Scoping Study to Determine the Potential Impact of Agricultural Chemical Substances (Pesticides) with Endocrine Disruptor Properties on the Water Resources of South Africa

by

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Report to the Water Research Commission on the project
Scoping Study to Determine the Potential Impact of Agricultural Chemical Substances (Pesticides) with Endocrine Disruptor Properties on the Water Resources of South Africa

WRC Report No 1774/1/08
ISBN 978-1-77005-714-2

SEPTEMBER 2008

EXECUTIVE SUMMARY

An endocrine disruptor chemical (EDC) is an exogenous chemical substance or mixture that alters function(s) of the endocrine system and consequently causes adverse health effects in an organism, or its progeny, or (sub)populations (WHO definition).

EDCs are known to interfere with the structure or function of hormone-receptor complexes. They can cause endocrine disruptive effects at exposure levels much lower than carcinogen exposure levels of concern. Internationally, the negative impact of EDCs on health is recognized and no longer an issue of dispute. Examples include the increase of testicular and prostatic cancer, the higher incidence of undescended testes and hypospadia, the decline in male reproductive health and fertility, and the very likely causal effect on cognitive and immunological development of children. The presence of EDCs in South African water systems may have an impact on the health of the South African population and wildlife.

Some pesticides (insecticides, herbicides, fungicides, nematocides and acharicides) used in agricultural practice have ED (Endocrine Disruptive) properties which may contaminate South African water resources. Concern has been expressed that some of these pesticides may enter and pollute the rivers and dams and cause ED effects in animals and humans that use the water for drinking and recreational purposes. It is, however, not clear what the impact of these chemicals or their breakdown-products is on the water resource. Only limited research was done on possible contamination of pesticides with ED properties in the country.

The mechanisms of how these EDCs react on the human and animal hormonal systems are not yet fully understood, but the effects have been observed by researchers doing field studies along selected rivers and dams. The farmers using the pesticides and the users of the water are not always aware of the effects caused by EDCs.

The main objective of this study is to gather information in order to determine whether a larger study is justified to establish the impact of pesticides with ED properties in water systems of the country. Very little data on pollution of water resources by these pesticides exist in the country. The majority of studies were aimed at determination of toxicity with either the onset of cancer or death as the end point. ED effects may occur at exposure levels a million times lower than levels causing other toxic effects and the data generated in toxicity studies can therefore not be used to forecast ED effects of such a compound. In this project, the focus will be on chemicals (pesticides and drugs for domestic animal production) used in crop production and animal husbandry activities. Although malaria vector control, red-billed quelea control as well as locust control is not directly linked to agricultural practices, the pesticides used are regarded as agricultural pesticides and these activities are included in the report. Pesticide spray programmes on forests, sport fields and golf estates are also taken into account for the same reasons.

The country was divided into areas where specific agricultural practices are taking place. (Water Management Areas as described by the Department of Water Affairs and Forestry). A survey was done on which crops are cultivated and which domesticated farm animals are found in these areas. A survey was conducted on which pesticides and drugs used for animal health with ED properties were registered for use of pest control on the specific crops and for disease and pest control on the domestic farm animals. The chemicals were selected using the South African list of priority compounds and the European Union lists. Pesticides listed as persistent organic pollutants (POPs) are also EDCs. Monitoring for these substances is compulsory under the Stockholm Convention of which South Africa is a signatory. Many of them has been banned for use or voluntarily withdrawn from the market.

It is important to establish the amounts and frequency of the pesticides used. This was a difficult task because the registration holders and distributors of the chemicals are unwilling to disclose sales figures and usage because it is regarded as confidential marketing information. Information gained on volumes of EDCs produced and frequency of use is outdated, inaccurate and not dependable. Information regarding the recommended application of selected pesticides on the relevant crops, frequency of application and withholding periods after application was obtained from the Department of Agriculture.

In a study like this, the geological make up of the areas needs to be taken into account to establish the likelihood of the pesticides and drugs to reach the catchment areas of streams, rivers and dams. The topography of rivers changes very often and it will be impossible to give the information on all rivers in this report. It is recommended that this study be done once a study area has been identified.

The survey indicated that a large number of pesticides with ED properties are registered for use in all the Water Management Areas (WMAs) of the country. It may be assumed that most of them are used on crops in these areas depending on the prevalent disease and/or pest. In a few studies conducted in the country, ED activity was detected in various rivers and dams of the country. Whether this activity was caused by agricultural pesticides is not clear because industrial chemicals and natural hormones that can also cause ED activity were also found in the same rivers and dams. Because of lack of data, the magnitude of the EDC pollution could not be established. It is, however, clear that some areas are more vulnerable than others due to DDT spraying and the variety of crops cultivated (Areas 1, 2, 4, 5 and 6). In studies conducted by researchers of the WRC and universities, some of these pesticides were found in water, sediment and biota in selected rivers and dams. In all these studies, only a few selected pesticides were monitored. Chemical analysis of all pesticides was not possible because of the high cost of analysis and the fact that the ED properties of the chemicals were not known. Currently only one study is in progress on the impact of veterinary drugs used in feedlots on the water resources. The main impact of these practices may be felt in Areas 1, 3, 4, 7, 8, 11, and 13. Although the use of DDT has been banned for agricultural use since 1976, it is still being used in parts of the country for malaria vector control.

Climatic conditions and marketing trends play a significant role in production of crops and will therefore have an impact on the pesticide usage in a WMA. Higher quantities of pesticides are applied to crops planted for use other than food and feed. Note should be taken of this when crops such as maize and sugar cane may be produced for bio-fuel.

The results indicate that a more comprehensive study is needed to determine the impact of agricultural pesticides with ED properties on South African water resources. The presence of EDCs in South African water systems and the fact that they can influence wildlife and human health is no longer a matter of contention. The ED activity is, however, not only due to the presence of agricultural pesticides. To determine the impact of agricultural pesticides on the ED activity on water systems will be a difficult and complex exercise. The study will have to include the study of other chemicals with ED properties, such as industrial chemicals and natural and synthetic hormones. It is not certain that field studies alone will supply the knowledge necessary for the development of a risk assessment model that is needed for the management of these compounds. A laboratory study is proposed to determine the effect of *mixtures* of pesticides in water. This study may be done concurrently with field studies.

Water is South Africa's most precious natural resource. A national effort is needed to protect this resource. State departments such as Department of Water Affairs and Forestry, Department of Agriculture, Department of Environmental Affairs and Tourism, Department of Health and Department of Trade and Industry should be involved. All future research should be aimed at the management of the problem. A comprehensive policy is needed and a management programme put in place to address the problem. Knowledge gaps were identified that need attention to meet this objective. Determining the magnitude of the pollution, understanding the mode of action of the pesticides in the human and animal body, the fate and behaviour of pesticides in soil and water and the behaviour of mixtures of pesticides, are all matters that need attention before a human health risk assessment that is necessary for management, can be put into place. Suggestions were put forward to address these gaps.

Laboratory capability and capacity have deteriorated significantly in the last couple of years. The country lacks capability and capacity at all levels to realize the aims and objectives of addressing the EDC pollution in the country. Capacity building at personal as well as institutional level is necessary for the success of any further projects in this field. A state of the science study is needed to co-ordinate research between the different universities and other scientific organizations. This may eliminate duplication of studies and the pooling of scarce resources. An awareness should be created amongst farmers using the pesticides as well as the users of the water resources about the risks and dangers associated with the EDCs.

Acknowledgements

The financing of the project by the Water Research Commission and the contribution of the steering committee is gratefully acknowledged.

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NOTE

The authors would like to thank the following persons and institutions for their support, input and information supplied: Dr. JB Vermeulen, Mrs. Isabella Vermeulen, Dr. Johan van Niekerk, Prof. Tiaan de Jager, Mrs. Azel Swemmer, Dept. of Water Affairs and Forestry, Dept. of Agriculture, Dr. Ben Cilliers, Dow AgroSciences Southern Africa (Pty) Ltd., Bayer Chemicals (Pty) Ltd., and various Agri Co-ops.

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1. BACKGROUND

An endocrine disruptor chemical (EDC) is an exogenous chemical substance or mixture that alters function(s) of the endocrine system and consequently causes adverse health effects in an organism, or its progeny, or (sub) populations (WHO definition, WHO/PCS/EDC/02.2).

Many compounds that are in daily use in industry, agriculture and in households have ED (endocrine disruptive) effects. These include the alkylphenols, polychlorinated biphenyls, dioxins and furans, and organochlorine compounds, which are used in different forms as plasticizers, lubricants, packaging material, fire retardants and pesticides (insecticides, fungicides, herbicides, nematocides and acharicides). Dichloro-diphenyl trichloro-ethane (DDT) and other organochlorine pesticides are well known for their ED effects. Substantial quantities of pesticides and drugs for animal disease control are used annually by commercial and small farmers, in afforestation, on sport fields and in homes and private gardens. According to a report published by the United Nations Environmental Programme (UNEP), pesticides constitute one of the major sources of Persistent Toxic Substances (PTS) in the sub-Sahara region of Africa. The majority of pesticides are imported into this region of Africa. The pesticides most used are DDT, endosulfan, lindane, chlordane, heptachlor, toxaphene, aldrin and atrazine. South Africa is a main distributor of pesticides but only atrazine is produced in South Africa. The use of chlordane, toxaphene and aldrin was banned in South Africa (Annexure B) and none of them was detected in water sources in studies done in recent years. The UNEP report states that one of the serious problems facing the region now is the issue of stocks and reservoirs of obsolete discarded and banned PTS pesticides. The FAO estimates that there might be more than 40 000 tons of these substances. Other pesticides with ED properties were, however, identified in studies done in Europe, Japan and the USA. Some of these "newer" pesticides have replaced the older, banned pesticides in agricultural practice. A list of organic compounds with ED properties was compiled by the EU (Annexure F). Pesticides mentioned in this list were selected and combined with information obtained from the Global Water Research Coalition (GWRC) and trade partners of South Africa, such as Japan, to compile a priority list for this study (http://ec.europa.eu/environment/encocrine/strategy/substances.en.htm).

Concern has been expressed that some of the pesticides used in agricultural practice (crop spraying and animal disease control) may enter and pollute the rivers and dams and cause endocrine disruptor effects in animals and humans that use the water for drinking and recreational purposes. The UNEP reported that many cases of accidental or intentional release of large amounts of pesticides were reported in the sub-Sahara region that caused severe stress to the environment and humans.

The mechanisms of how these compounds react in humans and animals are not yet fully understood, but the effects can be observed. The users of these chemicals are not always aware of these effects.

Persistent organic pollutants (POPs), a subgroup of EDCs, are hazardous chemical substances that do not break down naturally, or do so extremely slowly. They accumulate in fatty tissue, becoming more concentrated higher up in the food chain over time, thereby putting the environment and human health at risk. Of all pollutants released into the environment every year by human activity, POPs are amongst the most harmful. Pesticides included in the POPs list are DDT, DDE dieldrin, aldrin, heptachlor, toxaphene, mirex, γ-BHC and chlordane. They are highly toxic, causing an array of adverse effects, notably death, disease and birth defects, among humans and animals. There is a drive worldwide to ban these substances and ultimately led to the signing of the Stockholm Convention. Specific effects can include cancer, allergies and hypersensitivity, damage to the central and peripheral nervous systems, reproductive disorders and disruption of the immune system. They present a special risk to children because they are conveyed through the placenta and in breast milk, and can have a critical effect on the foetus and infant whose systems are at key stages of development (WHO Report 2002, Fenster et al., 2006, Bhatta et al., 2005). The focus of The National Toxicant Monitoring Program (NTMP) is mainly on the POP pesticides, but many other pesticides in daily use also pose a threat to human and animal life.

1.1 Health implications of EDCs

The endocrine system is a complex physiological process by which the body can respond to a range of internal and external signals and stresses. Hormones are the chemical messengers of the body that are secreted from the endocrine glands directly into the blood and are involved in regulating the growth, development and functions of the body.

A diverse range of chemicals discharged in the environment can mimic or antagonize the action of hormones. These EDCs may interact with the physiological systems that cause alterations in development, growth and reproduction in humans and wildlife.

1.1.1 EDC effects on the reproductive system

Exposure of male embryos in the early stages of development has been linked to the increased incidence of male reproductive health disorders including hypospadias, undescended testes, intersex, subfertility and testicular cancer (Paulozzi 1999; Sharpe and Skakkebaek 1993; Toppari et al., 1996). EDCs can cause endocrine disruptive effects at exposure levels up to a million times lower than carcinogen exposure levels of concern. Internationally, the negative impact of EDCs on health is evident and no longer an issue of dispute. Pesticides used for crop spraying which were identified to have an effect on the reproductive system, included p-p'DDE (insecticide), vinclozolin (fungicide), linuron and diuron (herbicides) (COMPREDO CREDO Workshop, 2004 and COMPREDO CREDO Workshop, 2006, www.credocluster.info). Examples include the increase of testicular and prostatic cancer (Toppari et al., 1996; Bergstrom et al., 1996; Møller, 1998) the higher incidence of undescended testes and hypospadia (Møller & Weidner, 1999; Skakkebaek et al., 2001) and the decline in male reproductive health and fertility.

Female reproductive health and fertility, particularly conditions like endometriosis, adenomyosis of the breast, reproductive tract cancer and possibly Polycystic Ovarian Syndrome, seem to be mediated by EDCs (Gerhard and Runnebaum, 1992). Foetal exposure to EDCs was found to influence reproductive and general health.

1.1.2 EDC effect on the nervous system and thyroid function

The nervous system and thyroid function play an integrative role along with the endocrine and immune system in orchestrating important physiological functions in the body. The integrative functions are critical for normal development and cognitive functions and behaviour. A number of environmental chemicals (including potential EDCs have been shown to cause neurotoxic effects (WHO Report 2002). A variety of adverse health effects have been observed ranging from motor impairment and memory loss to subtle behavioural changes (Spencer and Schaumburg, 2000). Of particular concern are the potential effects of the exposure on the developing nervous system, because both the nature and adversity of the outcome may depend on the time window during which the chemical exposure occurs and result in irreversible neurobehavioral changes later in life. EDCs very likely have detrimental effects on the cognitive and immunological development of children (Tilson, 1998). Atrazine, a widely used broad leave herbicide is reported to have a significant influence on the nervous system and thyroid function (Calamandrei et al., 2006). Vinclozolin, a fungicide registered in South Africa for use on grapes (vineyards), is reported to have negative effects on the thyroid function. (WHO Report, 2002)

1.1.3 EDC effect on the immune system

The major function of the immune system is defence against infectious agents and certain neoplastic cells. Various cell types and their soluble mediators execute the function of the system in a finely tuned manner. Toxic responses may occur when the immune system acts as a passive agent of chemical inputs, leading to altered immune function. Toxicity may also arise when the immune system responds to the antigenic specificity of the chemical as part of a specific immune response, that is, hypersensitivity or allergy. Chemically induced toxicity, in which the immune system is the target, can result in immunosuppression and potential disease susceptibility (WHO Report 2002). This is of special concern in South Africa with the high rate of HIV/AIDS. Only limited studies were done in this field. Atrazine is suspected of having an influence on the immune system. (Calamandrei et al., 2006).

1.2 Influence of EDC contamination on the environment

EDCs probably contribute to declines in some wildlife populations such as fish, alligators and birds (Guilette et al., 1996; Johnstone et al., 1996; Vos et al., 2000). Indications are that wildlife in South Africa is being adversely affected by EDCs (Bornman et al., 2007). Eggshell thinning in bird species has been observed as well as feminization of fish and amphibian species in Europe as well as the USA.

1.3 Economic and industrial implications of EDC contamination

1.3.1 The Stockholm Convention

South Africa is a signatory to the Stockholm Convention (2001) on the Control of Persistent Organic Pollutants (POPs) ratified during the World Summit on Sustainable Development in August 2002 and signed September 2002 (www.pops.int/documents/signature/signstatus.htm). Parties undertake to limit and control the release of persistent organic pollutants in the environment. The National Government through several National Departments, such as Department of Water Affairs and Forestry (DWAF), Department of Health (DOH), Department of Environmental Affairs and Tourism (DEAT), Department of Trade and Industry (DTI) and Department of Agriculture (DOA), is under obligation to initiate programmes so that the process of cooperative governance may be put in place in order to enable South Africa to honour the Stockholm Convention obligations.

1.3.2 Crop yields

Fox et al. (2007) reported that certain pesticides in the soil may reduce the yield of leguminous crops.

The long lasting POPs travel in multiple cycles of evaporation and condensation and are transported by air to remote areas far from the source of their release, necessitating international regulation. The international POPs convention, signed in May 2001 in Stockholm, defined measures to reduce global concentration levels of the twelve identified POPs. These POPs have been grouped in three categories:

1. Pesticides: aldrin, chlordane, DDT, dieldrin, endrin, heptachlor, mirex and toxaphene (camphechlor).
2. Industrial chemicals: hexachlorobenzene (HCB) and polychlorinated biphenyls (PCBs).
3. Unintended byproducts: dioxins and furans.

Apart from the POPs, also included in the pesticide group that have ED effects are:

1. Herbicides
2. Fungicides
3. Insecticides
4. Nematocides and acharicides

(For full list see Table 2)

Not all of them remain sufficiently stable to travel across international borders and to be classified as POPs. Clearly, the less stable ones are specifically harmful in the area of their release where the exposure levels are high. These, therefore, require additional local monitoring and regulations, as they are not covered by the international convention.

1.4 Summary

Public fear of EDCs, which include pesticides, can be compared to that of radioactivity and disease-causing bacteria and viruses - they are not readily detectable and introduce an additional risk of unknown magnitude that requires government protection of the population. On the other hand, agriculture as well as industry is also involved and proper controls will undoubtedly be at a cost. Pesticide pollution, therefore, is a politically sensitive issue. Even *perceived* threats to health and environment can be an extreme risk for survival of the South African economy. It may easily fall prey to manipulated or spontaneous international actions to ban export products from SA due to high levels of one or the other of the identified pollutants. The only defence against such threats is an improved knowledge of the state of our environment, by using the information to ensure that our present and future legislation is strictly enforced as far as banning - or controlled use - of certain pesticides and drugs and clean industrial production is concerned. For this process to come into effect it is needed to establish facilities to monitor both the target chemicals and their endocrine disrupting effects.

The limited water sources of South Africa, the limited health budget, the likelihood of significant pollution by agricultural practice and industrial activity, the lack of proper waste control, the need to use DDT for malaria vector control, emphasize the need for timely measures to be taken by the authorities.

2. SCOPE OF THIS PROJECT

In this project, the focus will be on agricultural chemicals (pesticides) used on crop cultivation and animal husbandry activities. Although malaria vector control, red-billed quelea control as well as locust control is not directly linked to agricultural practice, the chemicals (pesticides) used are regarded as agricultural pesticides and these activities are included in the report. Pesticide spray programmes on forests, sport fields and golf estates are also taken into account for the same reasons.

3. AIMS AND OBJECTIVES

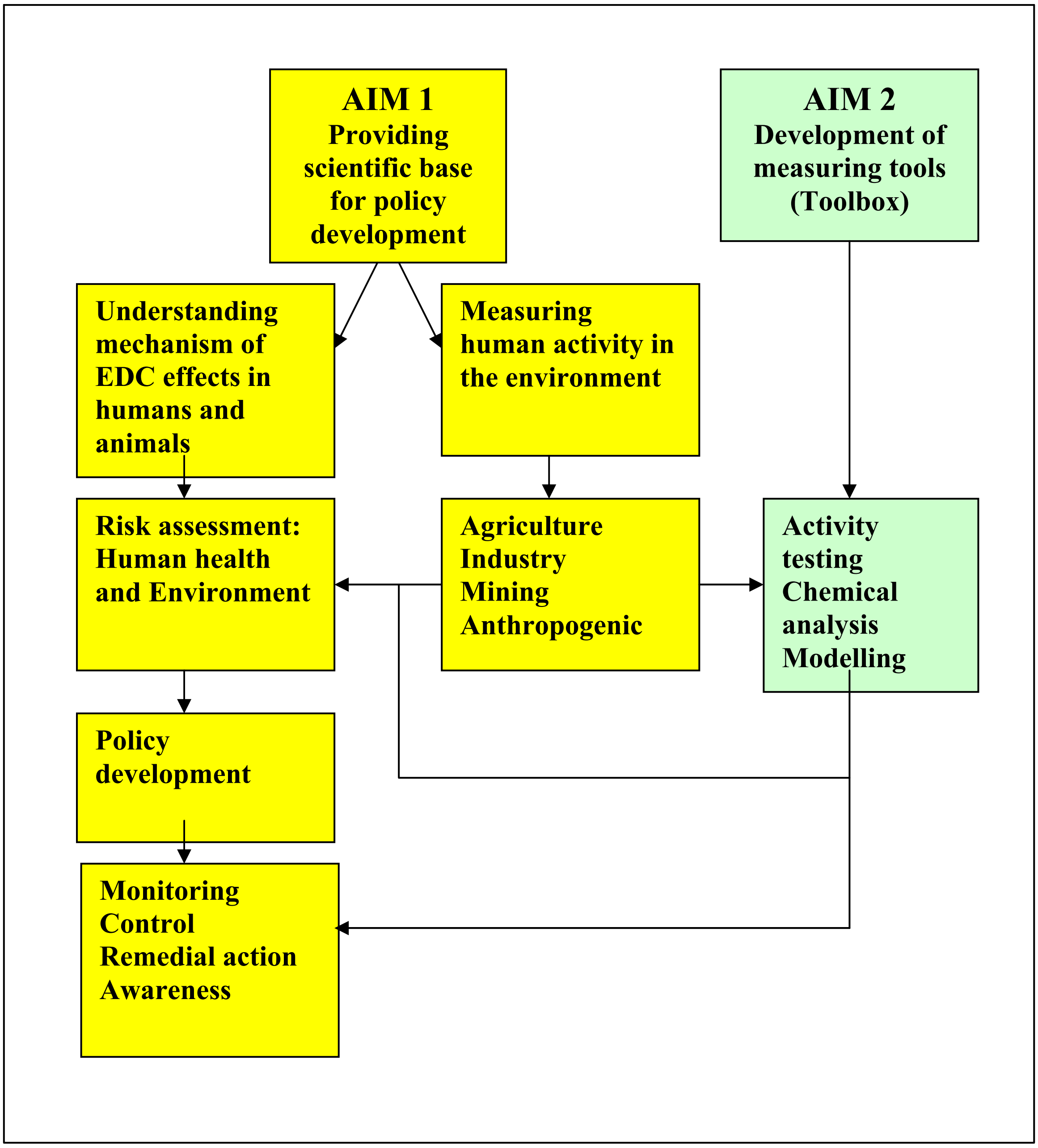
3.1 Aims

The aim of this project is to gather information in order to determine whether agricultural substances (pesticides) with Endocrine Disruptor (ED) properties could possibly have a significant impact on the water resources of South Africa and whether a more comprehensive study on the impact of pesticides on water resources is justified. The project should also fit into the broad framework of the WRC EDC programme. The aims of the WRC EDC programme are (Refer to Figure 1):

- To provide government with a sound basis for policy development
- To develop tools for measurement which would lead to risk assessment

Knowledge gaps will be identified in order to establish a programme for further research.

Figure 1: Broad Framework for the WRC Strategic Research Programme for Endocrine Disruptor Chemicals (EDCs) in Water Resources



3.2 Objectives of scoping study

In order to determine the potential impact of agricultural chemicals (pesticides) with EDC properties on water resources of the country, it is necessary to establish the following:

a) The various crops that are cultivated in the country and animals used in animal husbandry
b) The areas in which these crops are cultivated and animals held
c) The chemicals used in the cultivation of the crops and for disease control on domestic animals
d) The frequency and amount of the chemicals used
e) Whether the geology of the areas and the movement of the chemicals in the soil and air will result in the entering of the chemicals in the water resources.

4. METHODOLOGY

4.1 Identification of main crops cultivated in the country and most important domestic animals used in animal husbandry (Objective a)

Information was gathered from registration holders of pesticides, Department of Agriculture, the Feedlot Association of South Africa and various Agri Co-ops to establish which are the main crops cultivated in the country and the main groups of animals used in animal husbandry.

4.2 Areas where specific crops are cultivated and where domestic animals are held. (Objective b)

The country was divided into areas where specific agricultural practices are taking place. (Water Management Areas as described by the Department of Water Affairs and Forestry). A survey was done on which crops are cultivated by using information obtained from registration holders of pesticides. Information regarding areas where animals are found was obtained from a progress report on a WRC study. (De Jager and Swemmer, WRC project 1686, 2006-2007)

4.3 Pesticides registered for use on crops and drugs used for animal health (Objective c)

A survey was conducted on which pesticides were registered for use on the specific crops using guidelines published by the Dept. of Agriculture (Refer to Annexure A and B):

- A Guide for the Control of Plant Diseases (2003)
- A Guide for the Control of Plant Pests (2002)
- A Guide to Use of Herbicides (2000)
- A Guide for the Control of Household and Industrial Pests (2000).
  (These publications are available from the Department of Agriculture).

For disease control on the animals, information was obtained from a progress report on a WRC study (De Jager and Swemmer, WRC Project 1686, 2006-2007), IVS Volume 44, No 5 (2005) and advice from Prof H de Brabander (personal communication) from the University of Ghent (Dept. of Veterinary Science) as well as from the Ph.D. thesis of H Noppe done at the University of Ghent, Belgium. The chemicals were selected using the South African list of priority compounds (Burger, 2005), lists of chemicals for animal disease control (De Jager, de Brabander and Patel, 2006), as well as the European Union lists (http://ec.europa.eu/environment/encocrine/strategy/substances.en.htm). Chemicals such as toxaphene (camphechlor) and chlordane have been banned in South Africa and are no longer used. Mirex was voluntarily taken off the market by the registration holder. They are still on the POPs list and it is compulsory for the country to monitor them under the Stockholm Convention. The use of DDT for agricultural purposes was banned in 1976. This chemical is, however, still used in malaria infested areas for malaria vector control.

4.4 Volumes of pesticides used and frequency of use (Objective d)

An effort will be made to establish the amounts and frequency of application of the chemicals used from distributors and registration holders. Previously this proved to be a difficult operation because the registration holders of the chemicals (pesticides) are unwilling to disclose sales figures and usage. The recommended application rate for various pesticides will be obtained from the Department of Agriculture.

4.5 The Geological make up of the areas (Objective e)

The geological make up of the areas needs to be taken into account to establish the likelihood of the chemicals to reach the catchment areas of main rivers and dams. The topography of rivers changes very often and it will be impossible to give the information on all rivers in this report. It is recommended that this study be done once a study area has been identified.

5. RESULTS

5.1 Identification of main crops cultivated and animals used for husbandry

Information was obtained from DOA, various Agri Co-ops and registration holders of pesticides.

Table 1: **Main crops cultivated and animals used for husbandry**

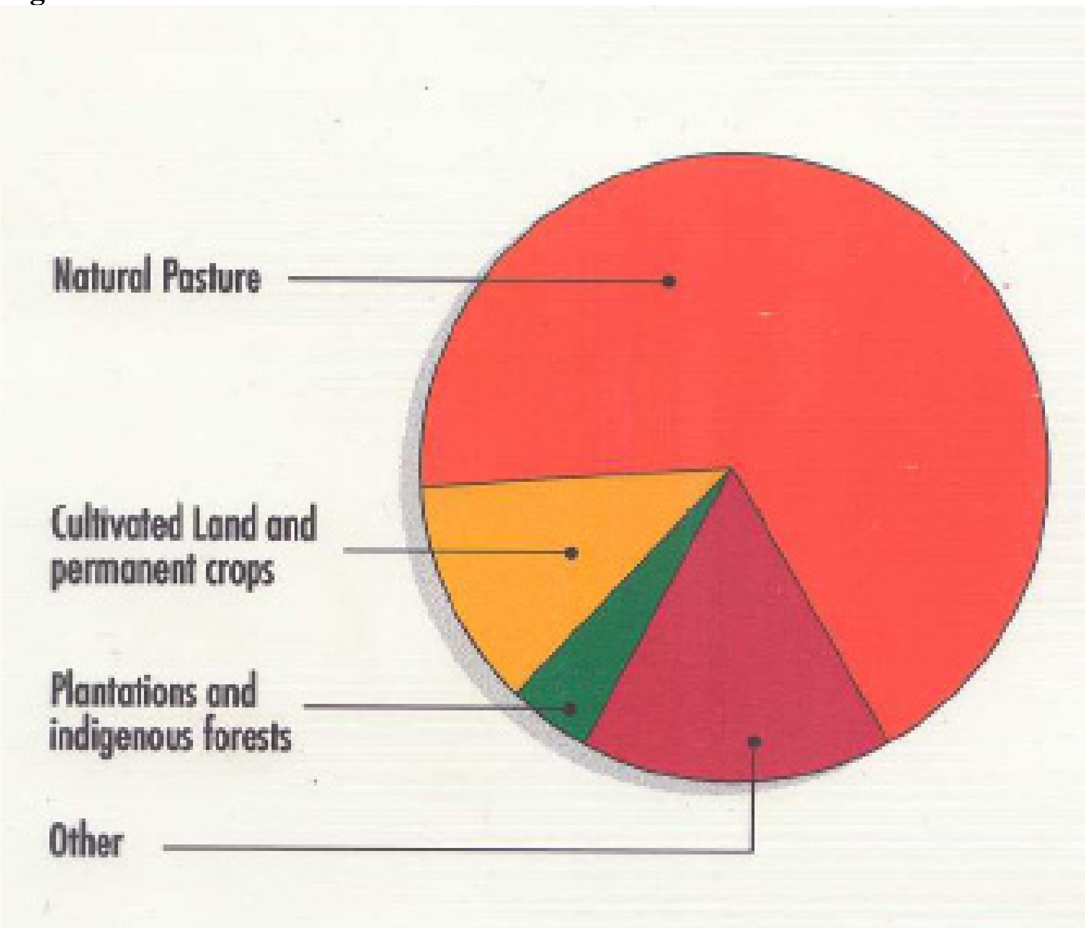
Main crops	Minor but important crops	Domestic animals used mostly for husbandry
Maize Wheat Sunflower Soybeans Sugar Deciduous fruits (apples, pears) Stone fruit (peaches, apricots, plums) Tropical fruit (bananas, pineapples, guavas, avocadoes) Citrus Grapes (table and wine) Vegetables (potatoes, tomatoes, onions)	Coffee, tea and Rooibos Oats, barley Cherries Cotton Canola Tobacco Vegetables	Cattle Sheep Goats Pigs Poultry Ostriches

5.2 Identification of areas where crops are cultivated and animals held

5.2.1 Land utilization

Only a small area of the country is suitable for crop cultivation. A chart indicating land utilization is given below (Figure 2). This information was provided by DOA (2000). Although this information is not recent, it is anticipated that it did not change much during the past years (Personal communication DOA).

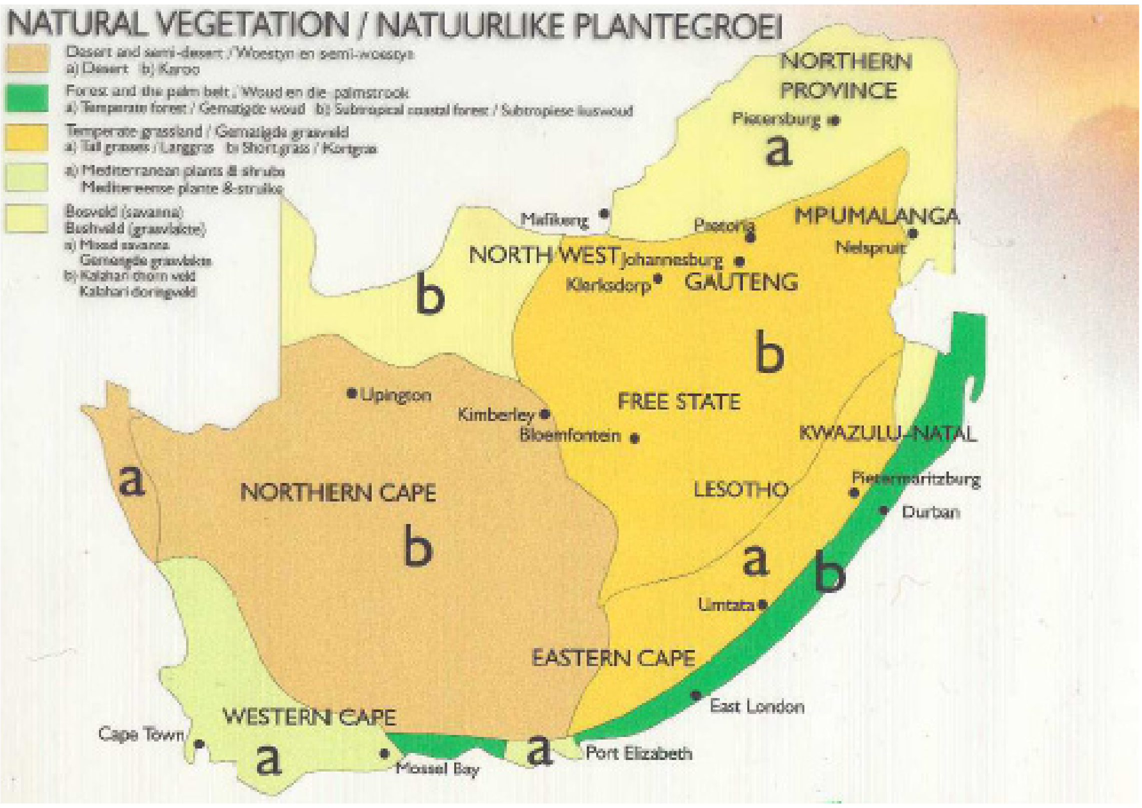
Figure 2: Land utilization



5.2.2 Natural Vegetation

A map showing the natural vegetation of the country is given below. This map indicates that a large part of the country (north western region) is desert and semi-desert and therefore not suited for crop cultivation. Domestic animals, especially sheep and goats as well as ostriches, are kept in these areas. Grain crops are mainly cultivated in the south western and central parts of the country. Grapes are cultivated mainly in the south Western Cape and along irrigation systems of the Olifants River (Western Cape) and Gariep Rivers (North West province).

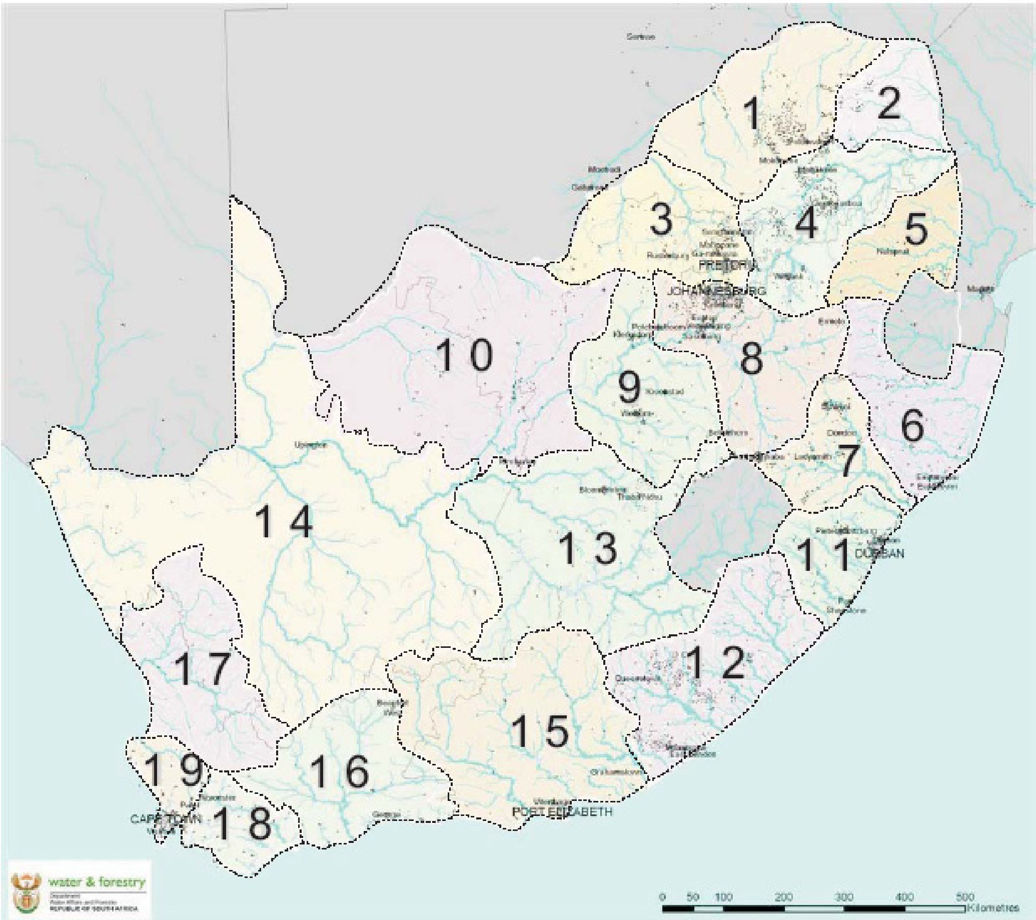
Figure 3: Natural vegetation of the country



5.2.3 Water Management Areas

A map indicating the Water Management Areas (WMAs) is given below. Information supplied by the Department of Water Affairs and Forestry.

