients and various pesticides to force nature into production. The effects of these agricultural practices on natural resources are an increasing degradation of soil and vegetation and low productivity leading to higher input costs in order to maintain high yields (Hugo *et al.*, 1998).

Cultivation has a number of adverse effects on soil resources, some of which are reduction in soil fertility, increase of toxic substances, salinisation, acidification and heavy soil losses. Compaction and crusting lowers the infiltration rate of water into the soil and therefore keep water away from the root zone and at the same time, causes escalating run-off intensity, resulting in reduction in crop yields and loss of the productive, nutrient rich topsoil (Laker, 1997; Van der Stoep and Steyn, 1999). In South Africa, soil degradation in the former 'homelands' has been increased by the cultivation of marginal soils, while the increasing demand for agricultural produce and the accompanying over-use of agrochemicals and monoculture farming had devastating effects on productivity and crop output (Laker, 1997; Ballance and King, 1999).

Improved production through modern technologies impacts on the environment, contaminating water sources by leaching of fertilisers, pesticides, herbicides and livestock wastes from surface lands. Contamination of food and fodder by residues of agricultural chemicals pose major risks to the health of humans and animals (Newby and Wessels, 1997; Pretty, n.d.).

The White Paper on Agricultural (1995), states clearly in its mission statement that all South Africans are custodians of the natural resources of the country and should accept responsibility for the sustainable utilization thereof. Moreover, all farmers should have the special responsibility to be responsible in their actions and activities and how resources are being influenced, as it is recognized that they, both large and small-scale farmers, are the principle users and primary custodians of these resources.

2.2 Agriculture as generator of hazardous substances

Th use of agricultural chemicals is standard practice by farmers in small and large undertakings. Many of these chemicals are handled and disposed of in a manner that does not meet basic standards of environmental safety and protection of public health. Pollutants, especially pesticides, accumulate in fatty tissue of organisms, and, as they pass up the food chains, become concentrated. Through this mode of bio-accumulation, their effective dosages magnify 10 - 100 times with each step in the biocycles, resulting in concentrations a million times higher at consumption and ingestion (Myers, 1994). Pesticides and herbicides containing organochlorines and organophosphates as the active ingredients, are suspected of causing cancer, birth defects, disorders of the central nervous system, heart, lungs and kidneys (De, 1993; Buell and Girard, 1994; Myers, 1994; Watts, 1997).

The Institute of Waste Management (IWM) assessed that Agriculture and Forestry generate about 20 million tonnes of solid waste per annum, yielding 0,13 million tonnes of hazardous waste (Appendix A). The Crop Protection and Animal Health Association's Crop Protection Compendium (1997), as well as the Waste Management Series (DWAF, 1998), list agricultural chemicals available and most probably used and disposed of during agricultural practices in South Africa. These chemicals form part of the hazardous materials which are in circulation and thus need to be managed according to the minimum requirements for the handling, classification and disposal of hazardous waste (DWAF, 1998; IOMC, 2000). Land-filling has been and still is the main mode of disposal (Buell and Girard, 1994; Manahan, 1994; Myers, 1994; Ballance and King, 1999). In rural areas and informal settlements, adequate waste management strategies are still widely lacking, resulting in the possibility that hazardous chemicals are not correctly disposed of at all.

2.3 Legislative issues regarding the handling of hazardous substances

One of the most sensitive environmental issues throughout the world revolves around the management of hazardous waste. South Africa, being a signatory to the *Basel Convention for the Trans-Boundary Movements of Hazardous Wastes and their Disposal*, is now a member of the international community and will have to comply with international policy regarding the management of hazardous waste (DWAF, 1998). Currently, South African regulations for hazardous waste management are not in line with international legislation. Ballance and King (1999) indicated that of the 5 million cubic metres of hazardous waste produced annually, only 5% is disposed of at an appropriate waste site, suggesting illegal dumping or frequent spillages. The Department of Water Affairs and Forestry has initiated the *Waste Management Series* with the objective to 'upgrade the standard of waste management in South Africa and to provide a system whereby waste disposal can be regulated' (DWAF, 1998, iii). These documents propose a classification system, treatment and disposal methods for hazardous waste. Through the application of the requirements for correct handling of waste streams by authorities and the public at large, it would eventually lead to a cleaner and healthier environment, thus addressing an important element of the Reconstruction and Development Programme (RDP) advocated by the Government.

Eleven industrial groups have been identified as generators of hazardous materials due to their processes and activities (Appendix B). Waste streams have been categorized into six different waste types, each representing similar ecological or health impacts (Appendix C). Future regulation of these substances would be dependent on the identification of industrial groups, processes and waste streams, as well as the generators of hazardous materials in order for them to 'register, when it becomes mandatory with the appointed government institution' (DWAF, 1998, 4-2).

Although South Africa has fairly advanced waste management practices, effective waste management and pollution control face vital dilemmas (Theron, 1994). A proliferation of legislation, together with the overlap of duties and divisions of responsibilities among the many government departments involved, and a lack of reliable statistics are but a few problems causing confusion and inefficiency. Most of the available data are estimations because there is no law which compels waste generators, waste disposal companies or other authorities to publish or supply information on the quantity and type of waste generated, handled, treated or disposed of. According to Lombard (1997) a system of registering generators, transporters, users and disposers is required for effective monitoring and auditing of substance movement. Law enforcement can only be effective if pollution levels are quantified, standards are available and legislation is in place in accordance with information which would be appropriate for sound environmental and waste management practices.

Visser[3] (1999) alluded to agricultural chemicals being used and disposed of by workers and farmers alike, neither of whom understands the risk to human health or the degradation of the environment. Newby and Wessels (1997) discuss the need for monitoring and auditing the important trends in natural resources degradation. Inventories at appropriate levels of detail are needed in order to be able to advise on future land use and planning strategies. Reliable data generation and accurate documentation underlies the need for innovative scientific solutions to many local problems. New environmental laws, policies and strategies need to be drafted to bring South Africa into the ambit of international trade.

2.4 The management of chemicals

According to the Inter-Organization Programme for the Sound Management of Chemicals (IOMC, 1998), chemicals have been a source of great benefit to the world community. Fertilizers and pesticides have greatly improved agricultural productivity, while industrial and consumer chemicals bestowed improvements to the quality of life. Disease control and the protection of environmental quality have been given large impetus by many different chemicals. It is an established fact that chemicals are being used in rural as well as urban communities in all parts of the world. If chemicals are used in terms of best practice pertaining to cost-effectiveness and a high degree of safety, no or little harm will be effected on public health or the environment. But best practice is, however, not always followed and together with a huge increase in chemical usage during recent times, has brought about serious environmental degradation and an increase in health problems. The United Nations Institute for Training and Research (UNITAR) and the IOMC are encouraging countries to undertake efforts to promote the safe management and use of chemicals for industrial, agricultural, public health and consumer uses in order to help ensure sustainable development. The IOMC (1998) advocates that to be able to use and manage chemicals safely, countries should aim to develop and implement a comprehensive, integrated national chemical safety programme with sound chemicals management, into national health and environmental policies and strategies. Very few countries have such elaborate and comprehensive programmes in place. The management of chemicals have mostly taken place in fragmentary fashion. It usually happens as crisis management with the realization that chemicals might pose health hazards or having detrimental effects on segments of the environment. Regulations are brought into place in specific areas for specific toxic chemicals as problems are being encountered. It is a matter of taking action when there is an outcry (Friend, 1999). The main focus to bring about good regulatory principles, starts with occupational and public health and more recently in the area of environmental degradation and threats thereto. The implementation of comprehensive programmes will need considerable resources and skilled personnel (DWAF, 1998; IOMC, 1998; Visser, 1999). Agricultural chemicals as well as many household chemicals are classified as hazardous and should therefore be scrutinized and regulated to the extent that public health is not compromised.

2.5 The research problem

South Africa, as a signatory to the *Basel Convention for the Trans-boundary Movement of Hazardous Wastes and their Disposal*, will have to comply with international policy regarding the management of hazardous substances. Small-scale farming practices are the largest group of active farmers. An inventory of the small-scale urban farming practices is needed to find baseline information on the use and exposure to agricultural and hazardous household chemicals that should be taken into consideration for the development of an integrated national chemicals safety programme.

2.6 Objectives

In developing countries, authorities do not always have information on the quantities and types of hazardous chemicals and wastes generated. Baseline information will become necessary for future handling of hazardous chemicals and wastes. This research problem was examined with the following objectives as a guideline:

2.6.1 Estimating the types and volumes of chemicals used in agricultural and household practices in informal settlements of Soshanguve.

2.6.2 Ascertaining the use, storage and disposal practices of hazardous chemicals by active farmers in the designated area.

2.6.3 Investigating the technologies used for soil conditioning and cultivation.

2.6.4 Establishing which crops the small-scale farmers preferred to grow.

2.6.5 Establishing the role of extension services available to small-scale farmers.

3. METHODOLOGY

In order to be able to draw profiles of small-scale farmers, their needs and use of chemicals, the following processes were devised and implemented.

3.1 Experimental design

A survey was done to view the situation of small-scale farmers in designated areas of Soshanguve. An interview questionnaire was designed to embody the objectives and piloted in Block SS, an informal settlement in rural Soshanguve, situated on the Soutpan M35 Road (Appendix E). After analyzing information from this pilot study, the questionnaire was redesigned to the current format and then used for the final interviews done in Block L, Soshanguve (Appendix F). The outcomes of the initial survey done in Block SS and reasons for redesigning the experimental tool is contained in Appendix G. The final survey that generated data for this report, was done in Block L. The reasons for this decision is also discussed in Appendix G.

Information was gathered from fifty five (55) respondents living in an informal settlement and practicing small-scale farming in Block L, Soshanguve. Interviews were conducted in English, but in some cases the respondents preferred discussions in Afrikaans or their particular vernacular. The farmers divulged information without hesitation while the students and myself were accepted gracefully in their homes and on their lands. Visits to the land were conducted in order to gather soil samples and to do an approximation of the surface area under cultivation. This activity was included because I wanted the students to be exposed to a real-life situation where they had to roughly measure surface area. They had to collect soil samples according to a specific method that would lead to a soil mix being a representative sample belonging to a known area and farmer. These students learn chemical analytical techniques but are not aware where samples for analysis originate from.

3.2 Population

According to the Municipal Demarcation Board (SA Explorer, 2001), the majority of people living in Soshanguve, Block L were of African origin organized in 3358 households. Of the 10 343 adults, 41,7% were between 30 and 49 years old and 14,9% between 50 to 64 years with only 3,6% being 65 years and older. People had a variety of occupations, a seemingly basic occupation was ascribed to 938, with12 engaged in the farming industry. The total population of 17 763 people was composed of 51,6% females to 48,4% males. From the given demographic information, it can therefore be implied that 7 420 children were younger than 20 years.

3.3 Sample size

During the pilot study in Block SS, fifty five (55) questionnaire interviews were recorded. The outcomes of this experience was used as a guide to redesign the experimental tool. For completion of the study, fifty six (56) interviews were conducted in Block L. One set of responses of the Block L interviews, had to be rejected when it was discovered that the information had already been recorded.

3.4 Sampling procedure

Random choice of households in Block SS was made. Random sampling technique was used to target small-scale farming households in the informal settlement on the eastern border of Block L

3.5 Data collection instruments

A questionnaire was developed to embody the objectives as discussed above and piloted in Block SS on 29th November 1999. It was found that interviewees could not differentiate between pesticides, herbicides, insecticides and fertilizers or identify trade names of these chemicals. Inquiring about the literacy level and marital status of household members were not well accepted and perceived to be invading privacy of the respondents. The document was quite cumbersome to fill out. The format of the questionnaire was redesigned to provide categories for possible responses. Space was available for more outcomes and information if the respondent wanted to do so. The different categories of agricultural chemicals were grouped as pesticides and household chemicals, with trade name options, as identified during the pilot study. The inquiry about the literacy level of respondents was incorporated as the ability to read labels and to enquire whether respondents would have a need for more information and training in the use of chemicals. Topics like these, were not seen as probing into the privacy by the respondents and were elaborated on without hesitation. The demographic information merely inquired about the marital status and number of children in households. The responses were coded on the questionnaire itself, which proved helpful during the final statistical analysis. English was used as the language of the written document, but interviews were conducted in the vernacular as well as in Afrikaans, where respondents felt that they needed more explanation and elaboration.

3.6 Data collection

Twenty four (24) assistants, selected from students in the environmental chemistry course in the 3rd semester of study towards a National Diploma in Analytical Chemistry, were trained in the use and completion of the pilot questionnaire in Block SS. They were requested to complete five (5) questionnaires each, during a period of two hours. The group was supported by the author during the entire period. The redesigned questionnaire format was used in Block L. Twelve (12) student assistants from the same group mentioned above, were selected and trained to conduct the interviews and complete the questionnaire. The students and the author conducted interviews on the 9th and 11th March 2000.

3.7 Data analysis

The coded questionnaires were analysed by the Corel Quatro Pro 8 programme to determine the frequency distribution of the different categories of information presented hereafter in graphs, pie charts and tables.

3.8 Soil sampling and collection

Soil samples from selected sites were collected in a systematic random manner at distances of three metres between sampling positions, stored in self-sealing plastic bags and labelled with the block number, stand number, name and signature of the respondent, name and signature of the interviewer, and date of sampling. Elemental chemical analysis was done by *TEMO LABORATORY SERVICES CC* at Technikon Northern Gauteng. The pH, electrical conductivity (EC, mS/cm) and the cation exchange complex (CEC, cmol/kg) in 20 soil samples were analyzed and recorded and the concentrations of the following elements were measured:

- ❑ Phosphorous (P) mg/kg (BRAY 1),
- ❑ Phosphorous (P) mg/kg (HCl extract),
- ❑ Calcium (Ca) mg/kg (HCl extract),
- ❑ Calcium (Ca) mg/kg; (ammonium acetate extraction),
- ❑ Magnesium (Mg) mg/kg; (ammonium acetate extraction),
- ❑ Potassium (K) mg/kg; (ammonium acetate extraction),
- ❑ Iron (Fe) mg/kg; (ammonium acetate extraction),
- ❑ Sodium (Na) mg/kg; (ammonium acetate extraction) and
- ❑ Chloride (Cl) mg/kg; (ammonium acetate extraction).

The analytical procedures for evaluating pesticide residues in soil is a very specialized field and too expensive to consider at this stage of the survey. Bruce A'Bear[1] of the *AGROFERT ACADEMY*, Rustenburg, has prepared an interpretation of the standard soil analyses and offered advice on a soil fertilization programme that would be suitable for the selected environment.

4. RESULTS AND DISCUSSION

The main objective of this study was to estimate types, volumes and handling practices of agricultural and household chemicals by small-scale farmers in Soshanguve, Block L. It was, however, deemed important to build a profile of the respondents with regard to their environment and household situation.

4.1 Demographic information

The following is a brief overview of the age, marital status and number of household members provided by the small-scale farmers in the study area. The age distribution of a small-scale farmer community who live in an urban area, was explored.