Figure 4: Water management areas



5.2.4 Production areas of main crops

Production areas of major crops such as maize, wheat, grapes and citrus are fairly stable, but the production of vegetables varies widely. Maps indicating production areas of main crops are given in Annexure E. Information was obtained from registration holders of pesticides and agricultural co-ops. It must be firmly understood that these areas change from season to season and from year to year. The maps only give an indication of production. Farmers cultivate smaller crops, such as butternuts, carrots, melons and other vegetables across the country as cash crops, especially when main crop production fails. It is therefore impossible to map all these crops. It must also be clearly understood that the production areas indicated change from time to time because production is driven by market trends and climatic conditions.

5.3 Pesticides with ED properties used on crop cultivation

5.3.1 Registered active ingredients with ED properties

Registered pesticides with ED properties used on crops are listed in Annexure A. Recommended application rates and dosages are also given. Apart from the pesticides on the POPs list, the following list of compounds was selected:

Table 2: Compounds with ED properties

Fungicides	Herbicides	Insecticides
Benomyl** Carbendazim[1] Cyhexatin* Fentin hydroxide (Triphenyltin)** Mancozeb** Maneb** (only in a mixture with zinc oxide) Metiram** Pentachlorphenol** (wood preservative) Procymidone**** Tributyltin oxide ** (wood preservative) Vinclozolin* Zineb**	2,4-D* (dimethyl amine salt, iso-octyl ester and sodium salt) Acetochlor Alachlor Amitrole** Atrazine* Diuron**** Linuron Metribuzin** Nitrifen** (not registered in South Africa) Metoxychlor* (not registered in South Africa) Propazine*** Simazine* Terbuthylazine* Tributyltin** (not registered in RSA but could be used in paints for use on ships and boats as an anti-fouling agent) Trifluralin**	Aldicarb* Alpha-cypermethrin[2] Azinphos-methyl* Beta-cypermethrin[2] Carbaryl** Chlorpyrifos (Ethyl) Chlorpyrifos-methyl Cypermethrin** Deltamethrin* 1,2-Dibromo-3-chloropropane** (DBCP) (not registered in South Africa since at least 1991) Endosulfan* Esfenvalerate** Fenvalerate** gamma-BHC* Mercaptothion (Malathion)** Methomyl** Parathion* Permethrin** Zeta-cypermethrin[2]

* **Publication** ***WRC Programme on Endocrine Disrupting Compounds (EDCs) Volume 1 Strategic Research Plan for Endocrine Disrupters in South African Water Systems*** **WRC Report No. KV 143/05, August 2005, 3.3.1 & 3.3.3**

** **Publication** ***WRC Programme on Endocrine Disrupting Compounds (EDCs) Volume 1 Strategic Research Plan for Endocrine Disrupters in South African Water Systems*** **WRC Report No. KV 143/05, August 2005, 3.3.4**

*** **Propazine (not listed but mentioned in text see p 13 of report given at end of table)**

**** **Global Water Research Coalition (GWRC)**

1 **Benomyl breaks down to carbendazim relatively rapidly in plants and therefore included in the list**

2 **Alpha-, beta and zeta-cypermethrin. Closely related to cypermethrin and therefore included in list**

Pesticides are often applied in combinations. Refer to Annexure B for information in this regard.

Some chemical and physical properties of selected compounds are given in Annexure D (Pesticide Manual)

Although some organophosphate pesticides (OPs) have ED properties, they decompose rapidly in water and are therefore unlikely to be found in their natural state in water. They were for this reason excluded from the list of compounds to be considered in this study. (Exceptions are parathion and parathion-methyl, which are widely used in citrus cultivation). Humans and animals are, however, exposed to these compounds by ingestion, inhalation and dermal absorption (especially while crop spraying is taking place).

The use of agricultural chemicals (pesticides) listed under the POPs list, such as DDT, dieldrin, aldrin and lindane, are banned but are still used for certain purposes such as DDT for malaria vector control (Areas 1,2,4,5 and 6). (Refer to Annexure A). The compounds listed as POPs all have long half-lives and may persist in the environment for years.

Agricultural chemicals (pesticides) with ED properties are also widely used for non- agricultural purposes on sport fields and golf courses, along roads and railway lines to eliminate organisms and unwanted plant growth. This is especially important as the dosages used for control of unwanted plant growth along roads, and railway lines are high and runoff may reach the rivers and dams. (Refer to Annexure B). Pesticides are also used for pest control in industrial sites as well as homes. They may also end up in water resources via effluents from industrial sites and waste water and run-off from households and home gardens.

The main crops cultivated in the WMAs as well as the pesticides registered for use on these crops are given in Table 1. Only the major rivers are indicated. It is however very important that minor rivers are also monitored, because the rural population very often uses water from minor rivers for drinking water and for recreational purposes. It is also of importance to study the formulation as it is applied because combinations of pesticides are often used which may contain active ingredients as well as inactive ingredients which may also have ED properties.

Table 3: Main crops cultivated in Water Management Areas and pesticides with EDC properties registered on these crops

Note: Crops cultivated in large areas and pesticides with strong ED properties are indicated in bold

WATER MANAGEMENT AREAS	CROPS CULTIVATED	PESTICIDES WITH EDC PROPERTIES REGISTERED	PESTICIDE TYPE	MAJOR RIVERS
AREA 1 LIMPOPO	Maize	Carbendazim	Fungicide	Limpopo
	Wheat	Acetochlor	Herbicide	Mathlabas
	Grain sorghum	**Atrazine**	Herbicide	Mokolo
	Sunflowers	**Propazine**	Herbicide	Lephalala
	Groundnuts	**Terbuthylazine**	Herbicide	Mogalakwena
	Tea	**2,4-D**	Herbicide	Sand
	Coffee	**Chlorpyrifos-Ethyl**	Insecticide	Nzhelele
	Citrus	**Deltamethrin**	Insecticide	
	Cotton	**Endosulfan**	Insecticide	
		Gamma-BHC	Insecticide	
		Linuron	Herbicide	
		Parathion	Insecticide	
		Fenvalerate	Insecticide	
		Esfenvalerate	Insecticide	
		Methomyl	Insecticide	
		Mercaptothion	Insecticide	
		Metribuzin	Herbicide	
		Alachlor	Herbicide	
		Trifluralin	Herbicide	
		Permethrin	Insecticide	
		Cypermethrin	Insecticide	
		Alpha-cypermethrin	Insecticide	
		Beta-cypermethrin	Insecticide	
		Parathion-methyl	Insecticide	
		Cyhexatin	Insecticide	
		Aldicarb	Insecticide	

Table 3 (continued): Main crops cultivated in Water Management Areas and pesticides with EDC properties registered on these crops

<u>Note</u>: Crops cultivated in large areas and pesticides with strong ED properties are indicated in bold

AREA 2 LEVUBU AND LETABA	Maize **Subtropical fruit and nuts** (pineapples bananas, guavas, avocadoes, pecan nuts, macadamia nuts) Tomatoes Citrus	Carbendazim Benomyl Acetochlor **Atrazine** **Propazine** **Terbuthylazine** **2,4-D** **Chlorpyrifos-Ethyl** **Deltamethrin** **Endosulfan** **Gamma-BHC** Linuron Trifluralin Mercaptothion Alachlor Cypermethrin Beta-cypermethrin **Carbary**l Metribuzin Tralomethrin Permethrin Methomyl Fenvalerate Esfenvalerate Alpha-cypermethrin Cyhexatin **Aldicarb** Parathion-methyl	Fungicide Fungicide Herbicide Herbicide Herbicide Herbicide Herbicide Insecticide Insecticide Insecticide Insecticide Herbicide Herbicide Insecticide Insecticide Insecticide Insecticide Insecticide Herbicide Insecticide Insecticide Insecticide Insecticide Insecticide Insecticide Insecticide Insecticide Insecticide	Mutale Levuvhu Letaba

Table 3 (continued): Main crops cultivated in Water Management Areas and pesticides with EDC properties registered on these crops

Note: Crops cultivated in large areas and pesticides with strong ED properties are indicated in bold

AREA 3 CROCODILE (WEST) AND LETABA	Maize Wheat Grain Sorghum Sunflower Groundnuts **Subtropical fruit and nuts** (pineapples, bananas, guavas, avocadoes, pecan nuts, macadamia nuts) Tomatoes Apples Pears Plums Prunes Peaches Apricots Citrus Tobacco	Acetochlor **Propazine** **Atrazine** **Terbuthylazine** **Simazine** **2,4-D** **Chlorpyrifos-Ethyl** **Deltamethrin** **Endosulfan** **Gamma-BHC** Linuron Parathion Fenvalerate Esfenvalerate Methomyl Mercaptothion Metribuzin Alachlor Trifluralin Cypermethrin Permethrin Acetochlor Beta-cypermethrin Benomyl Carbendazim Tralomethrin Alpha-cypermethrin Cyhexatin Chlorpiriphos-ethyl **Aldicarb** **Carbaryl** **Azinphos-methyl** Metiram Parathion-methyl	Herbicide Herbicide Herbicide Herbicide Herbicide Herbicide Insecticide Insecticide Insecticide Insecticide Herbicide Insecticide Insecticide Insecticide Insecticide Insecticide Herbicide Herbicide Herbicide Insecticide Insecticide Herbicide Insecticide Fungicide Fungicide Insecticide Insecticide Insecticide Insecticide Insecticide Insecticide Insecticide Fungicide Insecticide	Crocodile (west) Marico

Table 3 (continued): Main crops cultivated in Water Management Areas and pesticides with EDC properties registered on these crops

Note: Crops cultivated in large areas and pesticides with strong ED properties are indicated in bold

AREA 4 OLIFANTS	Maize	Carbendazim	Fungicide	Elands
	Wheat	Benomyl	Fungicide	Wilge
	Sunflowers	Acetochlor	Herbicide	Steelpoort
	Cotton	**Atrazine**	Herbicide	Olifants
	Dry beans	**Propazine**	Herbicide	
	Potatoes	**Terbuthylazine**	Herbicide	
	Grapes	**Simazine**	Herbicide	
	Apples	**2,4-D**	Herbicide	
	Pears	**Chlorpyrifos-Ethyl**	Insecticide	
	Quinces	**Deltamethrin**	Insecticide	
	Plums, prunes	**Endosulfan**	Insecticide	
	Peaches	**Gamma-BHC**	Insecticide	
	Apricots	Linuron	Herbicide	
	Citrus	Parathion	Insecticide	
	Tobacco	Fenvalerate	Insecticide	
		Esfenvalerate	Insecticide	
		Trifluralin	Herbicide	
		Tralomethrin	Insecticide	
		Permethrin	Insecticide	
		Cypermethrin	Insecticide	
		Alpha-cypermethrin	Insecticide	
		Beta-cypermethrin	Insecticide	
		Carbaryl	Insecticide	
		Azinphos-methyl	Insecticide	
		Aldicarb	Insecticide	
		Acetochlor	Herbicide	
		Metribuzin	Herbicide	
		Methomyl	Insecticide	
		Vinclozolin	Fungicide	
		Mercaptothion	Insecticide	
		Metiram	Fungicide	
		Carbaryl	Plant growth regulator	
		Parathion-methyl	Insecticide	
		Cyhexatin	Insecticide	

Table 3 (continued): Main crops cultivated in Water Management Areas and pesticides with EDC properties registered on these crops

Note: Crops cultivated in large areas and pesticides with strong ED properties are indicated in bold

AREA 5 INKOMATI	Maize Sunflowers Cotton Sugarcane **Subtropical fruit and nuts** (pineapples, bananas, guavas, avocados, pecan nuts, macadamia nuts) Tomatoes **Coffee** Apples Pears **Tobacco**	Carbendazim Benomyl Acetochlor **Atrazine** **Propazine** **Terbuthylazine** **2,4-D** **Chlorpyrifos-Ethyl** **Deltamethrin** **Endosulfan** **Gamma-BHC** Tralomethrin Permethrin Cypermethrin Alpha-cypermethrin Beta-cypermethrin **Carbaryl** **Azinphos-methyl** **Aldicarb** Mercaptothion Metribuzin Alachlor Acetochlor Trifluralin Methomyl Fenvalerate Esfenvalerate Cyhexatin Metiram **Carbaryl** Paration-methyl	Fungicide Fungicide Herbicide Herbicide Herbicide Herbicide Herbicide Insecticide Insecticide Insecticide Insecticide Insecticide Insecticide Insecticide Insecticide Insecticide Insecticide Insecticide Insecticide Insecticide Herbicide Herbicide Herbicide Herbicide Insecticide Insecticide Insecticide Insecticide Fungicide Plant growth regulator Insecticide	Nwanedzi Sabie Crocodile (east) Komati

Table 3 (continued): Main crops cultivated in Water Management Areas and pesticides with EDC properties registered on these crops

Note: Crops cultivated in large areas and pesticides with strong ED properties are indicated in bold.

AREA 6 USUTU TO MHLATUZE	Wheat Cotton **Sugarcane** **Subtropical fruit and nuts** (pineapples, bananas, guavas, avocados, pecan nuts, macadamia nuts) **Tobacco**	**Atrazine** **Propazine** **Terbuthylazine** **2,4-D** **Chlorpyrifos-Ethyl** **Deltamethrin** **Endosulfan** **Gamma-BHC** Linuron Parathion Fenvaletate Esfenvalerate Tralomethrin Permethrin Cypermethrin Alpha-cypermethrin Beta-cypermethrin **Carbaryl** **Azinphos-methyl** **Aldicarb** Mercaptothion Metribuzin Alachlor Acetochlor Trifluralin Benomyl Carbendazim Methomyl	Herbicide Herbicide Herbicide Herbicide Insecticide Insecticide Insecticide Insecticide Herbicide Insecticide Insecticide Insecticide Insecticide Insecticide Insecticide Insecticide Insecticide Insecticide Insecticide Insecticide Insecticide Herbicide Herbicide Herbicide Herbicide Fungicide Fungicide Insecticide	Isutu Pongola Mthantuze Mfolozi Mkutze

Table 3 (continued): Main crops cultivated in Water Management Areas and pesticides with EDC properties registered on these crops

Note: Crops cultivated in large areas and pesticides with strong ED properties are indicated in bold

AREA 7 THUKELA	Maize	Acetochlor	Herbicide	Thukela
	Grain sorghum	**Atrazine**	Herbicide	
	Groundnuts	**Propazine**	Herbicide	
	Dry beans	**Terbuthylazine**	Herbicide	
	Potatoes	**2,4-D**	Herbicide	
	Peaches	**Chlorpyrifos-Ethyl**	Insecticide	
	Apricots	**Deltamethrin**	Insecticide	
	Plums	**Endosulfan**	Insecticide	
	Prunes	**Gamma-BHC**	Insecticide	
	Citrus	Methomyl	Insecticide	
		Mercaptothion	Insecticide	
		Metribuzin	Herbicide	
		Alachlor	Herbicide	
		Trifluralin	Herbicide	
		Permethrin	Insecticide	
		Cypermethrin	Insecticide	
		Tralomethrin	Insecticide	
		Esfenvalerate	Insecticide	
		Alpha-cypermethrin	Insecticide	
		Beta-cypermethrin	Insecticide	
		Carbaryl	Insecticide	
		Linuron	Herbicide	
		Aldicarb	Insecticide	
		Cyhexatin	Insecticide	
		Azinphos-methyl	Insecticide	
		Benomyl	Fungicide	
		Carbendazim	Fungicide	
		Metiram	Fungicide	
		Parathion	Insecticide	
		Parathion-methyl	Insecticide	

Table 3 (continued): Main crops cultivated in Water Management Areas and pesticides with EDC properties registered on these crops

Note: Crops cultivated in large areas and pesticides with strong ED properties are indicated in bold

AREA 8 UPPER VAAL	**Maize**	Carbendazim	Fungicide	Wilge
	Wheat	Benomyl	Fungicide	Liebenbergsvlei
	Grain sorghum	Acetochlor	Herbicide	Mooi
	Dry beans	**Atrazine**	Herbicide	Vaal
	Apples	**Propazine**	Herbicide	
	Pears	**Terbuthylazine**	Herbicide	
		2,4-D	Herbicide	
		Chlorpyrifos-Ethyl	Insecticide	
		Deltamethrin	Insecticide	
		Endosulfan	Insecticide	
		Gamma-BHC	Insecticide	
		Linuron	Herbicide	
		Parathion	Insecticide	
		Fenvalerate	Insecticide	
		Esfenvalerate	Insecticide	
		Methomyl	Insecticide	
		Mercaptothion	Insecticide	
		Metribuzin	Herbicide	
		Alachlor	Herbicide	
		Trifluralin	Herbicide	
		Permethrin	Insecticide	
		Cypermethrin	Insecticide	
		Tralomethrin	Insecticide	
		Esfenvalerate	Insecticide	
		Alpha-cypermethrin	Insecticide	
		Beta-cypermethrin	Insecticide	
		Carbaryl	Plant growth regulator	
		Metiram	Fungicide	
		Azinphos-methyl	Insecticide	
		Parathion-methyl	Insecticide	
		Cyhexatin	Insecticide	

Table 3 (continued): Main crops cultivated in Water Management Areas and pesticides with EDC properties registered on these crops

Note: Crops cultivated in large areas and pesticides with strong ED properties are indicated in bold

AREA 9	**Maize**	Carbendazim	Fungicide	Vet
MIDDLE VAAL	**Wheat**	Benomyl	Fungicide	Vaal
	Sunflowers	Acetochlor	Herbicide	
	Groundnuts	**Atrazine**	Herbicide	
	Apples	**Propazine**	Herbicide	
	Pears	**Terbuthylazine**	Herbicide	
	Plums	**2,4-D**	Herbicide	
	Peaches	**Chlorpyrifos-Ethyl**	Insecticide	
	Apricots	**Deltamethrin**	Insecticide	
		Endosulfan	Insecticide	
		Gamma-BHC	Insecticide	
		Linuron	Herbicide	
		Parathion	Insecticide	
		Fenvalerate	Insecticide	
		Esfenvalerate	Insecticide	
		Trifluralin	Herbicide	
		Permethrin	Insecticide	
		Cypermethrin	Insecticide	
		Alpha-cypermethrin	Insecticide	
		Beta-cypermethrin	Insecticide	
		Mercaptothion	Insecticide	
		Metiram	Fungicide	
		Azinphos-methyl	Insecticide	
		Carbaryl	Plant growth regulator	
		Tralomethrin	Insecticide	
		Parathion-methyl	Insecticide	
		Cyhexatin	Insecticide	

Table 3 (continued): Main crops cultivated in Water Management Areas and pesticides with EDC properties registered on these crops

Note: Crops cultivated in large areas and pesticides with strong ED properties are indicated in bold

AREA 10 LOWER VAAL	Maize Wheat Sunflowers Groundnuts Cotton Apples Pears	Carbendazim Benomyl Acetochlor **Atrazine** **Propazine** **Terbuthylazine** **2,4-D** **Chlorpyrifos-Ethyl** **Deltamethrin** **Endosulfan** **Gamma-BHC** Linuron Parathion Fenvalerate Esfenvalerate Trifluralin Tralomethrin Permethrin Cypermethrin Alpha-cypermethrin Beta-cypermethrin **Azinphos-methyl** **Aldicarb** Acetochlor Metiram **Carbaryl** Parathion-methyl Mercaptothion Cyhexatin	Fungicide Fungicide Herbicide Herbicide Herbicide Herbicide Herbicide Insecticide Insecticide Insecticide Insecticide Herbicide Insecticide Insecticide Insecticide Insecticide Insecticide Insecticide Insecticide Insecticide Insecticide Insecticide Insecticide Herbicide Insecticide Plant growth regulator Insecticide Insecticide Insecticide	Harts Molopo Vaal

Table 3 (continued): Main crops cultivated in Water Management Areas and pesticides with EDC properties registered on these crops

Note: Crops cultivated in large areas and pesticides with strong ED properties are indicated in bold

AREA 11 MVOTI TO UMZIMKULU	Maize **Sugarcane** **Subtropical fruit and nuts** (pineapples, bananas, guavas, avocados, pecan nuts, macadamia nuts) Tobacco	Carbendazim Acetochlor **Atrazine** **Propazine** **Terbuthylazine** **2,4-D** **Chlorpyrifos-Ethyl** **Deltamethrin** **Endosulfan** **Gamma-BHC** Mercaptothion Metribuzin Alachlor Trifluralin Cypermethrin Beta-cypermethrin **Carbaryl** Benomyl Methomyl Aldicarb	Fungicide Herbicide Herbicide Herbicide Herbicide Herbicide Insecticide Insecticide Insecticide Insecticide Insecticide Herbicide Insecticide Herbicide Insecticide Insecticide Insecticide Fungicide Insecticide Insecticide	Mvoti Umgeni Umkomazi Umzimkulu

Table 3 (continued): Main crops cultivated in Water Management Areas and pesticides with EDC properties registered on these crops

Note: Crops cultivated in large areas and pesticides with strong ED properties are indicated in bold

AREA 12 MZIMVUBU TO KEISKAMA	Maize Subtropical fruit and nuts (pineapples, bananas, guavas, avocados, pecan nuts, macadamia nuts) Tomatoes Coffee Tobacco	Carbendazim Acetochlor **Atrazine** **Propazine** **Terbuthylazine** **2,4-D** **Chlorpyrifos-Ethyl** **Deltamethrin** **Endosulfan** **Gamma-BHC** Alachlor Trifluralin Mercaptothion Beta-cypermethrin **Carbaryl** Benomyl Carbendazim Metribuzin Tralomethrin Permethrin Methomyl Fenvalerate Esfenvalerate Alpha-cypermethrin Beta-cypermethrin Cyhexatin **Aldicarb**	Fungicide Herbicide Herbicide Herbicide Herbicide Herbicide Insecticide Insecticide Insecticide Insecticide Herbicide Herbicide Insecticide Insecticide Insecticide Fungicide Fungicide Herbicide Insecticide Insecticide Insecticide Insecticide Insecticide Insecticide Insecticide Insecticide Insecticide	Mzimvubu Mtata Mbashe Buffalo Nahoon Groot Kei Keiskamma

Table 3 (continued): Main crops cultivated in Water Management Areas and pesticides with EDC properties registered on these crops

Note: Crops cultivated in large areas and pesticides with strong ED properties are indicated in bold

AREA 13 UPPER GARIEP (ORANGE)	Maize Wheat Potatoes Onions **Cherries**	Carbendazim Acetochlor **Atrazine** **Propazine** **Terbuthylazine** **2,4-D** **Chlorpyrifos-Ethyl** **Deltamethrin** **Endosulfan** **Gamma-BHC** Linuron Parathion Fenvalerate Esfenvalerate Metabuzin Alachlor Tralomethrin Methomyl Beta-cypermethrin Alpha-cypermethrin **Aldicarb** Mercaptothion	Fungicide Herbicide Herbicide Herbicide Herbicide Herbicide Insecticide Insecticide Insecticide Insecticide Herbicide Insecticide Insecticide Insecticide Herbicide Herbicide Insecticide Insecticide Insecticide Insecticide Insecticide Insecticide	Modder Riet Caledon Orange

Table 3 (continued): Main crops cultivated in Water Management Areas and pesticides with EDC properties registered on these crops

Note: Crops cultivated in large areas and pesticides with strong ED properties are indicated in bold

AREA 14 LOWER GARIEP (ORANGE)	Cotton	Tralomethrin	Insecticide	Origers
	Grapes	Permethrin	Insecticide	Hartbees
	Subtropical fruit and nuts (pineapples, bananas, guavas, avocados, pecan nuts, macadamia nuts)	Cypermethrin	Insecticide	Orange
	Apples	Alpha-cypermethrin	Insecticide	
	Pears	Beta-cypermethrin	Insecticide	
	Lucerne seed	**Carbaryl**	Plant growth regulator	
		Azinphos-methyl	Insecticide	
		Aldicarb	Insecticide	
		Acetochlor	Herbicide	
		Endosulfan	Insecticide	
		Deltamethrin	Insecticide	
		Trifluralin	Herbicide	
		Simazine	Herbicide	
		Propazine	Herbicide	
		Terbuthylazine	Herbicide	
		Gamma-BHC	Insecticide	
		Fenvalerate	Insecticide	
		Esfenvalerate	Insecticide	
		Chlorpyrifos-Ethyl	Insecticide	
		Vinclozolin	Fungicide	
		Alachlor	Herbicide	
		Mercaptothion	Insecticide	
		Benomyl	Fungicide	
		Carbendazim	Fungicide	
		Metiram	Fungicide	
		Parathion-methyl	Insecticide	
		Cyhexatin	Insecticide	
		Metribuzin	Herbicide	
		Methomyl	Insecticide	

Table 3 (continued): Main crops cultivated in Water Management Areas and pesticides with EDC properties registered on these crops

Note: Crops cultivated in large areas and pesticides with strong ED properties are indicated in bold

AREA 15 FISH TO TSITSIKAMMA	Subtropical fruit and nuts (pineapples, bananas, guavas, avocados, pecan nuts, macadamia nuts) **Citrus**	**Atrazine** **Terbuthylazine** **Propazine** **Simazine** Alachlor Acetochlor Trifluralin Mercaptothion **Endosulfan** **Deltamethrin** Cypermethrin Alpha-cypermethrin Beta-cypermethrin **Chlorpyriphos-ethyl** **Carbaryl** Benomyl Carbendazim Parathion Parathion-methyl Methomyl Cyhexatin	Herbicide Herbicide Herbicide Herbicide Herbicide Herbicide Herbicide Insecticide Insecticide Insecticide Insecticide Insecticide Insecticide Insecticide Insecticide Fungicide Fungicide Insecticide Insecticide Insecticide Insecticide	Fish Kowie Boesmans Sundays Gamtoos Kromme Tsitsikamma Groot

Table 3 (continued): Main crops cultivated in Water Management Areas and pesticides with EDC properties registered on these crops

Note: Crops cultivated in large areas and pesticides with strong ED properties are indicated in bold

AREA 16	Grapes	**Terbuthylazine**	Herbicide	Gouritz
GOURITZ	Cherries	**Simazine**	Herbicide	Olifants
	Apples	**Propazine**	Herbicide	Kamanassie
	Pears	Trifluralin	Herbicide	Gamka
	Plums	**Gamma-BHC**	Insecticide	Buffels
	Prunes	Tralomethrin	Insecticide	Touws
	Peaches	Permethrin	Insecticide	Goukou
	Apricots	**Deltamethrin**	Insecticide	Duiwenhoks
	Lucerne seed	Cypermethrin	Insecticide	
		Alpha-cypermethrin	Insecticide	
		Beta-cypermethrin	Insecticide	
		Fenvalerate	Insecticide	
		Esfenvalerate	Insecticide	
		Endosulfan	Insecticide	
		Chlorpyrifos-Ethyl	Insecticide	
		Carbaryl	Plant growth regulator	
		Aldicarb	Insecticide	
		Vinclozolin	Fungicide	
		Cyhexatin	Insecticide	
		Azinphos-methyl	Insecticide	
		Benomyl	Fungicide	
		Carbendazim	Fungicide	
		Metiram	Fungicide	
		Methomyl	Insecticide	
		Mercaptothion	Insecticide	
		Parathion-methyl	Insecticide	
		Metribuzin	Herbicide	

Table 3 (continued): Main crops cultivated in Water Management Areas and pesticides with EDC properties registered on these crops

Note: Crops cultivated in large areas and pesticides with strong ED properties are indicated in bold

AREA 17 OLIFANTS/ DOORN	Maize	Carbendazim	Fungicide	Olifants
	Wheat	Benomyl	Fungicide	Doorn
	Lupins	Acetochlor	Herbicide	Krom
	Potatoes	**Atrazine**	Herbicide	Sand
	Grapes	**Propazine**	Herbicide	Sout
	Tomatoes	**Simazine**	Herbicide	
	Rooibos	**Terbuthylazine**	Herbicide	
	Apples	**2,4-D**	Herbicide	
	Pears	**Chlorpyrifos-Ethyl**	Insecticide	
	Quinces	**Deltamethrin**	Insecticide	
	Plums	**Endosulfan**	Insecticide	
	Prunes	**Gamma-BHC**	Insecticide	
	Peaches	Linuron	Herbicide	
	Apricots	Parathion	Insecticide	
		Fenvalerate	Insecticide	
		Esfenvalerate	Insecticide	
		Tralomethrin	Insecticide	
		Methomyl	Insecticide	
		Mercaptothion	Insecticide	
		Cypermethrin	Insecticide	
		Alpha-cypermethrin	Insecticide	
		Beta-Cypermethrin	Insecticide	
		Alachlor	Herbicide	
		Metabuzin	Herbicide	
		Aldicarb	Insecticide	
		Methomyl	Insecticide	
		Tralomathrin	Insecticide	
		Trifluralin	Herbicide	
		Carbaryl	Insecticide	
			Plant growth regulator	
		Vinclozolin	Fungicide	
		Permethrin	Insecticide	
		Cyhexatin	Insecticide	
		Azinphos-methyl	Insecticide	
		Metiram	Fungicide	

Table 3 (continued): Main crops cultivated in Water Management Areas and pesticides with EDC properties registered on these crops

Note: Crops cultivated in large areas and pesticides with strong ED properties are indicated in bold

AREA 18 BREEDE	**Wheat** **Canola** **Grapes** Tomatoes **Plums** **Prunes** **Peaches** **Apricots** **Apples** **Pears** Quinces	**Atrazine** **Propazine** **Simazine** **Terbuthylazine** **2,4-D** **Chlorpyrifos-Ethyl** **Deltamethrin** **Endosulfan** **Gamma-BHC** Linuron Parathion Fenvalerate Esfenvalerate Tralomethrin Cypermethrin Alpha-cypermethrin Beta-cypermethrin **Carbaryl** **Aldicarb** **Vinclozolin** Mercaptothion Trifluralin Cyhexatin **Azinphos-methyl** Benomyl Carbendazim Metiram Parathion-methyl	Herbicide Herbicide Herbicide Herbicide Herbicide Insecticide Insecticide Insecticide Insecticide Herbicide Insecticide Insecticide Insecticide Insecticide Insecticide Insecticide Insecticide Insecticide Insecticide Fungicide Insecticide Herbicide Insecticide Insecticide Fungicide Fungicide Fungicide Insecticide	Breede Sonderend Sout Bot Palmiet

Table 3 (continued): Main crops cultivated in Water Management Areas and pesticides with EDC properties registered on these crops

Note: Crops cultivated in large areas and pesticides with strong ED properties are indicated in bold

AREA 19 BERG	Maize **Wheat** Canola Lupines Potatoes **Grapes** **Subtropical fruit and nuts** (pineapples, bananas, guavas, avocados, pecan nuts, macadamia nuts) **Plums** **Prunes** **Apples** **Pears** **Peaches** **Apricots** **Citrus**	Acetochlor **Atrazine** **Propazine** **Simazine** **Terbuthylazine** Trifluralin **2,4-D** **Chlorpyrifos-Ethyl** **Deltamethrin** **Endosulfan** **Gamma-BHC** Tralomethrin Permethrin Methomyl Mercaptothion Cypermethrin Alpha-cypermethrin Beta-cypermethrin Alachlor Metribuzin Linuron Fenvalerate Esfenvalerate **Aldicarb** **Carbaryl** **Vinclozolin** Benomyl Carbendazim Metiram Azinphos-methyl Parathion Parathion-methyl Cyhexatin	Herbicide Herbicide Herbicide Herbicide Herbicide Herbicide Herbicide Insecticide Insecticide Insecticide Insecticide Insecticide Insecticide Insecticide Insecticide Insecticide Insecticide Insecticide Herbicide Herbicide Herbicide Insecticide Insecticide Insecticide Plant growth regulator Fungicide Fungicide Fungicide Fungicide Insecticide Insecticide Insecticide Insecticide	Berg Diep Steenbras

5.3.2 Vegetables

A great variety of vegetable crops is cultivated in all the WMAs. These were not listed in Table 3 because their cultivation varies considerably from season to season. The pesticides used on these crops are the same as those used on the main crops.

5.3.3 Research done on pesticides in South Africa

To date, only a small number of the pesticides listed in the tables of this report were found by analysis in South African water systems. It would be very expensive to conduct chemical analysis on all of them. No systematic study was done on water resources for all the listed pesticides. The studies conducted in the country concentrated on small groups of chemicals that could be analysed by multi-residue methods and a few that were specifically chosen for a project. Activity tests done in several rivers and dams indicate that EDCs are present. Whether this activity was due to unknown pesticides was not established. Some of these pesticides were detected in the water resources of other countries (UNEP Report). Table 4 gives an indication of pesticides found in the country. It must be emphasised that studies done in South Africa was not aimed at ED activity, but at toxicity testing. Because ED activity can take place at concentration levels a million times lower than the toxicity level, these pesticides may have not been detected.