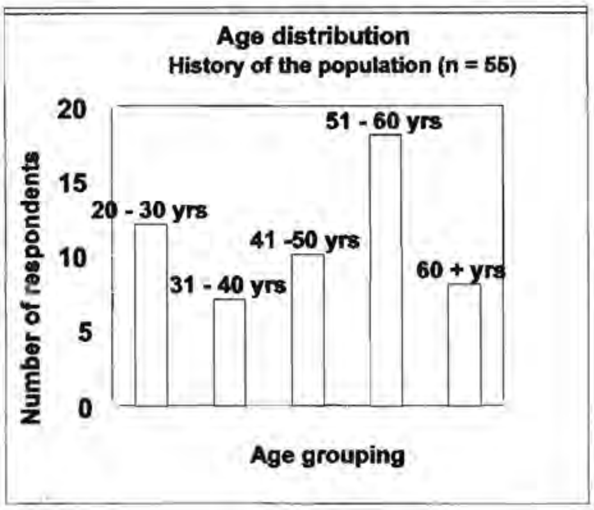

Figure 4.1 Population age distribution in Soshanguve, Block L.

Respondents between 30 to 50 years comprise 30,9% of the sample, with 47,3% accounting for persons older than 50 years (Figure 4.1). If compared to the demographics of Block L (SA Explorer, 2001) the age breakdown in the target population, shows a smaller group younger than 50 years, 30,9% compared to 41,7%. In Africa, women are the largest group of people who work the land (Arnon, n.d.; Chambers, 1992; Myers, 1994). The majority of the estimated 600 000 small-scale farming activities in South Africa are managed by black women (Vermaak, 2000). However, it is the men who usually take the decisions and undergo training while the women very seldom have the opportunity to do so (Arnon, n.d.). The author wanted to gain some insight into the situation around the above-mentioned matter in the current South African context, therefore the question regarding how households are managed and how many people are taking part in the farming activities.

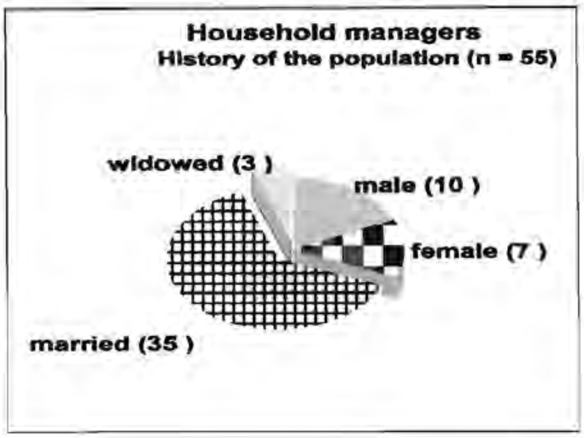

Figure 4.2 Household managers in the small-scale farmers community in Soshanguve, Block L.

The designation *male* and *female* was recorded as a response to whether the household was managed by single parents. No breakdown was done on made decisions, merely to form a picture of how the families are operating. When asked about who saw themselves as the persons mainly responsible for cultivating the land, thirty two (32) male and seventeen (17) female respondents assumed the task while six (6) respondents indicated that the whole family worked the field.

Table 4.1 Household configuration.

Number of persons	Number of households
0 - 4	27
5 - 9	26
10 - 14	1
15 - 19	1

The majority (96,4%) households consist of relatively small numbers, i.e. 27 households report that they have between 1 and 4 members per household. Respondents were also queried about the number of children attending school. Table 4.2 illustrates the situation.

Table 4.2 Households with school attending children

Number of children at school	Number of households
0 - 4	53
5 - 9	2

The responses were recorded according to the number of school attending children categories presented in the questionnaire. No specific number of school going members of the households can be reported here as the question was not drafted in such a manner that represented a head-count. What is reflected here is that all the households responded but that twenty one (21) respondents mentioned that they were either too young or to old to have any children at school. During the survey, the respondents communicated to the student assistants and the author, that it is mostly older people cultivating the land. If the age distribution in Figure 4.1 is considered, this general comment is also reflected here in terms of school going youngsters (Table 4.2).

4.2 Types and volumes of chemicals in use in the study

Different scientific terms were used for the variety of agricultural chemicals available. For this reason, the questionnaire was at the outset designed to ascertain the types and volumes of fertilizers, pesticides, herbicides or weed killers that might be in use. As mentioned earlier, the initial group of respondents clearly did not and probably could not, differentiate between the variety of agricultural chemicals. They also said that they were too poor to buy chemicals. It was found that the 'chemicals' were understood as pesticides and household chemicals which might have hazardous effects on the health of people as well as the environment. The trade names of chemicals that might be in use were thus compiled from these previous responses and presented as a list of names in the final document, with the prospect of adding any other chemicals in use. It was found that trade names of specific agricultural fertilizers and pesticides were not properly stipulated by some of the respondents in the survey. These responses could be either due to them not being able to afford these commodities, or not having any experience and information about the benefits or disadvantages of the uses. It might also be that the respondents were not able to read the labels properly. The manner by which these substances were obtained might also have an influence on the ability to specify the chemicals in use. Five (5) respondents indicated that they were using no chemicals, while fifty (50) respondents, reported the use of household and farming practice related substances. The lifestyle and needs of the respondents dictated the chemicals known under the trade names described in the following table. The target group were living in the informal settlement on the far outskirts of the built-up Block L area. Their housing consisted of many different kinds of building material varying from wooden houses, bricks and mortar buildings, cardboard walls and plastic sheeting. Their dwellings were bordered by open field on the western periphery, leaving them very vulnerable to wild areas without any municipal services or cleaning up undertakings. They needed substances to keep veld animals out of their dwellings and a fair chance to harvest a crop from their plantings. The farming activities were part of a lifestyle that forced people to fend for food security by applying their skills till and work open land in the area.

The following table contains information on the types of chemicals listed by means of trade names. Respondents could enter more trade names if they wished to. The total number of responses was given as f = 154, counted by means of the *Corel Quatro Pro* programme using the frequency distribution action. The number of individual responses per chemical was calculated as a percentage of the total response pattern.

Table 4.3 Trade names of agricultural and/or household chemicals used by the small-scale farmers in Soshanguve, Block L.

Trade Names	**Active ingredient**	**Percentage use of chemicals (f = 154)**
Bayer Insecticide	Pyrethroid; organosphosphate	5,8
Blue Death	carbamate	19,48
Dieldrin	organochlorine derivative	5,8
Doom	organophosphate; pyrethroid	27,9
Synthetic fertilizers	not enough information given about fertilizers that were in use	9,09
Chlorophos; chlorpyrifos	organophosphate	5,19
Rattex	blood anti-coagulent	22,1
Mosquito coil	pyrethroid (D-Allethrin)	3,2
Dyroach, Jeyes Fluid, paints, *etc.*	organophosphate in *Dyroach*	1,3
Agricultural lime	calcium hydroxide	1,3

The high figure for *Rattex* and *Blue Death* was a result of the respondents experiencing loss of crops on a large scale due to rat infestation. The lands which the small-scale farmers use are mostly open fields adjacent to their housing areas. The close proximity of lands to open veld resulted in rats being a huge problem, because it destroyed crops and also invaded the living quarters, thus forcing the inhabitants to use hazardous substances like these mentioned above. Living conditions in the informal settlement were very basic. Shelters were built from every conceivable type of material. Although the shelters were, in most cases, kept in immaculate condition with clean swept yards and running water available from house taps, the overall waste handling practices needed serious improvement and was also a source of pest infestations. Litter was strewn indiscriminately and uncollected waste is piled into mounds on the sides of the roadways. It was not an objective of this survey to ascertain whether waste collection was done in the informal settlements, something which would need attention during further investigations. The high percentage use of *Doom* insect repellent could therefore also be ascribed to these conditions. Agricultural chemicals in use were mostly to combat pests. Very little synthetic fertilizers and agricultural lime (10,39%) were applied as a source of soil improvement programmes. Respondents indicated their need for information and training in the use and disposal of these chemicals (see 4.3.8).

It was difficult for respondents to estimate the volumes of chemicals used in a household. Therefore an approximation of amounts or quantities used during a three month period was given as a guideline for recording purposes in this survey. As chemicals are available in different volume measurements, approximations as kilograms (kg) and litres (*l*) were used. Approximate quantities used by fifty (50) respondents have been recorded and reflected upon in the following Figure 4.3.

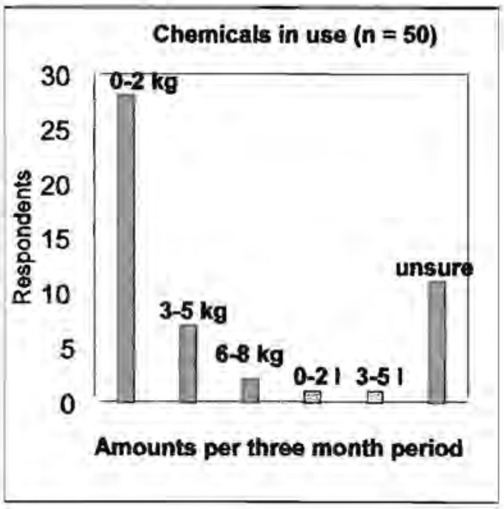

Figure 4.3 Approximate amounts of chemicals used in a three month period per small-scale farming household in Soshanguve, Block L.

The small-scale farmers affirmed that they were not in a financial position to buy chemicals and thus it can be expected that the majority (27) would not be using more than 2 kg of substances in a given three month period. It was necessary to make estimations of approximate amounts of chemicals used and it was correlated with the types of hazardous waste that might be accumulated by the practices under discussion. Vermaak (2000) reported that 600 000 small-scale farmers were currently busy with agricultural activities and in this small survey, it was found that hazardous chemicals were used by 90,9% respondents. These chemicals lead to the generation of hazardous waste that need to be handled in the minimum required manner prescribed by DWAF (1998). Appropriate waste management strategies were at the time of writing, not yet in place.

4.3 Use of chemicals

In order to outline the use practices of chemicals and to report on the life-cycle of such substances, it was also necessary to inquire about the conditions under which the respondents store and dispose of these hazardous substances. It was found that only 5,8% respondents used *Dieldrin.* This is an agricultural chemical belonging to the class organo-chlorine insecticides applied primarily for eradicating pests that would attack field crops, mosquitoes and insects which cause the spread of malaria, typhus, yellow fever and bubonic plague (Watts, 1997). These insecticides are lipophilic (fat-loving) compounds which can easily infuse the skins and cellular membranes of insects. By doing so, the toxicity involves interference with the sodium-potassium balance in cell membranes and disrupt neurological functions. Humans would suffer neurological effects if they were exposed in an unsafe manner to these substances. Compounds in this category, were banned in the United States of America (USA) by the Environmental Protection Agency (EPA) in 1975 due to their tendency to bio-concentrate, its bio-recalcitrance (bio-resistance), chronic toxicity and having detrimental ecological effects (Watts, 1997). These compounds do not degrade fast enough and remain toxic even after a long time. Benefits for disease control and increased agricultural production remained undisputed, but its releases in the environment created hazardous waste sites found in isolated locations with minimal regulations and improper disposal practices. These locations are characterized by surface soil and groundwater contamination from accidental and deliberate spillages and disposal (Watts, 1997).

The insecticide *Doom* was reported as the most widely used chemical (27,9%, Table 4.3). The active ingredients are organo-phosphates and pyrethroid. The products, *Chloropyrifos, Mosquito coil,* and *Dyroach* contain one or both of these compounds. Organophosphates are non-selective, broad spectrum insecticides which inhibit acetyl chlolinesterase, an important enzyme in neurological functions. The compounds persist only a few days to a few weeks in the environment if compared to the organo-chlorine compounds. These rapid degradation rates leave them with less chance to bio-accumulate and have detrimental ecological effects (Watts, 1997). In the case of humans ingesting organophosphate compounds, irregular heartbeat, convulsions and even death, can result (Buell and Girard, 1994).

Blue Death, used by 19,48% respondents, has chlorinated hydrocarbons and carbaryl, a derivative of carbamate, as active ingredients. The carbamate inactivates acetyl cholinesterase, the enzyme that plays a vital role in the transmission of nerve impulses between nerve fibre (Buell and Girard, 1994; Watts, 1997). The carbamates are rapidly broken down in animal tissue and the environment and are less toxic to humans than the organo-phosphates. *Doom Surface* and *Dyroach* contain carbamate compounds in conjunction with organo-phosphates and pyrethroid as active ingredients. Carbamates are narrow-spectrum insecticides being toxic to a few types of insects and thus used for specific purposes. *Rattex*, a rodenticide containing a blood anti-coagulant, is used by 22,1% respondents to keep rats from destroying crops. This chemical prevents blood plates to form, thus allowing blood to flow freely. This reaction is irreversible in rodents but also to humans if accidentally digested.

The use of synthetic fertilizers was indicated by a small number of responses (9,09%). Only 1,3% respondents applied agricultural lime in order to modify the pH of the soil. Investing in soil conditioning was not done on a large scale because the farmers were poor. Organic wastes from the land and kitchen were used by thirty six (36) respondents to prepare compost, eighteen (18) respondents did not make any effort and one (1) respondent indicated that he was buying compost to enrich his land. White paint was used to keep ants away from the trunks of fruit trees. *Jeyes Fluid* was used as an aphid repellent as well as a natural pesticide on mostly vegetable crops.

4.3.1 Storage practices of chemicals

The prevention of contamination, accidents and poisonings can be achieved through sound management of chemicals, which in turn aim to protect human health and avoid adverse impact on the environment (IOMC, 1998). The Pest Protection Compendium (1997) lists chemicals with information about active ingredients, safe use practices and whether containers are marked with expiry dates or dates of batch production. An area that seriously needed attention in terms of knowledge transfer and training in the sound management of dangerous chemicals is the rural, urban and peri-urban small-scale farmer populations. They probably do not use large quantities of chemicals and thereby do not accumulate considerable stocks of unused or expired compounds, but being a large collective group with little training, it is a matter of urgency that inventories of the compounds and hazardous waste generated by this group be conducted

4.3.2 Period of storage

Most chemicals are provided with an expiry date after which it is deemed necessary to dispose of, or destroy the unused and leftover substances. Future regulations will have to take time of storage of hazardous chemicals into consideration to keep track of life cycles and applicable disposal methods. Forgotten and unlabeled chemicals pose a real threat to the environment (Verdoorn, 1995). The pesticide *DDT*, has already been banned by the EPA, but is still manufactured and exported and stockpiled by farmers. Storage time of chemicals should play an important role when devising waste management systems. Figure 4.4 is a reflection of storage times for chemicals. Periods of 4 week intervals were given as guidelines to make approximations of how long chemicals might be residing in the households.

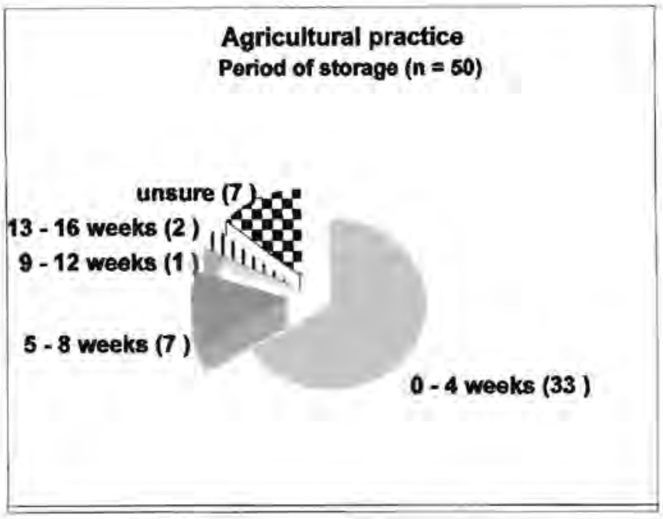

Figure 4. 4 Average storage time of chemicals by small-scale farmers in Soshanguve, Block L.

As can be expected, with small amounts in use, thirty three (33) respondents stored chemicals for less than four weeks. Seven (7) respondents were unsure of storage time by virtue of not keeping any record. The amount of chemicals acquired and the activity for which it was used, would probably dictated the time of storage. From the figure it can be seen that only three (3) respondents kept chemicals between 9 and 16 weeks. The majority kept their chemicals for a relatively short period in storage. This could indicate that little stockpiling of hazardous substances were taking place. The respondents were not questioned about them observing expiry dates and whether they would use chemicals after expiry or dispose them after such dates.

4.3.3 Place of storage

Young children and the elderly are usually the most vulnerable to possible health hazards due to ignorant use and storage of hazardous substances. The population in this survey, was from an urbanizing township, but living in an informal setting. The living facilities were basic and limited. Where and how respondents stored chemicals needed investigation for the purpose of developing future integrated hazardous waste management systems and information programmes.

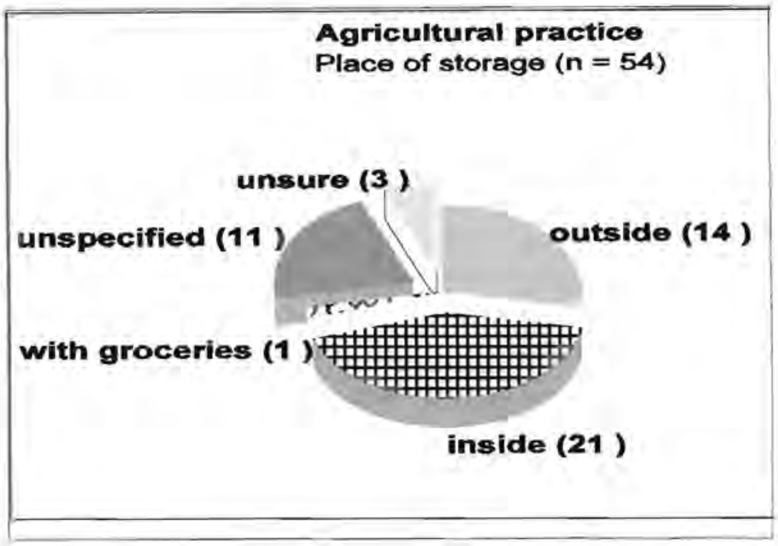

Figure 4.5 Place of storage of chemicals by small-scale farmers in Soshanguve, Block L..

Since most houses were small and space fairly restricted, storage systems had to be innovative to keep chemicals in safe storage. An investigation on where people kept chemicals or substances which they recognized as hazardous, showed that chemicals were stored inside (21) the dwelling but not in the same place as where foodstuff was stowed. Eleven (11) respondents took care that chemicals were stored out of the reach of children. Fourteen (14) respondents locked their chemicals away outside the house and only one (1) respondent kept chemicals in the grocery cupboard. Inexperience about the use of chemicals was cited by three (3) respondents as the reason why they were not able to comment on how and where chemicals they would store chemicals. In a situation with limited facilities, it was noteworthy that care was taken to keep chemicals separate from consumables.

Blue Death should not be stored with consumables and empty containers must be destroyed and never reused according to the Pest Protection Compendium (1997). *Doom , Dyroach* and *Bayer* insecticides should never be stored or used near open flames or in places where the temperature would be higher than 50° C or in the sunlight because the contents of the containers are flammable and explosive. These chemicals should be kept out of the reach of children, uninformed persons and animals. It is commendable that the respondents in this survey, tried to store chemicals as safely as possible.

4.3.4 Manner of obtaining chemicals

Sources through which small-scale farmers obtained chemicals might be of interest for future control and safety measures. Coded labeling to inform the users on storage, hazardousness and disposal methods might be introduced in future strategies to effect sound management of dangerous chemicals. The distribution lines whereby dangerous chemicals enter the market play as an important role in the life cycle of the substances as the development of waste management strategies or information transfer programmes. The respondents do not live close to large retail centres. They probably do not own cars and would probably be dependent on the local taxi services to acquire their groceries and other needs. From the demographic background (Figure 4.1) it was found that mostly older people were busy with farming activities. They also share their experiences and daily lives intimately and would probably be in a position to obtain supplies in an informal manner. Chemicals might also be available from other outlets than from designated retailers and farmers' cooperatives.

Recent deaths of several dogs and at least three incidents of children being admitted to Johannesburg hospitals have been linked to an agricultural pesticide, which contains *aldicarb* a highly toxic active ingredient. Smith, (*Saturday Star* 2001) revealed that this pesticide was sold as rat poison in unmarked bags. Presumably, selling took place on street corners and at taxi ranks by hawkers and unlicenced agents. The chemical was sold in repackaged bags without any indication of the contents or its hazardousness. Registered suppliers can only sell this compound and the person buying have to sign a poison register.

The following figure gave an indication of how respondents went about obtaining chemicals that they had in use. In the light of the above-mentioned story reported in the daily news it is all the more important to investigate the manner of chemicals distribution networks in the formal and informal sectors.

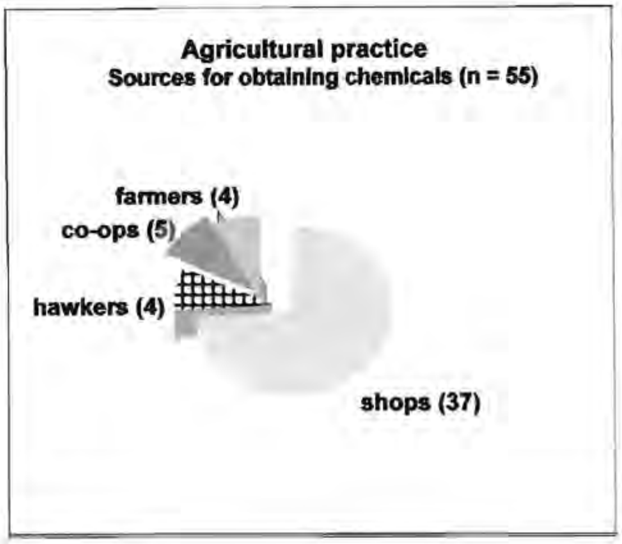

Figure 4.6 The main sources from which small-scale farmers obtain chemicals for agricultural and household use.

Most of the respondents (42) obtained chemicals from retail shops and farmers co-operatives (Figure 4 6). It was not established exactly which source supplied respondents with chemicals like *Dieldrin*, *Blue Death* and other hazardous substances. Inquiring into the possibility of receiving chemicals without buying, four (4) respondents mentioned receiving materials from other farmers and seven (7) obtained from friends. Nobody received or bought any products from extension officers. The fact that four (4) respondents obtained chemicals from hawkers, should be noted and more research conducted as to the types of merchandise or hazardous substances might be obtained from sources like these.

Shops are large 'faceless' entities and it can be foreseen that the small-scale farmer buying from such an enterprise have little opportunity to get expert advice on the products needed. The person will have to rely on his/her own ability to read and interpret the instructions for use and safety precautions which should be observed for storing, usage practices and disposal. The spray mist of the aerosol products should not be inhaled during usage. *Doom* and *Bayer* insecticides should not be sprayed on plants, animals, rugs, curtains or on plastic materials, while hands should be washed after use and foodstuff and drinking water should be protected during spraying. *Blue Death* insecticide powder should not be used on edible crops for 30 days before harvesting and should not be used in soil for root crops. If a user cannot read the instructions and are not informed by a knowledgeable person, the risk to health and environment will be high. Farmer-to-farmer support in the small-scale practices can be used to improve the overall situation including sharing information, seed and soil conditioning agents. Family and friends were the main source of any support in their farming activities.

4.3.5 The fate of empty chemicals containers

Many low risk and hazardous chemicals are usually provided in containers that can be put to other uses. People are prone to using such containers for other different purposes and this may pose a risk to their health. Forty six (46) respondents stored their chemicals in the original, labeled container, while four (4) respondents stored in unlabeled containers. Inquiring about how empty containers were utilized showed that forty three (43) respondents did not reuse these containers for any other purpose while seven (7) respondents made use of them to store water, paraffin, compost and fertilizer. They were also used for seedling trays and to store water for irrigation purposes. Since in many instances containers are made of plastic material which has the capacity to retain chemical residues even after thorough cleaning, reusing them could result in accidental poisoning and health impairment. Taken into consideration that the chemicals *Doom, Blue Death, Bayer, Dyroach, Mosquito coil* and *Rattex* that are used in the majority of cases, are usually supplied in aerosol cans and in cardboard or paper wrappers, reusing these containers is not possible. The proper disposal methods of these are a problem because in the absence of waste management strategies, these containers can have adverse environmental impacts.

4.3.6 Ability to read instructions for safe usage of chemicals

Adhering to safety precautions in the use of chemicals is necessary for protection of health and the environment. The ability to read and follow instructions is the first step to ensure the well-being of the users. Forty five (45) respondents reported that they are able to read and understand labels and instructions, whereas two (2) respondents replied that they can read but do not pay attention to the contents. Seven (7) respondents were unable to read, because they are illiterate. One (1) respondent, an elderly gentleman, did not enter any response. The enquiry was only intended to determine if reading ability was such that in the absence of any other information sources, users would be able to assist themselves and guard their own health. The Pest Protection Compendium (1997) listed an orange tag to show toxicity, a red tag indicate use with caution and a green tag warns that the chemical is harmful. These codes are part of the movement to transfer knowledge and to give instructions on labels regarding safety precautions.

4.3.7 Disposal of chemicals

The main aim of the minimum requirements for the handling, classification and disposal of hazardous substances and waste, is the protection of public health and the environment (DWAF, 1998). Informal settlements suffer from a lack of waste management strategies, as demonstrated by excessive littering and waste piled on roadways. This study, however, is not reporting on public waste management practices, but is focused on waste disposal activities by the fifty five (55) small-scale farmers (Table 4.4).

Table 4. 4 Disposal of agricultural and household waste substances

Preferred method of waste disposal by households	Number of respondents (n = 55)
As part of household waste	37
Discard in the veld (fields)	4
Dig a hole and bury	5
Discard into the toilet	4
Burning	2
No response	3

By far the most preferred method of disposal of chemicals containers and leftover or expired hazardous chemicals, was with the normal household waste that eventually ends up littering the neighborhood or being discarded indiscriminately in the absence of public waste management systems. The exact type of sanitation in each household was not surveyed. However, being an informal settlement, sanitation facilities would probably be pit toilets. If hazardous chemicals and waste were disposed of into toilet facilities and in ways mentioned in Table 4.4, the soil and groundwater as environmental resources, might in time be subject to pollution (IOMC, 1998). Discarding hazardous waste in the veld not only added to the excessive littering but also became a health hazard as reusable materials were collected by children or uninformed members of the society.

Given the importance of future waste management systems and national chemicals management programmes, the disposal methods of hazardous waste and leftover or excess hazardous substances need to be investigated thoroughly. Soil sampling should be done regularly to determine its fertility and suitability to crop growing as well as to check if pollution levels are acceptable and will not compromise either public health or the environment.

4.3.8 Training and transfer of information regarding safety and proper use of chemicals for small-scale farmers

It is important that public awareness programmes should reach members of the community who have responsibilities which require them to deal in a safe manner with all types of chemicals. Education and training in chemical risk management is needed at different levels of the community. Implementation of initiatives on a voluntary basis towards improving sustainable environmental management procedures and safe use practices with regard to hazardous substances will be much better supported if communities are well informed.

Thirty eight (38) respondents expressed a need to be more acquainted about the advantages and disadvantages of agricultural chemicals, while twelve (12) respondents said they were informed by having instructions available on the labels of chemicals, whether it be agricultural or household chemicals.

Various sources of information were available to the small-scale farmer where he or she might be able to obtain information and training with varying degrees of depth and content. The following table reflected several sources.

Table 4.5 Sources of information on the use of chemicals

Small-scale farmers received information from:	**Number of respondents (n = 55)**
Family, own initiatives	6
Friends	9
Supplier	10
Extension officer	2
Farmers	4
No source listed	21
No response	3

The supplier played an important role in rendering services regarding equipment and materials but also as an information and training role player. It was said that the main source of obtaining chemicals were normal retail stores and shops. Shop attendants are not always informed about chemicals on sale and may not be able to transfer much needed instructions to the users. Farmer-to-farmer education and training can be a powerful means of transferring knowledge and inspiration. From the above-mentioned responses, it can be concluded that the possibility of harnessing the collective knowledge and resources among small-scale farmers should be researched and developed towards improving practical farming activities and crop production, especially in the light of 38,2% respondents who said that they have no source of information.

4.4 Cultivation technologies

South Africa, similarly to the rest of Africa, is poorly endowed with land resources because the major part is made up of poor quality, shallow soils which are a result of low and inefficient rainfall that diminishes soil formation (Laker, 1997). Limited irrigation potential exists because South Africa does not have enough irrigable soil with sufficient water supply. Land degradation is a critical environmental problem with soil degradation being the most serious in this regard (Laker, 1997). In the light of small-scale farmers regarded as the largest group of farmers, information was gathered as to how soil cultivation was done in this area.

4.4.1 Landholding patterns

It was not the intention of this study to explore the political and historical argument about land rights but merely to investigate how the individual practicing farmer practiced agriculture. However, some information about landholding was gathered to view the relationship between land rights and agricultural practices. It was found that forty two (42) respondents regarded themselves as having a right to use the land in contrast to thirteen (13) who did not. Moreover, the status of the land was seen by twenty six (26) respondents as privately owned, and by twenty four (24) as communal property and five (5) were unsure. 'Communal' in this survey meant land which might belong to local authority, or regarded as 'open space' alongside the informal settlement. Those respondents who had no rights to the land reported that the land either belonged to the local authority or that they merely make use of the open or empty land bordering the settlements. This survey did not investigate whether property or other rights to any land under cultivation, affect their day-to-day farming activities and investment into either any equipment, seed and soil improving technologies. However, it was said that farmers would invest in soil conservation measures if rates of return were high to themselves and with the establishment of secure property rights both for men and women (Kinwa, *et al*, 1996). If land is made available under more permanent conditions, training of small-scale farming practices might aid the people to become more profitable and self-sufficient and probably secure sustainable livelihoods.