Table 4: Some pesticides with ED properties found by analysis in South Africa
<u>Note:</u> * Concentrations not available

PESTICIDE	MATRIX	AREA FOUND	LEVEL	REFERENCE
2,4,-D	Marine water Fresh water sediment	Eastern Cape	0.055 µg/ℓ 0.006 µ/g	Fatoki & Awofulu (2003)
Aldicarb	High usage in Hex river valley	Western Cape	*	Weaver (1993)
Aldrin	Sediment	Eastern Cape	0.006 µg/kg	Fatoki (2003)
Atrazine	1. Surface water, Johannesburg 2. Residues in water and fish 3. Water and fish 4. Water	Gauteng Northern and central South Africa Vaalharts irrigation system Vaal river barrage Hartbeespoort dam	* 0.1-11.6 µg/ℓ * 0.78 µg/ℓ 3.76 µg/ℓ	Grange et al. (2003) Bouwman et al. (2003) Weaver (1993) Burger (In press)
Azinphos-methyl	1. Water 2. Run-off and spray drift 3. Streams 4. Water 5. Suspended sediment	Lourens river Lourens river Western Cape Western Cape Western Cape Western Cape	0.08 -0.7 µg/ℓ 27.8 and 0.0069 µg/ℓ * 0.2 µg/ℓ 0.6 µg/ℓ 152 µg/kg	Bennet et al. (2003) Schultz (2003a and b) Dabowski (2003) London et al. (2000) London et al. (2000) London et al. (2000)
BHC (Lindane)	1. Fish tissue (fat) 2. Marine water 3. Fresh water sediments	Crocodile river, Mpumalanga Eastern Cape Eastern Cape	0.86 µg/kg 4.5 µg/ℓ 1.84 µg/kg	Heath et al. (2003) Fatoki et al. (2003)
Chlorpyrifos-ethyl	1. Sediment cores 2. Water 3. Suspended sediment 4. Water	Lourens river, Western Cape Western Cape Hex river valley	0.8-12 µg/kg 0.19 µg/ℓ 245 µg/kg 19.13 µg/ℓ	Bennet et al. (2003) Dabowski et al. (2003) London et al. (1995a)
DDT, DDE, DDD (Banned but used for malaria vector (mosquito) control)	1. Fish tissue (fat) 2. Surface water	Crocodile river, Mpumalanga Ubombo and Ingwavuma KwaZulu-Natal	0.69; 0.90; 0.69 µg/kg *	Heath et al. (2003) Sereda & Meinardt (2003)

	3. Surface water	Johannesburg Gauteng	1.8-2.0 µg/ℓ	Grange et al. (2003)
	4. Water	Madandze river	1.6-3.2 µg/ℓ	Fatoki (2003)
			1.8 µg/kg	
	5. Sediment	Mvudi river	3.6 µg/kg	
	6. Water	Madandze river	0.02 µg/ℓ	Burger (in press)
		Mvudi river	2.8 µg/ℓ	
		Makatini flats	0.68 µg/ℓ	
Deltamethrin	1. Surface water	Ubombo and Ingwavuma	*	Sereda et al. (2003)
		KwaZulu-Natal	*	
	2. Surface and ground water	Hex river valley	*	Dalvie et al. (2003)
	3. Water	Lourens river, Western Cape	1.4 µg/ℓ	Dabowski et al. (2003)
Dieldrin (banned but used for tsetse fly control)	1. Water Fish	KwaZulu-Natal	*	Bouwman et al. (2003)
	2. Fish tissue (fat)	Crocodile river, Mpumalanga	0.01 µg/kg	Heath et al. (2003)
Endosulfan	1. Wetlands near Lourens river	Lourens river, Western Cape	0.8-12µg/kg	Bennet et al. (2003)
	2. Surface and groundwater	Hex river valley, Grabouw and	0.83-3.16µg/ℓ	Dalvie et al. (2003a)
		Piketberg	*	London et al. (2000)
	3. Water	Mhakatini flats	0.55 µg/ℓ	Burger (In press)
		Vaal river barrage	0.31 µg/ℓ	
		Rietvlei dam	0.55 µg/ℓ	
		Hartbeespoort dam	0.18 µg/ℓ	
		Crocodile river, Mpumalanga	0.95 µg/kg	
	4. Fish tissue (fat)			Heath et al. (2003)
Heptachlor (banned)	Fish tissue (fat)	Crocodile river, Mpumalanga	0.01 µg/kg	Heath et al. (2003)
Lindane	Fish tissue (fat)	Crocodile river, Mpumalanga	0.99 µg/kg	Heath et al. (2003)
	Water	Mhakatini flats	0.01 µg/ℓ	Burger (In press)
		Vaal river barrage	0.02 µg/ℓ	
		Hartbeespoort dam	0.03 µg/ℓ	
		Rietvlei dam	0.01 µg/ℓ	
Parathion	Farm dams	Elgin, Western Cape	*	Davies (1997)
Terbuthylazine	Water	Vaal river barrage	0.48 µg/ℓ	Burger (In press)

5.4 Drugs with ED properties used in animal production

Drugs are used in animal production not only for treatment and prevention of disease, but also as growth promoters. A number of these hormones are involved in endocrine regulation of growth. These include sex hormones (estrogens and androgens), β-agonists and growth hormones.

Steroid hormones are steroids which act as hormones. They can be divided into different groups: corticosteroids (glucocorticosteroids, mineralocorticosteroids) and estrogens, gestagens and androgens (EGAs). This large group of estrogenic compounds is legally used in human and veterinary medicine. However, besides their use under regulated conditions, they are also illegally used in animal fattening and aquaculture because of their potential to increase weight gain and to reduce the feed conversion ratio, which is the average feed intake in relation to the weight gain. In addition, their synergetic effects and their possibility to reduce nitrogen retention and to increase the water retention and fat content have been reported in literature (Noppe, 2006). Illegal growth promoters are mostly injected, resulting in injection sites in which high concentrations (mostly esters) can be found. A list of compounds with ED properties used in animal husbandry internationally is given below:

β-zeranol
hexestrol
diethylstilbestrol (DES)
dienestrol (DE)
β-boldenone (bBOL)
α-boldenone (aBOL)
ethinyl estradiol (EE2)
fluoxymesterone (FMT)
α-zeranol (aZ)
17β-nortestosterone (bNT)
methyl boldenone (MeBol)
17α-nortestosterone (aNT)
norgestrel (NG)
chlorandrosteendione (ClAD)
methyl testosterone (MT)
methanedriol (MAD)
acetoxy progesterone (AP)
norethandrolone (NE)
methyl androstandiol (MeAD)
ethyl estrandiol (EED)
medroxyprogesterone acetate (MPA)
melengestrol acetate (MeLA)
megestrol acetate (MeGA)
chlormadinon acetate (CMA)
caproxy progesterone (CP)
chlortestosterone acetate (ClTA)

The following corticosteroids are used in animal husbandry:

dexamethasone (Dxm)
betamethasone (Btm)
prednisolone (prolon)
methyl prednisolone (Mprolon)
flumethasone (Flm)
fluorometholone (Fml)

The improper or illegal use of these compounds may result in drug residues in food products produced of these animals. Nowadays, the presence of steroid hormones in animal matrices is not a new issue. The illegal use of veterinary medicines is monitored both by injections sites as well as by analysis of urine, faeces, fat, muscle and organ tissue (e.g. kidney, thyroid gland). In this sense, the need to develop highly sensitive and specific analytical methods for the determination of these compounds in a wide variety of animal matrices has increased due to the wide variety of illegal applications of steroid hormones (Noppe, 2006).

5.4.1 Bovine feedlots

According to the Feedlot Association of SA, 75% of all bovine produced in SA stems from the feedlot production system. There are 57 of these feedlots registered in the country (De Jager and Swemmer, WRC Report 1686, 2006-2007). Figure 5 indicates the location of these feedlots. These feedlots were ranked by Swemmer and De Jager in order of the effect they may have on water resources (Figure 6). Information on how the ranking was done may be found in the WRC Progress Report 1686, which will be published in 2008. With the introduction of intensive farming practices, the usage of and nature of the veterinary drugs being used changed to more effective and usually more environmentally stable compounds and metabolites. The residues of these drugs excreted by the animals may reach the water resources of the areas in which they are situated and have an effect on human and animal health.

Figure 5: Bovine feedlots (Information supplied by The Feedlot Association of South Africa and mapped by Groundwater Square (WRC Progress Report 1686, 2006)

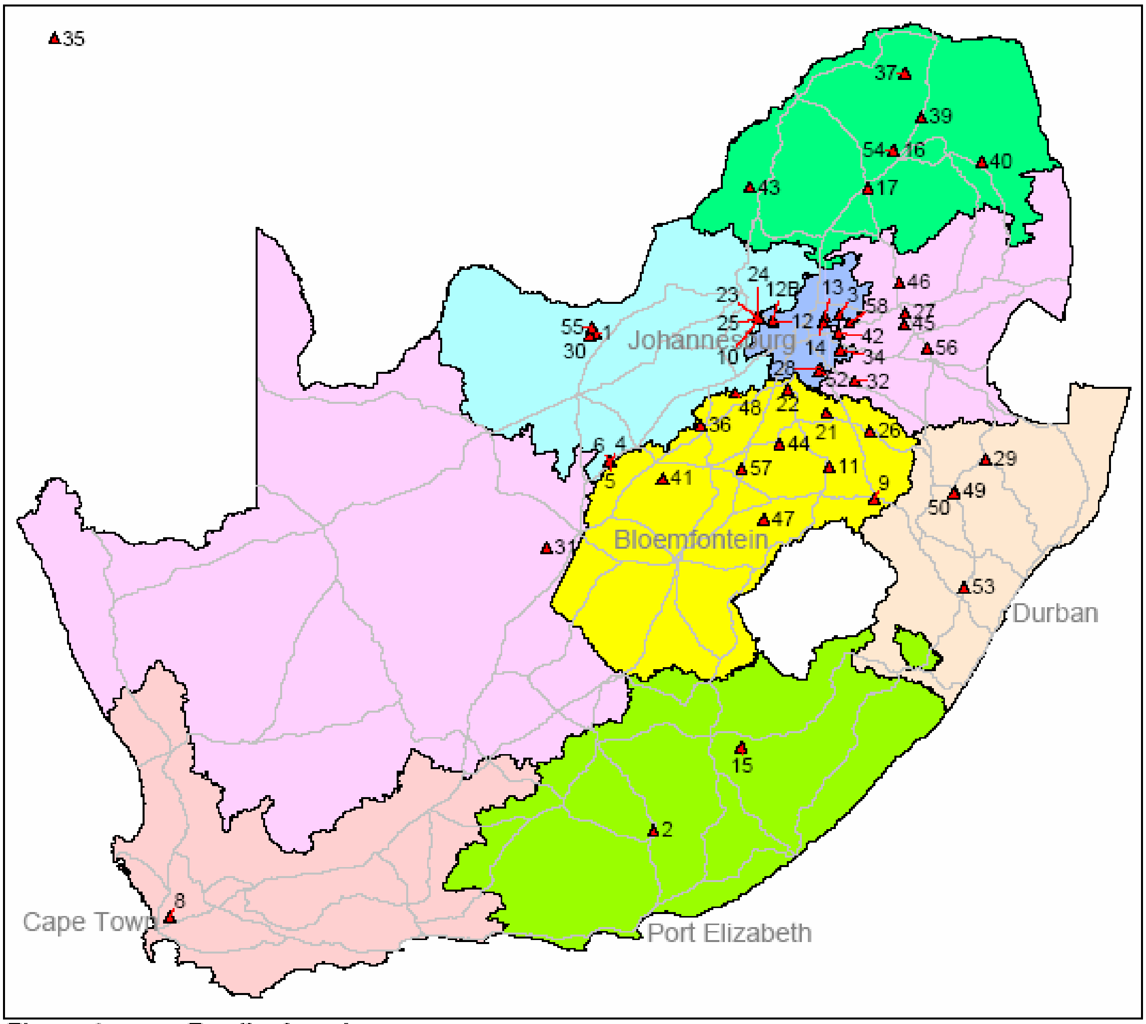
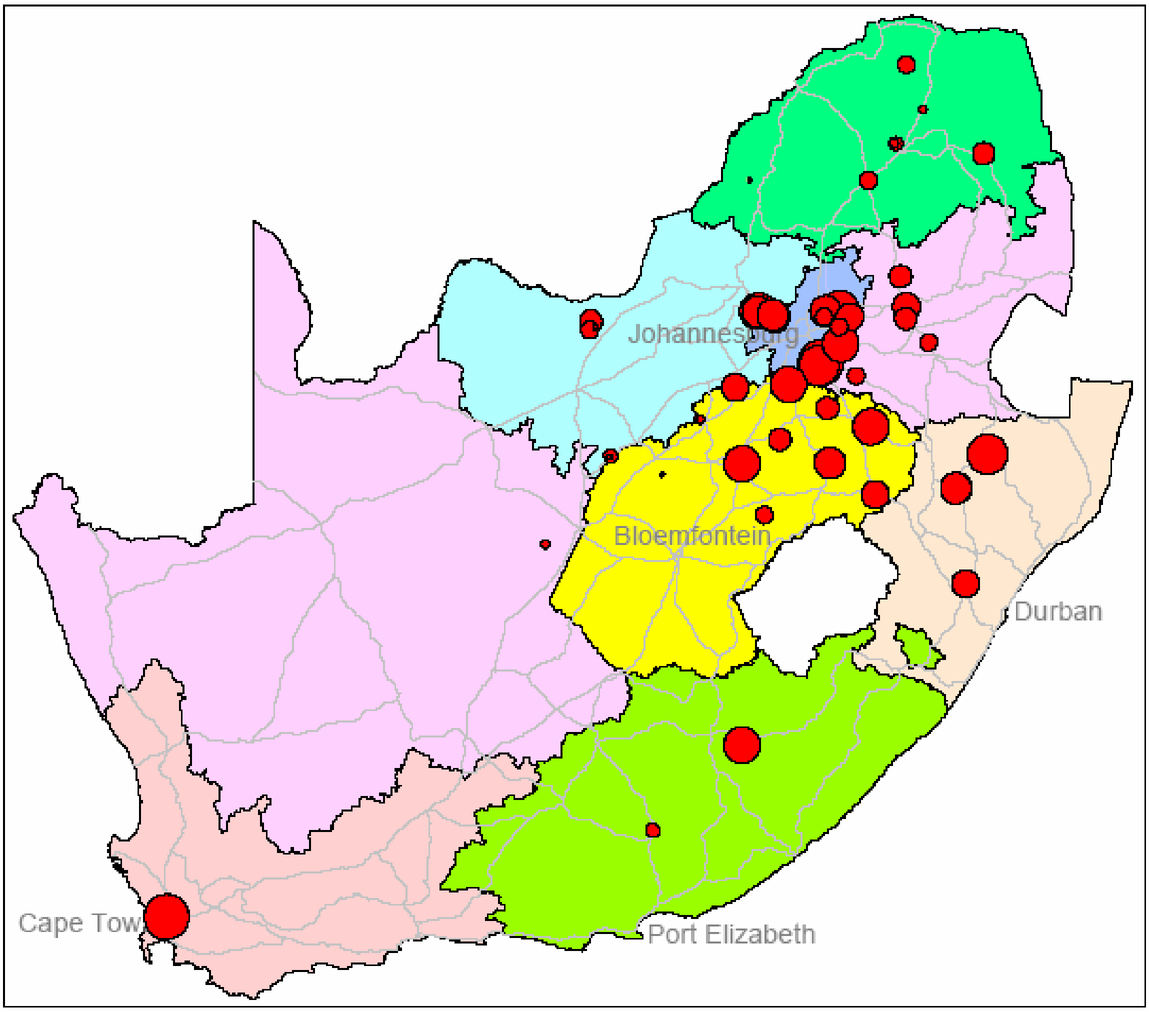


Figure 6: Thematic map of final ranking of feedlot susceptibility indices. Information supplied by Groundwater Square (WRC Report 1686, Swemmer and De Jager, to be completed by 2008)



5.4.2 Porcine feedlots

The major porcine feedlots are given in Table 5.

Table 5: The location of the porcine feedlots in the country.

TOWN	PROVINCE	WATER MANAGEMENT AREA (Refer to Figure 4)
Magaliesburg	Gauteng	3
Riebeeck West	Western Cape	17
Durbanville	Western Cape	19
Pietermaritzburg	KwaZulu-Natal	11
Polokwane	Northern Transvaal (now Limpopo)	1
Warmbaths (now Bela-Bela)	Northern Transvaal (now Limpopo)	1
Middelburg	Mpumalanga	4
Welkom	Free State	13
Virginia	Free State	13

5.4.3 Sheep, goats and horses

Sheep, goats and horses are found in all WMAs. They are normally not kept in feedlots, but are sent out to graze in fields. One sheep feedlot was located at Durbanville, Western Cape. The concentration of the applied drugs is therefore not concentrated in a small area.

5.4.5 Drugs used for pest- and disease control in South Africa

A list of drugs with ED properties mainly used in South Africa is given in Table 6.

Table 6: Drugs with ED properties used in animal production in South Africa.

ANIMAL	DRUG	CHEMICAL TYPE	DRUG ACTION
Bovine	Diethylstilbesterol (DES) Ethynylestradiol 17β-Estradiol	Synthetic estrogen	Growth promoter
	Trenbolone Nortestosterone Methyltestosterone	Androgenic steroids	Growth promoter
	17α-Estradiol Testosterone Progesterone	Natural estrogens	Growth promoter
	Thiomethyl uracil Thioproyl uracil	Thyrostatics	
	Zeranol		Estrogenic action
	Clenbutarol Salbutanol Mabutanol Zilpaterol	B-agonists	
Porcine	Progesterone Prednisolone Roxarzone	Sex hormone Corticosteroid	Growth promoter Anti-inflammatory Growth promoter
Goats	Testosterone	Sex hormone	
Sheep	Zeranol Testosterone Progesterone	Sex hormone	Growth stimulant
Poultry Ostriches	Zeranol Roxarzone		Growth stimulant Growth promoter

6. AGRICULTURAL CHEMICALS USED IN APPLICATIONS OTHER THAN AGRICULTURE

6.1 Chemicals used for malaria vector control, locust control and red–billed quelea control.

Certain chemicals, such as DDT and Deltamethrin (DM), are used in certain parts of the country for malaria vector control. Both DDT and DM are endocrine disruptors. Studies undertaken in malaria prevalent areas indicate evidence of detrimental effects of DDT on the human and wildlife population. (Bornman et al., 2006)

Esvenvalerate and deltamethrin are widely used for locust control in areas where no or little crops are planted. Lindane, which was previously used, is one of the persistent chemicals with a long half-life and is still detected in fat of sheep and cattle. BHC (mixture of various isomers) was registered for locust control. In 1983 the acquisition, alienation, sale or use of BHC was prohibited (banned). It could be that, as large stock was still available in the Karoo, BHC was used illegally.

Red-billed quelea finches cause extensive damage to crops in the northern parts of the country and different mixtures of pesticides in high concentrations are used to exterminate them. Fenthion, which has weak ED properties, is only one of two pesticides registered for red-billed quelea control.

Rotenone is used for control of exotic fish in certain rivers. No reference as to the ED properties of rotenone could be found.

6.2 Pesticides used on sport fields and railway lines

Many herbicides, fungicides and insecticides are used on sport fields and railway lines. Some of these have ED properties. Although these activities could not be classified as agricultural practice, the chemicals used were developed for agricultural use. Usually the concentrations used in these applications by far exceed the concentrations prescribed for crops cultivated as food and feed. It is therefore recommended to take the locations of these fields into consideration in a monitoring programme for agricultural chemical contamination in water resources. The Roundup formulation is very popular for application along roads and railway lines. (See Annexure A for further information).

6.3 Pesticides used in homes and home gardens

Some pesticides formulated for domestic use and home gardens contain insecticides such as cypermethrin, deltamethrin and chlorpyriphos. They may reach the water resources via run-off and waste water.

7. UNIDENTIFIED INERT INGREDIENTS USED IN PESTICIDE FORMULATIONS

By statute in the USA, South Africa and elsewhere, the ingredients of a formulated pesticide are divided into two categories: active and inert compounds (also sometimes called adjuvants). Inert compounds are added to the active ingredient to form a pesticide formulation. Despite their name, inert compounds may be chemically and biologically active and are labelled inert only because of their function in the formulated product (Cox and Surgan*,* 2006). Inert ingredients serve a variety of functions in a formulation. They act as solvents, surfactants and preservatives among other functions.

Inert ingredients can increase the ability of pesticide formulations to affect significant toxicological end points, including developmental neurotoxicity, genotoxicity and disruption of the endocrine system (Cox and Surgan, 2006, as well as http://www.epa.gov/opprd001/inerts/lists.html). Companies are not required to list inert ingredients on their labels and they are unwilling to give this information as it is regarded as trade secrets. The implication is that, for instance in the case of Roundup, the active ingredient, glyphosate, in a formulation does not have ED properties, but the formulation has. (Walsh et al., 2000). In another study it was found that two 2,4-D formulations caused estrogen-like proliferation of MCF-7 breast cancer cells *in vitro*, whereas 2,4-D did not (Lin et al.*,* 2000).

Some of these EDCs active inert ingredients such as 4-nonylphenol, are more stable in the water environment than the active compound and will have detrimental effects long after the active ingredient has decomposed. It is therefore important to take the presence of these inert ingredients into consideration when conducting a study on the impact of agricultural chemicals (pesticides) on the quality of water resources. *P*-Nonylphenol (PNP) and *p*-nonylphenol ethoxylate are amongst those used in formulations as adjuvants of registered pesticides in South Africa and residues are found in water resources.

8. TOPOGRAPHY AND CLIMATIC CONDITIONS

It is not within the scope of this study to describe the geological makeup of all South African rivers or dams because it varies considerably from place to place. It is, however, important when selecting a study site that the geological composition of the specific area, through which the river flows, be taken into account. Some information may be gained from the “State of the Rivers” reports published by DWAF and the CSIR. The movement of chemicals in the soil depends on various factors such as sand/clay content, organic material, slope, pH, soil temperature, rainfall and various other environmental factors. Some of the properties of pesticides and their movement in the environment may be found in Annexure D. Noppe (2006) also indicates that the mineral content of the water resource has an influence on the solubility and breakdown of certain EDCs. The average temperature zones are given in Figure 7. It is also of importance that not only a main river be studied, but also the small streams and rivulets that lead into the main river, because humans and animals very often make use of these small rivulets and streams for drinking and recreational purposes. Rainfall and runoff play a very important part in the pollution pattern of rivers and streams. Schultz et al. (2001) indicated that endosulfan levels in the Lourens River increased in the river as the result of run-off after the first rainfall of the wet season but not after the second rainfall event. A simplified rainfall distribution map is given in Figure 7. It must be emphasized that this map is based on averages and can only be used as an indicator of rainfall deposition in a certain area.

Figure 7: Average rainfall deposition (Simplified)

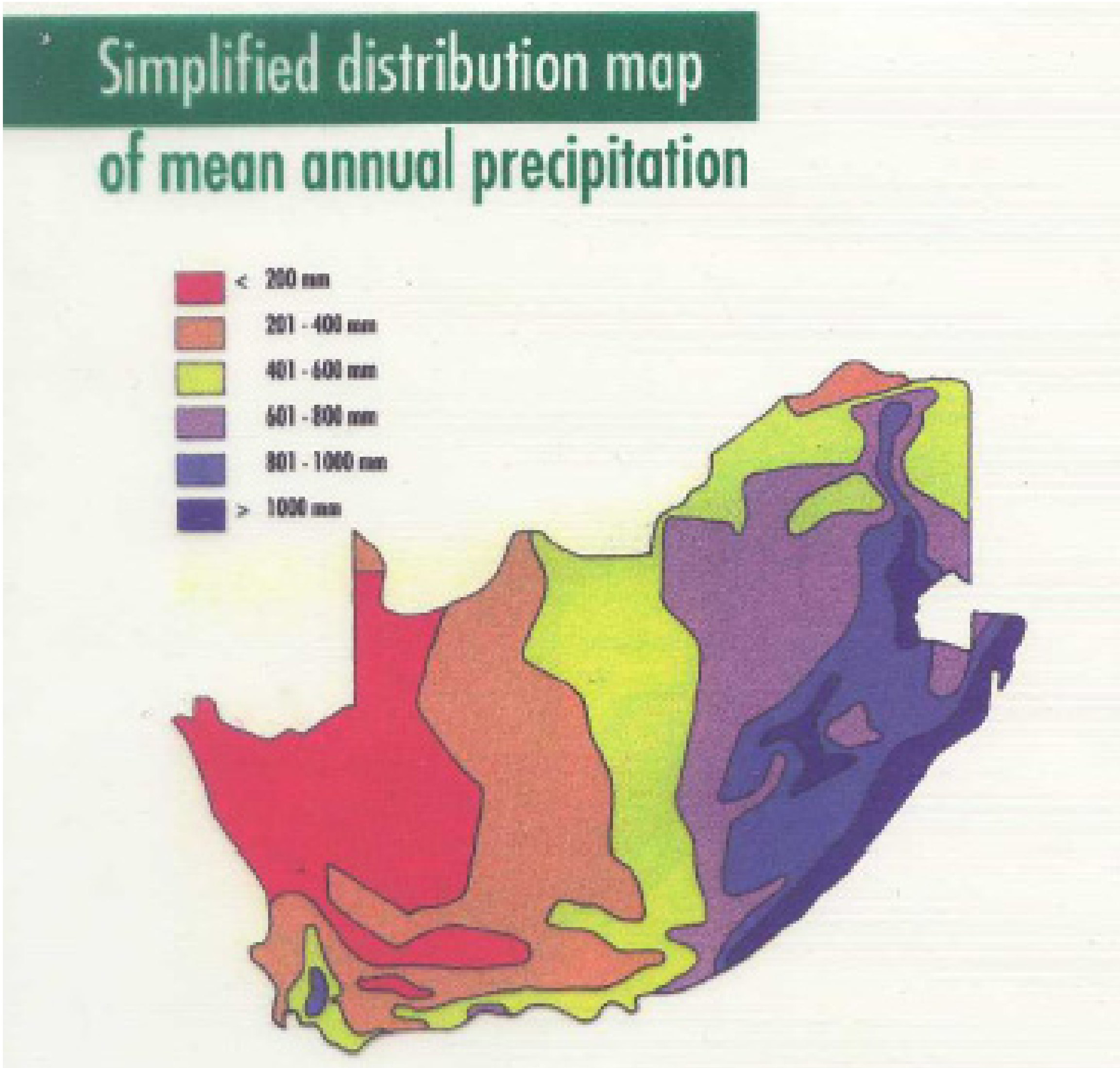
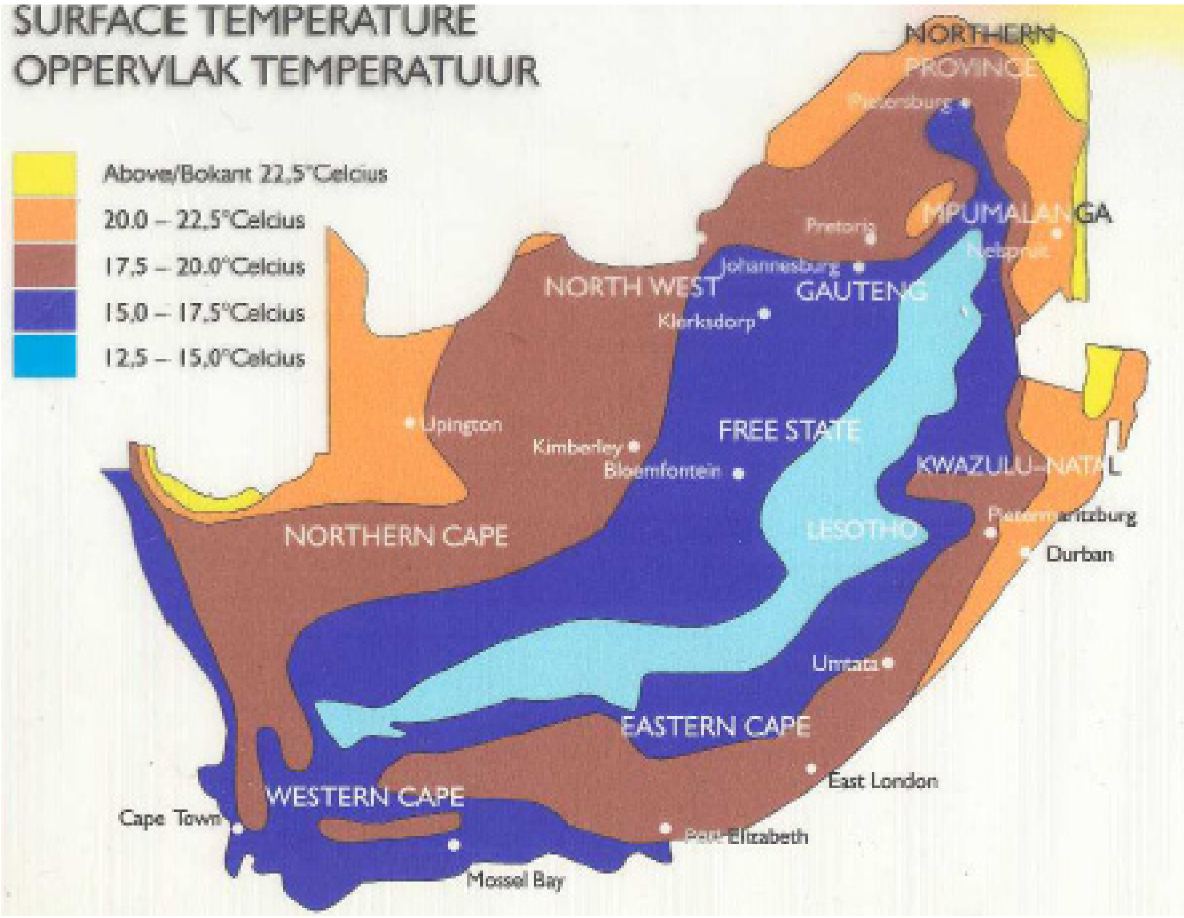


Figure 8: Average surface temperature



9. VOLUMES OF PESTICIDES PRODUCED AND FREQUENCY OF APPLICATION

It is extremely difficult to determine the volume of pesticides produced and used in the country. Pesticide registration holders are unwilling to give this information, because it is seen as confidential marketing information. Information obtained was outdated (2000). It is however still of value as an indication of production. Suggested frequency of application of certain pesticides is given in Annexure B.

10. MEETING OF OBJECTIVES

10.1 Crops cultivated and animals held for husbandry

Objective a of the project was met:

- A large variety of crops was identified: The main crops being grain, sugar cane, fruit, vegetables and fodder. Non-food crops, such as cotton and tobacco are cultivated on smaller scale.
- Beef and pork are mainly produced for food. Sheep and goats are produced for food, wool and hair.
- Large numbers of small poultry are produced, but drugs used on them do not have ED properties.

10.2 Areas where crops are cultivated and animals held

Objective b of the project was met:

- Except for vegetables the majority of crops are cultivated in the central, northern and eastern parts of the country. Citrus is also cultivated along the irrigation areas of the Gariep River in the North West province of the country and along the irrigation area of the Olifants River in the Western Cape province.
- Animals are held in the entire country, but sheep and goats are predominantly held in the arid parts of the country.

10.3 Pesticides and drugs used on crops and animals

Objective c of the project was met:

- **Pesticides**

  The survey indicated that a large number of pesticides with ED properties are registered for use in all the WMAs of the country. It may be assumed that most of them are used on crops in these areas depending on the prevalent disease or pest. ED activity was detected in various rivers and dams of the country. Whether this activity was caused by agricultural chemicals (pesticides) is not clear, because industrial chemicals and natural hormones, that can also cause ED activity, were also found in the same rivers and dams. It is, however, clear that some areas are more vulnerable than others due to DDT spraying and variety of crops (Areas 1, 2, 4, 5 and 6). In studies conducted by researchers from the WRC and universities, some of these pesticides were found in water, sediment and biota in selected rivers and dams (Bornman et al., 2007; Burger, 2005: Schultz, 2001). In all these studies, only a few selected pesticides were monitored. Chemical analysis of all pesticides was not possible because of the high cost of analysis and the fact that the ED properties of the chemicals were not known.

- **Drugs for animal health**

  Currently only one study is in progress on the impact of veterinary drugs used in feedlots on the water resources. The main impact of these practices may be felt in areas 1, 3, 4, 7, 8, 11 and 13.

10.4 Establishment of the frequency and amount of the chemicals used

Objective d was not met because information regarding volumes of EDCs produced and frequency of use is inaccurate and not dependable. Registration holders of pesticides and distributors are unwilling to give this information as it is regarded as confidential marketing information. Information available was dated before 2000.

10.5 Study of the topography of the areas and the movement of the chemicals in the soil and air

Objective e was not met because it was impractical to gather the topographical information of all the rivers. Climatic conditions and marketing trends play a significant role in production of crops and will therefore also have an impact on the pesticide usage of a WMA.

11. KNOWLEDGE GAPS IDENTIFIED

During the study the following knowledge gaps were identified:

11.1 Magnitude of EDC pollution

Although data indicates the occurrence of pesticides in South African rivers and dams, little is known about the magnitude of the pollution in the various rivers and dams. No data exist on the levels where mixtures of pesticides generate the ED effect in humans and animals. This knowledge is essential for risk assessment and the development of guidelines for control of EDCs in water resources.

11.2 Mode of action

The mechanism (mode of action) of how EDCs work on the various hormonal systems of the human and animal body is not yet fully understood, especially the effect on the thyroid function and the nervous system. This knowledge is needed so that break-down products can be detected in the water systems. More information is needed on how pesticides react in the South African environment. It was indicated in the UNEP study that pesticides take longer to break down in arid and semi-arid conditions.

11.3 Human health risk assessment

No human health risk assessment model exists for EDCs. The classical risk assessment for toxicity rests on the onset of cancer or death as an endpoint. This cannot be applied to EDCs because EDCs only have an effect on the hormonal system and does not necessarily lead to cancer or death of the individual.

11.4 Awareness programme

No formal programme is available to create awareness amongst users of agricultural pesticides on the responsible use of these chemicals.

12. CONCLUSIONS:

12.1 A large variety of crops is cultivated in the country. There is a multitude of pesticides, with ED properties, registered on these crops. According to the DOA it may be assumed that the majority of these pesticides are used either singly or in combinations, on the relevant crops. Although some information is available on the ED effects of single pesticides, no information exists on the effect of mixtures of pesticides.

12.2 Application may take place by manual spraying, spraying by tractor or by air spraying. The pesticides or their by-products and breakdown-products may reach streams, rivers and dams by run-off or deposition. Several researchers in different studies found proof of this.

12.3 Only limited information regarding the fate and behaviour of ED pesticides and drugs used for animal health in the environment and human and animal body is available. This information is essential for risk assessment.

12.4 Effects of ED disruption on aquatic animals and terrestrial animals living near water resources was observed by some researchers. It could, however, not be proven that the effects were due to pesticide pollution because other EDCs (industrial chemicals and natural hormones) were also present in the water resource.

12.5 Humans may be at risk when using water polluted with ED pesticides when using the water for drinking purposes or for recreation. They may also be exposed when ingesting fish or other animals that was exposed to ED pesticides or when they are exposed to pesticides in their homes (DDT spraying or other insecticide used in homes). No human health risk assessment is currently available.

12.6 Research done on EDC pollution is still fragmented. Several universities and research organisations conduct small studies with the result that valuable information gets lost or work is duplicated.

12.7 Users of pesticides are not always aware of the consequences of their actions.

13. RECOMMENDATIONS

Water is South Africa's most precious natural resource. A national effort is needed to protect this resource. Government departments such as Department of Agriculture, Department of Water Affairs and Forestry, Department of Environmental Affairs and Tourism, Department of Health and Department of Trade and Industry should be involved. The presence of EDCs in South African water systems and the fact that they can influence wildlife and human health is no longer a matter of contention. The EDC activity is, however, not only due to the presence of agricultural chemicals. To determine the impact of agricultural chemicals on the EDC activity in water systems will be a difficult and complicated exercise. The study will have to include the study of other chemicals with EDC properties, such as industrial chemicals and natural and synthetic hormones. However, a study on agricultural chemicals (pesticides) may serve as a model for research done on industrial chemicals and minerals from mining activity.

All future research should be aimed to assist the authorities to develop a policy to manage the problem and to develop tools for measuring human activity in the environment. In order to address the knowledge gaps identified in Paragraph 11, the following scenarios may be considered:

13.1 State of the science survey

Collecting data from various research projects undertaken by universities and other researchers on sensitive areas such as Limpopo, KwaZulu-Natal and the Western Cape and using this data to establish the possible sensitive areas and magnitude of EDC pollution.

13.2 A study on the magnitude of the pollution

A study is needed on the levels of pesticides with ED properties present in the water resources in order to determine the risk to animals and humans that use the water for drinking purposes. Field studies should continue in sensitive areas (WMAs). It is recommended that an Eco Based system (see Rapport and Singh, 2005) be followed: the study should include the analysis of water, sediments, fish, invertebrates, small mammals and plants. The lifestyle of the human population in the vicinity of the water resource should also be taken into account. (Water for drinking purposes is only one part of exposure. People are also exposed to EDCs via ingestion of food and through dermal absorption).

During the monitoring exercise great care should be taken on issues such as sampling, transport, analysis and interpretation of results. It is recommended that a tiered approach be followed as recommended by the EPA of the United States and used in the WRC EDC programme:

Firstly, testing the water, sediment and biota of a river or dam for ED activity using the battery of the biochemical/biological methods. Secondly, testing the positive samples chemically for the presence of specific pesticides using accredited methods. (**Note that both activity testing and specific testing should be conducted on the same sample).** It is recommended that industrial chemicals, hormones and heavy metals be determined on the same samples. The following process should be followed:

- Samples should be taken while pesticide spraying is taking place. (Pesticides from runoff go down a river in a "plug" and damage biota on the way. Monitoring during a "quiet" period will produce false negative results).