4.4.2 Land care technology

Crop output depends on good, fertile plant material that is suitable for the season and soil type, appropriate soil preparation and a plan to irrigate the fields. Soil enrichment and conservation is the first step in the cycle to produce healthy crops. Methods and appliances used for cultivation and irrigation were reflected upon in the following figures and tables.

Table 4.6 Land care technologies used by small-scale farmers in Soshanguve, Block L.

Cultivation apparatus	**Number of respondents (n = 55)**
Tractor	2
Small appliances	53
Animal drawn ploughs	0
Main sources for irrigation water	**Percentage responses (f = 63)**
Rain fed lands	44,4
Piped water	55,6
Stream, well, borehole	0

Only two (2) farmers indicated the use of mechanical apparatus like a tractor for soil preparation. This small number was expected, under the prevailing conditions where farmers indicated that they were poor and not even in a position to buy any fertilizer for soil treatment. It was found that spades, forks, shovels and picks, as small appliances were used by the majority of the respondents. These small apparatus have less impact on soil quality and would not cause large scale compaction and crusting. Although soil compaction will not be the end result, the soil needed to be prepared well through digging and feeding with compost and manure, especially if other fertilizers were not in use. The unused veld was covered by tall grass cover that would help to curb water and wind erosion. In the absence of any mechanical apparatus, soil preparation for successful crop growing was not taking place. However, if trench gardening and organic farming principles could be applied, correct cultivation resulting in successful crop growing and conservation of the land resources could be achieved without detrimental impact on the fragile conditions.

Although the small-scale farmers were living in fairly close proximity to their lands, irrigating crops was dependent on seasonal rain as well as water from water piped to the dwellings. A variety of irrigation methods were found (Figure 4.7).

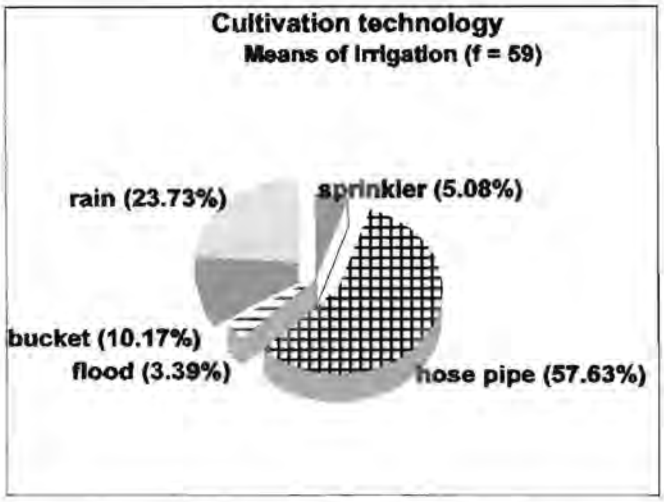

Figure 4.7 Irrigation methods used for crop growing by small-scale farmers in Soshanguve, Block L.

The main means of irrigation was with hose pipes fitted to home faucets. However, 3.39% of the respondents utilized flood or furrow-flow irrigation (Figure 4.7). Committed farmers carried water in pails and buckets. The practice of rain water harvesting methods was not investigated; employment of these methods could greatly enhance crop variety and output and could alleviate dry spells even if farmers were solely dependent on rain water. Rain harvesting techniques must be communicated and implemented as appropriate technology for soil conservation and improved crop output.

Soil fertilization programmes and irrigation methods depend greatly on the size of available land. The setting up of soil feeding programmes requires skill, experience and considerable financial resources, as is evident from the *Agrofert* overview. The soils in the survey showed high levels of potassium (K^+) coupled with low levels of calcium (Ca^{2+}) and magnesium (Mg^{2+}) cation concentrations, a situation expected in sandy and leached soils and where ongoing removal of plant material and crop harvesting, was taking place. Different crops have different needs for plant nutrients which complicate fertilization programmes even more.

4.4.3 Area of land under cultivation

Surface area under cultivation was estimated by means of walking with the farmer and roughly calculating the length and breadth of a specific piece of land. As can be appreciated, surface area measurement is only an approximation (Figure 4.8).

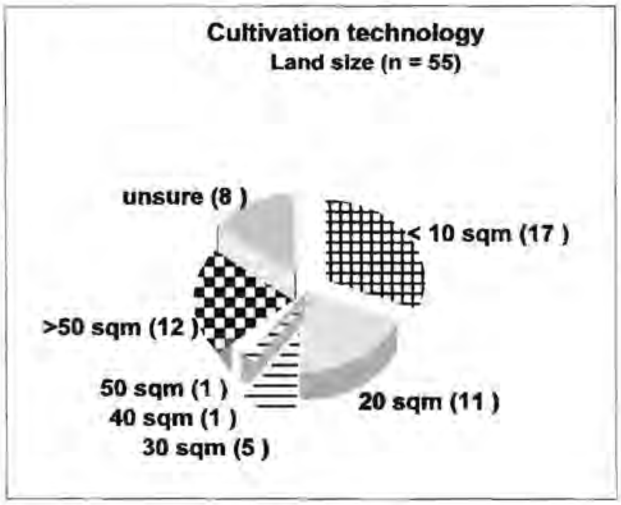

Figure 4.8 Approximation of surface area of land cultivated by individual small-scale farmers in Soshanguve, Block L.

The respondents (8) who indicated that they were unsure of the land that they farm indicated that they work different open patches at a time and due to time and distance constraints, physical measurements were not conducted. It was therefore decided that an 'unsure' response would be entered. Three farmers wished for more land. The local school gave them permission to work the school grounds but they could not utilize the opportunity properly due to them not having people to assist them in such endeavours. These three respondents had the potential to be successful farmers. One female farmer mentioned that she would like to extend her farming activities to a the grounds of a local creche to further environmental awareness and to improve the livelihood with a supply of fresh vegetables for the young children.

4.5 A survey of the crops grown in the study area

The farming practices in the study area was mostly crop farming, but in some cases poultry was also kept. The following figures and tables contain information about crop growing and how and where they would obtain gardening information and plant material. Figure 4.9 show the types of crops that were cultivated during the time that the survey was done.

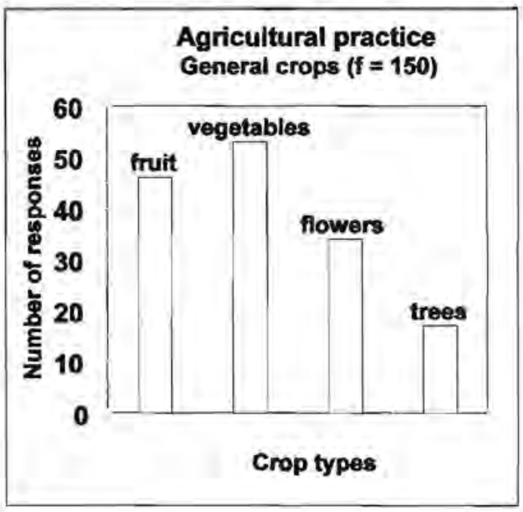

Figure 4.9 Agricultural crops grown on the farm lands of the small-scale farmers in Soshanguve, Block L.

Vegetables and fruit trees proved to be the most popular crops, a fact which confirmed the notion that food security was the most important reason for people embarking on farming activities in peri-urban areas. Fruit tree cultivation was observed as single garden items. No orchard development took place. Roses, aloes and palm trees were cited as garden plants.

Sources for obtaining plant material and information on appropriate technologies for seasonal farming and soil preparation procedures for different soil types and geographical areas varied greatly. Figure 4.10 show the sources for getting hold of plants and seeds that were used to grow the crops mentioned earlier.

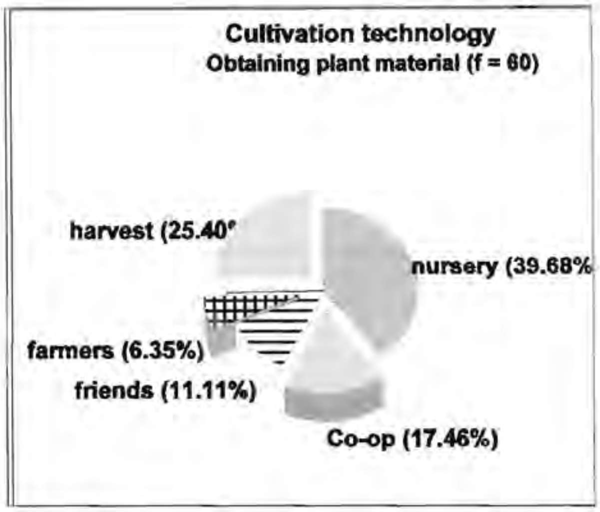

Figure 4.10 The main sources where small-scale farmers in Soshanguve, Block L obtain plant material and information.

Nurseries and harvesting of seeds from own crops were the main sources for obtaining plant material (65,08%) as shown in Figure 4.10. Friends and members of the farming communities proved equally resourceful for finding seeds and plants as it was found for the larger cooperatives.

Basic knowledge about seed harvesting and general crop growing knowledge were gained from own experience and by observing and working with friends and family (88%), farmer-to-farmer extension (2,6%) and attending agricultural colleges (8%) if $f = 75$. Extension officers from the Department of Agriculture should be available to offer assistance and advice, but did not visit or engage with the small-scale farmers in this area. Small-scale farmers were growing a wide variety of trees and vegetables as shown in tables 4.7 and 4.8.

Sources for obtaining plant material and information on appropriate technologies for seasonal farming and soil preparation procedures for different soil types and geographical areas varied greatly. Figure 4.10 show the sources for getting hold of plants and seeds that were used to grow the crops mentioned earlier.

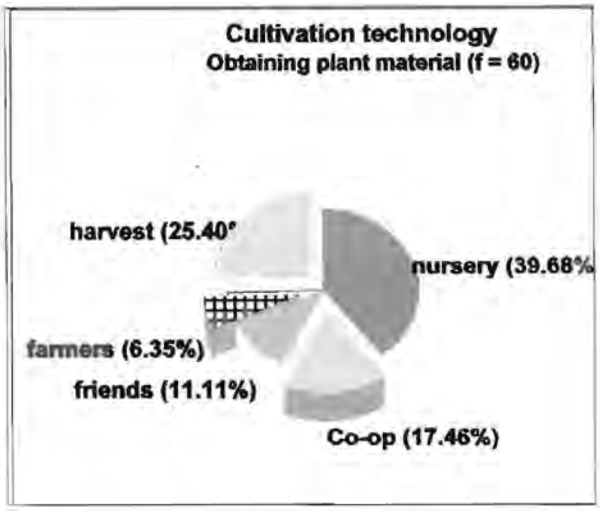

Figure 4.10 The main sources where small-scale farmers in Soshanguve, Block L obtain plant material and information.

Nurseries and harvesting of seeds from own crops were the main sources for obtaining plant material (65,08%) as shown in Figure 4.10. Friends and members of the farming communities proved equally resourceful for finding seeds and plants as it was found for the larger cooperatives.

Basic knowledge about seed harvesting and general crop growing knowledge were gained from own experience and by observing and working with friends and family (88%), farmer-to-farmer extension (2,6%) and attending agricultural colleges (8%) if $f = 75$. Extension officers from the Department of Agriculture should be available to offer assistance and advice, but did not visit or engage with the small-scale farmers in this area. Small-scale farmers were growing a wide variety of trees and vegetables as shown in tables 4.7 and 4.8.

Table 4.7 Fruits grown on the lands of the small-scale farmers in Soshanguve, Block L.

(f= 181)

Crop	%	Crop	%
Apples	4.4	Guava	2,2
Apricot	8.3	Lemon	1,1
Avocado	9.4	Litchis	0,55
Banana	12.7	Mangoes	1,5
Coconut	0.55	Oranges	9,4
Fig	4.97	Peach	22,7
Granadilla	0.55	Pomegranate	0,55
Grapes	2.76	Strawberries	3,87

Peaches, mangoes and bananas were popular cultivars. It was interesting to record that granadilla, litchi and even pomegranate found its way into the crop growing practices of the small-scale farmers (Table 4.7). Many cultivars of crops were grown from harvested seeds in the garden plots which might be a future source of unmodified genetic material. Research into the possibility of training small-scale farmers to do proper seed harvesting and develop fresh plant material from cuttings, might be a way of preserving unmodified genetic material for conserving the indigenous plant diversity and as a source of seeds for the poorer members of crop communities.

Vegetable cultivation was mostly done on the larger open lands. An extensive variety was grown. Maize and vegetables were planted on the same plot broadly following the principles of companion planting which could be employed to combat pests in an organic, natural way.

Table 4.8 Vegetables grown on the lands of the small-scale farmers in Soshanguve, Block L (f = 319)

Crop	% response	Crop	% response
Beans	9,4	Lettuce	0,31
Beetroot	5,3	Maize	14,4
Carrots	4,4	Marogo (African spinach) and spinach	8,46
Cabbage	7,84	Onions	8,46
Chillies	0,62	Potatoes	8,77
Cucumber	0,31	Pumpkin	7,5
Garlic	2,2	Sugarcane	3,45
Green peppers	3,13	Sweet potatoes	1,9
Groundnuts	2,8	Tomatoes	9,4
Herbs	1,25		

Maize was cultivated by the majority of small-scale farmers followed by potatoes, marogo and spinach (Table 4.8). All respondents demonstrated eagerness and enthusiasm with all their farming activities. Problems with low production output were expressed by the majority of the farmers; forty six (46) farmers did not produce enough to be able to sell any of their produce and only eight (8) respondents indicated that some income was generated by selling surplus. Only one farmer could generate substantial earnings. Many reasons for this situation were given as mentioned in Table 4.9, following here.

Table 4.9 Remarks by small-scale farmers on their crop output (n = 55).

Remarks regarding crop output	Respondents (%)
Respondents could harvest less than the previous season	4,7
Respondents could yield the same harvest	13,0
Respondents were busy planting for the first time	3,7
Respondents complained about soil fertility and little money to remedy the situation	5,6
Respondents rated their crop better as the previous season	37,0

Respondents offered many possible reasons for them experiencing low crop output in their respective areas. Some of these were:

- no money available to buy seed and fertilizers
- rats ruining the crops
- no water except seasonal rains
- poor soil condition
- loss of plant material during transplanting of seedlings
- too few hands who can work the fields
- very little knowledge about the use and advantages of fertilizers

A wide variety of crops were grown with little money for soil improvement and to buy seeds. Irrigation depended on seasonal rains, soil conditions were found to be poor and respondents reported little knowledge about the use and advantages of fertilizers.

4.6 Extension officers communicating with small-scale farmers

The FSSWG (1997) defined extension as a process to bring about voluntary change among rural people through the transfer of technology to enhance sustainable agricultural production, transformation and marketing. The rural farming communities ought to be mobilized into action and educated to build human resources and enhance local capacity. Extension could have a more specific emphasis on agricultural processes or a much wider focus on rural development. The potential for further growth would be substantial if backward and if forward linkages were to be taken into account, agriculture could contribute closer to 11% of the GDP of the overall economy (FSSWG, 1997).

It was found that South African farmers have not relied on the Government provided extension system for technical assistance needs (FSSWG, 1997). Farmers rather make use of the vast array of private services and take advantage of research which are done at the different institutions. An estimated number of 2,400 extension staff members was at the time of writing this report, employed by Government at a cost of R 515 million. Their main task was the provision of advice on technical and agricultural needs to farmers of all categories. Most public extension staff providing advice to small farmers were aware of the low impact they were having on agricultural incomes and production. Special efforts in this area needed to be made to bring the previously disadvantaged into the mainstream agricultural economy. The FSSWG (1997) was unable to find quantitative data on the performance of the public extension service for the previously disadvantaged farmers (van der Stoep and Steyn, 1999). Havinga (2000, 7) stated that in the past and also recently, the same complaints were voiced about extension officers not being deployed in the correct way. He cited examples of officers who were trained in crop production being deployed in areas where they had to give advice to red meat producers; that they were sitting in endless meetings and had to write monthly reports "while advisory actions in the field were conspicuous in their absence".

Extension services could be engaged to offer management skills, training opportunities and help organizing the farmers to form small co-operatives for sharing knowledge and developing markets for produce. Small-scale farmers have to be informed about the advantages and disadvantages of chemicals with relation to improvement of soil conditions, safe and appropriate handling and disposal practices and about less hazardous chemicals which proved to be environmentally more friendly and posed less risk to the users. Technology transfer should be facilitated at as broad a base as possible (Van Staden[2], 1999).

Improving the effectiveness of the existing extension services will require a clear definition of who the clients are and will mean that an inventory of farmers and their needs at provincial, sub-regional and ward levels will have to be done. Information will have to be gathered quickly and effectively over a large area but having less detail. A detailed pilot study in selected areas should provide information in greater detail so that the bigger picture can be described with the help of specifics. This will provide a means of defining the clients and their needs towards whom extension services should be focused. It is also foreseen that extension staff should concentrate on agriculture and that emergent or small, active farmers should be targeted (FSSWG, 1997). The public extension service will always be hampered by ineffective budgets and a lack of trained personnel, but the FSSWG (1997) is of the opinion that much good can be achieved through encouraging public-private partnerships where business expertise, managerial skills and mentoring can be traded as commodities.

The Urban and Peri-urban Group has been estimated as comprising approximately 462,000 households concentrated in about 90 townships lying on the outskirts of previous 'white' areas and in close proximity to industries. A township survey estimated that there could be between 14 000 to 20 000 potential livestock owners and about 2000 potential communal garden and 6000 backyard vegetable grower clients; this group could be immediately accessible for service delivery (FSSWG, 1997).

In the study area it was found that two farmers used their own initiative to find advice and training from the Roodeplaat Agricultural Research Council (ARC) farm; they have well run farming enterprises and were able and willing to share their knowledge. They were also in a position to sell their produce. The rest of the respondents replied that no extension service was ever rendered to them or that an officer ever visited their area.

4.7 Appropriate crops for soil types

As part of the survey, it was decided to have soil samples from the lands that the individual small-scale farmers were working on, analyzed. It was done partially to expose the student assistants to sampling techniques in a real life situation. A set of soil analyses from a known area could also be used as a training tool in the environmental chemistry course material as a rudimentary introduction to soil chemistry. The author also felt that some of the research funds which were made available for the survey project, could be ploughed back into Temo Laboratory Services CC, which is an entrepreneurial undertaking initiated by former students of Technikon Northern Gauteng.

A breakdown of one set of laboratory analysis, number B0001, is offered here to serve as an example of how soil analysis values can be used to interpret soil conditions as a guideline to design a soil feeding scheme or to decide on appropriate crops for a given set of soil conditions. Soil fertility is concerned with the inherent capacity of soil to provide nutrients, in the needed amounts and appropriate balance for specific plants to produce abundant crops. Adequate supply of nutrients is also dependent on other factors like water, temperature, light and the physical condition of the soil. The mineral nutrient elements are loosely classified as macro, secondary and micro nutrients in relation to the relative amounts that are normally present in plants, but not on their relative importance. Nitrogen (N), phosphorous (P) and potassium (K) are the macro-nutrient elements; magnesium (Mg), calcium (Ca) and sulphur (S) are the secondary elements and iron (Fe), sodium (Na), zinc (Zn), copper (Cu) and others, are the micro-nutrient elements (Biswas and Mukherjee, 1994). These nutrients should be available to plant root systems. Their availability depends on, *inter alia,* the pH, electrical conductivity (EC), electrical resistance (R) and the cation exchange capacity (CEC) expressed as cmol(p^+)/kg. Each clay (soil) particle acts as a cation exchange substance which is fundamental to cation release, eg. calcium cation (Ca^{2+}), from their compounds, eg. calcium carbonate ($CaCO_3$). The EC value will have an influence on the mobility of cations, the dissolved species of nutrients in the soil and groundwater and the ability of plant root systems to absorb nutrient.

Temo Laboratory Services CC at Technikon Northern Gauteng prepared the results for twenty soil samples collected in Block L and analyzed for the parameters, mentioned in the methodology.

Bruce A'Bear[1] of the *Agrofert* Academy, Rustenburg, offered an overview of the ammonium acetate soil analysis (Standard Analysis) results. The complete soil results report is attached in Appendix H.

The following is an extract from the *Soil Report:Temo Laboratory Services CC.* (A Table Number is not given to the extract as it only serves for easier reference to values and their manipulation yielding certain outcomes).

				Bray 1
Lab. No.	pH (H_2O)	pH (KCl)	Conductivity mS/cm	P mg/kg
B0001	7,12	6,22	0,11	26

The pH, determined with two different procedures, the element P (phosphorous) using the Bray 1 (Bray and Kurtz No.1 method, Biswas and Mukherjee, 1994) and the electrical conductivity (mS/cm) - the ability of soil to conduct electrical charge, is compared to the 'Norms for Soil Analysis'(A'Bear, 2000). The outcomes of soil analysis should, however, only be used as a guideline as it only gives an idea of what one can expect in certain soils. Ideally one should not look at actual values reported in an analysis and also not respond to a single report. Once a few analyses have been done, trends can be followed and conclusions made (A'Bear, 2000). Biswas and Mukherjee (1994) put it in perspective by stating that soil test value interpretations should take the peculiarities of both the soil and the crops into consideration. Different soils with given soil test values for nutrients, differ in their capacity to supply nutrients to plant root systems and influence the yield produced.

2000). A conclusion on the status of the soil and fertilization schemes can only be reached once the trends had been established. The following diagram is a continuance of the soil test values reported for B0001 and for the same reason mentioned above, not given a Table Number.

AMMONIUM ACETATE EXTRACT							
Lab. No.	Ca mg/kg	Mg mg/kg	K mg/kg	Fe mg/kg	Na mg/kg	Cl mg/kg	CEC cmol/kg
B0001	381	54	249	0,2	31	138	7,1

The major cation concentrations have been analyzed, these being Ca^{2+} (calcium); Mg^{2+} (magnesium); K^{+} (potassium) and Na^{+} (sodium) and also Cl^{-} (chloride) anions.

Table 4.11. Determination of ratios of selected cations: standard ammonium acetate analysis values.
(Source: A'Bear)

Reported cation as ppm	ppm to cmol/kg conversion	Cation ratio selection	Ratio value	Acceptable norm values
Ca: 381/200	1,91	Ca/Mg 1,91/0,44	4,3	1,5 to 4,5
Mg: 54/122	0,44			
K: 249/391	0,64	Mg/K 0,44/0,64	0,7	3,0 to 4,0
Na: 31/230	0,13	Ca + Mg/K (1,91 + 0,44)/0,64	3,7	10 to 20
	Sum = 3,12			

These values indicate that the ratio of Ca to Mg (4.3) is acceptable although in the incidence of a crop being sensitive to low magnesium or high calcium levels, crop growth might be stunted and yield influenced. For the ratio Mg to K (0.7), either K is very high or Mg is low. From the first ratio it has been decided that Ca and Mg are acceptable, therefore the K level must be too high in relation to Mg. The last ratio Ca + Mg/K (3,7), shows that the K (0,64) level is far too high in relation to Ca and Mg. According to Biswas and Mukherjee (1994), K as a macro-nutrient in plants, is responsible for the maintenance of cellular organizations regulating cell membrane permeability and keeping the cell contents in the proper degree of hydration. It activates the enzymes for carbohydrate and protein metabolism and transportation of carbohydrates and give plants an ability to fight fungal and bacterial diseases. An imbalance between the cations under discussion will have an influence on plant health and yield and can only be remedied once the overall trends have been established.

The final sets of ratios that are worked out are the percentage of each cation on the cation exchange complex (CEC) and is determined as follows:

100 x Ca/**sum**:	100 x Mg/sum:	100 x K/sum:	100 Na/sum
100 x 1,91/3,12:	100 x 0,44/3,12:	100 x 0,64/ 3,12 :	100 x 0,13/3,12

The manipulation of the values results in the general ratio that is compared to the normative ration.

General ratio for B0001	**Normative ratio**
61:14:20:2**::**Ca:Mg:K:Na	65:25:8:2**::**Ca:Mg:K:Na

From the general ratio it is clear that K is way over the acceptable levels. Thereby, Ca and particularly Mg show low levels which can be much easier evaluated than with the first set of ratios (A'Bear, 2000).

The cation exchange capacity (CEC cmol/kg) is the ability of the soil to attenuate or hold onto cations. Clay soils have CEC values to the order of 20 cmol/kg which demonstrates strong attenuation of cations, while sand will have very low CEC values, in the order of ≤ 1. Acceptable normative values usually lie between 3 - 7 cmol/kg. CEC values above 7 cmol/kg, indicate soils holding the cations so strongly that plants may even end up deficient in some cations even if soil analyses measure differently. Sample B0001 has a CEC value of 7,1 cmol/kg which fall well within the value range where it is expected that cations should be available if other environmental factors are also within normative ranges. If all the CEC values for the sampled areas are taken into consideration, it can be expected that the soils should release nutrient cations if other environmental factors are also within acceptable ranges. The above mentioned values reported should be used as guidelines to start a soil fertilization programme although not all plants have the same requirements.

Different crops have different needs. The *Hygrotech* vegetable chart is a handy tool to use for determining crop removal figures when drawing up fertilization programmes, because feeding the soil must be done in accordance to what and how much is taken out during a planting season. As an example, A'Bear (2000) proposes a possible feeding scheme for growing cabbage. The VegData file gives the removal figures for nitrogen (N) as 150kg; 80kg for phosphorous (P) and 150kg for potassium (K). These amounts of elemental nutrients must be applied to one hectare. In the given instance, plenty K is in the soil and it is suggested that 120kg of K per hectare is applied. If the full amount of K had been applied there is a chance that a Ca or Mg deficiency may be induced (A'Bear, 2000).

The full amount of N must be applied because it is assumed that the amount of N applied for a previous crop has been depleted during the growing season, lost to the atmosphere through soil bacteria chemical reactions or leached out of the soil. The P is within range, therefore the removal figure, 80kg is applied. Ca and Mg are low. Dolomitic lime is a cheap product which can supply both cations in the correct ratio. Addition of lime will increase the pH, which is already at the ideal level, therefore this action is not a solution. Gypsum ($CaSO_4$) supplies only Ca and can be applied by putting 60kg per hectare down. Magnesium sulphate [($MgSO_4$) or Epsom salts] will supply the necessary Mg if 25kg is applied per hectare. As can be appreciated, the setting up of soil feeding programmes need skill, experience and considerable financial resources.

Soil fertility need to be maintained because nutrients are continuously removed from the soil by crop growing and to losses by leaching and erosion. Crop rotation, including leguminous crops in the sequence of cropping, is well known (Biswas and Mukherjee, 1994). The benefits of a good crop rotation system are increased organic matter, nitrogen fixation and improved physical structure of the soil. Soil is kept under crop cover for most of the year which in turn controls runoff, soil erosion and effective use of fertilizers. Maintaining fertility with organic manures has been illustrated in India by the Long-Term Fertilizer Experiments in 1971, where intensive cropping systems were successful with applications of N, P and K according to soil test values and farm yard manure. The results with the highest yield were for wheat during 1971 - 1978 and showed an increasing trend during the documented time. It was found that a similar trend could be observed for the available soil phosphorous. Soil fertility, soil productivity and the maintenance of soil physical conditions have been illustrated overwhelmingly in field trials in India with the long-term application of organic manures and chemical fertilizers (Biswas and Mukherjee, 1994)

Correct application of plant nutrients to the soil should result in higher crop yields. Not all factors can always be remedied with nutrient applications, but through observing plant performance, it is possible to diagnose needs and deficiencies. Van Biljon (2000) gave a helpful guide that can be used to draw some conclusions relating to excesses and deficiencies having influence on soil and plant interrelationships. The need for N and P is usually stressed, well documented and has almost become common knowledge. Van Biljon (2000) described the use and need of potassium, calcium and magnesium that is only recently better understood. The following table illustrate how plant health could be influenced by these plant nutrients.

Table 4.12 Cations as plant nutrients
[Source: Van Biljon (2000)]

Cation	Use of the cations during the life cycle of plants
K^+ (potassium)	Transport nutrients from the soil through the roots to the leaves. The reversed pathway is transporting proteins and starch from the leaves to the roots, seeds and fruits.
Ca^{2+} (calcium)	Absorbed throughout the life-cycle of plants; build cell structures, mostly the cell walls. It is also important for the quality and shelf-life of a variety of crops, including fruit and vegetables. The roots of plants in calcium-deficient soils and conditions are more sensitive to disease during the later stage of the life-cycle of plants.
Mg^{2+} (magnesium)	Necessary during the photosynthesis reaction because Mg cation forms the nucleus of the chlorophyll molecule. It activates enzymes and is crucial during carbohydrate metabolism.

Deficiencies in cation levels described above, can be expected under the following conditions:

- sandy and leached soils, low CEC values,
- acid soils, (low Ca^{2+} and Mg^{2+}), low pH,
- soils low in exchangeable K^+; Mg^{2+}; Ca^{2+}, high CEC values,
- soil with extremely high concentrations of K^+; Ca^{2+} ; Mg^{2+} will cause imbalances of nutrients,
- ongoing removal of plant material without replenishing nutrients,
- incorrectly limed (pH adjustments) soil and
- cold or wet conditions early in the growth season.

The following table contains information on how deficiencies can be detected by observing plant conditions.

Table 4.13. Cation deficiency symptoms demonstrated by plants.
[Source: Van Biljon (2000)]

Cation	Symptoms
K^+	Yellowing, dead leaf edges.
Ca^{2+}	Gel-like leaves which open slowly and have a 'whip-tail' appearance.
Mg^{2+}	Yellowing observed between the veins of leaves; string of bead-like growths between the veins.