- Samples should be taken, transported and stored in glass containers according to the sampling guide for EDCs.
- Extraction procedures should be undertaken according to the analysis guide for EDCs as soon as possible and not longer than 72 hours after sampling (pH of water should be adjusted to 7 before extraction as it may influence the effectiveness of the extraction procedure). The extracts should be stored in glass containers at -20°C.
- EDC activity testing should be done on the extracts using any recognised validated biological/biochemical method. Both *in vitro* and *in vivo* methods should be used.
- A variety of chemical methods is available for testing specific chemicals. The specific method used should be appropriate to the matrix and have the necessary low detection limit. It should be validated as to sensitivity, repeatability, specificity and robustness. Laboratories, conducting the tests, should be accredited or have a recognised quality control system in place. The EDC methods manual should be consulted.
- The recommended list of inorganic chemicals should also be done. (List available in the EDC methods manual)

13.3 A study to understand the mode of action of EDCs in living bodies:

Research should continue to study the effects and mechanism of EDCs in living bodies (*in vitro* and *in vivo)* especially effects on the immune system, the thyroid function and the nervous system. It recommended that an investigation into the mode of action of certain pesticides and mixtures of pesticides on the thyroid function and nervous systems as well as on other hormonal systems such as the immune system and pancreas function should be done. This study could also include a study at molecular level. (2-3 years)

13.4 Development of a risk assessment model for animal and human health.

A human health risk assessment model for EDCs should be developed. The classical risk assessment model for toxicity cannot be used because it uses the onset of cancer as an endpoint. A new risk assessment model is needed to formulate guidelines for the maximum levels of ED pesticides in drinking, surface and ground water. Such guidelines can only be put into place once sufficient data is available and risk assessments have been done.

The data needed for the development of a risk assessment model and the resulting guidelines need not necessarily be obtained in field studies. Results may be obtained in laboratory studies by following the following procedures.

- Obtaining information on cultivation of crops and animal husbandry in specific WMAs (Table 2 of this report).
- Selecting pesticides and drugs which may be potentially used in these areas from the tables in this report and a limited field survey on farms.
- Making “cocktails” of mixtures of selected groups, i.e. herbicides, insecticides, fungicides and animal drugs
- Testing different concentrations of the mixtures on fish, tadpoles and small mammals (or other biota) under controlled laboratory conditions to determine at which level they show an ED effect.
- Using the data generated for the development of a risk assessment model.

This model will have the following advantages:

- Cost saving, since very little chemical analysis will be needed.
- The EDC activity of agricultural chemicals may be tested without interference of industrial chemicals and/or human hormones.

- The study may be done at any time of the year as it will not depend on a spraying season or climate conditions.
- More information will be obtained regarding levels of mixtures and the interaction of agricultural chemicals.

13.5 The awareness campaign:

An awareness campaign should be launched amongst farmers on the potential danger of pesticides with ED properties. Not only should the active ingredient be taken into account, but also the adjuvants in the specific formulation. Emerging farmers especially must be informed of the dangers of excessive and irresponsible use of pesticides.

13.6 Policy development

Policies should be developed for the registration of pesticides. Not only should the active ingredient be stated on the label of a formulation, but also the adjuvant. Toxicity data supplied for registration should include information regarding the ED properties of the formulation.

13.7 Storage of data

Data generated in the monitoring process as well as information gained in all the abovementioned projects should be stored in a central data base.

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ANNEXURE A

Chemical (EDC), Crop or Situation Used In and Pest (Acarid, Insect, Nematode, Plant Pathogen [Fungus or Bacterium], Weed) or Condition to be Corrected (Plant Growth Regulants)

(See Guidelines published by the Department of Agriculture)

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I AGRICULTURE

FUNGI- and BACTERICIDES

1. BENOMYL

CROP	DISEASE
Apples & pears	Post harvest decay (post harvest treatment), powdery mildew, scab
Apricots	Blossom blight
Avocados	Fruit spot (+ mineral oil)
Citrus	Black spot (+ mineral oil & mancozeb)
Cruciferae	Ring spot
Cucurbits	Powdery mildew
Grapes	*Botrytis* rot, powdery mildew
Mangoes	Post harvest decay (post harvest treatment) (+ copper oxychloride)
Ornamentals & flowers	Black spot (roses), bulb & corm rot (gladioli), powdery mildew (roses)
Peaches	Blossom blight, brown rot, freckle
Peppers	Powdery mildew
Plums	Blossom blight
Sugar cane	Pineapple disease
Tomatoes	*Botrytis* rot, powdery mildew
Wheat	Loose smut

2. CARBENDAZIM

CROP	DISEASE
Avocados	Fruit spot (+ mineral oil)
Barley	Eye spot, halo spot (all in a mixture* with tebuconazole), leaf rust (in mixtures with flusilazole or tebuconazole or triadimefon), leaf spot (in mixtures with epoxiconazole or flusilazole or tebuconazole or triadimefon), net blotch (in a mixture with flusilazole or tebuconazole), powdery mildew (in a mixture with flusilazole or tebuconazole or triadimefon
Beans	*Ascochyta* leaf spot, rust (in a mixture with flusilazole)
Soybeans	Soybean rust (in a mixture with flisilazole
Chicory	Leaf spot (in mixture with difenoconazole)
Citrus	Black spot (+mancoseb mineral oil)
Grapes	*Botrytis* rot (on own & in mixture with tebuconazole)
Groundnuts	Leaf spot diseases (in a mixture with bromuconazole or chlorothalonil or difenoconazole or epoxiconazole or flusilazole), rust (in a mixture with epoxiconazole or flusilazole)
Maize	Grey leafspot (in a mixture with bromuconazole or difenoconazole or epoxiconazole or flusilazole), northern leaf blight (in a mixture with difenoconazole or eposiconazole or flusilazole)
Mangoes	Powdery mildew (in mixture with flusilazole)
Oats	Crown rust (in a mixture with triadimefon)
Peas	Powdery mildew (in a mixture with flusilazole)
Potatoes	Early blight (in a mixture with flusilazole + mancozeb)
Tomatoes	Early blight (in a mixture with difenoconazole)
Wheat	Eye spot (in a mixture with bromuconazole or cyproconazole or epoxiconazole or flusilazole or tebuconazole or triadimefon or propiconazole, leaf rust (in a mixture with cyproconazole or flusilazole or tebuconazole or triadimefon), powdery mildew (in a mixture with cyproconazole or flusilazole or tebuconazole or triadimefon), speckled leaf and glume blotch (in a mixture with cyproconazole or epoxiconazole or flusilazole or tebuconazole), yellow rust (in a mixture with cyproconazole or epoxiconazole or flusilazole or tebuconazole or propiconazole)

* in a mixture with = formulation contains carbendazim; + the other active ingredient indicate plus
e.g.
+ mineral oil is when recommended to apply carbendazim in tank mixture with mineral oil

3. FENTIN HYDROXIDE

CROP	DISEASE
Onions	Purple (*Alternatia*) blotch
Pecan nuts	Scab
Potatoes	Early and late blight (also + mancozeb)

4. HEXACHLOROBENZENE (HCB) – (not registered as a fungicidal seed treatment in South Africa)

5. MANCOZEB

CROP	DISEASE
Apples & pears	Scab, Septoria leaf spot
Apricots	Freckle, gum spot, rust
Bananas	Sigatoke (+ mineral oil)
Beans	Rust
Boysen- & youngberries	Anthracnose, downy mildew (+ metalaxyl & metalaxyl-M)
Citrus	*Alternaria* spot (+ copper compounds, iprodione, procymidone), black spot (on own & + benomyl, carbendazim, mineral oil), brown rot, necrostoma, rust mite, melanose
Cruciferae	Downy mildew
Cucurbits	Downy mildew
Grapes	Dead arm, downy mildew (+ cymoxanil, dimethomorph,fenamidone, fosetyl-Al, pyraclostrobin, metalaxyl,, metalaxyl-M, potassium phosphate, zoxamide)
Groundnuts	Leaf spot diseases
Olives	Anthracnose
Onions	Downy mildew
Ornamentals, flowers	Black spot (roses), downy mildew & various leaf-spot diseases, rust
Papaya	Black speckle
Peaches	Freckle, gum spot, rust
Peas	Downy mildew
Pineapples	Root & base rot (+metalaxyl,, metalaxyl-M)
Plums	Gum spot, rust
Potatoes	Common scab, early blight (procymidone, zoxamide), late blight (+ copper hydroxide, cymoxanil, dimethomorph, fosetyl-Al, metalaxyl, metalaxyl-M, propamocarb hydrochloride) *Fusarium* dry rot
Quinces	Black spot
Tomatoes	Bacterial spot & blight, early & late blight (+ cymoxanil, dimethomorph, metalaxyl, metalaxyl-M), Septoria leaf spot

6. MANEB (only in a mixture with zinc oxide)

CROP	DISEASE
Apples & pears	Scab, Septoria leaf spot
Beans	Rust
Boysen- & youngberries	Anthracnose, downy mildew (+ metalaxyl & metalaxyl-M)
Citrus	Black spot, rust mite
Grapes	Dead arm, downy mildew
Onions	Downy mildew
Potatoes	Early blight, late blight (+ copper hydroxide, cymoxanil, dimethomorph, fosetyl-Al, metalaxyl, metalaxyl-M, propamocarb hydrochloride) *Fusarium* dry rot
Tomatoes	Early & late blight, Septoria leaf spot

7. METIRAM

CROP	DISEASE
Apples & pears	Scab
Apricots	Gum spot
Beans	Anthracnose
Grapes	Downy mildew
Peaches	Rust
Plums	Rust
Potatoes	
Tomatoes	

8. VINCLOZOLIN

CROP	DISEASE
Grapes	*Botrytis* rot

9. ZINEB

CROP	DISEASE
Apricots	Rust
Beans	Rust
Citrus	Black spot, melanose, rust mite
Cucurbits	Anthracnose, downy mildew
Onions	Downy mildew
Ornamentals & flowers	Black spot (roses), downy mildew & various leaf spot diseases, rust
Peaches	Rust
Plums	Rust
Potatoes	Early & late blight
Tobacco	Anthracnose
Tomatoes	Late blight

HERBICIDES

1. ACETOCHLOR

CROP	WEEDS
Afforestation	Annual grasses and broad-leaved weeds in *Eucalyptus* and pine plantations
Cotton	Annual grasses and certain broad-leaved weeds
Grain sorghum	Extended control of annual grasses and broad0leaved weeds (Concept treated seed only). Annual broad-leaved weeds and certain grasses (in a formulation with atrazine/propazine - safener treated seed only)
Groundnuts	Annual grasses and certain broad-leaved weeds
Maize	Mainly annual grasses (also + safener). Annual broad-leaved weeds and certain grasses (in a formulation with atrazine/propazine – also + safener <u>and</u> in a formulation with atrazine/terbuthylazine – also + safener)
Potatoes	Annual grasses and certain broad-leaved weeds
Sugar cane	Annual grasses and certain broad-leaved weeds
Sweet corn	Annual grasses and certain broad-leaved weeds

2. ALACHLOR

CROP	WEEDS
Broccoli	Mainly annual grasses and under certain conditions, yellow nutsedge
Brussels sprouts	Mainly annual grasses and under certain conditions, yellow nutsedge (cultivar Jade Cross)
Cabbage	Mainly annual grasses and under certain conditions, yellow nutsedge
Forage sorghum	Mainly annual grasses and under certain conditions, yellow nutsedge
Grain sorghum	Mainly annual grasses (Concep treated seed only)
Groundnuts	Mainly annual grasses and certain broad-leaved weeds and under certain conditions, yellow nutsedge
Lupins	Annual grasses and certain broad-leaved weeds
Maize	Annual grasses. Annual grasses and certain broad-leaved weeds (in a formulation with atrazine)
Paprika	Annual grasses and certain broad-leaved weeds (only with Ronstar)
Pineapples	Mainly annual grasses and under certain conditions, yellow nutsedge
Potatoes	Annual grasses, certain broad-leaved weeds and under certain conditions, yellow nutsedge. Annual grasses and broad-leaved weeds (in a formulation with linuron). Annual broad-leaved weeds and certain grasses (in a formulation with prometryn)
Soy beans	Mainly annual grasses and certain broad-leaved weeds and under certain conditions, yellow nutsedge
Sugar cane	Mainly annual grasses and under certain conditions, yellow nutsedge. Mainly annual grasses and certain broad-leaved weeds (in a formulation with atrazine)
Sunflowers	Mainly annual grasses and under certain conditions, yellow nutsedge. Annual grasses and broad-leaved weeds (in a formulation with prometryn)
Sweet corn	Mainly annual grasses and under certain conditions, yellow nutsedge

3. ATRAZINE

CROP	WEEDS
Grain sorghum	Annual broad-leaved weeds (on own and in a formulation with terbuthylazine and latter in a tank mixture with 2,4-D [dimethylamine salt]). Annual grasses and broad-leaved weeds and under certain conditions, yellow nutsedge (in a formulation with S-metolachlor – Consep treated seed only). Annual broad-leaved weeds and certain grasses (in a formulation with terbuthylazine)
Maize	Annual broad-leaved weeds on own and in a formulation with cyanazine). Annual grasses and certain broad-leaved weeds (in a formulation with metazachlor/terbythylazine). Annual grasses and broad leaved weeds (in a formulation with S-metolachlor). Mainly broad-leaved weeds (in formulations with sulcotrione, terbuthylazineand terbutryn and a tank mixture with 2,4-D and formulation of atrazine/terbuthylazine)
Pineapples	Annual broad-leaved weeds
Sugar cane	Mainly annual broad-leaved weeds. Annual grasses and broad-leaved weeds (in a formulation with S-metolachlor). Mainly annual broad-leaved weeds and certain grasses (in a formulation with sulcotrione)
Sweet corn	Mainly annual broad-leaved weeds and certain grasses (in a formulation with sulcotrione)

4. 2,4-D (dimethyl amine salt)

CROP	WEEDS
Barley	Mainly annual broad-leaved weeds (also + MCPA)
Grain sorghum	Annual broad-leafed weeds (also + MCPA)
Golf courses	Annual broad-leaved weeds
Grass pastures	Annual broad-leaved weeds (also + MCPA)
Lawns & turf	Annual broad-leaved weeds (also + MCPA; dicamba/MCPA)
Maize	Mainly annual broad-leaved weeds (also + MCPA)
Potatoes	Annual broad-leaved weeds and some grasses (also + MCPA)
Rye	Annual broad-leaved weeds (also + MCPA)
Sugar cane	Annual broad-leaved weeds (also + MCPA)
Wheat	Annual broad-leaved weeds (also + MCPA)

5. 2,4- D (iso-octyl ester)

CROP	WEEDS
Grass pastures	Annual broad-leaved weeds (not for use in KwaZulu-Natal)
Sugar cane	Annual broad-leaved weeds (not for use in KwaZulu-Natal) (also + ioxynil)
Wheat	Annual broad-leaved weeds

Note: Also refer **PLANT GROWTH REGULANTS**

6. 2,4,5-T (not registered as a herbicide in South Africa)

7. LINURON

CROP	WEEDS
Carrots	Annual broad-leaved weeds and certain grasses
Gladioli	Annual broad-leaved weeds and certain grasses
Maize	Annual broad-leaved weeds and certain grasses in irrigated maize
Parsley & parsnips	Annual broad-leaved weeds and certain grasses
Potatoes	Annual broad-leaved weeds and certain grasses
Roses	Annual broad-leaved weeds and certain grasses
Sweet potatoes	Annual broad-leaved weeds and certain grasses

8. METRIBUZIN

CROP	WEEDS
Asparagus	Annual broad-leaved weeds and grasses
Barley	Annual broad-leaved weeds and grasses
Lawns & turf	Annual broad-leaved weeds and grasses
Lucerne	Annual broad-leaved weeds and grasses
Maize	Annual broad-leaved weeds and certain grasses
Potatoes	Annual broad-leaved weeds and grasses
Soy beans	Annual broad-leaved weeds and grasses (only certain soy bean cultivars)
Sugar cane	Annual broad-leaved weeds and grasses
Tomatoes	Annual broad-leaved weeds and grasses

9. METOXYCHLOR (not registered as an herbicide in South Africa)

10. NITROFEN (not registered as an herbicide in South Africa)

11. PROPAZINE

CROP	WEEDS
Apples	Mainly annual broad-leaved weeds in orchards older that 3 years (also + terbuthylazine)
Asparagus	Mainly annual broad-leaved weeds
Canola	Annual broad-leaved weeds and certain annual grasses
Citrus	Annual broad-leaved weeds and certain grasses on trees older than 1 year (also + terbuthylazine)
Grain sorghum	Annual broad-leaved weeds and certain grasses (in a mixture with acetochlor/atrazine)
Maize	Annual broad-leaved weeds and certain grasses (in a mixture with acetochlor/atrazine)

Note: Kindly refer III INDUSTRIAL USE for use of simazine in combination with propazine for control of weeds on e.g. industrial premises, along roads etc.

12. SIMAZINE

CROP	WEEDS
Apples	Mainly annual broad-leaved weeds in orchards older that 3 years (also + terbuthylazine)
Asparagus	Mainly annual broad-leaved weeds
Canola	Annual broad-leaved weeds and certain annual grasses
Citrus	Annual broad-leaved weeds and certain grasses on trees older than 1 year (also + terbuthylazine)
Grapes	Mainly annual broad-leaved weeds in vineyards older that 3 years (also + terbuthylazine)
Hops	Annual grasses and broad-leaved weeds
Pears	Mainly annual broad-leaved weeds in orchards older that 3 years (also + terbuthylazine for also grasses)

Note: Refer III INDUSTRIAL USE for use of simazine in combination with propazine for control of weeds on e.g. industrial premises, along roads etc.

13. TERBUTHYLAZINE

CROP	WEEDS
Afforestation	Annual broad- leaved weeds in *Eucalyptus* plantations
Apples	Annual broad-leafed weeds in orchards 1 year after transplant (also + glyphosate/isopropylamine salt/simazine for broad-leaved weeds and annual grasses; simazine and S-metalochlor for annual broad-leaved weeds and certain grasses)
Avocados	Mainly annual broad-leaved weeds (also + S-metalochlor for annual broad-leaved weeds and certain grasses)
Citrus	Annual broad-leaved weeds (also + simazine and S-metalochlor for annual broad-leaved weeds and certain grasses)
Grapes	Annual broad-leaved weeds (also + simazine in vineyards older that 3 years for mainly broad-leaved weeds and S-metolachlor for mainly annual broad-leaved weeds)
Maize	Annual broad-leaved weeds (+ 2,4-D/dicamba) (also + acetochlor/atrazine for annual broad-leaved weeds and certain grasses; atrazine/metazachlor for annual grasses and certain broad-leaved weeds; atrazine/S-metolachlor for mainly annual broad-leaved weeds; atrazine for mainly annual broad-leaved weeds; bromoxynil for annual broad-leaved weeds; s-metolachlor for annual broad-leaved weeds and certain grasses
Mangoes	Annual broad-leaved weeds (also + S-metolachlor for annual broad-leaved weeds and certain grasses)
Pears	Mainly annual broad leaf weeds in orchards older that 3 years (also + glyphosate/simazine for broad-leaved weeds and annual grasses; simazine for annual broad-leaved weeds and grasses)

14. TIBUTYLTIN (not currently registered in RSA. Used as an anti-fouling agent in paints for boats and ships. Could be used inland e.g. at Vaal Dam and most probably on a small scale (personal communication Dr J B Vermeulen)

15. TRIFLURALIN

CROP	WEEDS
Apples	Annual grasses and certain broad-leaved weeds
Apricots	Annual grasses and certain broad-leaved weeds
Cabbage	Annual grasses and certain broad-leaved weeds
Carrots	Annual grasses and certain broad-leaved weeds
Chillies	Annual grasses and certain broad-leaved weeds
Citrus	Annual grasses and certain broad-leaved weeds
Cotton	Annual grasses and certain broad-leaved weeds
Cowpeas	Annual grasses and certain broad-leaved weeds
Dry beans	Annual grasses and certain broad-leaved weeds
Grapes	Annual grasses and certain broad-leaved weeds
Groundnuts	Annual grasses and certain broad-leaved weeds
Guavas	Annual grasses and certain broad-leaved weeds
Kidney beans	Annual grasses and certain broad-leaved weeds
Macadamia nuts	Annual grasses and certain broad-leaved weeds
Nectarines	Annual grasses and certain broad-leaved weeds
Peaches	Annual grasses and certain broad-leaved weeds
Pears	Annual grasses and certain broad-leaved weeds
Pecan nuts	Annual grasses and certain broad-leaved weeds
Plums & prunes	Annual grasses and certain broad-leaved weeds
Quinces	Annual grasses and certain broad-leaved weeds
Soy beans	Annual grasses and certain broad-leaved weeds
Sunflowers	Annual grasses and certain broad-leaved weeds
Tomatoes	Annual grasses and certain broad-leaved weeds

INSECTI-, ACARI-, NEMATICIDES

1. ALDICARB

CROP	PEST
Bananas	Nematodes, root borer
Citrus	Nematodes, psylla, bud mite, aphids, rust mite and suppress red mite, red scale, thrips
Cotton	Nematodes, aphids, thrips, leaf hopper and suppress red spider mite
Grapes	Nematodes, erinose mite, aphids
Groundnuts	Nematodes
Pineapples	Nematodes
Potatoes	Nematodes, aphids
Sugar cane	Nematodes,
Sweet potatoes	Nematodes
Tobacco	Nematodes, aphids, red mite and slug
Tomatoes	Nematodes

2. ALDRIN (Acquisition, alienation, sale or use banned except for use to protect buildings against subterranean wood-destroying termites in 1983. Voluntarily withdrawn in 1992)

3. ALPHA-CYPERMETHRIN

CROP	PEST
Afforestation	Pine tree emperor moth larva, wattle bagworm, willow tree emperor moth larva
Apples & pears	American bollworm, codling moth larva, leaf roller, weevil
Beans	American bollworm, semi-looper
Citrus	Ants
Cotton	American bollworm, red and spiny bollworm, semi-looper, leaf-eaters, stainers
Cruciferae	American bollworm, diamond back moth larva, thrips
Grain sorghum	American bollworm, maize stalk borer
Grapes	Ants (trellised vines only), weevils
Groundnuts	American bollworm
Lucerne	Caterpillar
Maize	American bollworm, pink stalk borer, maize stalk borer and suppress leafhopper
Peaches	American bollworm, codling moth larva, false codling moth larva, fruit flies, weevil
Peas	American bollworm, lesser army worm
Potatoes	Tuber moth larva, lesser army worm
Tomatoes	American bollworm
Various crops	Cutworms, fruit flies (+ hydrolysate in traps)
Veld & grazing	Army worm, brown locust

Note: Also refer **II PUBLIC HEALTH** for the use of alpha-cypermethrin in the control of pests in human and animal dwellings and **III INDUSTRIAL USE** for use in the control of pests in stored commodities

4. AZINPHOS-METHYL

CROP	PEST
Apples / Pears	Codling moth larva, bud mite, leaf rollers, woolly aphid
Apricots	Bryobia mite
Citrus	Aphids, soft brown scale
Cotton	Red bollworm, aphids, stainer
Olives	Leaf eating beetles, scale
Peaches	Bryobia mite, Codling moth larva, Oriental fruit moth, false codling moth larva
Plums	Bryobia mite, codling moth larva
Potatoes	Tuber moth larva

5. BETA-CYPERMETHRIN

CROP	PEST
Afforestation	Pine tree emperor moth larva, wattle bagworm
Apples & pears	American bollworm, codling moth larva, leaf roller and suppress weevil
Beans	American bollworm
Citrus	Thrips
Cotton	American bollworm, red and spiny bollworm, stainers
Grapes	Weevils
Groundnuts	American bollworm
Lucerne	Caterpillar
Lupins	American bollworm
Macadamias	Stinkbug
Maize	American bollworm
Peaches	American bollworm, codling moth larva, false codling moth larva, fruit flies, weevil
Peas	American bollworm, lesser army worm
Plums	American bollworm, codling moth larva, false codling moth larva, weevil
Tomatoes	American bollworm
Wheat	American bollworm
Various crops	Cutworms
Veld & grazing	Army worm

6. CAMPHECHLOR (TOXAPHENE) (withdrawn as an agricultural remedy in 1970 in South Africa)

7. BHC (mixture of various isomers) (the acquisition, alienation, sale or use prohibited in 1983)

8. CARBARYL

CROP	PEST
Apples & pears	Bud mite, codling moth larva, leaf roller, mealy bugs
Apricots	Mealy bugs
Beans	Chafer beetles
Cactus & spineless pears	Cactoblustis, cochineal
Castor oil	Caterpillars
Cotton	American bollworm, aphids, elegant grasshopper, leaf hopper, red and spiny bollworm, syagrus beetle, stainers
Cruciferae	Diamond back moth larva (+ chlorpyrifos) (home garden), greater cabbage moth larva (+ chlorpyrifos) (home garden)
Grapes	Mealy bugs, weevils, snails (+ metaldehyde)
Litchis	Bark borer larvae, stem borer larva
Lucerne	Caterpillar
Macadamias	Bark borer larvae, stem borer larva
Maize	Chafer beetle, maize stalk borer
Ornamentals & flowers	American bollworm, aphids (+ chlorpyrifos) (home garden), chafer beetles, crickets (lawns only), lawn caterpillar (on own & + chlorpyrifos – home garden), shield bugs & twig wilters (on own & + chlorpyrifos – home garden)
Pecan nuts	Bark borer larvae, stem borer larva
Tobacco	American bollworm, slug
Various crops	Ants (+ chlorpyrifos) (home garden), Astylus beetle (home garden), cutworms (+chlorpyrifos), elegant grasshopper, snails & slugs (+ metaldehyde)
Veld & grazing	Army worm, brown locust, northern harvester termite (home garden)

Note: Also refer PLANT GROWTH REGULANTS AND II PUBLIC HEALTH for the use of carbaryl in the control of pests in human and animal dwellings and III INDUSTRIAL USE for use in the control of pests in stored commodities

9. CHLORPYRIFOS (ETHYL)

CROP	PEST
Apples / Pears	Aphids (home garden only), mealy bug, pernicious scale, woolly aphid
Apricots	Aphid, mealy bug, pernicious scale
Bananas	Thrips, moths (vapourizing strip) flat mite, flower thrip (vapourizing)
Beans	Black maize beetle, false wire worm
Citrus	American bollworm, aphids, mealy bug, orange dog caterpillar, psylla, red scale
Cruciferae	Aphids, diamond back moth
Grapes	Ants, mealy bug
Hops	Cutworm
Lettuce	Cutworm
Maize	Black maize beetle, maize stalk borer
Ornamentals & flowers	American bollworm, aphids, crickets, lawn caterpillar, mealy bug, pernicious scale, red scale, red spider mite
Peaches	Aphids (home garden only), mealy bug (home garden only), pernicious scale, red scale
Pineapples	White grub
Plums	Aphids (home garden only), mealy bug (home garden only), pernicious scale
Potatoes	Black maize beetle, cutworm
Sorghum	Black maize beetle, false wire worm
Tobacco	Cutworm, wire worm
Tomatoes	American bollworm, semi-looper, thrips
Various crops	Ants, cutworm
Veld & grazing	Army worm
Wheat	Aphids, Russian aphid

Note: Also refer II PUBLIC HEALTH for the use of chlorpyrifos in the control of pests in human and animal dwellings

10. CHLORPYRIFOS METHYL

Note: Refer **III INDUSTIAL USE** for the use of chlorpyrifos methyl in the control of pests in stored commodities

11. CYHEXATIN

CROP	PEST
Apples & pears	Red spider & European red mite
Citrus	Grey, Lowveld & rust mites
Hops	Red spider mite
Peaches	Red spider & European red mite
Plums	Red spider & European red mite
Tomatoes	Red spider mite

12. CYPERMETHRIN

CROP	PEST
Afforestation	Pine tree emperor moth larva, wattle bagworm, willow tree emperor moth larva
Apples & pears	American bollworm, codling moth larva, leaf roller, weevil
Beans	American bollworm
Citrus	False codling moth larva, thrips
Cotton	American bollworm, red and spiny bollworm, semi-looper, leaf-eaters, stainers
Cruciferae	American bollworm, diamond back moth larva, greater cabbage moth larva, thrips
Grapes	Weevils
Groundnuts	American bollworm
Lucerne	Caterpillar
Lupins	American bollworm
Macadamias	Stinkbug
Maize	American bollworm, chafer beetle, pink stalk borer, maize stalk borer and suppress leafhopper
Ornamentals & flowers	American bollworm (+ piperonyl butoxide), aphids (home garden), CMR beetle (+ piperonyl butoxide), crickets, flower beetles, lawn caterpillar, lily borer (home garden), mealy bug (home garden), pine tree emperor moth in proteas, scale and semi-looper (+piperonyl butoxide), shield bugs, twig wilters, thrips (+ piperonyl butoxide), white fly (home garden)
Peaches	American bollworm, codling moth larva, false codling moth larva, fruit flies, weevil
Peas	American bollworm, lesser army worm
Plums	American bollworm, codling moth larva, false codling moth larva, weevil
Rooibos	Leafhoppers
Sorghum	American bollworm, stalk borer
Tomatoes	American bollworm
Wheat	American bollworm,
Various crops	Ants (home garden), cutworms
Veld & grazing	Army worm, brown locust, northern harvester termite (home garden)

Note: Also refer **II PUBLIC HEALTH** for the use of cypermethrin in the control of pests in human and animal dwellings and **III INDUSTRIAL USE** for use in the control of pests in stored commodities

13. DELTAMETHRIN

CROP	PEST
Afforestation	Pine bark beetle, wattle mired, white grub
Apples & pears	American bollworm, Antestia bug, codling moth larva, leaf roller, weevil
Beans	American bollworm
Cactus & spineless pears	Cactoblastis larva
Cotton	American bollworm, red and spiny bollworm, stainers
Cruciferae	Diamond back moth larva
Grapes	American bollworm, weevil
Groundnuts	American bollworm
Hops	American bollworm
Lettuce	American bollworm, cutworm
Lucerne	Caterpillar
Lupins	American bollworm
Maize	American bollworm, chafer beetle, chilo stalk borer, maize stalk borer
Mangoes	Weevil
Onions	Thrips
Ornamentals & flowers	American bollworm, aphids, Australian bug, chafer beetle, lawn caterpillar, lily borer, shield bug, semi-looper (+esbiothrin), twig wilters, thrips, white fly
Paprika	American bollworm
Peaches	American bollworm, weevil???
Peas	American bollworm
Plums	American bollworm, weevil
Potatoes	Tuber moth larva , cutworm
Sorghum	American bollworm
Sweet potatoes	Hawk moth larva, leaf miners, weevil
Tobacco	Storage pests (moth & beetle)
Tomatoes	American bollworm
Wheat	American bollworm,
Various crops	Astylus beetle, cutworms, short horned grasshoppers (home garden)
Veld & grazing	Army worm, brown locust, northern harvester termite (home garden)

Note: Also refer II PUBLIC HEALTH for the use of deltamethrin in the control of pests in human and animal dwellings and III INDUSTRIAL USE for use in the control of pests in stored commodities

14. 1,2-DIBROMO-3-CHLOROPROPANE (not registered as an agricultural remedy in South Africa. Remedies containing 1,2-dichloropropane withdrawn by registration holder before 1992)

15. DIELDRIN (all registrations withdrawn in 1980. The acquisition, alienation, sale or use prohibited in 1983)

16. ENDOSULFAN (use on fodder crops suspended in 1970)

CROP	PEST
Afforestation	Pine tree emperor moth larva
Apples & pears	American bollworm, Antestia bug, aphids, slug (pears), woolly aphid
Apricots	American bollworm, aphids
Beans	American bollworm
Boysen & youngberries	American bollworm, Antestia bug, tree cricket
Cherries	American bollworm, slug
Citrus	American bollworm, aphids, bud mite, orange dog caterpillars, psylla
Coffee	Antestia bug, slug caterpillar
Cotton	American bollworm, aphids, leafhopper, thrips, semi-looper, red spider mite (suppress)
Cruciferae	Aphids, diamond back moth and greater cabbage moth larvae
Cucurbits	American bollworm, thrips
Granadilla	Green vegetable bug
Grapes	American bollworm, Erinose mite, leafhopper
Groundnuts	American bollworm, aphids
Hops	American bollworm
Macadamias	Stinkbugs
Maize	American bollworm, chafer beetle, chilo stalk borer (+ beta-cyfluthrin, permethrin, tralomethrin) maize stalk borer
Onions	Thrips
Ornamentals & flowers	American bollworm, aphids, flower moth (aloes), lily borer, pine emperor moth (proteas)
Paprika	American bollworm, thrips
Peaches	American bollworm, Antestia bug, aphids
Peas	American bollworm
Pineapples	Pineapple mite (leathery pocket) Eastern Cape only
Plums	American bollworm, Antestia bug, slug caterpillar
Potatoes	Aphids
Quinces	American bollworm, Antestia bug, aphids, slug
Sorghum	American bollworm, aphids, chilo stalk borer (+beta-cyfluthrin), maize stalk borer
Sugar cane	Leafhoppers
Sunflowers	American bollworm
Tobacco	American bollworm, aphids, thrips
Tomatoes	American bollworm
Wheat	American bollworm
Various crops	Cutworms
Veld & grazing	Army worm

17. ENDRIN (voluntarily withdrawn in 1980)

18. ESFENVALERATE

CROP	PEST
Apples & pears	American bollworm, codling moth larva, leaf roller, weevil
Beans	American bollworm
Cotton	American, red and spiny bollworms, semi looper, stainers
Grapes	Mealy bugs, weevils, snails (+ metaldehyde)
Hops	American bollworm
Maize	American bollworm, chilo stalk borer (on own + benfuracarb), maize stalk borer
Mangoes	Weevil
Peas	American bollworm
Potatoes	Tuber moth larva, cutworms, suppress aphids
Sorghum	American bollworm
Sunflowers	American bollworm (on own & + methomyl)
Tomatoes	American bollworm
Wheat	American bollworm
Various crops	Cutworm
Veld & grazing	Brown locust

Note: Also refer **II PUBLIC HEALTH** for the use of deltamethrin in the control of pests in human and animal dwellings

19. FENVALERATE

CROP	PEST
Apples & pears	American bollworm, codling moth larva, leaf roller, weevil
Beans	Chafer beetles
Cotton	American, red and spiny bollworms, semi looper, stainers
Grapes	Weevils
Maize	American bollworm, chilo stalk borer (on own & + benfuracarb), maize stalk borer
Mangoes	Weevil
Peas	American bollworm
Potatoes	Tuber moth larva, cutworms, suppress aphids
Sorghum	American bollworm
Sunflowers	American bollworm (on own & + methomyl)
Tomatoes	American bollworm
Wheat	American bollworm
Various crops	Cutworm

20. gamma-BHC

CROP	PEST
Afforestation	Pine bark beetle, whit grub (at planting of pine tree sapling)
Beans	Aphids, CMR beetle, seed maggot (seed treatment), thrips
Cotton	Stainers
Grapes	Weevils
Cruciferae	Bagrada bug, diamond-back moth, greater cabbage moth
Maize	Astylus beetle larva, black maize beetle, false wire worm (all seed treatment)
Onions	Thrips
Ornamentals & flowers	Aphids, Bagrade bug, chafer beetles, CMR beetles, crickets (home garden), lawn caterpillar, shield bugs and twig wilters, snout beetles (aloes), thrips,
Potatoes	Ladybird
Sweet potatoes	Weevil
Wheat	Astylis beetle larva, black maize beetle, wire worm (all seed treatment)
Various crops	Ants (home garden), Astylus beetle, short horned grasshoppers, wire worms, white grubs (application to plants, soil and seed treatments)

Note: Also refer **III INDUSTRIAL USE** for use in the control of pests in skins, hides & wool

21. HEPTACHLOR (withdrawn in 1980. CHLORDANE withdrawn for use in agriculture in March 1999 and withdrawn as an agricultural remedy in 2000)

22. MERCAPTOTHION (MALATHION)

CROP	PEST
Apples & pears	Aphids, bryobia mite, mealy bugs, woolly aphid
Apricots	Aphids, bryobia mite, mealy bugs
Avocados	Soft brown scale
Bananas	Aphid, thrips
Beans	Aphids, chafer beetles, CMR beetles, thrips
Citrus	Aphids, Australian bug, brown scale, fruit flies, mealy bugs, mussel scale, red scale, soft brown scale, thrips
Cotton	Aphids
Cruciferae	Aphids, diamond back moth and greater cabbage moth larvae
Cucurbits	Aphids, ladybirds, pumpkin flies, thrips
Granadilla	Circular purple scale, mealy bugs, pumpkin flies, red scale, soft scale, thrips, white scale
Groundnuts	Aphids
Guavas	Mealy bugs, scale
Lucerne	Caterpillar, earth flea
Lupins	American bollworm
Maize	American bollworm, aphids, chafer beetle, chilo stalk borer, maize stalk borer
Mushrooms	Fungus gnats
Onions	Thrips
Ornamentals & flowers	Aphids, Australian bug, chafer beetle, CMR beetles, crickets, lawn caterpillar, mealy bug, red scale, red spider mite, scales, small stinkbug (aloes), snout beetles, soft brown scale, thrips,
Papaya	Aphids
Peaches	Aphids, bryobia mite, mealy bugs
Peppers	Astylus beetle, aphids, thrips
Pineapples	Mealy bugs
Plums	Aphids, bryobia mite (home garden), mealy bugs, slug caterpillar (home garden) weevil
Quinces	Slug (home garden)
Sorghum	Aphids
Sugar cane	Leafhoppers
Tobacco	Aphids, slug, whitefly
Tomatoes	Aphids, thrips
Various crops	Ants, Astylus beetle, fruit flies, lesser army worm, short horned grasshoppers
Veld & grazing	Army worm

Note: Also refer II PUBLIC HEALTH for the use of mercaptothion in the control of pests in human and animal dwellings and III INDUSTRIAL USE for use in the control of pests in stored commodities

23. METHOMYL

CROP	PEST
Beans	American bollworm
Citrus	American bollworm, aphids, orange dog, mealy bugs, red scale (+ mineral oil), white wax scale
Cruciferae	American bollworm, aphids, diamond back moth and greater cabbage moth larvae
Lucerne	American bollworm
Lupins	American bollworm
Maize	American bollworm
Ornamentals & flowers	Aphids, carnation worm (carnations)
Peaches	False codling moth larva
Potatoes	American bollworm, tuber moth larva
Sorghum	American bollworm
Sunflowers	American bollworm (+ esfenvalerate & fenvalerate)
Tobacco	American bollworm, leaf miner, slug
Tomatoes	American bollworm, aphids, leaf miner, thrips
Veld & grazing	Army worm

Note: Also refer **II PUBLIC HEALTH** for the use of methomyl pests in human and animal dwellings

24. PARATHION (registration in deciduous fruit and vineyards withdrawn in 1992. Voluntarily withdrawn in June 1993 from use in beans, coffee, cotton, groundnuts, mangoes, ornamentals, as well as for the control of short-horned grasshopper in various crop)

CROP	PEST
Barley	Aphid (Russian) (+ demeton-S-methyl & oxydemeton-methyl)
Cactus & spineless pears	Cochineal
Castor oil	Stinkbug
Citrus	Red scale
Cruciferae	Bagrada bug, diamond-back moth larva
Grain sorghum	Aphids (on own and + dimethoate & thiometon)
Onions	Thrips
Wheat	Aphids (green and brown); Russian aphid (+ demeton-S-methyl, dimethoate, oxydemeton-methyl, thiometon)
Various crops	Ants

25. PARATHION-METHYL

CROP	PEST
Apples & pears	Codling moth larva
Citrus	False codling moth

26. PERMETHRIN

CROP	PEST
Apples & pears	American bollworm, codling moth larva, leaf rollers, weevil
Beans	American bollworm, semi-looper
Cotton	American, red & spiny bollworms, stainers
Grapes	Weevils
Groundnuts	American bollworm
Lucerne	Caterpillar
Maize	Chilo stalk borer (+ endosulfan), maize stalk borer
Tomatoes	American bollworm, leaf miner (+ pheromone)
Various crops	Cutworm
Veld & grazing	Northern harvester termite (lawns)

Note: Also refer **II PUBLIC HEALTH** for the use of permethrin in the control of pests in human and animal dwellings and **III INDUSTRIAL USE** for use in the control of pests in stored commodities

27. TRALOMETHRIN

CROP	PEST
Apples & pears	American bollworm, Antestia bug, codling moth larva, weevil and suppress leaf roller
Beans	American bollworm
Cactus & spineless pears	Cactoblastis larva
Cotton	American bollworm, red and spiny bollworm, stainers
Cruciferae	Diamond back moth larva
Grain sorghum	American bollworm
Grapes	American bollworm, weevil
Groundnuts	American bollworm
Lucerne	Caterpillar
Lupins	American bollworm
Maize	American bollworm, chafer beetle, chilo stalk borer, maize stalk borer
Peaches	American bollworm, weevil
Peas	American bollworm
Plums	American bollworm, weevil
Potatoes	Tuber moth larva
Sweet potatoes	Hawk moth larva, leaf miners, weevil
Tomatoes	American bollworm
Wheat	American bollworm
Various crops	Cutworms

28. ZETA-CYPERMETHRIN

CROP	PEST
Afforestation	Pine tree emperor moth larva, wattle bagworm, willow tree emperor moth larva
Apples & pears	American bollworm, codling moth larva, leaf roller, weevil
Beans	American bollworm
Cotton	American bollworm, red and spiny bollworm, semi-looper, leaf-eaters, stainers
Cruciferae	American bollworm, diamond back moth larva, thrips
Grain sorghum	American bollworm, stalk borer
Grapes	Weevils
Groundnuts	American bollworm
Lucerne	Caterpillar
Macadamias	Stinkbug
Maize	American bollworm, pink stalk borer, maize stalk borer and suppress leafhopper
Ornamentals & flowers	Pine tree emperor moth in proteas
Peaches	American bollworm, codling moth larva, false codling moth larva, fruit flies, weevil
Peas	American bollworm, lesser army worm
Tomatoes	American bollworm
Wheat	American bollworm
Various crops	Cutworms
Veld & grazing	Army worm

PLANT GROWTH REGULANTS

1. CALCIUM ARSENATE

CROP	SITUATION
Citrus	Sugar-acid ratio correction

2. CARBARYL

CROP	SITUATION
Apples	Chemical thinning (fruit thinning)

3. 2,4- D (sodium salt)

CROP	SITUATION
Citrus	Stem-end rot prevention

II PUBLIC HEALTH

1. CARBARYL

SITUATION	PEST
Human & animal dwellings	Ants (+chlorpyrifos), bedbugs (also + chlorpyrifos, gamma-BHC), cockroaches (+ chlorpyrifos, gamma-BHC), crickets (+ chlorpyrifos, gamma-BHC), fish moths (+ chlorpyrifos, gamma-BHC), fleas (also + chlorpyrifos, gamma-BHC), red mite (on birds)

2. CHLORFENVINPHOS (not registered as an insecticide for the control of fly maggots in manure heaps after 1999)

3. CHLORPYRIFOS

SITUATION	PEST
Human and animal dwellings	Ants, bedbugs, carpet beetles, clothes moths, cockroaches, crickets, fish moths, fleas, flies (adults & maggots), lice (also + fenoxycarb,

4. CYPERMETHRIN

SITUATION	PEST
Human and animal dwellings	Fleas

5. DELTAMETHRIN

SITUATION	PEST
Human and animal dwellings	Ants, bedbugs, cockroaches, fish moths, fleas, mosquitoes

6. DDT (DDE, DDD) (use as an agricultural remedy severely restricted in 1970 and in 1971 withdrawn as a stock remedy. Withdrawn from all uses in agriculture in 1976, except for control of malaria vectors by the Government. The acquisition, alienation, sale or use banned in 1983 except for control of malaria vectors by Government.

7. ESFENVALERATE

SITUATION	PEST
Human and animal dwellings	Ants, bedbugs, cockroaches

8. gamma BHC

SITUATION	PEST
Human & animal dwellings	Ants, bed bugs, carpet beetles, clothes moths, cockroaches, crickets, fish moths, fleas, flies (adults & maggots), lice

9. MERCAPTOTHION (MALATHION)

SITUATION	PEST
Human and animal dwellings	Ants, bedbugs (also + pyrethrins), carpet beetles, cockroaches, crickets, fish moths, fleas, (also + pyrethrins), flies (adults); flies (maggots - also + pyrethrins), lice, mosquitoes, red mite (on birds)

10. METHOMYL

SITUATION	PEST
Human and animal dwellings	Flies (also + tricosene)

11. PERMETHRIN

SITUATION	PEST
Human and animal dwellings	Ants, bedbugs, (all also + tetramethrin/piperonyl butoxide), carpet beetles, clothes moths, cockroaches (also + tetramethrin/piperonyl butoxide), crickets, fish moths (also + tetramethrin/piperonyl butoxide), fleas (also + tetramethrin/piperonyl butoxide), flies (also + tetramethrin/piperonyl butoxide), lesser mealworm, lice, mosquitoes, ticks

III INDUSTRIAL USES

HERBICIDES
(for total weed control)

1. SIMAZINE

SITUATION	PEST
Along roads and railways, on industrial premises etc.	Mainly annual broad-leaved weeds (on own and in a mixture with terbuthylazine), annual broad-leaved weeds and grasses (in a mixture with propazine)

2. TERBUTHYLAZINE

SITUATION	PEST
Along roads and railways, on industrial premises etc.	Annual broad-leaved weeds and grasses, mainly annual broad-leaved weeds (in a mixture with simazine)

FUNGI- & INSECTICIDES

1. CHLORPYRIFOS METHYL

SITUATION	PEST
Bulk storage of commodities in silo bins & bag surfaces - wheat barley, maize, oats, rye and wheat only	Angoumois grain moth, Cadelle, flour beetles, granary weevil, Indian meal moth, lesser grain borer, maize weevil, rice weevil, saw-toothed grain beetle, tropical warehouse moth
Buildings	Subterranean wood-destroying termites (+ chlorpyrifos)
Skins, hides & wool	Beetles and larvae

2. DELTAMETHRIN

SITUATION	PEST
Bulk storage of commodities in silo bins & bag surfaces - wheat barley, maize, oats, rye and wheat only	Angoumois grain moth, Cadelle, flour beetles, granary weevil, Indian meal moth, lesser grain borer, maize weevil, rice weevil, saw-toothed grain beetle, tropical warehouse moth (+ fenitrothion - wheat only; piperonyl butoxide – maize, wheat, rye, oats & sunflowers)
Buildings & timber in contact with soil	Subterranean wood-destroying termites
Timber – structural & joinery	Brown house borer, Cossonid woodborer, dry wood termites, subterranean wood-destroying termites, false furniture beetle, shot-hole borers, furniture beetle, Italian beetle, powder post beetles
Skins, hides & wool	Beetles and larvae

3. CARBARYL

SITUATION	PEST
Skins, hides & wool	Beetles and larvae

4. CYPERMETHRIN

SITUATION	PEST
Timber – structural & joinery and in situ	Brown house borer, Cossonid woodborer, dry wood termites, subterranean wood-destroying termites, false furniture beetle, shot-hole borers, furniture beetle, Italian beetle, powder post beetles (+ boric acid/sulphur)

5. gamma-BHC

SITUATION	PEST
Skins, hides & wool	Beetles and larvae
Seed storage	Angoumois grain moth, Cadelle, flour beetles, granary weevil, Indian meal moth, lesser grain borer, maize weevil, rice weevil, saw-toothed grain beetle, tropical warehouse moth (seed treatment)
Pests of timber structural & joinery and in situ	Brown house borer, Cossonid woodborer, dry wood termites, subterranean wood-destroying termites, false furniture beetle, shot-hole borers, furniture beetle, Italian beetle, powder post beetles and decay (also + PCP, TBTO)

6. MERCAPTOTHION (MALATHION)

SITUATION	PEST
Bulk storage of commodities in silo bins, bag surfaces & storage premises	Angoumois grain moth, Cadelle, flour beetles, granary weevil, Indian meal moth, lesser grain borer, maize weevil, rice weevil, saw-toothed grain beetle, tropical warehouse moth (+ fenitrothion - wheat only; piperonyl butoxide – maize, wheat, rye, oats & sunflowers)
Skins, hides & wool	Beetles and larvae

7. PERMETHRIN

SITUATION	PEST
Bulk storage of commodities in silo bins and storage premises	Angoumois grain moth, Cadelle, flour beetles, granary weevil, Indian meal moth, lesser grain borer, maize weevil, rice weevil, saw-toothed grain beetle, tropical warehouse moth (+ pirimiphos-methyl in wheat only)
Buildings	Subterranean wood-destroying termites
Skins, hides & wool	Beetles and larvae

8. TRIBUTYLTIN OXIDE (not registered as wood preservative anymore –was registered but registrations lapsed)

CROP	WEEDS
Industrial use: Timber structural and joinery and in situ	Brown house borer, Cossonid woodborer, dry wood termites, subterranean wood-destroying termites, false furniture beetle, shot-hole borers, furniture beetle, Italian beetle, powder post beetles and decay (also + gamma-BHC, paradichlorobenzene)

9. PENTACHLOROPHENOL

CROP	WEEDS
Industrial use: Timber structural and joinery and in situ	Brown house borer, Cossonid woodborer, dry wood termites, subterranean wood-destroying termites, false furniture beetle, shot-hole borers, furniture beetle, Italian beetle, powder post beetles and decay (also + zinc naphthenate, gamma BHC)

10. PROPAZINE (herbicide)

SITUATION	WEEDS
Industrial use	Total weed control (+ simazine)

ANNEXURE B: Selected crops with pesticides used

1. HERBICIDES

Active ingredient(s) (common name)	Formulation: Type	Formulation: Grams pure active ingredient	% Clay	Dosage	Time of application	Remarks
AFFORESTATION						**AFFORESTATION**
acetochlor	EC	750 g/ℓ	0-10 11-30	0,9-1,8 ℓ/ha 1,2-3,6 ℓ/ha	Weeds: Pre-E	*Annual grasses and broad-leaved weeds in* Eucalyptus *plantations.* Apply as a full cover spray. Use the higher dosages for the extended control of grasses and improved control of yellow nutsedge
		900 g/ℓ	0-10 11-30	0,75-1,5 ℓ/ha 1,0-3,0 ℓ/ha	Weeds: Pre-E	*Annual grasses and certain broad-leaved weeds in* Eucalyptus *plantations. 'Harness' can also be used in* Pinus *plantations. Apply* as a full cover spray pre-plant or after transplanting ot healthy young trees. Use the higher dosages for the extended control of grasses and improved control of yellow nutsedge
S-metolachlor/ terbuthylazine	SC	102,8/497,2 g/ℓ	–	3 ℓ/ha	Weeds: Pre-E	*Annual broad-leaved weeds and certain grasses in* Eucalyptus *plantations.* Dosage depends on specific rainfall area, the growth stage of trees, clay content of soil, and weed species to be controlled
terbuthylazine	WG	900 g/kg	–	2 kg/ha	Weeds: Pre-E	*Annual broad-leaved weeds in* Eucalyptus *plantations*
S-metolachlor/ terbuthylazine	SC	102,8/497,2 g/ℓ	–	2,8–4,2 ℓ+ 4–6 ℓ glyphosate/ha	Weeds: Post-E	**Annual broad-leaved weeds and certain grasses in *Eucalyptus* plantations***.* Dosage depends on the specific rainfall area, the growth stage of trees, clay content of soil, and weed species to be controlled.
terbuthylazine	WG	900 g/kg	–	2 kg/ha	Weeds: Pre-E	**Annual broad-leaved weeds in *Eucalyptus* plantations.**
APPLES						**APPLES**
glyphosate isopropylamine salt/ simazine/ terbuthylazine	SC	127/175/175 g/ℓ	<15 >15	6.0 ℓ/ha 8.5 ℓ/ha	Weeds: Post-E	**Annual grasses and broad-leaved weeds***.* Apply as a directed spray. Apply when weeds are 100–300 mm high. Prevent spray contact with leaves, green stems and fruit
S-metolachlor/ terbuthylazine	SC	102,8/497,2 g/ℓ	–	2,8–4,2 + 5–6 ℓ glyphosate/ha	Weeds: Post-E	**Annual broad-leaved weeds and certain grasses**. Dosage depends on the specific rainfall area, growth stage of trees, clay content of soil and weed species to be controlled
simazine			**SINGLE APPLICATION**			
	SC WP WG	500 g/ℓ 800 g/kg 900 g/kg	0–15 > 15 0–10 > 10 0–15 > 15	4 ℓ/ha 6 ℓ/ha 2,5 kg/ha 3,75 kg/ha 2,2 kg/ha 3,3 kg/ha	Weeds: Pre-E Weeds: Pre-E Weeds: Pre-E	**Mainly annual broad-leaved weeds in orchards older than three years.** Apply in spring as follow-up treatment after existing weeds have been eradicated with a suitable post-emergence herbicide
			SPLIT APPLICATION			
	SC WP WG	500 g/ℓ 800 g/kg 900 g/kg	> 15 > 10 > 15	3 + 3 ℓ/ha 2 + 2 kg/ha 1,7 + 1,7 kg/ha	Weeds: Pre-E Weeds: Pre-E Weeds: Pre-E	**Mainly annual broad-leaved weeds in orchards older than three years** **First application** in spring on a weed-free soil surface **Second application** at the germination of the first weeds or within three months of the first application
simazine/ terbuthylazine	SC	250/250 g/ℓ	<15 >15	,0 ℓ/ha 6,0 ℓ/ha	Weeds: Pre-E	**Annual broad-leaved weeds and grasses** in orchards older than three years in the Western Cape
	SC	213/287 g/ℓ	–	4,7 ℓ/ha	Weeds: Pre-E	**Annual broad-leaved weeds and grasses** in established orchards
terbuthylazine	SC	500 g/ℓ	–	3,5 ℓ/ha	Weeds: Pre-E	**Annual broad-leaved weeds**. Do not apply to trees within one year of transplanting
	WG	750 g/kg	–	2,5 kg/ha	Weeds: Pre-E	**Annual broad-leaved weeds**. Do not apply to trees within one year of transplanting
trifluralin	EC	480 g/ℓ	0–30	8 ℓ/ha	Weeds: Pre-E	**Annual grasses and certain broad-leaved weeds.** Apply to clean, cultivated soil before the establishment of nurseries and orchards. Incorporate within ten minutes after applications
APRICOTS						**APRICOTS**
trifluralin	EC	480 g/ℓ	0–30	8 ℓ/ha	Weeds: Pre-E	**Annual grasses and certain broad-leaved weeds***.* Apply to clean, cultivated soil before the establishment of the orchards. Incorporate within ten minutes after application

Active ingredient(s) (common name)	Formulation Type	Grams pure active ingredient	% Clay	Dosage	Time of application	Remarks
ASPARAGUS						**ASPARAGUS**
metribuzin	SC WG	480 g/ℓ 700 g/kg	> 10 > 10	1,5 ℓ/ha 1 kg/ha	Weeds: Pre-E	**Annual grasses and broad-leaved weeds**. USE ONLY on transplanted, established plants in the summer rainfall areas. Apply as a full cover spray on a moist soil surface.
simazine	SC WG WP	500 g/ℓ 900 g/kg 800 g/kg	0–20 > 20 0–20 > 20 0–20 > 20	4 ℓ/ha 6 ℓ/ha 2,2 kg/ha 3,3 kg/ha 2,5 kg/ha 3,75 kg/ha	Weeds: Pre-E Weeds: Pre-E Weeds: Pre-E	**Mainly annual broad-leaved weeds.** APPLY ONLY to established plants as a full cover spray immediately after ridges have been levelled. Application should be followed by rain or irrigation within 10–14 days
AVOCADOS						**AVOCADOS**
S-metolachlor/ terbuthylazine	SC	85,6/414,4 g/ℓ	–	3,3–5 ℓ + 4–6 ℓ glyphosate/ha	Weeds: Early Post-E	**Annual broad-leaved weeds and certain grasses**. Dosage depends on the specific rainfall area, growth stage of trees, clay content of soil and weed species to be controlled
		102,8/497,2 g/ℓ	–	2,8–4,2 ℓ + 4–6 ℓ glyphosate/ha	Weeds: Post-E	**Annual broad-leaved weeds and certain grasses**. Dosage depends on the specific rainfall area, growth stage of trees, clay content of soil and weed species to be controlled
terbuthylazine	WG	900 g/kg	–	1,5–2,2 kg/ha	Weeds: Pre-E	**Mainly annual broad-leaved weeds**
BARLEY						**BARLEY**
2,4-D (dimethylamine salts)	SL	480 g/ℓ	–	1,5–2,6 ℓ/ha	Weeds: Post-E	**Mainly annual broad-leaved weeds**. Apply when the crop is in the five leaf stage
	SG	800 g/kg	–	0,75–1,3 kg/ha	Weeds: Post-E	**Mainly annual broad-leaved weeds**. Apply when the crop is in the five leaf stage
BROCCOLI						**BROCCOLI**
alachlor	CS	480 g/ℓ	0–16 > 16	3,2 ℓ/ha 4 ℓ/ha	Weeds: Pre-E	**Mainly annual grasses and under certain conditions, yellow nutsedge**. Cultivars Late Corona and Premium Crop. Apply as soon as possible after the first post-transplant irrigation
	EC	384 g/ℓ	0–15 > 15	4 ℓ/ha 5 ℓ/ha	Weeds: Pre-E	**Mainly annual grasses and under certain conditions, yellow nutsedge**. Cultivars Late Corona and Premium Crop. Apply as soon as possible after the first post-transplant irrigation
BRUSSELS SPROUTS						**BRUSSELS SPROUTS**
alachlor	CS	480 g/ℓ	0–16 > 16	3,2 ℓ/ha 4 ℓ/ha	Weeds: Pre-E	**Mainly annual grasses and under certain conditions, yellow nutsedge** (cultivar Jade Cross) Apply as soon as possible after the first post-transplant irrigation
	EC	384 g/ℓ	0–15 > 15	4 ℓ/ha 5 ℓ/ha	Weeds: Pre-E	**Mainly annual grasses and under certain conditions, yellow nutsedge** (cultivar Jade Cross) Apply as soon as possible after the first post-transplant irrigation
CABBAGE						**CABBAGA**
alachlor	CS	480 g/ℓ	0–16 > 16	3,2 ℓ/ha 4 ℓ/ha	Weeds: Pre-E	**Mainly annual grasses and under certain conditions, yellow nutsedge**. Apply as soon as possible after first post-transplant irrigation.
	EC	384 g/ℓ	0–15 > 15	4 ℓ/ha 5 ℓ/ha	Weeds: Pre-E	**Mainly annual grasses and under certain conditions, yellow nutsedge**. Apply as soon as possible after first post-transplant irrigation.
trifluralin	EC	480 g/ℓ	0–15 16–35 36–50	1 ℓ/ha 1,5 ℓ/ha 2 ℓ/ha	Pre-plant	**Annual grasses and certain broad-leaved weeds** Apply on a well-prepared seedbed and incorporate within ten minutes
CANOLA						**CANOLA**
simazine (triazine resistant cultivars only)	SC	500 g/ℓ	–	2 ℓ/ha	Weeds: Pre-E	**Annual broad-leaved weeds and certain annual grasses**. Apply directly after planting on a well prepared seedbed

Active ingredient(s) (common name)	Formulation: Type	Formulation: Grams pure active ingredient	% Clay	Dosage	Time of application	Remarks
CARROTS						**CARROTS**
linuron	SC	500 g/ℓ	11–15 16–20 21–25	1 ℓ/ha 1,5 ℓ/ha 2,0 ℓ/ha	Weeds: Pre-E	**Annual broad-leaved weeds and certain grasses.** Apply immediately after sowing. Seeds should be sown not less than 12,5 mm deep in a fine, moist seedbed
			11–35	1–1,5 ℓ/ha	Weeds: Post-E	**Annual broad-leaved weeds and certain grasses**. Apply after the carrots have reached the four leaf stage. Dosage depends on the growth stage of the weeds
	WG	500 g/kg	11–15 16–20 21–35	1,0 kg/ha 1,5 kg/ha 2,0 kg/ha	Weeds: Pre-E	**Annual broad-leaved weeds and certain grasses**. Apply immediately after sowing. Seeds should be sown no less than 12,5 mm deep in a fine, moist seedbed
			–	1,0–1,5 kg/ha	Weeds: Post-E	**Annual broad-leaved weeds and certain grasses**. Dosage depends on the growth stage of the weeds. Apply after the carrots have reached the four leaf stage
trifluralin	EC	480 g/ℓ	0–15 16–35 36–50	1 ℓ/ha 1,5 ℓ/ha 2 ℓ/ha	Pre-plant	**Annual grasses and certain broad-leaved weeds**. Can be applied from three weeks to immediately prior to sowing. Must be incorporated within ten minutes after application
CHILLIES						**CHILLIES**
trifluralin	EC	480 g/ℓ	0–15 16–35 36–50	1 ℓ/ha 1,5 ℓ/ha 2 ℓ/ha	Pre-plant	**Annual grasses and certain broad-leaved weeds.** Apply evenly on a well-prepared soil surface and incorporate within ten minutes
CITRUS						**CITRUS**
S-metolachlor/ terbuthylazine	SC	102,8/497,2 g/ℓ	–	2,8–4,2 ℓ + 4–6 ℓ glyphosate/ha	Weeds: Post-E	**Annual broad-leaved weeds and certain grasses**. Dosage depends on the specific rainfall area, growth stage of trees, clay content of soil and weed species to be controlled
simazine	SC	500 g/ℓ	0–15 > 15	4 ℓ/ha 6 ℓ/ha	Weeds: Pre-E	**Annual broad-leaved weeds and certain grasses**. Apply to the soil and irrigate lightly to leach the herbicide into the soil. The trees must be OLDER THAN ONE YEAR
	WG	900 g/kg	0–15 > 15	2,2 kg/ha 3,3 kg/ha	Weeds: Pre-E	**Annual broad-leaved weeds and certain grasses**. Apply to the soil and irrigate lightly to leach the herbicide into the soil. The trees must be OLDER THAN ONE YEAR
	WP	800 g/kg	0–15 > 15	2,5 kg/ha 3,75 kg/ha	Weeds: Pre-E	**Annual broad-leaved weeds and certain grasses.** Apply to the soil and irrigate lightly to leach the herbicide into the soil. The trees must be OLDER THAN ONE YEAR
simazine/ terbuthylazine	SC	213/287 g/ℓ	–	4,7 ℓ/ha	Weeds: Pre-E	**Annual broad-leaved weeds and certain grasses.** The trees must be OLDER THAN ONE YEAR
terbuthylazine	SC	500 g/ℓ 600 g/ℓ	–	3,5 ℓ/ha	Weeds: Pre-E	**Annual broad-leaved weeds**. Do not apply within one year of transplanting
	WG	750 g/kg 900 g/kg	–	2,3 kg/ha 1,5–2,2 kg/ha	Weeds: Pre-E	**Annual broad-leaved weeds**. Do not apply within one year of transplanting
trifluralin	EC	480 g/ℓ	0–30	8 ℓ/ha	Pre-plant	**Annual grasses and certain broad-leaved weeds**. Apply to clean, cultivated soil before the establishment of orchards. Incorporate within ten minutes after application
COTTON						**COTTON**
trifluralin	EC	480 g/ℓ	0–15 16–35 36–50	1 ℓ/ha 1,5 ℓ/ha 2 ℓ/ha	Pre-plant	**Annual grasses and certain broad-leaved weeds**. Apply evenly on a well-prepared seedbed and incorporate within ten minutes after application
COWPEAS						**COWPEAS**
trifluralin	EC	480 g/ℓ	0–15 16–35 36–50	1 ℓ/ha 1,5 ℓ/ha 2 ℓ/ha	Pre-plant	**Annual grasses and certain broad-leaved weeds**. Can be applied from three weeks to immediately prior to sowing. Incorporate within ten minutes after application
DRY BEANS						**DRY BEANS**
fluralin	EC	480 g/ℓ	0–15 16–35 36–50	1 ℓ/ha 1,5 ℓ/ha 2 ℓ/ha	Pre-plant	**Annual grasses and certain broad-leaved weeds.** Can be applied on a well-prepared seedbed from three weeks before sowing to immediately prior to sowing. Incorporate within ten minutes after application

FORAGE SORGUM						FORAGE SORGHUM
Active ingredient(s) **(common name)**	**Formulation**		**% Clay**	**Dosage**	**Time of application**	**Remarks**
	Type	**Grams pure active ingredient**				
alachlor	CS	480 g/ℓ	21–30 > 30	1,3 ℓ/ha 1,5–2,0 ℓ/ha	Weeds: Pre-E	**Mainly annual grasses and under certain conditions, yellow nutsedge**. Apply on a well-prepared seedbed within three days of planting
	EC	384 g/ℓ	11–15 16–20 21–50	4 ℓ/ha 4,5 ℓ/ha 5 ℓ/ha	Weeds: Pre-E	**Mainly annual grasses and under certain conditions, yellow nutsedge**. Apply on a well-prepared seedbed within two days of planting
bromoxynil/ terbuthylazine	SE	150/333 g/ℓ	–	1,25–1,5 ℓ/ha	Weeds: Post-E	**Annual broad-leaved weeds**. Dosage depends on the weed species and their growth stage. Not recommended in the lower Orange River irrigation schemes, as well as the irrigation area between Prieska and Douglas
GLADIOLI						**GLADIOLI**
linuron	SC	500 g/ℓ	–	1,5–2,0 ℓ/ha	Weeds: Post-E	**Annual broad-leaved weeds and certain grasses**. DO NOT spray later than two days before crop emergence
	WG	500 g/kg	–	1,5–2 kg/ha	Weeds: Post-E	**Annual broad-leaved weeds and certain grasses**. DO NOT spray later than two days before crop emergence
GRIAN SORGHUM						**GRIAN SORGHUM**
acetochlor (Concep treated seed ONLY)	EC	900 g/ℓ	–	0,75–1,0 ℓ/ha + 1,25–1,50 ℓ/ha bromoxynil/ terbuthylazine	Weeds: Early Post-E	**Extended control of annual grasses and broad-leaved weeds**
acetochlor/atrazine/ propazine (safener treated seed ONLY)	SC	96/202/202 g/ℓ	21–30 31–40 41–50	5 ℓ/ha 6 ℓ/ha 7 ℓ/ha	Weeds: Pre-E and Early Post-E	**Annual broad-leaved weeds and certain grasses**. Apply on a well-prepared seedbed. Where a post emergence application is made, broad-leaved weeds should not be beyond two leaf stage and the grasses should not have emerged.
alachlor (Concep treated seed ONLY)	CS	480 g/ℓ	11–20 21–30 > 30	3,2 ℓ/ha 3,6 ℓ/ha 4,0 ℓ/ha	Weeds: Pre-E	**Mainly annual grasses**. Apply on a well-prepared seedbed within three days of planting.
	EC	384 g/ℓ	11–15 16–20 21–50	4 ℓ/ha 4,5 ℓ/ha 5 ℓ/ha	Weeds: Pre-E	**Mainly annual grasses**. Apply on a well-prepared seedbed within two days of planting.
alachlor (Concep treated seed ONLY) *(continued)*	GR	150 g/kg	11–15 16–20 > 20	10 kg/ha 11,5 kg/ha 12,5 kg/ha	Weeds: Pre-E	**Mainly annual grasses**. Apply preferably with planting or immediately after planting, but not later than seven days after planting
atrazine	SC	500 g/ℓ	26–30 31–35 36–40 41–55	4,0 ℓ/ha 4,75 ℓ/ha 4,75 ℓ/ha 5 ℓ/ha	Weeds: Post-E Weeds: Post-E Weeds: Pre-E or Post-E	**Mainly annual broad-leaved weeds**. Apply on a well-prepared seedbed
	SC	500 g/ℓ	> 16	2 ℓ + 750 mℓ 2,4-D (dimethyl-amine salt)/ha	Weeds: Post-E	**Annual broad-leaved weeds**. Apply to actively growing weeds which ARE NOT taller than 100 mm. Can be applied any time before flowering. If the crop is taller than 400 mm a directed spray is recommended
	WG	900 g/kg	26–30 31–35 36–40 41–55	2,2 kg/ha 2,6 kg/ha 2,6 kg/ha 2,8 kg/ha	Weeds: Post-E Weeds: Post-E Weeds: Pre-E or Post-E	**Mainly annual broad-leaved weeds**. Apply on a well-prepared seedbed
	WP	800 g/kg	26–30 31–35 36–40 41–55	2,5 kg/ha 3,0 kg/ha 3,0 kg/ha 3,0 kg/ha	Weeds: Post-E Weeds: Post-E Weeds: Pre-E or Post-E	**Mainly annual broad-leaved weeds**. Apply on a well-prepared seedbed
	WP	800 g/kg	> 16	1,25 kg + 750 mℓ 2,4-D (dimethyl-amine salt)/ha	Weeds: Post-E	**Annual broad-leaved weeds**. Apply to actively growing weeds which ARE NOT taller than 100 mm. Can be applied any time before flowering. If the crop is taller than 400 mm a directed spraying is recommended
atrazine/ S-metolachlor (Concep treated seed ONLY)	SC	370,8/229,2 g/ℓ	> 30	4,2 ℓ/ha	At planting	**Annual grasses and broad-leaved weeds and under certain conditions, yellow nutsedge**. Apply on a well-prepared seedbed
		370,8/290 g/ℓ	> 30	4,2 ℓ/ha	At planting	**Annual grasses and broad-leaved weeds and under certain conditions, yellow nutsedge**. Apply on a well-prepared seedbed

GRIAN SORGHUM *(continued)* — GRIAN SORGHUM

Active ingredient(s) (common name)	Formulation: Type	Formulation: Grams pure active ingredient	% Clay	Dosage	Time of application	Remarks
atrazine/ terbuthylazine	SC	250/250 g/ℓ	21–30 31–40 41–50	4 ℓ/ha 4,75 ℓ/ha 5 ℓ/ha	Weeds: Early Post-E	**Mainly annual broad-leaved weeds**. When broad-leaved weeds have developed beyond the seedling stage they must be destroyed by cultivation prior to the application. Apply when crop is in the five leaf stage
		250/250 g/ℓ	> 11	2 ℓ + 0,5 ℓ 2,4-D (dimethyl-amine salt)/ha	Weeds: Post-E	**Tank mix for the control of annual broad-leaved weeds**. Apply 4–5 weeks after planting when the grain sorghum is in the 4–5 leaf stage
		300/300 g/ℓ	21–30 31–50	3,3 ℓ/ha 4,0 ℓ/ha	Weeds: Post-E	**Annual broad-leaved weeds and certain grasses**. When broad-leaved weeds have developed beyond the four leaf stage and grasses have emerged they must be destroyed by cultivation prior to the application. Apply when crop is in the five leaf stage
bromoxynil/ terbuthylazine	SC	150/333 g/ℓ	–	1,25–1,8 ℓ/ha	Weeds: Post-E	**Annual broad-leaved weeds**. Apply as full cover spray. Not recommended in the Lower Orange River irrigation schemes as well as the irrigation area between Prieska and Douglas
	SE	150/333 g/ℓ	–	1,25–1,8 ℓ/ha	Weeds: Post-E	
2,4-D (dimethylamine salt)	SL	480 g/ℓ	–	2 ℓ/ha	Weeds: Post-E	**Annual broad-leaved weeds**. Apply when the crop is 150–250 mm tall. When applied later drop arms must be used for directed spraying
	SG	800 g/kg	–	1 kg/ha	Weeds:Post-E	**Annual broad-leaved weeds**. Apply when the crop is 150–250 mm tall. When applied later drop arms must be used for directed spraying
S-metolachlor/ terbuthylazine (Concep treated seed ONLY)	SC	102,8/497,2 g/ℓ	21–30 31–35	3 ℓ/ha 3,7 ℓ/ha	Weeds: Pre-E	**Mainly annual broad-leaved weeds.** Apply at planting or immediately after planting
			16–20 21–30 > 30	2,6 ℓ/ha 3,0 ℓ/ha 3,0 ℓ/ha	Weeds: Post-E	**Mainly annual broad-leaved weeds.** Apply after five leaf stage