Soil analysis values are important, but the inter-relationships among cations are the deciding factors when decisions about fertilization programmes should be contemplated (Biswas and Mukherjee, 1994; A'Bear[1], 2000; Van Biljon, 2000).

With the soil analyses parameters of the lands under cultivation in Block L, plant nutrient availability and general trends can be studied. Plans to overcome imbalances in the soil nutrient composition and fertilization programmes can also be devised. Such programmes need expertise and financial resources, items which are not readily available to the small-scale farmers.

The trench gardening system as advocated and taught for many years by the Food Gardens Foundation has proved a secure manner of revitalizing soil through the constructive recycling of organic material generated both from kitchens and land use. By applying composting techniques, a step towards reducing organic waste is taken and at the same time cleaner technologies are being advocated. Once trench gardens have been established it induces energy as well as water saving technologies. Through the establishment of a piece of land which is fertilized by ongoing organic waste materials and demarcated as the area where crop growing will take place, it is therefore a great help to the small-scale farmer for whom water is a limiting factor for successful growing of crops and also them not having mechanical apparatus for ploughing the soil (Havinga, 2000). By adopting the principles of organic farming, much of the environmental degradation which result from incorrect farming activities relating to irrigation methods, soil loss due to erosion, not enough organic matter in the soil, little knowledge of fertilizers and little or no funds to invest in soil preservation agents, can be eradicated and rectified.

Academia should become more involved through the incorporation of community outreach programmes in the curricula of environmental related course material. In the absence of extension officers, the Technikon may develop information brochures on soil fertility needs, safe use practices of agricultural chemicals, programmes on the transfer of appropriate technology and other areas that can help to secure food production at household level. Students can be trained to fulfill a basic information-needs niche market for small-scale farmers in the absence of extension officers.

5. SUMMARY

The White Paper on Agriculture underlined the importance of small-scale farming within the context of food security on national and household level. For many decades soil productivity was manipulated by additions of essential plant nutrients and various pesticides leading to increasing degradation of natural resources and the environment. Agricultural chemicals were used and disposed of by workers and farmers alike, neither of whom understanding the risk to human health or the environment. The Institute of Waste Management estimated that Agriculture and Forestry generate about 20 million tones of solid waste per annum, yielding 0,13 million tonnes of hazardous waste. Various agricultural chemicals, which are probably in circulation and need to be managed in terms of usage, storage and disposal, are listed by the Waste Management Series (DWAF, 1998). South Africa, being a signatory of the *Basel Convention for the Trans-Boundary Movements of Hazardous Wastes and their Disposal* is now a member of the international community and will have to comply with international policy regarding the management of hazardous substances.

Small-scale farming practices represents the largest group of active farmers in South Africa and are an important means to ensure food self-sufficiency. To bring small-scale farmers into the mainstream agricultural economy and to develop integrated chemicals safety programmes, inventories of the needs of small-scale farmers and their practices with regard to types, volumes, use and disposal of hazardous substances have to be compiled. Questionnaire interviews were conducted in selected areas of Soshanguve.

It was found that small-scale farmers interviewed, were too poor to buy agricultural chemicals and that neither the terms nor the trade names of fertilizers, herbicides, pesticides or weed killers were identified by the respondents. This was either due to them not being able to afford such or not having any experience or information about the benefits or disadvantages of chemicals. The use of chemicals, household and agriculture, which have possible hazardous effects on health and the environment was consequently investigated.

5.1 Types and volumes of chemicals in use.

The lifestyle and needs dictated the types of chemicals in use. Large scale loss of crops due to rat and insect infestations caused broad use of chemicals like *Doom*, *Rattex* and *Blue Death* by most of the respondents. Synthetic fertilizers and agricultural lime, were used by a small number of respondents. Most respondents were using not more than 2 kg or 2 litres during a given three month period per household.

5.2 Use, storage and disposal of chemicals.

Shops were cited as the main source for buying chemicals, but some were also obtained from hawkers, while five respondents acquired their substances from cooperatives. Chemicals were mostly stored inside the house or dwelling but care was taken to store away from foodstuff and out of the reach of children. Storage outdoors were done under lock and key. The majority of the respondents stored their chemicals in original, labeled containers. Empty and discarded chemicals containers were not re-utilized for any other purpose. Containers were in some cases used to store water, paraffin, compost, fertilizer and to cultivate seeds. In most cases excess chemicals, hazardous waste and empty containers were mixed with domestic waste. Burning, burying and discarding in the fields as well as pouring down toilet facilities were also used as disposal methods.

5.3 Soil conditioning and cultivation technologies.

Cultivation of the land was done with small appliances like spades, forks, shovels and picks, while two respondents were using a tractor. Crops were irrigated mostly with hose-pipes using tap water at the dwelling or from communal taps. Other means of irrigation were furrow flooding, carrying water in buckets and pails and sprinkler systems used by two respondents. Seasonal rain was the main source of water for lands situated further away from the homes. Surface area under cultivation was physically measured by pacing the length and breadth of areas pointed out by individual farmers. Twenty eight respondents worked areas of about 20 square meters or less. Some respondents wished for more land, while others wished for more hands to help farming.

5.4 Crops grown in the study area.

Vegetables and fruit trees were the most popular crops. A large variety of crops were cultivated. Maize was the most popular crop, followed by marogo, spinach and potatoes. Peach, mango, banana and apricot fruit trees were grown by most respondents. Nurseries and co-operatives were cited as the preferred sources for obtaining plant material, while harvesting of seeds was also done by a substantial number of respondents. A decrease in crop yield or constant crop harvest was reported by more than half of the respondents if output is compared to the previous year. A small number of the respondents were able to sell some of their produce to generate an income.

5.5 Extension services.

Extension services and advice were rendered to two respondents who took the initiative to get into contact with ARC Roodeplaat. The main sources of information regarding farming activities were from suppliers, family and friends.

5.6 Soil sample analysis and interpretation demonstrated plant nutrient imbalances. On average, acceptable CEC values were reported, that signify the soil acting as a good cation exchanger under satisfactory environmental conditions. High potassium levels may induce low calcium and magnesium levels. As a result, plants might be affected by suffering nutrient deficiencies that might encourage impaired crop yield. The soil analysis can be studied in more detail with the help of the consultant agronomist. The design of fertilization programmes are complex and need fairly high financial resource inputs. The student assistants were engaged in soil sampling procedures exposing them to a real life learning situation. Soil analysis and the values generated can serve as a learning tool in environmental course material.

Organic farming methods may be an option for small-scale farmers with little or no funds for soil conditioning agents and knowledge of the correct application of such chemicals. Environmental degradation due to mismanagement of land resources can be reversed through constructive recycling of organic matter, water harvesting techniques and energy conservation practices.

6. CONCLUSION AND RECOMMENDATIONS

In conclusion, the degradation of natural and agricultural resources cannot be ascribed to the excessive use of fertilizers and pesticides in the study area because the small-scale farmers were too poor to invest in agricultural chemicals and have too little knowledge for administering chemicals. The use of household hazardous chemicals was mostly used to keep rats from ruining their crops and combat pest infestations in their homes and dwellings. Hazardous substances and leftover chemicals were mostly mixed with domestic waste which will need to be audited for the development of future chemicals safety management programmes as promoted by the Department of Water Affairs and Forestry (DWAF) and the Inter-Organization Programme for the Sound Management of Chemicals (IOMC). The study of soil quality parameters can have value for the development of fertilization programmes and for gaining some understanding when evaluation of crop quality and output are being observed.

The urban and peri-urban group small-scale farmers consist of approximately 462 000 households concentrated in about 90 townships lying on the outskirts of previous white residential areas and in close proximity to industry. It was estimated that there could be between 14 000 to 20 000 potential livestock owners and about 2000 potential communal garden and 6000 backyard vegetable and fruit growers (FSSWG, 1997). Small-scale farmers in the above-mentioned areas might experience the same limitations in their crop growing activities as was found with the respondents in the current survey. They might be using the same types of chemicals that were under discussion and using and disposing the hazardous waste in the same undesirable ways. Urbanization is increasing because job opportunities are fewer in the rural areas, thereby increasing the number of urban households keeping themselves busy with farming activities and repeating the whole cycle as described in the previous pages. The unbridled disposal of hazardous materials with domestic waste will continue and thereby increasing environmental degradation. It is clear, that no matter how well-intended waste management strategies and programmes are being developed by DWAF and IOMC, these programmes cannot succeed if they are not implemented concurrently with environmental awareness programmes targeted at peri-urban and urban communities. People need to be educated on the reasons why certain rules and regulations are put into action and not only be left to obey. Poor people need to survive and have no time to observe instructions which have no bearing on their need to put food on the table.

The small-scale farmers have demonstrated needs for training opportunities and information transfer on the effective use of agrochemicals and soil conditioning agents. The harnessing of indigenous knowledge to develop a network and support groups would alleviate the need for hands for land cultivation. It was ascertained that the main means of finding information about farming activities, whether it concerned the use of chemicals or finding plant material, friends and family proved to be the main providers in these needs. Extension services from the Department of Agriculture, that should be the main source of advice and information about farming activities, were not forthcoming in peri-urban and urban areas. Mostly older people were working the lands. Mothers indicated that they kept themselves and their children busy in their garden plots so that the children were occupied after school. By adopting organic farming methods and the notion of recycling organic matter during the making of compost would restore soil fertility and increase crop output. At the same time, the volume of waste could be reduced so that less would end up in the municipal landfill or as litter lining the streets. The principles of environmental awareness and sustainable living should become apparent by applying organic farming practices. Crop irrigation was done by hose-pipe from home taps, watering by buckets, pails and furrow-flooding or merely dependent on seasonal rain. No water harvesting technique implementation was observed, a process which should alleviate much of the low crop output reported during the survey.

The small-scale farmers in the peri-urban and urban areas was seen by the FSSWG as a very important client group who are immediately accessible for extension service delivery. They foresaw a basic needs training and advisory programme which would benefit the community at large. Extension officers were aware of their inefficient service delivery to this large group of farmers. Academia are in a position to form public-private partnerships with small-scale farmers to build capacity in the farming community but also to develop research capacity within their own ranks and student bodies. Active involvement in the day to day problems that these farmers have to cope with, could prove a rich and fulfilling environment wherein students and lecturers should be able to find real-life problems to solve and develop training curricula to be relevant when serving their communities.

Having had the opportunity to spend time with local small-scale farmers, investigating their activities, problems and achievements, a number of recommendations for future studies are mentioned below.

- South Africa is now a signatory of the *Basel Convention for the Trans-Boundary Movements of Hazardous Wastes and their Disposal* and is thus a member of the international community and will have to comply with international policy regarding the management of hazardous waste. In many developing countries, the authorities do not have accurate lists of the types and quantities of hazardous wastes generated or imported into their country. This information is important for regulating, planning, fixing priorities and controlling the management of wastes and in particularly the management of hazardous wastes (Series/SBC No: 99/009 (E), 2000). The lack of precise information curbs awareness on the part of political and administrative authorities. Environmental degradation and public health are at stake if certain appropriate measures cannot be taken. For this reason, national environmentally sound management policies for hazardous waste depend on initiating a process for an inventory of the types, quantities and management of those wastes. Only after this information is becoming available, can waste management systems for hazardous waste which cover the life-cycles of those wastes, including generation, transfer and disposal be drawn up and problems prioritized. These inventories should be kept up to date and be interlinked with other environmental databases which could yield data concerning generators, carriers and accredited disposers for hazardous waste. Small-scale farmers are an increasingly important group whose actions should be taken seriously and recorded in order to draw up an inventory of the types, quantities and use of hazardous substances. It is recommended that further surveys in relation to the use of hazardous substances be conducted in Soshanguve and the information be made available to the Basel Convention Regional Training and Transfer Centre for English Speaking African Countries to be taken up into national inventory databases which are planned for future waste management strategies and training activities.

- It is recommended that future surveys of hazardous substances focus on the types, quantities and handling practices, in order to comply to the FSSWG calling for an inventory of the needs of small-scale farmers over a large area with less detail but which can be useful to ascertain which types and how small-scale farmers are using hazardous substances.

- It is recommended that surveys be conducted to ascertain whether users of hazardous household chemicals are observing the instructions on the labels of these containers. Incorrect use and disposal of hazardous substances put the health of the public at risk as well as compromising the segments of the environment i.e. the soil, groundwater and the atmosphere. The dangers posed by one group of chemicals called persistent organic pollutants (POP's) have become a great concern and should feature in every aspect of hazardous waste management strategies worldwide. These carbon-based chemicals pose a particular hazard because of four characteristics namely, their toxicity; resistance to normal- break down processes; accumulation in body fat and thereby threatening unborn foetuses, as well as their mobility in water and wind. The POP's Convention listed initially 12 substances, or groups of substances, of which 9 are pesticides of the organochlorine class which include insecticides like *aldrin*, *dieldrin* and *DDT*. There is concern that pesticides like these mentioned may be stockpiled and have already become obsolete due to them having reached their expiry date but also not being used any longer because it has been banned by law. An inventory of such obsolete pesticides form the key for successful and safe disposal of these hazardous chemicals. International projects are developed to do these inventories and plan the follow-up of safe disposal strategies. It is necessary that the small-scale farmers are surveyed as part of these projects.

- Valuable information was gathered during this current survey regarding the use of a questionnaire and the types of information bits which were included. It was mentioned that academia should become relevant in the transfer of technology and training of small-scale farmers as part of their service to communities. Students participating as research assistants during this survey accomplished a much needed practical experience of real-life problems and situations in the real world. As was mentioned in the text, the student assistants were students studying towards a Diploma in Analytical Chemistry. During this survey, the group was exposed to field research work and the need for consequent and honest data collection from people. It was required from the assistants to gather soil samples according to certain conditions which brought them into contact with the reality of where and how samples are collected and stored for the required chemical analysis. The students who took part in data collection during this survey, are being trained as chemistry laboratory analysts, who during their training period have to learn the procedures of the chemical analysis of different samples. However, they very seldom have to collect their own samples and lack the knowledge of where samples originate from. This experience proved to be invaluable for students in chemistry in so far as them being part of a social study, but also having a component of collecting environmental samples, where these sample analysis might give insight into anthropogenic activities and its impact on the environment. It is recommended that students be exposed to inter-disciplinary projects to give them the opportunity to experience their learning in a holistic manner.

- It is recommended that the *Agrofert* soil analysis parameters be thoroughly studied with the help of the consultant agronomist. This in-depth study can form part of an environmental chemistry practical experiment to expose students to the interpretation of chemical parameter values in relation to soil fertility and its ability to attenuate plant nutrients as well as heavy metals and various other metallic organic compounds which might be present as pollutants. A soil fertilization programme, in conjunction with the *Agrofert* agronomist, can be developed and can form part of a training course for the environmental chemistry students, giving them insight into environmental sampling, analysis and interpretation of results.