GRAPES — GRAPES

Active ingredient(s) (common name)	Formulation: Type	Formulation: Grams pure active ingredient	% Clay	Dosage	Time of application	Remarks
S-metolachlor/ terbuthylazine	SC	102,8/497,2 g/ℓ	–	2,8–4,2 ℓ + 4–6 ℓ glyphosate/ha	Weeds: Pre-E and Post-E	**Mainly annual broad-leaved weeds**
simazine			**SINGLE APPLICATION**			
	SC	500 g/ℓ	0–15 > 15	4 ℓ/ha 6 ℓ/ha	Weeds: Pre-E	**Mainly annual broad-leaved weeds in vineyards older than three years**. Pre-bud burst (from early July) and post-bud burst (only trellised vines under irrigation, at the germination of the summer weeds) applications. Apply on a weed-free soil. Where weeds are present apply in combination with a suitable post-emergence herbicide e.g. paraquat or MCPA (potassium salt)
	WP	800 g/kg	0–15 > 15	2,5 kg/ha 3,75 kg/ha	Weeds: Pre-E	
	WG	900 g/kg	–	2,2 kg/ha	Weeds: Pre-E	**Mainly annual broad-leaved weeds in dryland vines older than three years**. See above remarks
			0–15 > 15	2,2 kg/ha 3,3 kg/ha	Weeds: Pre-E	**Mainly annual broad-leaved weeds in irrigated bush and trellis vines older than three years**. See above remarks
			SPLIT APPLICATION			
	SC	500 g/ℓ	> 15	3 + 3 ℓ/ha	Weeds: Pre-E	**Mainly annual broad-leaved weeds in trellised vines under irrigation**. Apply in spring on a weed-free soil. Repeat the application after the germination of the weeds or within three months of the first application. Where weeds are present apply in combination with a suitable post-emergence herbicide e.g. paraquat or MCPA (potassium salt)
	WP	800 g/kg	> 15	2 + 2 kg/ha	Weeds: Pre-E	
	WG	900 g/kg	> 15	1,7 + 1,7 kg/ha	Weeds: Pre-E	
terbuthylazine	SC	500 g/ℓ	–	3,5 ℓ/ha	Weeds: Pre-E	**Annual broad-leaved weeds**. Do not apply within one year of transplanting
	WG	750 g/kg 900 g/kg	–	2,3 kg/ha 1,5–2,2 kg/ha	Weeds: Pre-E	**Annual broad-leaved weeds**. Do not apply within one year of transplanting
trifluralin	EC	480 g/ℓ	0–30	8 ℓ/ha	Pre-plant	**Annual grasses and certain broad-leaved weeds**. Apply on a clean, cultivated soil before the establishment of the vineyards. Incorporate within ten minutes after application

GRASS PASTURES — GRASS PASTURES

Active ingredient(s) (common name)	Formulation: Type	Formulation: Grams pure active ingredient	% Clay	Dosage	Time of application	Remarks
2,4-D (dimethylamine salt)	SL	480 g/ℓ	–	3,3–4,4 ℓ/ha	Weeds: Post-E	**Annual broad-leaved weeds**. Established pastures ONLY. An application of nitrogenous fertiliser 2–3 weeks prior to the application is recommended

	SG	800 g/kg	–	1,6–2,2 kg/ha	Weeds: Post-E	**Annual broad-leaved weeds**. Established pastures ONLY. An application of nitrogenous fertiliser 2–3 weeks prior to the application is recommended
2,4-D (iso-octyl ester)	EC	500 g/ℓ	–	2–3 ℓ/ha	Weeds: Post-E	***DO NOT USE IN KWAZULU-NATAL.*** **Annual broad-leaved weeds**. Dosage depends on the growth stage of the weeds. Established pastures only. An application of nitrogenous fertiliser 2–3 weeks prior to application is recommended
2,4-D/dicamba (APM salts)	SL	240/80 g/ℓ	–	2,5–5 ℓ/ha	Weeds: Post-E	***DO NOT USE IN KWAZULU-NATAL.*** **Annual broad-leaved weeds**. Established pastures only. An application of nitrogenous fertiliser 2–3 weeks prior to application is recommended
GROUNDNUTS						**GROUNDNUTS**
acetochlor	EC	700 g/ℓ	0–10 11–30	1,0–2,1 ℓ/ha 1,4–4,1 ℓ/ha	Weeds: Pre-E	**Annual grasses and certain broad-leaved weeds**. Apply on a well-prepared seedbed after planting. Use the lower dosage for the control of annual grasses only
	EC	750 g/ℓ	0–10 11–30	0,9–1,8 ℓ/ha 1,2–3,6 ℓ/ha	Weeds: Pre-E	**Annual grasses and certain broad-leaved weeds**. Apply on a well-prepared seedbed after planting. Use the lower dosage for the control of annual grasses only
	EC	840 g/ℓ	0–10 11–30	0,75–1,5 ℓ/ha 1–3 ℓ/ha	Weeds: Pre-E	**Annual grasses and certain broad-leaved weeds**. Apply on a well-prepared seedbed after planting. Use the lower dosage for the control of annual grasses only
	EC	900 g/ℓ	0–10 11–30	0,75–1,5 ℓ/ha 1–3 ℓ/ha	Weeds: Pre-E	**Annual grasses and certain broad-leaved weeds**. Apply on a well-prepared seedbed after planting. Use the lower dosage for the control of annual grasses only
alachlor	CS	480 g/ℓ	–	3,2–4,0 ℓ/ha	Weeds: Pre-E	**Mainly annual grasses and certain broad-leaved weeds**. Application must take place at planting or immediately thereafter, but not later than two days after planting. Use the lower dosage on light soils
	EC	384 g/ℓ	–	4–5 ℓ/ha	Weeds: Pre-E	**Mainly annual grasses and under certain conditions, yellow nutsedge**. Application must take place at planting or immediately thereafter, but not later than two days after planting. Use the lower dosage on light soils
	GR	150 g/kg	0–15 > 15	10 kg/ha 12,5 kg/ha	At planting	**Mainly annual grasses and under certain conditions, yellow nutsedge**. Apply on a well-prepared seedbed
trifluralin	EC	480 g/ℓ	0–10 11–20	0,75 ℓ/ha 1 ℓ/ha	Pre-plant	**Annual grasses and certain broad-leaved weeds**. Apply on a well-prepared seedbed and incorporate within ten minutes. DO NOT use on cultivars Norden and Harts
GUAVAS						**GUAVAS**
trifluralin	EC	480 g/ℓ	0–30	8 ℓ/ha	Pre-plant	**Annual grasses and certain broad-leaved weeds**. Apply on a well-prepared seedbed and incorporate within ten minutes
HOME GARDEN						**HOME GARDEN**
2,4-D/dicamba/MCPA (APM salts)	SL	135/90/118,5 g/ℓ	–	70 mℓ/100 m²	Weeds: Pre-E	**Mainly annual broad-leaved weeds in newly planted turf**. Apply immediately after planting of stolons
			–	50–70 mℓ/100 m²	Weeds: Post-E	**Annual broad-leaved weeds in lawns**. Fertilise and irrigate three weeks prior to application. Use the higher dosages for the control of *Alternanthera pungens* (khaki bur weed) and *Brayulinea densa* (small matweed). Apply in at least 2 ℓ water/200 m²
isoxaben/trifluralin	GR	5/20 g/kg	–	15–20 g/m^2	Weeds: Pre-E	**Annual broad-leaved weeds and grasses in established perennial ornamentals.** Distribute granules uniformly over the cultivated soil surface
HOPS						**HOPS**
simazine	SC	500 g/ℓ	0–15 > 15	2 ℓ/ha 3 ℓ/ha	Weeds: Pre-E	**Annual grasses and broad-leaved weeds**. Use ONLY on plants older than one year
	WG	900 g/kg	0–15 > 15	1,1 kg/ha 1,7 kg/ha	Weeds: Pre-E	

Active ingredient(s) (common name)	Formulation		% Clay	Dosage	Time of application	Remarks
	Type	Grams pure active ingredient				
KIDNEY BEANS						**KIDNEY BEANS**
trifluralin	EC	480 g/ℓ	0–15 16–35 36–50	1 ℓ/ha 1,5 ℓ/ha 2 ℓ/ha	Pre-plant	**Annual grasses and certain broad-leaved weeds**. Can be applied on a well-prepared seedbed from three weeks before sowing to immediately prior to sowing. Incorporate within ten minutes after application
LAWNS AND TURF						**LAWNS AND TURF**
2,4-D (dimethylamine salt)	SL	480 g/ℓ	–	3,3–4,4 ℓ/ha	Weeds: Post-E	**Annual broad-leaved weeds**. USE ONLY on established lawns. Fertilise 2–3 weeks prior to application. Repeat if necessary
	SG	800 g/kg	–	1,6–2,2 kg/ha	Weeds: Post-E	**Annual broad-leaved weeds**. USE ONLY on established lawns. Fertilise 2–3 weeks prior to application. Repeat if necessary
2,4-D/dicamba (APM salts)	SL	240/80 g/ℓ	–	6 ℓ/ha	Weeds: Post-E	**Annual broad-leaved weeds**. USE ONLY on established lawns
2,4-D/MCPA (dimethylamine salts)	SL	360/315 g/ℓ	–	2,4–3 ℓ/ha	Weeds: Post-E	**Annual broad-leaved weeds**. USE ONLY on established lawns. Fertilise 2–3 weeks prior to application. Repeat if necessary
2,4-D/dicamba/MCPA (APM salts)	SL	135/90/118,5 g/ℓ	–	7 ℓ/ha	Weeds: Post-E	**For the control of *Alternanthera pungens* (khaki bur weed), *Brayulinea densa* (small matweed), and *Oxalis corniculata* (creeping sorrel)**
			–	7 ℓ/ha	Weeds: Pre-E	**Mainly annual broad-leaved weeds**. Apply in newly planted areas
			–	5 ℓ/ha	Weeds: Post-E	**Annual broad-leaved weeds**. Fertilise three weeks prior to application
			–	2 ℓ/ha	Weeds: Post-E	**Annual broad-leaved weeds**. Apply to putting and bowling greens
2,4-D/dicamba/MCPA (dimethylamine salts)	SL	180/120/157,5 g/ℓ	–	7 ℓ/ha	Weeds: Post-E	**For the control of *Alternanthera pungens* (khaki bur weed), *Brayulinea densa* (small matweed), and *Oxalis corniculata* (creeping sorrel).**
			–	7 ℓ/ha	Weeds: Pre-E	**Mainly annual broad-leaved weeds**. Apply in newly planted areas.
			–	5 ℓ/ha	Weeds: Post-E	**Annual broad-leaved weeds**. Fertilise three weeks prior to application.
			–	2 ℓ/ha	Weeds: Post-E	**Annual broad-leaved weeds**. Apply to putting and bowling greens. For use on common *Cynodon* varieties (Florida, Skaapplaas, Royal Cape etc.), kikuyu and Swazi Grass. DO NOT USE on Daisy Lawn
LUCERNE AND LEGUMINOUS PASTURES						**LUCERNE AND LEGUMINOUS PASTURES**
2,4-DB (sodium salt)	SL	400 g/ℓ	–	4 ℓ/ha	Weeds: Post-E	Annual broad-leaved weeds in lucerne, undersown lucerne in grain crops, and pastures containing clovers and grasses. Apply to lucerne and clovers in the 1–4 trifoliate stage or to lucerne that has been cut
			–	1,5 ℓ/ha	Weeds: Post-E	Spray-graze treatment of broad-leaved weeds in annual medics and clovers. Apply from 5–8 trifoliate stage. The purpose of the treatment is to make weeds more palatable for sheep
metribuzin	SC	480 g/ℓ	0–10 11–20 21–35	1,1 ℓ/ha 1,5 ℓ/ha 1,8–2,2 ℓ/ha	Weeds: Pre-E	**Annual grasses and broad-leaved weeds in lucerne**. Apply as a full cover spray to established, dormant lucerne prior to weed emergence
LUPINS						**LUPINS**
alachlor	CS	480 g/ℓ	0–16 > 16	3,2 ℓ/ha 4 ℓ/ha	Weeds: Pre-E	**Annual grasses and certain broad-leaved weeds**. Apply not later than two days after planting
	EC	384 g/ℓ	0–16 > 16	4 ℓ/ha 5 ℓ/ha	Weeds: Pre-E	**Annual grasses and certain broad-leaved weeds**. Apply not later than two days after planting
MACADAMIA NUTS						**MACADAMIA NUTS**
trifluralin	EC	480 g/ℓ	0–30	8 ℓ/ha	Pre-plant	**Annual grasses and certain broad-leaved weeds**. Apply on a clean, cultivated soil before establishment of the orchards

Active ingredient(s) (common name)	Formulation Type	Grams pure active ingredient	% Clay	Dosage	Time of application	Remarks
acetochlor	EC	750 g/ℓ	0–10 11–20 21–30 31–50	0,9 ℓ/ha 1,8 ℓ/ha 2,3 ℓ/ha 2,7 ℓ/ha	Weeds: Pre-E	**Mainly annual grasses**. Apply **early post-emergence of the crop.** Use as tank mixture with atrazine and/or terbuthylazine
		900 g/ℓ	0–10 11–20 21–30 31–50	0,5–0,75 ℓ/ha 0,75–1,0 ℓ/ha 1,0 ℓ/ha 1,0 ℓ/ha	Weeds: Pre-E	**Mainly annual grasses.** Apply **early post-emergence of the crop.** Use as tank mixture with atrazine and/or terbuthylazine
acetochlor (+safener)	EC	700 g/ℓ	0–10 11–15 16–20 21–30 31–40 41–55	0,7–1,7 ℓ/ha 0,9–2,1 ℓ/ha 1,1–2,1 ℓ/ha 1,4–2,4 ℓ/ha 1,7–2,7 ℓ/ha 2,7 ℓ/ha	Weeds: Pre-E	**Mainly annual grasses.** Apply **pre-emergence or early post-emergence of the crop.** ONLY use the lower dosages for the Northern and Western Free State and North West Provinces
		840 g/ℓ	0–10 11–20 21–30 31–40 41–55	0,75–1,0 ℓ/ha 1,0–1,3 ℓ/ha 1,3–1,65 ℓ/ha 1,65–1,8 ℓ/ha 2,0 ℓ/ha	Weeds: Pre-E	**Mainly annual grasses.** Apply within three days after planting. See label for specific dosages for the Northern and Western Free State and North West Province
acetochlor/atrazine/ propazine	SC	96/202/202 g/ℓ	0–10 11–20 21–30 31–40 41–55	3,25 ℓ/ha 4 ℓ/ha 5 ℓ/ha 6 ℓ/ha 7 ℓ/ha	Weeds: Pre-E	**Annual broad-leaved weeds and certain grasses**. Apply on a well-prepared seedbed
acetochlor/atrazine/ simazine (+ safener)	SC	160/165/165 g/ℓ	0–10 11–15 16–20 21–30 31–40	3,25 ℓ/ha 4 ℓ/ha 5 ℓ/ha 6,25 ℓ/ha 7,5 ℓ/ha	Weeds: Pre-E	**Annual broad-leaved weeds and certain grasses**. Apply at, or immediately after planting on a well-prepared seedbed
			0–40	3 ℓ/ha	Weeds: Pre-E	**Annual broad-leaved weeds and certain grasses.** Apply early post-emergence of crop
acetochlor/atrazine/ terbuthylazine	SC	125/187,5/ 187,5 g/ℓ	0–10 11–20 21–40	2,75–3,25 ℓ/ha 3,25–4 ℓ/ha 4–5 ℓ/ha	Weeds: Pre-E	**Annual broad-leaved weeds and certain grasses**. Apply at, or immediately after planting on a well-prepared seedbed
acetochlor/atrazine/ terbuthylazine (+ safener)	SC	125/181,5/ 181,5 g/ℓ	0–10 11–20 21–30 31–50	3 ℓ/ha 3,5 ℓ/ha 4 ℓ/ha 4–6 ℓ/ha	Weeds: Early Post-E	**Annual broad-leaved weeds**
acetochlor/atrazine/ terbuthylazine	SC	150/225/225 g/ℓ	0–10 11–20 21–40 >40	2,3–2,7 ℓ/ha 2,7–3,3 ℓ/ha 3,3–4,2 ℓ/ha –	Weeds: Pre-E	**Annual broad-leaved weeds and certain grasses**. Apply within three days of planting, but before crop and weed emergence
			0–10 11–20 21–30 31–50	2,5 ℓ/ha 2,9 ℓ/ha 3,3 ℓ/ha 3,3–5,0 ℓ/ha	Weeds: Early Post-E	**Annual broad-leaved weeds**. Apply after crop emergence, but before broad-leaved weeds develop to the four leaf stage
alachlor	CS	480 g/ℓ	0–15 16–20 > 20	3,2 ℓ/ha 3,6 ℓ/ha 4 ℓ/ha	Weeds: Pre-E	**Mainly annual grasses**. Apply at planting or immediately thereafter, but NOT later than two days after planting. DO NOT apply to sandy soils which are susceptible to wind erosion
	EC	384 g/ℓ	0–16 17–20 > 20	4 ℓ/ha 4,5 ℓ/ha 5 ℓ/ha	Weeds: Pre-E	**Mainly annual grasses**. Apply at planting or immediately thereafter, but NOT later than two days after planting. DO NOT apply to sandy soils which are susceptible to wind erosion
	GR	150 g/kg	0–15 > 15	10 kg/ha 12,5 kg/ha	At planting	**Mainly annual grasses.** Apply on a well-prepared seedbed. DO NOT use in the North West Province or North West Free State on soils with less than 11 % clay
alachlor	CS	480 g/ℓ	0–15 16–20 > 20	3,2 ℓ/ha 3,6 ℓ/ha 4 ℓ/ha	Weeds: Pre-E	**Mainly annual grasses**. Apply at planting or immediately thereafter, but NOT later than two days after planting. DO NOT apply to sandy soils which are susceptible to wind erosion
alachlor *(continued)*	EC	384 g/ℓ	0–16 17–20 > 20	4 ℓ/ha 4,5 ℓ/ha 5 ℓ/ha	Weeds: Pre-E	**Mainly annual grasses**. Apply at planting or immediately thereafter, but NOT later than two days after planting. DO NOT apply to sandy soils which are susceptible to wind erosion
	GR	150 g/kg	0–15 > 15	10 kg/ha 12,5 kg/ha	At planting	**Mainly annual grasses.** Apply on a well-prepared seedbed. DO NOT use in the North West Province or North West Free State on soils with less than 11 % clay

Active ingredient(s) (common name)	Formulation: Type	Formulation: Grams pure active ingredient	% Clay	Dosage	Time of application	Remarks
alachlor/atrazine	SC	336/144 g/ℓ	0–35 > 35	5,5 ℓ/ha 7 ℓ/ha	Weeds: Pre-E	**Annual grasses and certain broad-leaved weeds**. Apply on a well-prepared seedbed at planting or immediately thereafter. DO NOT use in the North West Province or North West Free State on soils with less than 16% clay
	GR	100/40 g/kg	16–35 > 35	18 kg 24 kg	At planting	**Annual grasses and certain broad-leaved weeds**. Apply on a well-prepared seedbed
alachlor/atrazine	SE	336/144 g/ℓ	0–35 >35	5,5 ℓ/ha 7 ℓ/ha	Weeds: Pre-E	**Mainly annual grasses.** Apply on a well prepared seedbed within two days after planting.
atrazine	SC	500 g/ℓ	0–10 11–20 21–30 31–40 41–50	2,5 ℓ/ha 3,25 ℓ/ha 4 ℓ/ha 4,75 ℓ/ha 5 ℓ/ha	Weeds: Pre-E or Early Post-E (two leaf stage)	**Mainly annual broad-leaved weeds.** Apply on a well-prepared seedbed. DO NOT use in the Springbok Flats area without consulting a representative of the supplier
			–	2 ℓ + 750 mℓ 2,4-D/ha	Weeds: Post-E	**Mainly annual broad-leaved weeds**. Apply to actively growing weeds, which are not taller than 100 mm. Can be applied any time before the flowering of crop
	WG	900 g/kg	0–10 11–20 21–30 31–40 41–50	1,4 kg/ha 1,8 kg/ha 2,2 kg/ha 2,6 kg/ha 2,8 kg/ha	Weeds: Pre-E or Early Post-E (two leaf stage)	**Mainly annual broad-leaved weeds**. Apply on a well-prepared seedbed. DO NOT use in the Springbok Flats area without consulting a representative of the firm
	WP	800 g/kg	0–10 11–20 21–30 31–40 41–55	1,5 kg/ha 2 kg/ha 2,5 kg/ha 3 kg/ha 3 kg/ha	Weeds: Pre-E or Early Post-E (two leaf stage)	**Mainly annual broad-leaved weeds**. Apply on a well-prepared seedbed. DO NOT use in the Springbok Flats area without consulting a representative of the firm
			–	1,25 kg + 750 mℓ 2,4-D/ha	Weeds: Post-E	**Annual broad-leaved weeds**. Apply to actively growing weeds which are not taller than 100 mm. Can be applied any time before the flowering of crop
atrazine/cyanazine	SC	250/250 g/ℓ	0–10 11–15 16–20 21–30 31–40	2,25–2,5 ℓ/ha 2,5–2,75 ℓ/ha 2,75–3,25 ℓ/ha 3,25–3,75 ℓ/ha 3,75–4,25 ℓ/ha	Weeds: Pre-E or Early Post-E	**Mainly annual broad-leaved weeds**. Apply on a well-prepared seedbed
	SC	333/167 g/ℓ	0–10 11–15 16–20 21–30 31–40 41–50 > 50	2,25 ℓ/ha 2,6 ℓ/ha 2,9 ℓ/ha 3,6 ℓ/ha 4 ℓ/ha 5,2 ℓ/ha 5,5 ℓ/ha	Weeds: Pre-E or Early Post-E	**Mainly annual broad-leaved weeds**. Apply on a well-prepared seedbed
atrazine/metazachlor/ terbuthylazine	SC	210/60/210 g/ℓ	0–10 11–20 21–30 31–40 >40	2,5 ℓ/ha 3 ℓ/ha 3,75 ℓ/ha 4,5 ℓ/ha 5 ℓ/ha	Weeds: Pre-E	**Annual grasses and certain broad-leaved weeds**. Apply within three days after planting
atrazine/metazachlor/ terbuthylazine	SC	210/60/210 g/ℓ	0–10 11–20 21–30 31–40 >40	2,5 ℓ/ha 2,5–3 ℓ/ha 3–3,5 ℓ/ha 3,5–4 ℓ/ha 4–4,25 ℓ/ha	Weeds: Post-E	**Annual grasses and certain broad-leaved weeds**. Apply as a follow-up treatment after a pre-emergence application with metazachlor
atrazine/ S-metolachlor	SC	370,8/229,2 g/ℓ	0–10 10–20 21–35	2,1–2,8 ℓ/ha 2,8–3,5 ℓ/ha 3,5–4,2 ℓ/ha	Weeds: Pre-E	**Annual grasses and broad-leaved weeds**. Apply at, or immediately after planting on a well prepared seedbed
		370/290 g/ℓ	>35	4,2 ℓ/ha	Weeds: Pre-E	
atrazine/ S-metolachlor/ terbuthylazine	SC	248,6/102,8/24 8,6 g/ℓ	0–10 11–20 21–30	2,2 ℓ/ha 2,5 ℓ/ha 3,2 ℓ/ha	Weeds: Pre-E	**Mainly annual broad-leaved weeds**. Apply on a well-prepared seedbed.
atrazine/sulcotrione	SC	300/125 g/ℓ	–	0,4–1,6 ℓ/ha	Weeds: Pre-E or Post-E	**Mainly annual broad-leaved weeds**. See label for more information on the different control strategies.

MAIZE *(continued)*						**MAIZE**
Active ingredient(s) **(common name)**	**Formulation**		**% Clay**	**Dosage**	**Time of application**	**Remarks**
	Type	**Grams pure active ingredient**				
atrazine/ terbuthylazine	SC	250/250 g/ℓ	0–10 11–20 21–30 31–40 41–50	2,5 ℓ/ha 3,25 ℓ/ha 4 ℓ/ha 4,75 ℓ/ha 5 ℓ/ha	Weeds: Pre-E or Early Post-E	**Mainly annual broad-leaved weeds***.* Apply on a well-prepared seedbed after planting
			–	2 ℓ + 0,5 ℓ 2,4-D/ha OR 1,5 ℓ + 0,75 ℓ 2,4-D/ha	Weeds: Post-E	**Tank mix for the control of annual broad-leaved weeds***.* This is a follow-up treatment where a grass killer has been applied prior to, or at the time of planting. Under cold, wet conditions use of the low quantity of 2,4-D is preferred. Where *Commelina benghalensis* and *Tribulus terrestris* are present the second treatment with higher quantity of 2,4-D is preferred
		270/270 g/ℓ	0–10 11–20 21–30 31–40	2,2 ℓ/ha 3,0 ℓ/ha 3,6 ℓ/ha 4,4 ℓ/ha	Weeds: Post-E	**Mainly annual broad-leaved weeds**. Apply prior to the four leaf stage of the weeds
		300/300 g/ℓ	0–10 11–20 21–30 31–40 41–50	2 ℓ/ha 2,7 ℓ/ha 3,3 ℓ/ha 4 ℓ/ha 4 ℓ/ha	Weeds: Pre-E or Early Post-E	**Mainly annual broad-leaved weeds***.* When broad-leaved weeds have developed beyond the four leaf stage and grasses have emerged, they must first be destroyed by cultivation
atrazine/terbutryn	SC	250/250 g/ℓ	0–35	4 ℓ/ha	Weeds: Pre-E	**Mainly annual broad-leaved weeds**. Apply at planting or immediately thereafter
bromoxynil/ terbuthylazine	SE	150/333 g/ℓ	–	1,25–1,8 ℓ/ha	Weeds: Post-E	**Annual broad-leaved weeds.** Apply as full cover spray
cyanazine	SC	500 g/ℓ				**Only to be used in conjunction with atrazine**
2,4-D (dimethylamine salt)	SL	480 g/ℓ	0–10 11–20 21–35 > 35	2,7 ℓ/ha 3,3 ℓ/ha 4,3 ℓ/ha 5,4 ℓ/ha	Weeds: Pre-E	**Mainly annual broad-leaved weeds***.* Apply 5–6 days after planting when seedbed is sufficiently moist and in good tilt
			–	2 ℓ/ha	Weeds: Post-E	**Annual broad-leaved weeds.** Apply when crop is 300–450 mm tall. Drop arms must be used for directed spraying so that the spray does not land in the funnel. *Striga asiatica* should be sprayed when flowers are first seen
	SG	800 g/kg	0–10 11–20 21–35 > 35	1,3 kg/ha	Weeds: Pre-E	**Annual broad-leaved weeds.** Apply 5–6 days after planting when seedbed is sufficiently moist and in good tilth
2,4-D/dicamba (APM salts)	SL	240/80 g/ℓ	–	0,5 ℓ + 2,0 ℓ atrazine 500 SC/ha	Weeds: Post-E	**Annual broad-leaved weeds***.* Apply to actively growing weeds from 3–6 leaf stage. Apply from full emergence of the crop until a height of 300 mm
linuron	SC	500 g/ℓ	11–35	1,5–2,5 ℓ/ha	Weeds: Post-E	**Annual broad-leaved weeds and certain grasses in irrigated maize.** Apply an inter-row directed spray when crop is 350–500 mm high. Use the higher dosages on weeds taller than 50 mm or on soils with more than 21 % clay
S-metolachlor/ terbuthylazine	SC	102,8/497,2 g/ℓ	0–10 11–20 21–30	2,2 ℓ/ha 2,6 ℓ/ha 3 ℓ/ha	Weeds: Pre-E	**Annual broad-leaved weeds and certain grasses.** Apply on a well-prepared seedbed
metribuzin	SC	480 g/ℓ	–	0,15 + 0,75 ℓ 2,4-D OR 0,15 + 0,2 ℓ bromoxynil	Weeds: Post-E	**Annual broad-leaved weeds and certain grasses.** Apply to actively growing weeds after they have emerged to the 4-6 leaf stage
terbuthylazine	SC	500 g/ℓ	–	2 ℓ/ha	Weeds: Post-E	**Annual broad-leaved weeds**. Use only with Trooper (2,4 D/dicamba)

MANGOES						**MANGOES**
S-metolachlor/ terbuthylazine	SC	102,8/497,2 g/ℓ	–	2,8–4,2 ℓ + 4–6 ℓ glyphosate/ha	Weeds: Post-E	**Annual broad-leaved weeds and certain grasses.** Dosage depends on the specific rainfall area, growth stage of trees, clay content of soil and weed species to be controlled
terbuthylazine	SC	600 g/ℓ	–	3,5 ℓ/ha	Weeds: Pre-E	**Annual broad-leaved weeds.** Do not apply within one year of transplanting
	WG	900 g/kg	–	1,5–2,2 kg/ha	Weeds: Pre-E	**Annual broad-leaved weeds.** Do not apply within one year of transplanting

Active ingredient(s) (common name)	Formulation Type	Formulation Grams pure active ingredient	% Clay	Dosage	Time of application	Remarks
NECTARINES						**NECTARINES**
trifluralin	EC	480 g/ℓ	0–30	8 ℓ/ha	Pre-plant	**Annual grasses and certain broad-leaved weeds.** Apply on a clean, cultivated soil surface before the establishment of orchards. Incorporate within ten minutes after application
ORNAMENTALS						**ORNAMENTALS**
isoxaben/trifluralin	GR	5/20 g/kg	–	15–20 g/m^2	Weeds: Pre-E	**Annual broad-leaved weeds and grasses in established ornamentals**. Apply prior to the germination of weeds or immediately after cultivation. If granules become lodged in foliage of ornamentals it should be brushed, shaken or irrigated off
PAPRIKA						**PAPRIKA**
alachlor	CS	480 g/ℓ	–	3–4 ℓ/ha	Weeds: Pre-E	**Annual grasses and certain broad-leaved weeds.** Use ONLY with RONSTAR
	EC	384 g/ℓ	–	4–5 ℓ/ha	Weeds: Pre-E	**Annual grasses and certain broad-leaved weeds.** Use ONLY with RONSTAR
PARSLEY AND PARSNIPS						**PARSLEY AND PARSNIPS**
linuron	SC	500 g/ℓ	11–15 16–20 21–25	1 ℓ/ha 1,5 ℓ/ha 2,0 ℓ/ha	Weeds: Pre-E	**Annual broad-leaved weeds and certain grasses**. Apply immediately after sowing. Seeds should be sown not less than 12,5 mm deep in a fine, moist seedbed
			11–35	1–1,5 ℓ/ha	Weeds: Post-E	**Annual broad-leaved weeds and certain grasses**. Dosage depends on the growth stage of the weeds
	WG	500 g/kg	11–15 16–20 21–35	1 kg/ha 1,5 kg/ha 2 kg/ha	Weeds: Pre-E	**Annual broad-leaved weeds and certain grasses**. Seed should be sown not less than 12,5 mm deep in fine seedbeds
				1–1,5 kg/ha	Weeds: Post-E	**Annual broad-leaved weeds and certain grasses**. DO NOT apply before the crop has reached the four leaf stage
PAVING						**PAVING**
isoxaben/trifluralin	GR	5/20 g/kg	–	15 g/m^2	Weeds: Pre-E	**Annual broad-leaved weeds and grasses.** **New paving.** Apply evenly on levelled bed just before laying the bricks. **Existing paving.** Apply over the dry bricks and sweep with a broom across to make sure that the granules are positioned in the openings between the bricks. Water well after treatment
PEACHES						**PEACHES**
trifluralin	EC	480 g/ℓ	0–30	8 ℓ/ha	Weeds: Pre-E	**Annual grasses and certain broad-leaved weeds.** Apply on a clean, cultivated soil surface before the establishment of orchards. Incorporate within ten minutes after application
PEARS						**PEARS**
glyphosate/simazine/ terbuthylazine	SC	125/175/175 g/ℓ	>15	8,5 ℓ/ha	Weeds: Post-E	**Annual grasses and broad-leaved weeds.** Apply as a directed spray. Apply when weeds are 100–300 mm high. Avoid spraying green parts of tree
			SINGLE APPLICATION			
simazine	SC	500 g/ℓ	0–15 > 15	4 ℓ/ha 6 ℓ/ha	Weeds: Pre-E	**Mainly annual broad-leaved weeds in orchards older than three years**. Apply in spring as a follow-up treatment after existing weeds have been eradicated with a suitable post-emergence herbicide
	WP	800 g/kg	0–10 > 10	2,5 kg/ha 3,75 kg/ha	Weeds: Pre-E	
	WG	900 g/kg	0–15 > 15	2,2 kg/ha 3,3 kg/ha	Weeds: Pre-E	**Mainly annual broad-leaved weeds in orchards older than three years**. Apply in spring

PEARS *(continued)*						**PEARS**
Active ingredient(s) **(common name)**	**Formulation**		**% Clay**	**Dosage**	**Time of application**	**Remarks**
	Type	**Grams pure active ingredient**				
simazine *(continued)*			**SPLIT APPLICATION**			
	SC	500 g/ℓ	> 15	3 ℓ + 3 ℓ/ha	Weeds: Pre-E	**Mainly annual broad-leaved weeds in orchards older than three years.** **First application** in spring on a weed-free soil surface. **Second application** at the germination of the first weeds or within three months of the first application. Where weeds are present, apply in combination with a suitable post-emergence herbicide.
	WP	800 g/kg	> 10	2 kg + 2 kg/ha	Weeds: Pre-E	
	WG	900 g/kg	> 15	1,7 kg + 1,7 kg/ha	Weeds: Pre-E	**Mainly annual broad-leaved weeds in orchards older than three years.** **First application** in spring on a weed-free soil surface. **Second application** at the germination of the first weeds or within three months of the first application. Where weeds are present, apply in combination with a suitable post-emergence herbicide
simazine/ terbuthylazine	SC	250/250 g/ℓ	>15	6 ℓ/ha	Weeds: Pre-E	**Annual broad-leaved weeds and grasses** in orchards older than three years in the Western Cape
terbuthylazine	SC	500 g/ℓ	–	3,5 ℓ/ha	Weeds: Pre-E	**Mainly annual broad-leaved weeds in orchards older than three years**. Apply in spring. Do not apply within one year of transplanting
	WG	750 g/kg	–	2,3 kg/ha	Weeds: Pre-E	**Mainly annual broad-leaved weeds in orchards older than three years.** Apply in spring. Do not apply within one year of transplanting
trifluralin	EC	480 g/ℓ	0–30	8 ℓ/ha	Weeds: Pre-E	**Annual grasses and certain broad-leaved weeds.** Apply to cleanly cultivated soil before the establishment of nurseries and orchards. Incorporate within ten minutes after application
PEAS						**PEAS**
terbuthylazine/ terbutryn	WP	150/350 g/kg	0–20 21–35	2,75 kg/ha 3 kg/ha	Weeds: Pre-E	**Annual broad-leaved weeds.** George area ONLY. Apply after planting to freshly cultivated soil and incorporate mechanically, or by means of irrigation in the absence of rain
PECAN NUTS						**PECAN NUTS**
trifluralin	EC	480 g/ℓ	0–30	8 ℓ/ha	Pre-plant	**Annual grasses and certain broad-leaved weeds.** Apply on a clean, cultivated soil before the establishment of the orchards. Incorporate within ten minutes after application
PINEAPPLES						**PINEAPPLES**
alachlor	CS	480 g/ℓ	0–16 > 16	3,2 ℓ/ha 4 ℓ/ha	Weeds: Pre-E	**Mainly annual grasses and under certain conditions, yellow nutsedge.**
	EC	384 g/ℓ	0–16 > 16	4 ℓ/ha 5 ℓ/ha	Weeds: Pre-E	**Mainly annual grasses and under certain conditions, yellow nutsedge**
atrazine	SC	500 g/ℓ	0–20 21–35	3,7 ℓ + 3,7 ℓ ametryn 500 SC/ha 5 ℓ + 5 ℓ ametryn 500 SC/ha	Weeds: Early Post-E	**Mainly annual broad-leaved weeds**. Apply where late-germinating weeds are a problem
	WG	900 g/kg	0–20 21–35	2 kg + 3,7 ℓ ametryn 500 SC/ha 2,8 kg + 5,2 ℓ ametryn 500 SC/ha	Weeds: Early Post-E	**Mainly annual broad-leaved weeds**. Apply where late-germinating weeds are a problem
	WP	800 g/kg	0–20 21–35	2,3 kg + 3,7 ℓ ametryn 500 SC/ha 3,3 kg + 5,2 ℓ ametryn 500 SC/ha	Weeds: Early Post-E	**Mainly annual broad-leaved weeds**. Apply where late germinating weeds are a problem