- Extension services are not available to the small-scale farmers in the peri-urban and urban environments. It is recommended that academia take part in the development of training courses in farmer-to-farmer support, facilitating in the formation of co-operatives and networks that could be the marketing nodes in the communities, but also the centre for information and adaptive research into appropriate technologies. A public-private partnership cooperation between academia, the private sector and small-scale farmers can be initiated to transfer technology and impart business and managerial skills. Many areas of appropriate technologies need to be researched and developed, some of which may include soil conservation, water harvesting, seed harvesting for conservation of biodiversity, harnessing the collective knowledge and resources among small-scale farmers for the improvement of practical farming skills, and market development and across the board environmental and waste awareness programmes.

- It is recommended that training institutions like Technikon Northern Gauteng form linkages with other academic institutions and private sector business to build capacity for the development of training courses and objective oriented project development work in the peri-urban and urban areas of Soshanguve with special emphasis on the needs of the small-scale farmers in this region.

- It is recommended that the outcomes of this study be communicated to the population who gave their time and cooperation during the process of data collection. It is also necessary that Technikon Northern Gauteng become more relevant and develop programmes to be of value to the communities it serves.

7. REFERENCES AND BIBLIOGRAPHY

Arnon, I. *Agricultural research and technology transfer*. Elsevier Applied Science, London. Undated.

Ballance A; King, N. 1999. State of the Environment South Africa 1999. Department of Environmental Affairs and Tourism. Pretoria.

Biswas, T D; Mukherjee, S K. 1994. *Textbook of soil science*. Second Edition. Tata McGraw-Hill Publising Company Limited. New Delhi.

Buell, P and Girard, J. 1994. *Chemistry an environmental perspective*. Prentice Hall.

Chambers, R. 1992. *Rural appraisal: rapid, relaxed and participatory*. Institute of Development Studies. DP 311.

Crop Protection Compendium. 1997. Crop Protection and Animal Health Association. AVCASA. CD Rom produced by Destiny. Johannesburg.

De, A.K. 1995. *Environmental chemistry*. Third Edition. Wiley Eastern Limited. New Age International Publishers. New Delhi.

Department of Environmental Affairs and Tourism. 1996. *Integrated Pollution Control and Waste Management: The Need for Integrated Pollution Control in South Africa.* Cloete, D editor, L & W Environmental, Johannesburg.

Department of Water Affairs and Forestry. 1998. *Minimum requirements for the handling, classification and disposal of hazardous waste.* Waste Management Series. Pretoria.

De Lange, M and Crosby, L. 1995. *Towards successful small-farmer irrigation.* S A Water Bulletin. September/October 12 -17.

Friend. J.F.C. 1999. Environmental Management Systems. Lecture notes University of Pretoria.

Farmer Support Services Working Group. 1997. Draft: *Extension.* September 29. From: Rural Natural Resources, LHZ 704. Department of Agricultural and Food Engineering. University of Pretoria. Pretoria.

IOMC 1998. Key Elements of a National Programme for Chemicals Management and Safety. International Programme on Chemical Safety. UNITAR.

Havinga, C.. 2000. Organic farms play a role. *Farmer's Weekly*. April 14.

Hugo, F; van der Merwe, A; Walters, M and Louw, A. 1998. Sustainable Agriculture: A prerequisite for sustainable life on earth. *Ensuring a sustainable life on earth - a challenge for science, engineering and technology.* World Environment Day Symposium. Midrand. June 4.

Kinwa. H K N; Ainslie, A; May, H; Ntsaba, M; Poonan, U; Fakir, S. 1996. *A study tour report on community-based land management in West Africa.* Land and Agricultural Policy Centre. Johannesburg. January.

Laker, M.C. 1997. Understanding that in the process of land reform, rural upliftment and restructuring, South Africa must ensure sustain-ability of our natural resources. Paper presented at Agritech '97.

Lombard, R., 1997 Keynote Address: Recycling in South Africa. *Recycling for a better life: the future unwasted.* World Environment Day Symposium. Midrand, June 4.

Manahan, S. 1994. *Environmental chemistry.* 6th Edition. Lewis Publishers.

Myers, N. ed. 1994. *The Gaia atlas of planet management.* Pan Books Ltd. London.

Newby. T; Wessels, K J. editors. 1997. *Report on the extent of natural resource degradation in South Africa.* (A contribution to the 'Policy on sustainable resource use'). ISCW Report: GW/A/97/95.

Pretty, J.N. n.d. *Regenerating agriculture.* Earthscan Publications Ltd. London.

S A Explorer. 2001. Municipal Demarcation Board. Reniel Digital.

Series/SBC No: 99/009 (E). 2000. *Methodological guide for the undertaking of national inventories of hazardous wastes within the framework of the Basel Convention.* First Version. Basel Convention Secretariat. Geneva. Switzerland. August.

Smith, D. Maker of 'rat-poison' speaks out. *Saturday Star.* Primedia Publications. July 21, 2001.

Theron, P F. 1994. Proceedings of a Waste Management Conference.

Van Biljon, J.J. 2000. Lifelines for your crops. *Farmer's Weekly.* August 18.

Van der Stoep, I and Steyn A; 1999. *Natural resources in South Africa.* From: Rural Natural Resources, LHZ 704. Department of Agricultural and Food Engineering. University of Pretoria. Pretoria.

Verdoorn, G. 1993. Chemicals in the environment. South African Chemical Society. Midrand.

Vermaak, M. 2000. Donation received for small-scale farming. Forum. Technikon Pretoria. 17/16.

Watts, R.J. 1997. Hazardous waste: sources, pathways, receptors. John Wiley & Sons, Inc. New York

White Paper on Agriculture. 1995. Http://www.polity.org.za/govdocs/white_papers/agric95.html June, 2000.

Personal communication

1. A'Bear, B. Agrofert Academy. Rustenburg. Consultant agronomist. Personal communication. July 2000.

2. Van Staden, J. Agricultural Research Council, Hatfield, Pretoria. Personal communication. November 1999

3. Visser, A J. Bohlweki Environmental CC, Midrand: Director, Education and Training. Personal communication. 1999 - 2001.

APPENDIX A WASTE GENERATION IN SOUTH AFRICA

According to Theron (1994) waste generation in South Africa, **excluding** water-borne and atmospheric pollutants has been broadly classified in the following categories:

Table 1. ESTIMATED WASTE GENERATION IN MILLION TONS/ANNUM.

Source	**Quantity**	**% Total**	**Hazardous portion (tonnes)**
Mining	377	81	105
Industrial	22	5	81
Power generation	20	4	1
Agriculture & forestry	20	4	13
Domestic & trade refuse	15	3	13
Sewage sludge	12	3	13
Total	**466**	**100**	**2,26 = ± 0,5%**

Table 2. COMPOSITION OF THE HAZARDOUS WASTE STREAM.

Type	**Tonnes/year**
Clinical	33 000
Hospital incinerator ash	15 000
Inorganic	1 271 000
Organic: spent solvents & liquids	118 000
Sludges and slurries	509 000
Miscellaneous material	310 000

APPENDIX B INDUSTRIAL GROUPS WITH PROCESSES AND ACTIVITIES LIKELY TO PRODUCE HAZARDOUS WASTE

Table 3. ELEVEN INDUSTRIAL GROUPS WITH PROCESSES AND ACTIVITIES LIKELY TO PRODUCE HAZARDOUS WASTE

SELECT INDUSTRIAL GROUPS IDENTIFIED WITH CORRESPONDING SYMBOLS	
A	Agriculture, Forestry and Food Products
B	Mineral Extraction and upgrading
C	Energy
D	Metal Manufacture
E	Manufacture of Non-Metal Mineral Products
F	Chemical and Related Industries
G	Metal Goods, Engineering, and Vehicle Industries
H	Textile, Leather, Timber, and Wood Products
J	Manufacture of Paper and Products, Printing and Publishing
K	Medical, Sanitary and other Health Services
L	Commercial and Personal Services

Source: DWAF, 1998

APPENDIX C WASTE TYPES HAVING SIMILAR HEALTH OR ECOLOGICAL CONCERN

Table 4. SIX DIFFERENT WASTE TYPES EACH HAVING SIMILAR HEALTH OR ECOLOGICAL CONCERN

Source: DWAF, 1998

Waste Stream Classification	
A	Inorganic wastes * acids and alkalis * cyanide wastes * heavy metal sludges and solutions * asbestos wastes * other solid wastes
B	Oily Wastes * primarily from the processing, storage and use of mineral oils
C	Organic Wastes * halogenated solvents residues * non-halogenated solvent residues * PCB wastes * paint and resin wastes
D	Putrescible Wastes * wastes from production of edible oils, slaughter houses, tanneries and other animal based products
E	High Volume/Low Hazard Wastes * those wastes which, based on their intrinsic properties, present relatively low hazards, but may pose problems, because of their high volumes. (*E.g. drilling mud, fly-ash from power plants, mine tailings, etc.*)
F	Miscellaneous Wastes * infectious waste from diseased human/animal * redundant chemicals * laboratory wastes * explosive wastes from manufacturing operations or redundant munitions

APPENDIX D HAZARDOUS WASTE EMANATING FROM THE AGRICULTURAL AND FORESTRY SECTORS

Table 5. HAZARDOUS CHEMICALS IDENTIFIED OF PARTICULAR CONCERN IN SOUTH AFRICA PRODUCED BY THE SECTORS MENTIONED.

AGRICULTURE, FORESTRY AND FOOD PRODUCTION
aldrin aluminium phosphide Warfarin chlordane paraformaldehyde paraquat
parathion potassium nitrate promecarb propoxur saccharine sodium nitrate
sodium phosphate dibasic strychnine systox 2,4,5-T tebuthiuron terbufos triazophos
trifluoralin chlordimeform chlorpyrifos DDT dematon dieldrin dimethilan dinoseb
dinoseb acetate dinoterb dinoterb acetate diquat endosulfan endrin ethylformate
phention hexanes isolan letarsenates lindane magnesium chlorate malathion maneb
methomyl methoxychlor mevinphos mirex nicotine 2-octanone Urea

This list is not comprehensive and need to be revisited and updated

Source: DWAF, 1998

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

APPENDIX E

QUESTIONNAIRE 1

THE DEVELOPMENT OF AN INVENTORY MODEL FOR AGRICULTURAL CHEMICALS

AGRICULTURAL PRACTICE

1. DEMOGRAPHIC INFORMATION

Name of interviewee.

1.4 Block:.................................... 1.2 Stand nr...

1.3 Private home garden Y........ N........ 1.4 Communal land Y........ N................

1.5 Other:...

....

1.6 Is the interviewee the farmer Y.................. N............................

1.7 Age of interviewee 20 - 30........... 31 - 40........... 41 - 50...........51 - 60.....................

Other...

1.8 Gender of interviewee: Female..................Male...................

1.9 Number of members in household (normally eat together):...

1.10 How many children are attending school:...

1.11 How many children are still below school age:..

1.12 Marital status of interviewee:

single................................	single..
married 1 wife.....................	married (husband home)..................
married + 1 wife..................	married (husband away)...................
widower/divorced...............	married (co-wife)............................
	widower/divorced............................

1.13 What is your position in the household:...

head....................wife...............brother...................... sister................other.......................

2. AGRICULTURAL PRACTICES

2.1 Does the interviewee cultivate (any) land Y.................. N............................

2.2 Do you have rights to any land under cultivation Y.................... N............................

Bought......... rent............ gift.............. communal.................other...........................

2.3 If you have no rights, can you tell us why?...

2.4 Which crops are you growing:..

2.5 Do you use pesticides Y.................. N..........................

2.5.1 Trade names...

2.5.2 How much per month: kg.................. L.....................................

2.5.3 How do you store the chemicals: original container......... unlabelled........ other..........

2.5.4 Where do you store them: outside.............. inside............ other..........

2.5.5 period of time of storage: weeks................ months..........years............

2.6 How do you get hold these chemicals:

2.6.1 buy........................ 2.6.2 from whom...

2.6.3 gift........................ 2.6.4 from whom...

2.9.5 other...

3. SAFE USE OF PESTICIDES

3.1 Are you able to read the instructions on the labels: Y................ N..........................

3.2 Do you know how to use them safely: Y................ N..........................

3.3 Have you received any training to use them: Y................ N..........................

3.3.1 If **YES,** by whom: husband........ wife............... friend........... extension officer......

supplier.................... other..

3.4 How do you obtain information on the use of chemicals:

friends..............farmers........ extension officer................... supplier..........other............

3.5 Would you like to have better opportunities for training in the use of these chemicals:

Y.................. N..........................

3.6 If you are a man, do you inform women on how to use chemicals:

Y.................. N...........................

3.7 If you use agrochemicals do you have any effects on your health:

sneeze.......... headache........ skin ailments............. stomach cramps........... other...........

....

3.8 How do you get rid (dispose) of excess or old chemicals:

3.8.1	household waste	Y....... N........	3.8.2	in the veld	Y....... N...............
3.8.3	wash into the waterways	Y........ N.......	3.8.4	burn	Y....... N..............
3.8.5	bury	Y....... N........	3.8.6	other...	

3.8.7 Do you reuse original chemicals containers: Y................ N............................

3.8.8 Purpose:...

4. CULTIVATION TECHNOLOGIES

4.1 Who is mainly responsible for the cultivation of the land:

male............ female.............children........ other...

4.2 How do you cultivate the land:

tractor............mechanical.......other...

4.3 Which small appliances do you use:

picks............ shovels..............hoes........... spades............ other....................................

4.4 How do you irrigate the land:

rain-fed.............irrigate from communal tap..............river............. other.......................

4.5 Technology used for irrigation:

sprinklers..................hose-pipes...................... PVC pipes................. other.......................

4.6 The size of the land under cultivation: m^2....................... ha..........................

4.7 How do you obtain seed/tubers/trees for planting:

4.7.1 nursery........................ 4.7.2 friends......................... 4.7.3 cooperation..........................

4.7.4 self harvest.................. 4.7.5 other..

4.8 How do you know what to plant on your land:

4.8.1 friends .... 4.8.2 learn from young age..............4.8.3 supplier..............................

4.8.4 other...