Active ingredient(s) (common name)	Formulation Type	Grams pure active ingredient	% Clay	Dosage	Time of application	Remarks
PLUMS AND PRUNES						**PLUMS AND PRUNES**
trifluralin	EC	480 g/ℓ	0–30	8 ℓ/ha	Pre-plant	**Annual grasses and certain broad-leaved weeds**. Apply on a clean, cultivated soil before the establishment of orchards. Incorporate within ten minutes after application
POTATOES						**POTATOES**
acetochlor	EC	700 g/ℓ	0–10 11–20 21–30 > 30	0,9 ℓ/ha 1,9 ℓ/ha 2,1 ℓ/ha 3,9 ℓ/ha	Weeds: Pre-E	**Annual grasses and certain broad-leaved weeds**. Apply after planting, but before crop emergence
		750 g/ℓ	0–10 11–20 21–30 > 30	0,9 ℓ/ha 1,8 ℓ/ha 2,0 ℓ/ha 3,6 ℓ/ha	Weeds: Pre-E	**Annual grasses and certain broad-leaved weeds**. Apply after planting, but before crop emergence
		900 g/ℓ	0–10 11–30 >31	0,75–1,5 ℓ/ha 1,0–3,0 ℓ/ha 3,0 ℓ/ha	Weeds: Pre-E	**Annual grasses and certain broad-leaved weeds**. Apply after planting, but before crop emergence. Use the lower dosage for the control of annual grasses ONLY
alachlor	CS	480 g/ℓ	0–16 > 16	3,2 ℓ/ha 4 ℓ/ha	Weeds: Pre-E	**Mainly annual grasses and under certain conditions, yellow nutsedge**. Apply after planting, but before crop emergence
			–	3,2–4 ℓ + 1–2 ℓ paraquat/ha	Weeds: Early Post-E	**Annual grasses, broad-leaved weeds and under certain conditions, yellow nutsedge**. Apply before 10 % crop emergence
	EC	384 g/ℓ	–	5 ℓ/ha	Weeds: Pre-E	**Mainly annual grasses and under certain conditions, yellow nutsedge**. Apply after the first summer rains
			–	5 ℓ + 1–2 ℓ paraquat/ha	Weeds: Early Post-E	**Annual grasses, broad-leaved weeds and under certain conditions, yellow nutsedge**. Apply before 10 % crop emergence
alachlor/linuron	EC	262/105 g/ℓ	0–15 16–30	5,5–6,5 ℓ/ha 6,5–7,5 ℓ/ha	Weeds: Pre-E	**Annual grasses and broad-leaved weeds**. Apply within five days of planting to moist soil
alachlor/prometryn	EC	240/120 g/ℓ	0–15 16–30 >30	5,5–6,5 ℓ 6,5–7,5 ℓ 7,5 ℓ	Weeds: Pre-E	**Annual broad-leaved weeds and certain grasses.** Apply on a fine even, firm seedbed which is free of any growing weeds
2,4-D (dimethylamine salt)	SL	480 g/ℓ	0–20 21–35 > 35	2,6 ℓ/ha 3,5 ℓ/ha 4,5 ℓ/ha	Weeds: Pre-E	**Mainly annual broad-leaved weeds**. If the crop was dry planted, harrow immediately after the first rain and apply. Apply before crop emergence
		720 g/ℓ	<20 20–35 >35	1,75 ℓ/ha 2,25 ℓ/ha 3,00 ℓ/ha	Weeds: Pre-E	**Annual broad-leaved weeds and some grasses.** If the crop was dry planted, harrow immediately after the first rain and apply
linuron	SC	500 g/ℓ	11–15 16–20 21–35	2,0 ℓ/ha 2,5 ℓ/ha 3,01 ℓ/ha	Weeds: Pre-E and Early Post-E	**Annual broad-leaved weeds and certain grasses**. Irrigated potatoes ONLY. Apply after planting, but pre-emergence of the crop. Can also be applied as a band treatment over the rows
	WG	500 g/kg	11–15 16–20 21–35	2,0 kg/ha 2,5 kg/ha 3,0 kg/ha	Weeds: Pre-E and Early Post-E	**Annual broad-leaved weeds and certain grasses**. Irrigated potatoes ONLY. Apply after planting, but pre-emergence of the crop. Can also be applied as a band treatment over the rows
metribuzin	SC	480 g/ℓ	0–10 11–20 21–35	1,1 ℓ/ha 1,5 ℓ/ha 1,8-2,2 ℓ/ha	Weeds: Pre-E	**Annual broad-leaved weeds and grasses**. Apply after planting, until just before crop emergence.
	WG	700 g/kg	0–10 11–20 21–35	750 g/ha 1,0 kg/ha 1,2–1,5 kg/ha	Weeds: Pre-E	**Annual broad-leaved and certain grasses.** Apply after planting, until just before crop emergence.
QUINCES						**QUINCES**
trifluralin	EC	480 g/ℓ	0–30	8 ℓ/ha	Pre-plant	**Annual grasses and certain broad-leaved weeds**. Apply on a clean, cultivated soil surface before the establishment of orchards. Incorporate within ten minutes after application

Active ingredient(s) (common name)	Formulation		% Clay	Dosage	Time of application	Remarks
	Type	Grams pure active ingredient				
ROSES						**ROSES**
isoxaben/trifluralin	GR	5/20 g/kg	–	15–20 g/m^2	Weeds: Pre-E	**Annual broad-leaved weeds and grasses in established ornamentals**. Apply prior to the germination of weeds, or immediately after cultivation
linuron	SC	500 g/ℓ	11–15 16–20 21–35 11–35	2,1 ℓ/ha 2,5 ℓ/ha 3,0 ℓ/ha 3,0–4,0 ℓ/ha	Weeds: Pre-E Weeds: Post-E	**Annual broad-leaved weeds and certain grasses**. Apply in spring before bud burst **Annual broad-leaved weeds and certain grasses**. Use as a directed spray and ensure that the growing plants are well shielded
	WG	500 g/kg	11–15 16–20 21–35 11-35	2 kg/ha 2,5 kg/ha 3 kg/ha 3–4 kg/ha	Weeds: Pre-E Weeds: Post-E	**Annual broad-leaved weeds and certain grasses**. Apply in spring before bud burst **Annual broad-leaved weeds and certain grasses**. Use as a directed spray and ensure that the growing plants are well shielded
RYE						**RYE**
2,4-D (dimethylamine salt)	SG	800 g/kg	–	0,75–1,3 kg/ha	Weeds: Post-E	**Annual broad-leaved weeds**. Apply when the crop is in the five leaf stage
	SL	480 g/ℓ	–	1,5–2,6 ℓ/ha	Weeds: Post-E	**Annual broad-leaved weeds**. Apply when the crop is in the five leaf stage
		720 g/ℓ	–	1–1,75 ℓ/ha	Weeds: Post-E	**Annual broad-leaved weeds**. Apply when the crop is in the five leaf stage
SOY BEANS						**SOY BEANS**
alachlor	CS	480 g/ℓ	0–10 11–20 21–30 > 31	3,2 ℓ/ha 3,2–3,6 ℓ/ha 3,6–4,0 ℓ/ha 4,0 ℓ/ha	Weeds: Pre-E	**Mainly annual grasses and certain broad-leaved weeds and under certain conditions, yellow nutsedge.** Apply pre-emergence of the crop and weeds within two days of planting
	EC	384 g/ℓ	0–10 11–20 21–30 >31	4 ℓ/ha 4–4,5 ℓ/ha 4,5–5 ℓ/ha 5 ℓ/ha	Weeds: Pre-E	**Mainly annual grasses and under certain conditions, yellow nutsedge**. Apply to a well-prepared seedbed not later than two days after planting
	GR	150 g/kg	0–16 > 16	10,0 kg/ha 12,5 kg/ha	Weeds: Pre-E	**Mainly annual grasses**. Apply on a well-prepared seedbed at planting
metribuzin	SC	480 g/ℓ	11–20 21–35	,6 + 5 ℓ alachlor/ha 0,7 + 5 ℓ alachlor/ha	Weeds: Pre-E Weeds: Pre-E	**Annual grasses and broad-leaved weeds ONLY IN CERTAIN CULTIVARS**
trifluralin	EC	480 g/ℓ	0–15 16–35 36–50	1 ℓ/ha 1,5 ℓ/ha 2 ℓ/ha	Pre-plant	**Annual grasses and certain broad-leaved weeds**. Apply on a well-prepared seedbed from three weeks before sowing to immediately prior to sowing. Incorporate within ten minutes after application
SUGAR CANE						**SUGER CANE**
acetochlor	EC	700 g/ℓ	0–35 >35	2,7 ℓ/ha 4,1 ℓ/ha	Weeds: Pre-E	**Annual grasses and certain broad-leaved weeds**. Mix with broad-leaved herbicides for prolonged control
		750 g/ℓ	0–30 >30	2,1–3,0 ℓ/ha 2,7–3,6 ℓ/ha	Weeds: Pre-E	**Annual grasses and certain broad-leaved weeds**. Mix with broad-leaved herbicides for prolonged control
		840 g/ℓ	0–30 >30	2 ℓ/ha 3 ℓ/ha	Weeds: Pre-E and Post-E	**Annual grasses and certain broad-leaved weeds.** Mix with broad-leaved herbicides for prolonged control
		900 g/ℓ	0–30 >30	1,75-2,5 ℓ/ha 2,25-3 ℓ/ha	Weeds: Pre-E and Post-E	**Annual grasses and certain broad-leaved weeds**. Mix with broad-leaved herbicides for prolonged control
		960 g/ℓ		1,9–2,9 ℓ/ha	Weeds: Pre-E and Post-E	**Annual grasses and certain broad-leaved weeds.** Mix with broad-leaved herbicides for prolonged control
alachlor	CS	480 g/ℓ	–	4–5,5 ℓ/ha	Weeds: Pre-E	**Mainly annual grasses and under certain conditions, yellow nutsedge**. Use the higher dosages for *Panicum maximum* (common buffalo grass) control. Apply on a well-prepared seedbed at planting or immediately thereafter, but not later than two days after planting
	EC	384 g/ℓ	–	5–6 ℓ/ha	Weeds: Pre-E	**Mainly annual grasses and under certain conditions, yellow nutsedge**. Use the higher dosages for *Panicum maximum* (common buffalo grass) control. Apply on a well-prepared seedbed at planting or immediately thereafter, but not later than two days after planting

SUGAR CANE *(continued)* **SUGER CANE**

Active ingredient(s) (common name)	Formulation: Type	Formulation: Grams pure active ingredient	% Clay	Dosage	Time of application	Remarks
alachlor/atrazine	SC	336/144 g/ℓ	0–35 >35	7 ℓ/ha 8,5 ℓ/ha	Weeds: Pre-E	**Mainly annual grasses and certain broad-leaved weeds**. Apply pre-emergence of crop and weeds
ametryn	SC	500 g/ℓ	–	8 ℓ/ha	Weeds: Post-E	**Annual grasses and broad-leaved weeds**. Apply as an inter-row directed spray if cane has developed beyond the five leaf stage
	WG	800 g/kg	–	5 kg/ha	Weeds: Post:E	**Annual grasses and broad-leaved weeds**. Apply as an inter-row directed spray if cane has developed beyond the five leaf stage
atrazine	SC	500 g/ℓ	0–35	2,5 ℓ/ha	Weeds: Pre-E	**Mainly annual broad-leaved weeds.** Apply immediately after planting
	WP	800 g/kg	0–35	1,5 kg/ha	Weeds: Pre-E	
	WG	900 g/kg	0–10 11–20 21–30 31–40	1,4 kg/ha 1,8 kg/ha 2,2 kg/ha 2,6 kg/ha	Weeds: Pre-E	
atrazine/ S-metolachlor	SC	370,8/229,2 g/ℓ 370/290 g/ℓ	–	4,2–5,6 ℓ/ha	Weeds: Pre-E	**Annual grasses and broad-leaved weeds**. Use the high dosages on soils with more than 35 % clay, or on all soil types where *Panicum maximum* is a problem or to improve control of *Cyperus esculentus*
atrazine/sulcotrione	SC	300/125 g/ℓ	–	1,6–3,6 ℓ/ha	Weeds: Post-E	**Mainly annual broad-leaved weeds and certain grasses**. Weeds must not be larger than the four leaf stage
bromoxynil/ terbuthylazine	SE	150/333 g/ℓ	–	2 ℓ/ha	Weeds: Post-E	**Annual broad-leaved weeds**. Apply when weeds have fully emerged, but not older than the six leaf stage
chlorimuron ethyl/metribuzin	WG	107/643 g/kg	7–20 21–35 >35	0,8 kg/ha 0,9 kg/ha 1,0 kg/ha	Weeds: Pre-E or Early Post-E	**Mainly annual broad-leaved weed, certain grasses, yellow and purple nutsedge**. Weeds must not be larger than the four leaf stage
	WP	107/643 g/kg	7–20 21–35 >35	0,8 kg/ha 0,9 kg/ha 1,2 kg/ha	Weeds: Pre-E or Early Post-E	**Annual and perennial broad-leaved weeds, some grasses, as well as yellow and purple nutsedge**. Weeds must not be larger than the four leaf stage
2,4-D (dimethylamine salt)	SL	480 g/ℓ	– –	5,25–7,25 ℓ/ha 5,25–7,25 ℓ/ha	Weeds: Pre-E Weeds: Post-E	**Mainly annual broad-leaved weeds**. **Annual broad-leaved weeds**. Apply as an inter-row directed spray after crop emergence
	SL	720 g/ℓ	–	3,5–4,75 ℓ/ha	Weeds: Pre-E and Post-E	**Mainly annual broad-leaved weeds**
	SG	800 g/kg	–	2,6–3,6 kg/ha 2,6–3,6 kg/ha	Weeds: Pre-E Weeds: Post-E	**Mainly annual broad-leaved weeds**. Apply within a few days after planting or harvesting. **Annual broad-leaved weeds**. Apply as an inter-row directed spray after crop emergence
2,4-D (iso-octyl ester)	EC	500 g/ℓ	–	4,7–6,7 ℓ/ha	Weeds: Pre-E or Post-E	**DO NOT USE IN KWAZULU-NATAL. Annual broad-leaved weeds**. Apply as an inter-row directed spray after crop emergence
2,4-D/dicamba (APM salts)	SL	240/80 g/ℓ	–	2,5 ℓ/ha	Weeds: Post-E	**Annual broad-leaved weeds**. Apply as an over-the-top or as an inter-row directed spray
2,4-D (iso-octyl ester)/ ioxynil (octanoate)	EC	600/100 g/ℓ	–	1,5 ℓ/ha	Weeds: Post-E	**DO NOT USE IN KWAZULU-NATAL. Mainly annual broad-leaved weeds and certain grasses.** Apply as an inter-row directed spray
diuron/metribuzin	WG	400/360 g/kg	6–35	4 kg/ha	Weeds: Pre-E and Early Post-E	**Annual broad-leaved weeds and grasses**. Apply as a directed spray across the inter-row area
metribuzin	SC	480 g/ℓ	6–20 21–35	3,6–4,3 ℓ/ha 4,3 ℓ/ha	Weeds: Pre-E	**Annual broad-leaved weeds and grasses**. Apply after planting or harvesting
			6–20 21–35	3,6–4,3 ℓ/ha 4,3 ℓ/ha	Weeds: Post-E	**Annual broad-leaved weeds and certain grasses**. Use the higher dosages when yellow nutsedge is present
	WG	700 g/kg	6–20 21–35	2,5–3,0 kg/ha 3,0 kg/ha	Weeds: Pre-E and Early Post-E	**Annual broad-leaved weeds and certain grasses**. The high rates will have a suppressing effect on yellow nutsedge

SUNFLOWERS **SUNFLOWERS**

Active ingredient(s) (common name)	Formulation: Type	Formulation: Grams pure active ingredient	% Clay	Dosage	Time of application	Remarks
alachlor	CS	480 g/ℓ	0–16 > 16	3,2 ℓ/ha 4 ℓ/ha	Weeds: Pre-E	**Mainly annual grasses and under certain conditions, yellow nutsedge**. Apply to a well-prepared seedbed at planting or immediately thereafter (not later than two days)
	EC	384 g/ℓ	0–15 > 15	4 ℓ/ha 5 ℓ/ha	Weeds: Pre-E	**Mainly annual grasses and under certain conditions, yellow nutsedge**. Apply on a well-prepared seedbed at planting or immediately thereafter, (not later than two days)

Active ingredient(s) (common name)	Formulation: Type	Formulation: Grams pure active ingredient	% Clay	Dosage	Time of application	Remarks
SUNFLOWERS *(continued)*						**SUNFLOWERS**
alachlor	GR	150 g/kg	0–15 > 15	10 kg/ha 12 kg/ha	At planting	**Mainly annual grasses and under certain conditions, yellow nutsedge**. Apply on a well-prepared seedbed at planting
alachlor/prometryn	EC	240/120 g/ℓ	0–15 16–30 >30	5,5–6,5 ℓ/ha 6,5–7,5 ℓ/ha 7,5 ℓ/ha	Weeds: Pre-E	**Annual grasses and broad-leaved weeds**. Apply not later than five days after planting
trifuralin	EC	480 g/ℓ	0–15 16–35 36–50	1 ℓ/ha 1,5 ℓ/ha 2 ℓ/ha	Pre-plant	**Annual grasses and certain broad-leaved weeds**. Apply on a well-prepared seedbed three weeks before planting to immediately prior to planting. Incorporate within ten minutes after application
SWEET CORN						**SWEET CORN**
acetochlor	EC	700 g/ℓ	0–10 11–20 21–30 > 30	1,7 ℓ/ha 2,1 ℓ/ha 2,4 ℓ/ha 2,7 ℓ/ha	Weeds: Pre-E	**Mainly annual grasses**. Apply on a well-prepared seedbed at planting or within five days thereafter
		840 g/ℓ	0–10 11–20 21–30 31–40 41–55	0,75–1,25 ℓ/ha 1,25–1,75 ℓ/ha 1,75–2,0 ℓ/ha 2,0–2,25 ℓ/ha 2,25 ℓ/ha	Weeds: Pre-E	**Annual grasses and certain broad-leaved weeds**. Apply within three days of planting
alachlor	CS	480 g/ℓ	11–15 16–20 21–35	3,2 ℓ/ha 3,6 ℓ/ha 4 ℓ/ha	Weeds: Pre-E	**Mainly annual grasses and under certain conditions, yellow nutsedge**. Apply on a well-prepared seedbed within two days after planting
	EC	384 g/ℓ	11–15 16–20 21–35	4 ℓ/ha 4,5 ℓ/ha 5 ℓ/ha	Weeds: Pre-E	**Mainly annual grasses and under certain conditions, yellow nutsedge**. Apply on a well-prepared seedbed within two days after planting
razine/sulcotrione	SC	300/125 g/ℓ	–	0,4–1,2 ℓ/ha	Weeds: Post-E	**Mainly annual broad-leaved weeds and certain grasses**. Use ONLY in combination with WENNER, BROMOXYNIL, RELAY or EPTAM SUPER
SWEET POTATOES						**SWEET POTATOES**
linuron	SC	500 g/ℓ	11–15 16–20 21–35	1,5 ℓ/ha 1,7 ℓ/ha 2,0 ℓ/ha	Weeds: Pre-E	**Annual broad-leaved weeds and certain grasses**. Apply directly before or immediately after the planting of the vines. Apply a light sprinkler irrigation directly after application to wash the herbicide off the leaves
	WG	500 g/kg	11–15 16–20 21–35	1,5 kg/ha 1,7 kg/ha 2,0 kg/ha	Weeds: Pre-E	**Annual broad-leaved weeds and certain grasses**. Apply directly before, or immediately after the planting of the vines. Apply light sprinkler irrigation directly after application to wash the herbicide of the leaves
TOMATOES						**TOMATOES**
metribuzin	SC	480 g/ℓ	0–10 11–20 21–35	1,1 ℓ/ha 1,5 ℓ/ha 1,8–2,2 ℓ/ha	Weeds: Early Post-E	**Annual grasses and broad-leaved weeds**. Apply 14 days after transplanting as a directed spray between the rows
	WG	700 g/kg	0–10 11–20 21–35	0,75 kg/ha 1,0 kg/ha 1,2–1,5 kg/ha	Weeds: Early Post-E	**Annual broad-leaved weeds and grasses**. Apply 14 days after transplanting as a directed spray between the rows
trifluralin	EC	480 g/ℓ	0–15 16–35 36–60	1 ℓ/ha 1,5 ℓ/ha 2 ℓ/ha	Pre-plant	**Annual grasses and certain broad-leaved weeds**. Apply on a well-prepared soil surface and incorporate within ten minutes
WHEAT						**WHEAT**
2,4-D (dimethylamine salt)	SG	800 g/kg	–	0,75– 1,3 kg/ha	Weeds: Post-E	**Annual broad-leaved weeds**. Apply between growth stages seven (centre double ridges enlarged) and 13 (awn of the top spikelets elongated), according to the list of growth stages of the ARC-Small Grain Institute, Bethlehem
	SL	480 g/ℓ	–	1,5–2,6 ℓ/ha	Weeds: Post-E	**Annual broad-leaved weeds**. Apply between growth stages seven (centre double ridges enlarged) and 13 (awn of the top spikelets elongated), according to the list of growth stages of the ARC-Small Grain Institute, Bethlehem

WHEAT *(continued)*						**WHEAT**
Active ingredient(s) **(common name)**	**Formulation**		**% Clay**	**Dosage**	**Time of application**	**Remarks**
	Type	**Grams pure active ingredient**				
2,4-D (dimethylamine salt) (*continued*)	SL	720 g/ℓ	–	1–1,75 ℓ/ha	Weeds: Post-E	**Mainly annual broad-leaved weeds**. Apply when the crop is between growth stages seven and 13 according to the list of growth stages of the ARC-Small Grain Institute, Bethlehem
Active ingredient(s) **(common name)**	**Formulation**		**% Clay**	**Dosage**	**Time of application**	**Remarks**
	Type	**Grams pure active ingredient**				
2,4-D (iso-octyl ester)	EC	500 g/ℓ	–	0,7–1,7 ℓ/ha	Weeds: Post-E	**Annual broad-leaved weeds.** *USE ONLY IN THE SUMMER RAINFALL AREAS (except KwaZulu-Natal).* Apply between growth stages seven (centre double ridges enlarged) and 13 (awn of the top spikelets elongated) according to the list of growth stages of the ARC-Small Grain Institute, Bethlehem
2,4-D/dicamba (APM salts)	SL	240/80 g/ℓ	–	1–1,5 ℓ/ha	Weeds: Post-E	**Mainly annual broad-leaved weeds***.* Apply between growth stages seven (centre double ridges enlarged) and 13 (awn of the top spikelets elongated) according to the list of growth stages of the ARC-Small Grain Institute, Bethlehem

2. PLANT GROWTH REGULANTS

Active ingredient(s) (common name)	Formulation		Dosage	Withholding period	Remarks
	Type	Grams pure active ingredient	Per 100 ℓ water or as indicated	(minimum number of days that have to lapse between last application and harvest)	
APPLES					**APPLES**
CHEMICAL THINNING (fruit thinning)					**CHEMICAL THINNING (fruit thinning)**
carbaryl	WP	850 g/kg	15-90 g	–	Apply as a full cover spray at 10 to 15 mm fruit size
CITRUS					**CITRUS**
STEM-END ROT PREVENTION					**STEM-END ROT PREVENTION**
2,4-D (sodium salt)	SL	25 g/ℓ	2 ℓ/ 100 ℓ water <u>or</u> wax	–	Spray or brush onto fruit of use as a dip treatment. Ensure that the button of the fruit is thoroughly covered
SUGAR-ACID RATIO CORRECTION					**SUGAR-ACID RATIO CORRECTION**
calcium asenate	WP	855 g/kg	100 g	180	*Valencias ONLY.* Apply a single full cover spray in spring

ANNEXURE C

Source of pesticide information

FUNGICIDES

BENOMYL**

CARBENDAZIM[1]

CYHEXATIN*

FENTIN HYDROXIDE (TRIPHENYLTIN)**

MANCOZEB**

MANEB** (only in a mixture with zinc oxide)

METIRAM**

PENTACHLOROPHENOL** (wood preservative)

TRIBUTYLTIN OXIDE ** (wood preservative)

VINCLOZOLIN*

ZINEB**

HERBICIDES

2,4-D* (dimethyl amine salt, iso-octyl ester and sodium salt)

ACETOCHLOR

ALACHLOR

AMITROLE**

ATRAZINE*

LINURON

METRIBUZIN**

NITROFEN** (not registered in South Africa)

METOXYCHLOR* (not registered in South Africa)

PROPAZINE***

SIMAZINE*

TERBUTYLAZINE*

TRIBUTYLTIN** (not registered in RSA but could be used in paints for use on ships and boats as an anti fowling agent)

TRIFLURALIN**

INSECTICIDES

ALDICARB*

ALPHA-CYPERMETHRIN[2]

AZINPHOS-METHYL*

BETA-CYPERMETHRIN[2]

CARBARYL**

CHLORPYRIFOS (ETHYL)*

CHLORPYRIFOS-METHYL

CYPERMETHRIN**

DELTAMETHRIN*

1,2-DIBROMO-3-CHLOROPROPANE** (DBCP) (not registered in South Africa since at least 1991)

ENDOSULFAN*

ESFENVALERATE**

FENVALERATE**

gamma-BHC*

MERCAPTOTHION (MALATHION)**

METHOMYL**

PARATHION*

PERMETHRIN**

ZETA-CYPERMETHRIN[2]

*** Publication *WRC Programme on Endocrine Disrupting Compounds (EDCs) Volume 1 Strategic Research Plan for Endocrine Disrupters in South African Water Systems* WRC Report No. KV 143/05, August 2005, 3.3.1 & 3.3.3**

**** Publication *WRC Programme on Endocrine Disrupting Compounds (EDCs) Volume 1 Strategic Research Plan for Endocrine Disrupters in South African Water Systems* WRC Report No. KV 143/05, August 2005, 3.3.4**

***** Propazine (not listed but mentioned in text see p 13 of report given at end of table)**

1 Benomyl breaks down to carbendazim relatively rapidly in plants and the reason for inclusion in the list

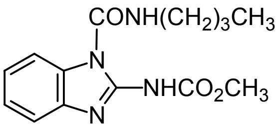
2 Alpha-, beta and zeta-cypermethrin. Closely related to cypermethrin and the reason for inclusion in list

ANNEXURE D

Properties of selected pesticides
(Information from *The e-Pesticide Manual*)

FUNGICIDES

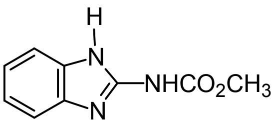
BENOMYL - benzimidazole



PHYSICAL CHEMISTRY:
Solubility: In water 3,6 (pH 5); 2,9 (pH 7); 1,9 (pH 9) (all in g/ℓ at room temperature). In chloroform 94; dimethylformamide 53; acetone 18; xylene 10; ethanol 4; heptane 0,4 (all in g/kg at 25 °C).
Stability: Hydrolysis DT_{50} 3,5 hours (pH 5); 1,5 hours (pH 7); <1 hour (pH 9) (all at 25 °C). In some solvents, dissociates to form carbendazim and butyl isocyanate. Stable to light. Decomposed on storage in contact with water and under moist conditions in soil. Mechanism of the acid-catalysed decomposition in aqueous media.
K_{ow} logP = 1,37 *[Partitioning coefficient (P) between n-octanol and water (as the log value). A high value for the partitioning coefficient is regarded as an indicator that a substance will bio-accumulate (unless other factors operate]. Note that, for molecules that dissociate, logP values measured within 3pH units of the pKa will present an average value over two or more forms present].*

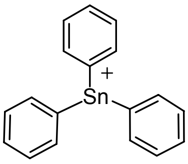
ENVIRONMENTAL FATE:
Plants: In plants, the butylcarbamoyl group is removed to give the relatively stable carbendazim, followed by slow degradation to non-toxic 2-aminobenzimidazole. Further degradation involves cleavage of the benzimidazole nucleus. Benomyl *per se* is stable on the surface of banana skins.
Soil/Environment: Benomyl is rapidly converted to carbendazim in the environment, DT_{50} 2 and 19 hours in water and in soil, respectively. Data from studies on both benomyl and carbendazim are therefore relevant for the evaluation of environmental effects. K_{oc} 1900 (soil sorption coefficient, adjusted for the proportion of organic carbon in soil).

CARBENDAZIM - benzimidazole



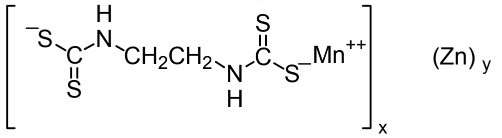
PHYSICAL CHEMISTRY:
Solubility: In water 29 mg/ℓ (pH 4); 8 mg/ ℓ (pH 7); 7 mg/ ℓ (pH 8) (at 24 °C). In dimethylformamide 5; acetone 0,3; ethanol 0,3; chloroform 0,1; ethyl acetate 0,135; dichloromethane 0,068; benzene 0,036; cyclohexane <0,01; diethyl ether <0,01; hexane 0,0005 (all in g/ℓ at 24 °C).
Stability: Decomposes at melting point (302-307 °C); stable for at least 2 years below 50 °C. Stable after 7 days at 20 000 lux. Slowly decomposed in alkaline solution (22 °C); DT_{50} >350 days (pH 5 and pH 7); 124 days (pH 9). Stable in acids, forming water-soluble salts.
pKa 4,2; weak base. **K_{ow}** logP = 1,38 (pH 5), 1,51 (pH 7), 1,49 (pH 9)
ENVIRONMENTAL FATE:
Plants: Readily absorbed by plants. One degradation product is 2-aminobenzimidazole.
Soil/Environment: 2-Aminobenzimidazole has been found as a minor metabolite. DT_{50} in soil 8-32 days under outdoor conditions. Carbendazim decomposes in the environment, DT_{50} 6-12 months on bare soil, 3-6 months on turf, and 2-25 months in water under aerobic and anaerobic conditions, respectively. It is mainly decomposed by micro-organisms. K_{oc} 200-250.

FENTIN HYDROXIDE (TRIPHENYLTIN) - organotin fungicide



PHYSICAL CHEMISTRY:
Solubility: In water *ca.* 1 mg/ℓ (pH 7 and 20 °C), (greater at lower pH values). In ethanol 32; isopropanol 48; acetone 46; polyethylene glycol 41 (all in g/ℓ at 20 °C).
Stability: stable in the dark at room temperature. Dehydration occurs on heating above 45 °C, yielding bis(triphenyltin) oxide, which is stable up to *ca.* 250 °C. Slowly decomposed by sunlight, and more rapidly by ultra violet light, to give inorganic tin via di- and mono-phenyltin compounds. K_{ow} logP = 3,54.
ENVIRONMENTAL FATE:
Soil/Environment: In soil, fentin acetate and fentin hydroxide are degraded to inorganic tin via di- and mone-phenyltin compounds. Soil DT_{50} *ca.* 20 days (in laboratory).

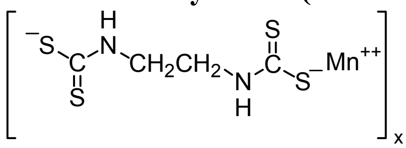
MANCOZEB - alkylenebis(dithiocarbamate)



x:y = 1:0.091

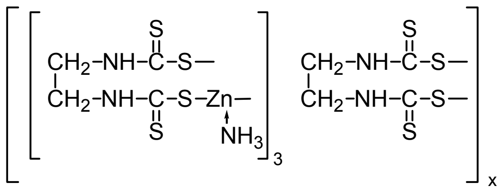
PHYSICAL CHEMISTRY:
Solubility: In water 6,2 ppm (pH 7,5 at 25 °C). Insoluble in most organic solvents; dissolves in solutions of powerful chelating agents but cannot be recovered from them.
Stability: Stable under normal, dry storage conditions. Slowly decomposed by heat and moisture. On hydrolysis
(25 °C), DT_{50} 20 days (pH 5); 17 hours (pH 7); 34 hours (pH 9). Mancozeb active ingredient is unstable and the technical material not isolated; the formulated product is produced in continuous process.
K_{ow} logP = 0,26.
ENVIRONMENTAL FATE:
Plants: Extensively metabolised in plants, forming ethylenethiourea, ethylenethiuram monosulfide, ethylenethiuram disulfide, and sulfur as transitory intermediates. Terminal metabolites are natural products, especially those derived from glycine.
Soil/Environment: Rapidly degraded in the environment by hydrolysis, oxidation, photolysis, and metabolism. Soil DT_{50} <1 day (average, 20 °C). K_{oc} 1 000 mℓ/g.

MANEB - alkylenebis(dithiocarbamate)



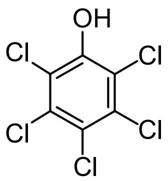
PHYSICAL CHEMISTRY:
Solubility: Practically insoluble in water and in common organic solvents. Soluble in chelating agents (e.g. sodium salts of ethylenediaminetetraacetic acid), with the formation of complexes.
Stability: Stable to light. Decomposes on prolonged exposure to air or moisture. On hydrolysis, DT_{50} <24 hours (pH 5, 7 or 9). Etem is one of the products formed on contact with moisture.
ENVIRONMENTAL FATE:
Plants: In plants, the principal metabolite is ethylenethiourea, which rapidly undergoes further metabolism. Ethylenethiuram monosulfide, ethylenethiuram disulfide, and sulfur are also metabolites.
Soil/Environment: Rapidly degraded in the environment by hydrolysis, oxidation, photolysis, and metabolism. Soil DT_{50} *ca.* 25 days (loamy sand in dark, aerobic conditions).

METIRAM - alkylenebis(dithiocarbamate)



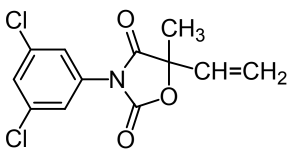
PHYSICAL CHEMISTRY:
Solubility: Practically insoluble in water. Soluble in pyridine (with decomposition). Practically insoluble in organic solvents (e.g. ethanol, acetone, benzene).
Stability: Stable at 30 °C. Slowly decomposed by light. Non-hygroscopic. Aqueous hydrolysis DT_{50} 17,4 hours
(pH 7).
K_{ow} logP = 0,3 (pH 7).
ENVIRONMENTAL FATE:
Plants: Extensively metabolised, mainly by hydrolysis and ring formation.
Soil/Environment: DT_{50} in soil 2,7 days (20 °C); DT_{50} in water 0,8 days.