4.9 Have you had a soil test done: Y.................. N..

4.9.1 If **YES**, what was the outcome:..

4.10 Do you sell surplus food: Y.................. N..

4.11 If **YES**, is this money your sole income: Y.................. N..

4.12 If **NO**, is the food you produce enough to feed your family: Y.................. N..............

APPENDIX F

QUESTIONNAIRE 2

THE DEVELOPMENT OF AN INVENTORY MODEL FOR AGRICULTURAL CHEMICALS

AGRICULTURAL PRACTICE

A. DEMOGRAPHICS		
❑ Household member		
❑ Block	Soshanguve	
❑ Stand	Soil sample Yes	No

A 1 Age	**1.** 20 - 30	**2.** 31 - 40	**3.** 41- 50	**4.** 51 - 60	**5.** 60 +	
A 2 Gender	1. Male	2. Female				
A 3 Members of the household	1. 0 - 4	2. 5 - 9	3. 10 - 14	4. 15 - 19		
A 4 Children attending school	1. 0 - 4	2. 5 - 9	3. 10 - 14	4. 15 - 19		
A 5 Children below school attending age	1. 0 - 4	2. 5 - 9	3. 10 - 14	4.15 - 19		
A 6 House hold managed by:	1. Single parent male	2. Single parent female	3. Married	4. Widowed or divorced	5. Grand parents	6. Other

B. AGRICULTURAL PRACTICES					
B 1 Land under cultivation	1. Land: private	2. Land: communal	3. Other	4.Comments	
B 2 Rights to land	1. Yes	2. No			
B 2.1 Rights vested as:	1. Bought	2. Rent	3.Communal chief	4. Gift	5. Other
B 3 No rights because:	1. Local authority property	2. Open space	3. Other		
B 4 Preferred crops grown on land under cultivation	1. Fruit apricot banana fig mangoes oranges peach strawberries	2.Vegetables beans beetroot cabbage carrots cauliflower garlic green pepper groundnuts herbs maize onions potatoes pumpkin spinach sugarcane tomatoes		3. Flowers	4. Trees

B. AGRICULTURAL PRACTICES					
B 5 Use of agricultural chemicals and/or pesticides	1. No	2. Yes	3. Trade names: *Bayer insecticide *Blue death *Dieldrin *Doom *synthetic fertilisers *Chlorophos *Rattex		
B 6 Approx. amount per 3 months	1. 0 - 2 kg	2. 3 - 5 kg	3. 6 - 8 kg	4. 0 - 2 *l*	5. 3 - 5 *l* 6. Unknown
B 7 Manner of storage	1. In original labelled container	2. Unlabelled non-original container	3. Other	4.Comments	
B 8 Place of storage	1. Outside and locked	2. Inside the house, away from food	3. In grocery cupboard	4. Away from reach of children	5. Comments
B 9 Approx. period of storage	1. Weeks 0 - 4 (1 month)	2. Weeks 5 - 8 (2 months)	3. Weeks 9 - 12 (3 months)	4. Weeks 13 - 16 (4 months)	5. Other

B. AGRICULTURAL PRACTICES					
B 10 Manner of obtaining chemicals:	**Buy** from	1. Shop	2. Hawkers	3. Co-ops	4. Farmers
B 10.1	**Given to** by:	1. Farmers	2. Friends	3. Extension services	4. Other
B 11 Crop output	1. Better than previous season	2. Less than previous season	3. Same	4. First time planting	5. Comments
B 12 Make own manure or compost	1. Yes	2. No	3. Comments		

C. SAFE USE OF PESTICIDES AND/OR AGRICULTURAL CHEMICALS					
C 1 Ability to read instructions on labels	1. Read and understand	2. Read but do not pay attention	3. Cannot read instructions	4. Difficult language on labels	5. Comments
C 2 Know how to use safely	1. Yes	2. No	3. Indifferent	4. Learning	
C 3 Receive **training** in usage	1. No	2. Yes: from 6. Supplier	3. Husband 7. Extension officer	4. Wife 8. Other	5. Friend

C. SAFE USE OF PESTICIDES AND/OR AGRICULTURAL CHEMICALS					
C 4 Receive **information** about usage	1. No	2. Yes: from 6. Supplier	3. Farmers 7. Other	4. Friends	5. Extension officer
C 5 Women learn from men	1. Yes	2. No			
C 6 Need training opportunities in safe use practices	1. Yes	2. No	3. Indifferent	4. Comments	
C 7 Health affected	1. Breathing problems	2. Headache	3. Skin ailments	4. Stomach cramps	5. None 6. Other
C 8 Method of disposal of excess and empty containers	1.Household waste	2. Veld	3. Bury	4. Toilet	5. Other
C 9 Reuse of chemicals containers	1. No 6. Other uses	2. Yes: to... 7. Comments	3. Store water	4. Store chemicals	5. Store foodstuff

D. CULTIVATION TECHNOLOGY						
D 1 Means of cultivating land	1. Tractor	2. Animal drawn plough	3. Small appliances	4. Comments		
D 2 Primary cultivator	1. Male	2.Female	3.Children	4. Comments		
D 3 Land irrigated by:	1. Rain-fed	2. Tap	3. Stream	4. Comments		
D 4 Means of irrigation	1.Sprinkler	2. hose pipes	3. Drip	4. Flood (Furrows)	5. Bucket	6. Other
D 5 Approx. size of land	1. < 10 **m²** 10. < 1 **ha**	2.10 - 20 11.> 1 ha	4. 21 - 30 12. Other	5. 31 - 40	6. 41 - 50	7. > 50 m²
D 6 Plant material obtained from	1. Nursery	2. Co-op	3. Friends	4. Farmers	5. Self harvesting	6. Extension officer
D 7 Crop growing knowledge obtained from:	1. Learn from young age father or mother	2.Farmer to farmer	3. Extension officer	4. Friends	5. Agric. College	6. Other
D 8 Sell surplus production	1. Yes	2. No	3. Only income	4. Extra income	5. Comments	
D 9 Feed family adequately	1. Yes	2. No				

APPENDIX G COMMENTARY ON DATA COLLECTION AND STUDENT ASSISTANTS ATTITUDES

Learning outcomes of the pilot study in Block SS, Soshanguve

Block SS, Soshanguve, is an informal settlement, lying about 25 km north west from Technikon Northern Gauteng, the M 35 Soutpan road. The area consists of permanent and semi-permanent informal dwellings. Each stand is provided with tap water and pit latrines. Block SS was chosen to conduct the pilot testing of the questionnaire, mainly due to its rural character, relatively far from the township centre and would probably house a large number of small-scale farmers. It was decided to randomly select the population by marking every third dwelling for the purpose of conducting an interview. The student assistants volunteered to take part in this exercise. They were trained by the author by means of role playing and a complete explanation of the reasons for this study. Two hours was allowed for two assistants to complete 5 questionnaires. While coding the data for frequency distribution analysis, a number of problems arose.

Even though the students were explicitly told that this process of data collection were not for examination or personal evaluation purposes, it was found that many questionnaires were filled out in duplicate or even triplicate in order to generate the requested number per group. Most questionnaires were not completed in full and could not be included for statistical analyses. The same trends were found in relation to the main objectives in this study. Notwithstanding, a number of very important issues came to the fore.

Fifty five data pieces were tendered of which only eighteen (18) to twenty one (21) were in such a state of completion that it could be used for analysis. The format of the questionnaire necessitated redesigning due to the many non-responses reported. Commentary by the student assistants revealed the following interesting insights. Questions were left unanswered because:

- Only a few respondents were cultivating land in Block SS. This observation served as the main drive to target only households in Block L who were actively working the land, for the final data collection process.
- Respondents who were cultivating land were not using chemical fertilizers, pesticides, herbicides and insecticides.
- Respondents could not discern between fertilizers, pesticides, herbicides and insecticides. Trade names of compounds were mentioned by respondents which made it clear that by giving guidelines during an interviews, more information would be forthcoming.
- Concern was mentioned by respondents that some of the questions were invading their privacy. These questions related to their marital status and the fact that a question about 'literacy' was included.
- Some respondents and student assistants said that this questionnaire would be more appropriate to the farming community.
- Although the student assistants were trained in the different aspects of the data to be collected with the

interview and although they had knowledge of chemicals - the group were studying environmental chemistry II and were already sensitised towards environmental issues - they could not estimate the quantities of chemicals used; understand or explain to the respondents what the differences between the different categories of chemicals were and could not do a physical approximation of the size of land under cultivation as m^2 or hectares. Moreover, respondents were not always able to understand English and the interviews had to be conducted in different vernaculars. In some instances, Afrikaans was the chosen language, which also brought another perspective into the completion of an interview. Most of the student assistants were not able to use Afrikaans as a spoken language.

- Respondents who had gardens, were using animal manure or making their own compost, therefore it was not possible to determine trade names and quantities of chemicals used per month.

These comments and the cumbersome format of the questionnaire, prompted a redesign and rephrasing of the questions which resulted in the interview questionnaire used for the final data collection in Block L, Soshanguve. This area was chosen for a number of reasons:

- Block L is situated in closer proximity to Technikon Northern Gauteng, which would make the logistics of transporting, controlling and ensuring the safety of the student assistants much easier.
- Large open fields are bordering this section and after visiting Block L, the author could ascertain that people living in the informal settlement bordering the built environment, were indeed utilizing the land for farming activities. The author could also make arrangements with the local farmers to be available on the days when the data collection were done. It also proved to be good practice to inform the target population of the reasons for the study and that they are valued by the Technikon, an institution which is situated in their midst and should be of value to the inhabitants of the area.

During this study, it was found that the format of the final questionnaire was easier to complete and also less cumbersome to analyse for frequency distributions because most of the responses were already coded. Guidelines given for land size, estimated quantities of chemicals and trade names for chemicals lessened many of the problems encountered beforehand. The student assistants had previous experience under similar conditions while collecting similar data. More consistent interviews could therefore be conducted, which generated more reliable information. Intrinsic problems with the wording and interpretation of the questions were still found, a matter which will need attention for further research in relation to the main objectives.

It is also necessary to mention that the student assistants evaluated the experience positive and indicated that they would like to part of future investigations. The following learning outcomes were found:

- Students have learnt ways of communicating effectively with the respondents and therefore felt that they could convince them to share their experiences. People were telling them 'wonderful stories on how to work the land'.

- Enthusiasm to work in a team was mentioned as a positive outcome as well as having had a new experience while doing social field work, something which students studying natural sciences are rarely exposed to.
- Soil can be fertilised by the decomposition of organic waste material - the students have theoretical knowledge of these aspects but could only by seeing this practice in action, realize the practical application. For the author it was again of importance to note that training should be much more 'hands on' and nothing should be taken for granted in terms of the previous experience of learners. They are dependent on the trainer!
- Respondents and students were aware of the dangers of chemicals and therefore buried the empty containers in order to ensure the safety of their children - but the threat to groundwater and the environment were not realized if such disposal methods are pursued.
- Students commented that they have found the respondents having great needs to be trained in the safe use and disposal of agricultural and household chemicals.
- Ethical behaviour under all circumstances is the mainstay of good relations with any population during any social research projects.

TEMO LABORATORY SERVICES CC
Ref : CK 99/25734/23
TEL : 012 799 9721
FAX : 012 799 9022
Email: Lab@agrofert.com
Private bag x07
PRETORIA NORTH 0116
01 College road Soshanguve
Technikon N. Gauteng premises

RSM / AGENT	Mrs C.van der Linde	DATE	10/03/2000	FARM /COMPANY	Technikon N.Gauteng
CLIENT	Mrs C. van der Linde	ADDRESS	Private bag x07	TEL. NUMBER	012 799 9029
			PRETORIA NORTH	FAX NUMBER	012 799 9022
			0116		

SOIL REPORT

						BRAY 1	HCl EXTRACT		AMMONIUM ACETATE EXTRACT						
LAB. NO.	NAME (of owner)	LAND NO. (Stand No.)	pH (H_2O)	pH (KCl)	COND mS/cm	P mg/kg	P mg/kg	Ca mg/kg	Ca mg/kg	Mg mg/kg	K mg/kg	Fe mg/kg	Na mg/kg	Cl mg/kg	CEC C.mol/kg
B0001	M.G.Khaude	N/A	7.12	6.22	0.11	26	105	389	381	54	249	0.2	31	138	7.10
B0002	H.Monoamadi	N/A	6.52	5.34	0.09	24	68	327	271	48	162	0.2	27	82	4.58
B0003	D.T.Ndala	N/A	8.62	7.91	0.16	83	669	731	477	68	112	0.2	23	78	5.52
B0004	A.Mashia	3435	7.24	6.07	0.09	20	66	368	301	54	141	0.2	14	75	4.47
B0005	A.Mogotlane	3437	6.46	5.42	0.09	17	29	355	243	47	132	0.3	9	82	4.28
B0006	M.Sanyane	3438	8.12	7.44	0.15	20	63	491	415	44	121	0.3	9	78	4.98
B0007	Mrs Magelo	3439	6.42	5.14	0.08	12	17	274	233	48	136	0.1	9	82	4.24
B0008	M.Mathinyane	3666	6.43	5.10	0.06	9	13	262	212	46	297	0.2	9	99	3.92
B0009	J.Matsepane	3799	7.86	2.56	0.25	31	101	710	655	70	137	0.2	21	99	9.28
B0010	L.Mosibi	3740	6.81	5.70	0.12	20	25	505	324	60	91	0.2	28	75	3.50
B0011	Westland	N/A	7.91	7.14	019	14	39	465	458	65	56	0.2	27	82	8.08
B0012	S.Ndlovu	3728	7.27	6.36	0.13	24	30	541	311	51	34	0.2	36	96	3.21
B0013	Mr Magathe	Hlomphanang	7.19	6.32	0.13	18	25	376	370	61	97	0.2	23	75	7.69
B0014	E.Motaung	3720	6.99	5.96	0.13	12	12	438	345	58	60	0.2	12	82	3.40
B0015	J.Mogase	3715	7.39	6.82	0.16	34	34	472	345	47	69	0.2	26	78	4.39

TEMO LABORATORY SERVICES CC

Ref : CK 99/25734/23
TEL : 012 799 9721
FAX : 012 799 9022
Email: Lab@agrofert.com

Private bag x07
PRETORIA NORTH 0116
01 College road Soshanguve
Technikon N. Gauteng premises

RSM / AGENT	Mrs C.van der Linde	DATE	10/03/2000	FARM /COMPANY	Technikon N.Gauteng
CLIENT	Mrs C. van der Linde	ADDRESS	Private bag x07	TEL. NUMBER	012 799 9029
			PRETORIA NORTH	FAX NUMBER	012 799 9022
			0116		

SOIL REPORT

						BRAY 1	HCl EXTRACT		AMMONIUM ACETATE EXTRACT						
LAB. NO.	NAME (of owner)	LAND NO. (Stand No.)	pH (H_2O)	pH (KCl)	COND mS/cm	P mg/kg	P mg/kg	Ca mg/kg	Ca mg/kg	Mg mg/kg	K mg/kg	Fe mg/kg	Na mg/kg	Cl mg/kg	CEC C.mol/kg
B0016	Wetland (R.A.)	N/A	8.10	7.53	0.19	14	19	463	365	40	33	0.2	39	89	6.45
B0017	S.A. Makgatho	3717	5.98	4.77	0.08	13	15	225	184	33	57	0.2	23	57	5.41
B0018	J. Mahlangu	3811(L-Ext)	7.76	7.18	0.31	18	31	443	365	57	49	0.2	55	64	22.7
B0019	Philly	3796(L-Ext)	7.61	6.78	0.37	13	32	401	352	49	64	0.3	104	89	5.58
B0020	Dominic	3763	7.34	6.23	0.15	12	13	389	351	64	76	0.3	33	67	6.61