PENTACHLOROPHENOL



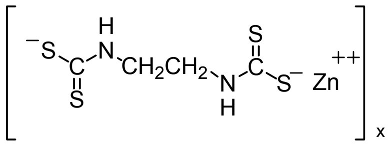
PHYSICAL CHEMISTRY:
Solubility: In water 80 mg/ℓ (30 °C). Soluble in most organic solvents, e.g. acetone 215 g/ℓ (20 °C). Slightly soluble in carbon tetrachloride and paraffins. The sodium, calcium and magnesium salts are soluble in water. **Stability:** Relatively stable and non-hygroscopic.
K_{ow} logP = 5,1 (25 °C, unionised).
ENVIRONMENTAL FATE:
Soil/Environment: Very persistent in the environment.

VINCLOZOLIN - dicarboximide



PHYSICAL CHEMISTRY:
Solubility: In water 2,6 mg/ℓ (20 °C). In methanol 1,54; acetone 33,4; ethyl acetate 23,3; *n*-heptane 0,45; toluene 10,9; dichloromethane 47,5 (all in g/100 mℓ solution at 20 °C).
Stability: Stable up to 50 °C. Stable for 24 hours in acidic media. In 0,1N sodium hydroxide, 50% hydrolysis occurs in 3,8 hours.
K_{ow} logP = 3 (pH 7)
ENVIRONMENTAL FATE:
Plants: In plants, the primary metabolites are (1-carboxy-1-methyl)allyl 3,5-dichlorophenylcarbamate and *N*-(3,5-dichlorophenyl)-2-hydroxy-2-methyl-3-butenamide. Alkaline hydrolysis leads to loss of 3,5-dichloroaniline from vinclozolin and its metabolites. The metabolites exist as conjugates.
Soil/Environment: Metabolism occurs by loss of the vinyl group, cleavage of the 5-membered ring and eventual formation of 3,5-dichloroaniline. K_{oc} 100-735. Soil degradation of vinclozolin takes place with half-lives of several weeks, and mainly leads to the formation of bound residues.

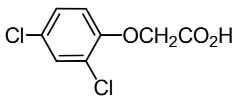
ZINEB - alkylenebis(dithiocarbamate)



PHYSICAL CHEMISTRY:
Solubility: In water *ca.* 10 mg/ℓ (room temperature). Practically insoluble in common organic solvents. Dissolves in some chelating agents, for example salts of ethylenediaminetetra-acetic acid, from which it cannot be recovered. **Stability:** Unstable to light, moisture and heat on prolonged storage (decomposition is reduced by stabilisers). When precipitated from concentrated solution, a polymer is formed which is less fungicidal.
K_{ow} logP ≤1,3 (20 °C)
ENVIRONMENTAL FATE:
Plants: Ethylenethiourea is the major metabolite in plants. Ethylenethiuram monosulfide and presumably ethylenethiuram disulfide and sulfur are also formed.

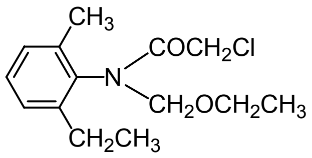
HERBICIDES

2,4-D - phenoxycarboxylic acid



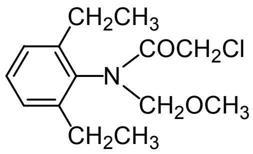
PHYSICAL CHEMISTRY:
Solubility: In water 311 (pH 1); 20 031 (pH 5); 23 180 (pH 7), 34 196 (pH 9) (all in mg/ℓ at 25 °C). In ethanol
1 250; diethyl ether 243; heptane 1,1; toluene 6,7, xylene 5,8 (all in g/kg at 20 °C); in octanol 120 g/ℓ (25 °C). Insoluble in petroleum oils. Mono-*n*-butylamine salt: in water 18 g/ℓ (30 °C).
Stability: 2,4-D is a strong acid, and forms water-soluble salts with alkali metals and amines. Hard water leads to precipitation of the calcium and magnesium salts, but a sequestering agent is included in formulations to prevent this. Photolytic DT_{50} (simulated sunlight) 7,5 days.
pKa 2,73. **K_{ow}** logP = 2,58-2,83 (pH 1); 0,04-0,33 (pH 5).
ENVIRONMENTAL FATE:
Plants: In plants, metabolism involves hydroxylation, decarboxylation, cleavage of the acid side-chain, and ring opening.
Soil/Environment: In soil, microbial degradation involves hydroxylation, decarboxylation, cleavage of the acid side-chain, and ring opening. DT_{50} in soil <7 days. K_{oc} *ca.* 60. Rapid degradation in the soil prevents significant downward movement under normal conditions.
2,4-D-dimethylammonium
PHYSICAL CHEMISTRY: Solubility: In water 3kg/ℓ (20 °C). Soluble in alcohols and acetone. Insoluble in kerosene and diesel oil.
2,4-D-isoctyl
PHYSICAL CHEMISTRY: Solubility: In water 10 mg/ℓ
2,4-D-sodium
PHYSICAL CHEMISTRY: Solubility: In water 18 g/ℓ (20 °C).

ACETOCHLOR - chloroacetamide



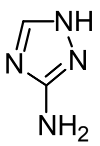
PHYSICAL CHEMISTRY:
Solubility: In water 223 mg/ℓ (25 °C). Soluble in diethyl ether, acetone, benzene, chloroform, ethanol, ethyl acetate, and toluene.
Stability: Stable for over 2 years at 20 °C (emulsifiable concentrate formulation).
K_{ow} logP = 4,14.
ENVIRONMENTAL FATE:
Plants: In maize and soya beans, rapidly absorbed and metabolised in the germinating plant. In maize, the first metabolite is glutathione, and in soya beans.
Soil/Environment: Adsorbed by soil, with little leaching. Microbial degradation accounts for most loss from soil; DT_{50} 8-18 days.

ALACHLOR - chloroacetamide



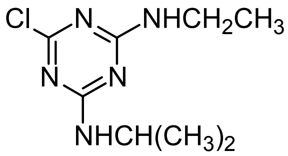
PHYSICAL CHEMISTRY:
Solubility: In water 170,31 mg/ℓ (pH 7 at 20 °C). Soluble in diethyl ether, acetone, benzene, chloroform, ethanol, and ethyl acetate. Slightly soluble in heptane.
Stability: Hydrolysed by strong acids and alkalis. Stable to ultra violet light. Decomposes at 105 °C.
K_{ow} logP = 3,09.
ENVIRONMENTAL FATE:
Plants: Rapidly metabolised in plants to 2-chloro-2',6'-diethylacetanilide, with further degradation to the aniline derivative.
Soil/Environment: Rapidly degraded in soil by microbial action to 2-chloro-2',6'-diethylacetanilide, with further degradation to the aniline derivative; DT_{50} 1-30 days. Persists in soil for *ca.* 6-10 weeks. In surface water, 55% degraded in 28 days.

AMITROLE - triazole



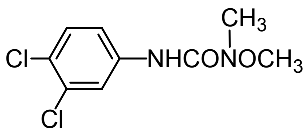
PHYSICAL CHEMISTRY:
Solubility: In water >1 384 (pH 4), 264 (pH 7), 261 (pH 10) (all in g/ℓ at 20 °C). In n-heptane and p-xylene <<0,1; dichloromethane <0,1; methanol 150; ethyl acetate 1 (all in g/ℓ).
Stability: Stable in neutral, acidic and alkaline media; DT_{50} >30 days (pH 4-9 at 23 °C). Photolysis DT_{50} >30 days (pH 5-9 at 25 °C). Powerful chelating agent.
pKa pKa_1 4,2; pKa_2 10,7. **K_{ow}** logP = -0,969 (pH 7 at 23 °C).
ENVIRONMENTAL FATE:
Plants: readily metabolised in plants, with formation of conjugates with endogenous plant constituents.
Soil/Environment: Persists in soil for *ca.* 2-4 weeks; loss from soil is principally by microbial degradation; DT_{50} (laboratory at
22 °C, aerobic) ≤5 days, DT_{90} (laboratory at 22 °C, aerobic) ≤22 days, DT_{50} (laboratory at 22 °C, anaerobic) <56 days.

ATRAZINE - 1,3,5-triazine



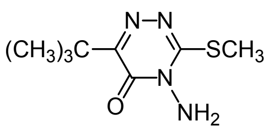
PHYSICAL CHEMISTRY:
Solubility: In water 33 mg/ℓ (pH 7 at 22 °C). In ethyl acetate 24; acetone 31; dichloromethane 28; ethanol 15; toluene 4,0;
n-hexane 0,11; *n*-octanol 8,7 (all in g/ℓ at 25 °C).
Stability: Relatively stable in neutral, weakly acidic and weakly alkaline media. Rapidly hydrolysed to the hydroxy derivative in strong acids and alkalis, and at 70 °C in neutral media; DT_{50} (pH 1) 9,5; (pH 5) 86; (pH 13) 5,0 days. **pKa** 1,7, very weak base. $\mathbf{K_{ow}}$ logP = 2,5 (25 °C)
ENVIRONMENTAL FATE:
Plants: In tolerant plants, atrazine is readily metabolised to hydroxyatrazine and amino acid conjugates, with further decomposition of hydroxyatrazine by degradation of the side-chains and hydrolysis of the resulting amino acids on the ring, together with evolution of CO_2. In sensitive plants, unaltered atrazine accumulates, leading to chlorosis and death.
Soil/Environment: Major metabolites under all conditions are desethylatrazine and hydroxyatrazine. Field DT_{50} 16-77 days (median 41 days), the longer values being from cold or dry conditions. In natural waters, DT_{50} 10-105 days (mean 55 days). DT_{50} under groundwater conditions 105->200 days, depending on test system. K_d 0,2-18 mℓ/g, K_{oc} 39-173 mℓ/g; desalkylated metabolites had values similar to those of atrazine, while hydroxyatrazine was much more strongly adsorbed.

LINURON - urea



PHYSICAL CHEMISTRY:
Solubility: In water 63,8 mg/ℓ (pH 7at 20 °C). In acetone 500; benzene, ethanol 150; xylene 130 (all in g/kg at 25 °C). Readily soluble in dimethylformamide, chloroform, and diethyl ether. Moderately soluble in aromatic hydrocarbons. Sparingly soluble in aliphatic hydrocarbons.
Stability: Stable at melting point and in aqueous solution at pH 5, 7 & 9; DT_{50} 945 days at all three pH values. $\mathbf{K_{ow}}$ logP = 3,00.
ENVIRONMENTAL FATE:
Plants: In plants, metabolism involves demethylation and demethoxylation.
Soil/Environment: Microbial degradation is the primary factor in disappearance from soil. DT_{50} under field conditions *ca.* 2-5 months. In soil, DT_{50} 38-67 days. Soil adsorption K_{oc} 500-600.

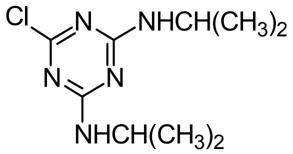
METRIBUZIN - 1,2,4-triazinone



PHYSICAL CHEMISTRY:
Solubility: In water 1,05 g/ℓ (20 °C). In dimethylformamide 1 780; cyclohexanone 1 000; chloroform 850; acetone 820; methanol 450; dichloromethane 333; benzene 220; *n*-butanol 150; ethanol 190; toluene 87; xylene 90; isopropanol 77; hexane 0,1-1,0 (all in g/ℓ at 20 °C).
Stability: Relatively stable to ultra violet irradiation. At 20 °C, stable to dilute acids and alkalis; DT_{50} (37 °C) 6,7 hours (pH 1,2); DT_{50} (70 °C) 569 hours (pH 4), 47 days (pH 7), 191 hours (pH 9). Photodecomposition in water is very rapid (DT_{50} <1 days). On soil surfaces under natural light conditions, DT_{50} 14-25 days.
$\mathbf{K_{ow}}$ logP = 1,6 (pH 5,6 at 20 °C)

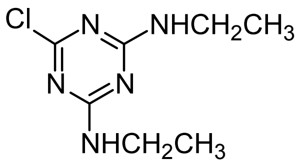
ENVIRONMENTAL FATE:
Plants: In plants, metribuzin undergoes oxidative deamination and further degradation to water-soluble conjugates. **Soil/Environment:** Rapidly degraded in soil; microbial breakdown is the major mechanism of loss; losses due to photodecomposition or volatilisation are insignificant; DT_{50} in soil *ca*. 1-2 months; DT_{50} in pond water *ca*. 7 days. Degradation involves deamination, followed by further degradation to water-soluble conjugates.

PROPAZINE - 1,3,5-triazine



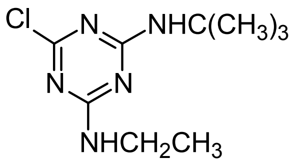
PHYSICAL CHEMISTRY:
Solubility: In water 5,0 mg/ℓ (20 °C). In benzene, toluene 6,2; diethyl ether 5,0; carbon tetrachloride 2,5 (all in g/kg at 20 °C).
Stability: stable in neutral, slightly acidic, and slightly alkaline media. Hydrolysed by acids and alkalis on heating, with the formation of hydroxypropazine.
pKa 1,7 (21 °C), very weak base.
ENVIRONMENTAL FATE:
Plants: In tolerant plants, the chlorine atom is hydrolysed, to give 6-hydroxypropazine. Both substituted amino groups are dealkylated, presumably followed by ring opening and decomposition. In susceptible plants, propazine is not readily metabolised to non-phytotoxic compounds, but instead accumulates and causes death.
Soil/Environment: In soil, microbial degradation occurs, with hydrolysis of the chlorine atom to give hydroxypropazine, dealkylation of both substituted amino groups, presumably followed by ring opening and decomposition. DT_{50} 80-100 days. Propazine is mobile: K_{ads} 0.67-3.19, K_{oc} 65-268 (8 soil types); hydroxypropazine is less mobile.

SIMAZINE - 1,3,5-triazine



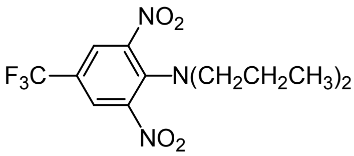
PHYSICAL CHEMISTRY:
Solubility: In water 6,2 mg/ℓ (pH 7 at 20 °C). In ethanol 570; acetone 1 500; toluene 130; *n*-octanol 390; *n*-hexane 3,1 (all in mg/ℓ at 25 °C).
Stability: Relatively stable in neutral, weakly acidic and weakly alkaline media. Rapidly hydrolysed by stronger acids and bases; DT_{50} (calculated) 8,8 days (pH 1); 96 days (pH 5); 3,7 days (pH 13) (all at 20 °C). Decomposed by ultra violet irradiation (*ca.* 90% in 96 hours).
pKa 1,62 (20 °C), very weak base. $\mathbf{K_{ow}}$ logP = 2,1 (25 °C, unionised).
ENVIRONMENTAL FATE:
Plants: Readily metabolised by tolerant plants to the herbicidally-inactive 6-hydroxy analogue and amino acid conjugates. The hydroxysimazine is further degraded by dealkylation of the side-chains and by hydrolysis of the resulting amino groups on the ring, with evolution of CO_2. In sensitive plants, unaltered simazine leads to chlorosis and death.
Soil/Environment: Major metabolites under all conditions are desethylsimazine and hydroxysimazine. Microbial breakdown in soil results in degradation of simazine at very variable rates; DT_{50} 27-102 days (median 49 days); temperature and soil moisture are the main factors affecting rates. K_{oc} 103-277 (median 160); K_d 0,37-4,66 (12 soils). Under field conditions, simazine has a low leaching potential. Loss by direct photodecomposition is insignificant. Indirect photodecomposition in the presence of photosensitisers such as humic acids is, however, likely.

TERBUTHYLAZINE - 1,3,5-triazine



PHYSICAL CHEMISTRY:
Solubility: In water 8,5 mg/ℓ (pH 7 at 20 °C). In acetone 41; ethanol 14; *n*-octanol 12; *n*-hexane 0,36 (all in g/ℓ at 25 °C).
Stability: Stable in neutral, weakly acidic and weakly alkaline media; hydrolysed in acidic or alkaline media; DT_{50} (20 °C) (calculated) 8 days (pH 1); 12 days (pH 13). In natural sunlight, DT_{50} >40 days.
pKa 2,0 very weak base. **K_{ow}** logP = 3,21 (unionised)
ENVIRONMENTAL FATE:
Plants: Triazine-tolerant plants (e.g. maize) rapidly de-chlorinate terbuthylazine to hydroxy-terbuthylazine. Various amounts of de-ethylated and hydroxy de-ethylated metabolites are produced, depending on the plant species. **Soil/Environment:** Adsorption on soils is strong: K_{oc} 162-278, K_d 2,2-25 are typical values for light agricultural soils. Terbuthylazine is only slightly mobile. Microbial degradation proceeds mainly by de-ethylation and hydroxylation, with eventual ring cleavage. DT_{50} 30-60 days in biologically active soil.

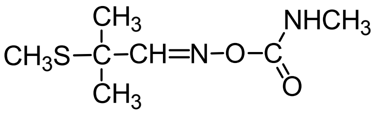
TRIFLURALIN - dinitroaniline



PHYSICAL CHEMISTRY:
Solubility: In water 0,184 (pH 5); 0,221 (pH 7); 0,189 (pH 9) (all in mg/ℓ); technical material 0,343 (pH 5); 0,395 (pH 7); 0,383 (pH 9) (all in mg/ℓ). In acetone, chloroform, acetonitrile, toluene, ethyl acetate >1 000; methanol 33-40; hexane 50-67 (all in g/ℓ at 25 °C).
Stability: Stable at 52 °C (highest storage temperature tested). Stable to hydrolysis at pH 3,6 and 9 (52 °C). Decomposed by ultra violet irradiation.
K_{ow} logP = 4,83 (20 °C)
ENVIRONMENTAL FATE:
Plants: Degradation in plants is as for soil.
Soil/Environment: Adsorbed by the soil, and is extremely resistant to leaching. Little lateral movement in the soil. Metabolism involves dealkylation of the amino group, reduction of the nitro group to an amino group, partial oxidation of the trifluoromethyl group to a carboxy group, and subsequent degradation to smaller fragments; DT_{50} 57-126 days. Duration of residual activity in soil is 6-8 months. In laboratory studies, degradation was more rapid under anaerobic conditions, e.g. for loam soil, DT_{50} (anaerobic) 25-59 days, DT_{50} (aerobic) 116-201 days. Soil photolysis DT_{50} 41 days; aqueous photolysis DT_{50} 0,8 hours. K_{oc} 4 400-40 000; K_d ranges from 3,75 (0.01% organic matter, pH 6,6) to 639 (16.9% organic matter, pH 6,8).

INSECTI-, ACARI-, NEMATICIDES

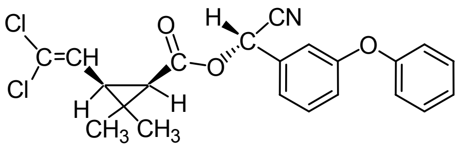
ALDICARB



PHYSICAL CHEMISTRY:
Solubility: In water 4,93 g/ℓ (pH 7 at 20 °C). Soluble in most organic solvents, e.g. in acetone 350, dichloromethane 300, benzene 150, xylene 50 (all in g/kg at 25 °C). Practically insoluble in heptane and in mineral oils. The sulfoxide has solubility >330 g/ℓ in water.
Stable in neutral, acidic, and weakly alkaline media. Hydrolysed by concentrated alkalis. Decomposes above 100 °C. Rapidly converted by oxidising agents to the sulfoxide, which is more slowly oxidised to the sulfone (aldoxycarb).
ENVIRONMENTAL FATE:
Plants: In plants, the sulfur atom is oxidised to sulfoxide and sulfone groups. The highly soluble sulfoxide acts systemically on the plant, and is 10-20 times more active as a cholinesterase inhibitor than aldicarb itself. Further degradation leads to the formation of oximes, nitriles, amides, acids and alcohols which are present in the plant only in conjugated form.
Soil/Environment: In soil, the sulfur atom is oxidised to sulfoxide and sulfone groups. Further degradation leads to the formation of oximes, nitriles, amides, acids and alcohols. Rapidly degraded in acid soils (pH >7.0), less so at pH ≤5.5.

ALPHA-CYPERMETHRIN

(*S*) (1*R*)-*cis*-



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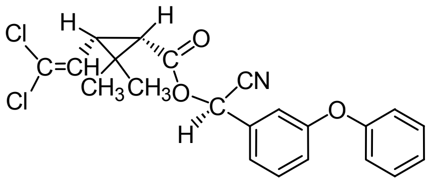
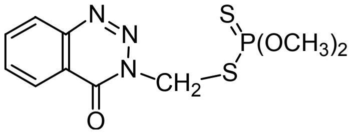


(*R*) (1*S*)-*cis*-

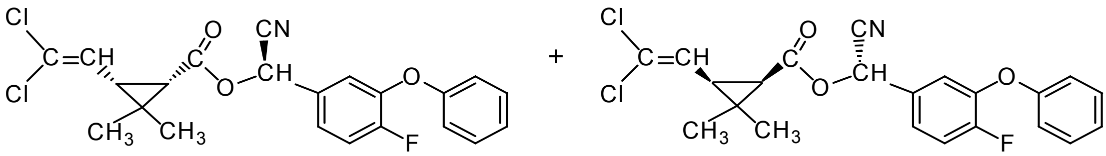
PHYSICAL CHEMISTRY:
Solubility: In water 0,67 (pH 4), 3,97 (pH 7), 4,54 (pH 9), 1,25 (double distilled water) (all in µg/ℓ at 20 °C). In *n*-hexane 6,5; toluene 596; methanol 21,3; isopropanol 9,6; ethyl acetate 584; acetone:hexane >0,5 (all in g/ℓ at 21 °C); miscible in dichloromethane and in acetone (>10^3 g/ℓ).
Stability: Very stable in neutral and acidic media, hydrolysed in strongly alkaline media; DT_{50} (pH 4 at 50 °C) stable over 10 days, (pH 7 at 20 °C) 101 days, (pH 9 at 20 °C) 7,3 days. Thermally stable up to 220 °C. Field data indicate that, in practice, it is stable to air.
Soil/Environment: Undergoes degradation in soil, DT_{50} *ca.* 13 weeks in loamy soil. See also cypermethrin (*q.v.*).

AZINPHOS-METHYL

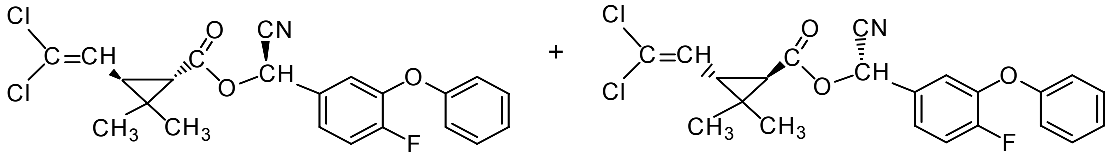


PHYSICAL CHEMISTRY:
Solubility: In water 28 mg/ℓ (20 °C). In dichloroethane, acetone, acetonitrile, ethyl acetate, dimethyl sulfoxide >250, *n*-heptane 1,2; xylene 170 (all in g/ℓ at 20 °C).
Stability: Rapidly hydrolysed in alkaline and acidic media; DT_{50} (22 °C) 87 days (pH 4), 50 days (pH 7), 4 days (pH 9). Photodegrades on soil surfaces and readily photodegrades in water.
ENVIRONMENTAL FATE:
Plants: In plants, major metabolites identified included azinphos-methyl-oxon, banzazimide, mercaptomethyl benzazimide and cysteinmethyl benzazimide
Soil/Environment: Degradation involves oxidation, demethylation, and hydrolysis. Based on the K_{oc} values and leaching studies, azinophos-methyl can be classified as a compound with low mobility. The halr-life in soil is several weeks.

BETA-CYPERMETHRIN



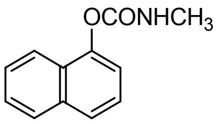
(II)



(IV)

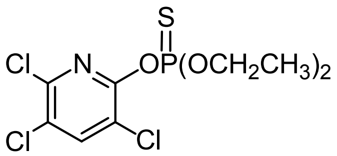
PHYSICAL CHEMISTRY:
Solubility: In water 51,5 (5 °C); 93,4 (25 °C); 276,0 (35 °C) (all in µg/ℓ at pH 7). In isopropanol 11,5; xylene 349,8; dichloromethane 3 878; acetone 2 102; ethyl acetate 1 427; petroleum ether 13,1 (all in mg/mℓ at 20 °C).
Stability: Stable to 150 °C; to air and sunlight; in neutral and slightly acidic media; epimerised in presence of base, hydrolysed in strongly alkaline media. DT_{50} (extrapolated) 50 days (pH 3, 5, 6), 40 days (pH 7), 20 days (pH 8), 15 days (pH 9) (all at 25 °C).
ENVIRONMENTAL FATE:
Soil/Environment: Soil DT_{50} 10 days (lime-furred chernozom, pH 6,96). DT_{50} in water 1,2 days.

CARBARYL



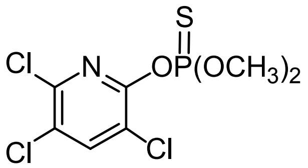
PHYSICAL CHEMISTRY:
Solubility: In water 120 mg/ℓ (20 °C). Readily soluble in polar organic solvents. In dimethylformamide, dimethyl sulfoxide 400-450, acetone 200-300, cyclohexanone 200-250, isopropanol 100, xylene 100 (all in g/kg at 25 °C).
Stability: Stable under neutral and weakly acidic conditions. Hydrolysed in alkaline media to 1-naphthol; DT_{50} *ca.* 12 days (pH 7), 3,2 hours (pH 9). Stable to light and heat.
ENVIRONMENTAL FATE:
Plants: Metabolites are 4-hydroxycarbaryl, 5-hydroxycarbaryl and methylol-carbaryl.
Soil/Environment: Under aerobic conditions, carbaryl at 1 ppm degraded with DT_{50} 7-14 days in a sandy loam and 14-28 days in clay loam.

CHLORPYRIFOS (ETHYL)



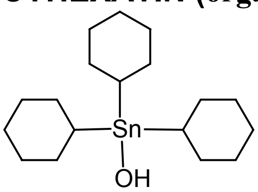
PHYSICAL CHEMISTRY:
Solubility: In water *ca.* 1,4 mg/ℓ (25 °C). In benzene 7 900, acetone 6 500, chloroform 6300, carbon disulfide 5 900, diethyl ether 5 100, xylene 5 000, iso-octanol 790, methanol 450 (all in g/kg at 25 °C).
Stability: Rate of hydrolysis increases with pH, and in the presence of copper and possibly of other metals that can form chelates; DT_{50} 1,5 days (water, pH 8 at 25 °C) to 100 days (phosphate buffer, pH 7 at 15 °C).
ENVIRONMENTAL FATE:
Plants: Non-systemic in plants, not absorbed from soil via the roots. Residues taken up by plant tissues are metabolised to 3,5,6-trichloropyridin-2-ol, which is conjugated and sequestered.
Soil/Environment: In soil, chlorpyrofos is degraded at a moderate rate; DT_{50} in laboratory, 10-120 days (25 °C); field DT_{50} for soil-incorporated applications 33-56 days, for soil-surface applications 7-15 days. Primary route of degradation is transformation to 3,5,6-trichloropyridin-2-ol, which is subsequently degraded to organochlorine compounds and CO_2. K_{oc} 1 250-12 600.

CHLORPYRIFOS-METHYL



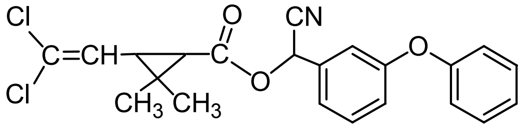
PHYSICAL CHEMISTRY:
Solubility: In water 2.6 mg/l (20 °C). In acetone >400, methanol 190, hexane 120 (all in g/kg, 20 °C).
Stability: Hydrolysis DT_{50} 27 days (pH 4), 21 days (pH 7), 13 days (pH 9). Aqueous photolysis DT_{50} 1,8 days (June); 3,8 days (December). K_{ow} logP = 4,24
ENVIRONMENTAL FATE:
Solubility: In water 2.6 mg/l (20 °C). In acetone >400, methanol 190, hexane 120 (all in g/kg, 20 °C).
Stability Hydrolysis DT_{50} 27 d (pH 4), 21 d (pH 7), 13 d (pH 9). Aqueous photolysis DT_{50} 1.8 d (June), 3.8 d (December).
Soil/Environment: In soil, undergoes microbial degradation to 3,5,6-trichloropyridin-2-ol, which is subsequently degraded to organochlorine compounds and CO_2; DT_{50} 1,5-33 days, DT_{90} 14-47 days, depending upon soil type and microbial activity.
K_d 3,5-407 mℓ/g, depending on soil type. K_{oc} is more constant: 1 190-8 100 mℓ/g.

CYHEXATIN (organotin acaricide)



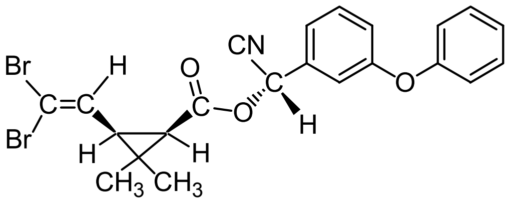
PHYSICAL CHEMISTRY:
Solubility: In water <1 mg/ℓ (25 °C). In chloroform 216; methanol 37; dichloromethane 34; carbon tetrachloride 28; benzene 16; toluene 10; xylene 3,6; acetone 1,3 (all in g/kg at 25 °C).
Stability: Stable to 100 °C in aqueous suspensions from slightly acid (pH 6) to alkaline conditions; degraded by ultra violet light.
ENVIRONMENTAL FATE:
Soil/Environment: Dicyclohexyl tin hydroxide, monocyclohexyl tin hydroxide, and inorganic tin compounds are formed as metabolites. Degradation is promoted by ultra violet light.

CYPERMETHRIN



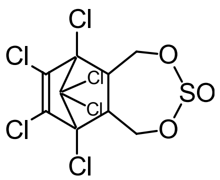
PHYSICAL CHEMISTRY:
Solubility: In water 0,004 mg/ℓ (pH 7). In acetone, chloroform, cyclohexanone, xylene >450, ethanol 337, hexane 103 (all in g/ℓ at 20 °C).
Stability: Relatively stable in neutral and weakly acidic media, with optimum stability at pH 4. Hydrolysed in alkaline media; DT_{50} 1,8 days (pH 9 at 25 °C); stable at pH 5 and 7 (20 °C). Relatively stable to light in field situations. Thermally stable up to 220 °C.
ENVIRONMENTAL FATE:
Soil/Environment: In soil, typical DT_{50} 60 days (fine sandy loam); hydrolysis with cleavage of the ester bond occurs and also further hydrolytic and oxidative degradation. Field dissipation is much faster. K_{oc} 26 492-144 652; K_f 821-1 042; not pH-dependent. In river water, rapid degradation occurs, DT_{50} *ca.* 5 days. DT_{50} for photochemical oxidative degradation in air 3,47 hours.

DELTAMETHRIN



PHYSICAL CHEMISTRY:
Solubility: In water <0,2 µg/l (25 °C). In dioxane 900, cyclohexanone 750, dichloromethane 700, acetone 500, benzene 450, dimethyl sulfoxide 450, xylene 250, ethanol 15, isopropanol 6 (all in g/ℓ at 20 °C).
Stability: Extremely stable on exposure to air. Stable ≤190 °C. Under ultra violet irradiation and in sunlight, a *cis-trans* isomerisation, splitting of the ester bond, and loss of bromine occur. More stable in acidic than in alkaline media; DT_{50} 2,5 days (pH 9 at 25 °C).
ENVIRONMENTAL FATE:
Plants: No uptake through leaves and roots - non-systemic compound. No major metabolites, except in oily crops, where *trans*-deltamethrin is part of the residue definition.
Soil/Environment: In soil, undergoes microbial degradation within 1-2 weeks. K_d 3 790-30 000, K_{oc} 4.6 x 10^5-1,63 x 10^7 cm^3/g, confirms strong adsorption by soil colloids and no risk of leaching. DT_{50} (laboratory, aerobic) 21-25 days, (anaerobic) 31-36 days. In field, DT_{50} <23 days. Soil photolysis DT_{50} 9 days. No incidence on soil microflora and nitrogen cycle.

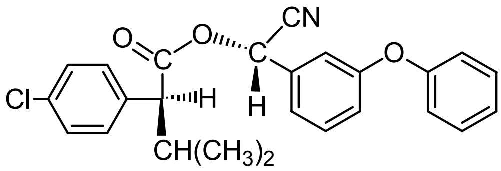
ENDOSULFAN



PHYSICAL CHEMISTRY:
Solubility In water alpha-endosulfan 0,32; beta-endosulfan 0,33 (both in mg/ℓ, 22 °C). In ethyl acetate, dichloromethane, toluene 200, ethanol *ca.* 65, hexane *ca.* 24 (all in g/ℓ, 20 °C).
Stability: Stable to sunlight. Slowly hydrolysed in aqueous acids and alkalis, with the formation of the diol and sulfur dioxide.
ENVIRONMENTAL FATE:
Plants: The plant metabolites (mainly endosulfan sulfate) were also found in animals and have thus been investigated from a toxicological point of view. 50% of residues are lost in 3-7 days (depending on plant species).
Soil/Environment: Endosulfan (alpha- and beta-) is degraded in soil with DT_{50} 30-70 days. The main metabolite usually found was endosulfan sulfate, which is degraded more slowly and is, for this reason,

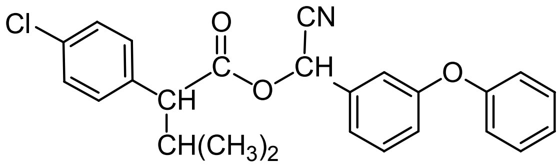
the most important metabolite. DT_{50} for total endosulfan (alpha- and beta-endosulfan and endosulfan sulfate) in the field is 5-8 months. No leaching tendency was observed. K_{oc} 3 000-20 000; K_d <3%.

ESFENVALERATE



PHYSICAL CHEMISTRY:
Solubility: In water 0,002 mg/ℓ (25 °C). In xylene, acetone, chloroform, ethyl acetate, dimethylformamide, dimethyl sulfoxide >600, hexane 10-50, methanol 70-100 (all in g/kg at 25 °C).
Stability: Relatively stable to heat and light. Stable to hydrolysis at pH 5, 7 and 9 (25 °C).
ENVIRONMENTAL FATE:
Plants: The major metabolite was decarboxylated fenvalerate. Ester cleavage, hydration of the cyano group to carboxamide and carboxylic acid, hydroxylation of the 2'- and 4'- phenoxy positions, conversion of the alcohol moiety to 3-phenoxybenzyl alcohol and 3-phenoxybenzoic acid, and conjugation of the resulting carboxylic acids and alcohols with sugars, also occur. **Soil/Environment:** In sand (0,38 % organic matter), K_d (25 °C) 4,4; in sandy loam (pH 7,3; 1,1% organic matter), K_d (25 °C) 6,4 DT_{50} 88 d; in silty loam (pH 5.3, 2.0% o.m.), K_d (25 °C) 71, DT_{50} 114 d; in clay loam (pH 5.7, 0.2% o.m.), DT_{50} 287 d; in clay loam (pH 6,4; 1,5 % organic matter), K_d (25 °C) 105. K_{oc} 5 300 (soil sorption coefficient for the proportion of organic carbon in soil).

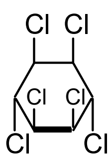
FENVALERATE



PHYSICAL CHEMISTRY:
Solubility: In water <10 µg/l (25 °C). In *n*-hexane 53, xylene ≥200, methanol 84 (all in g/l, 20 °C).
Stability: Stable to heat and moisture. Relatively stable in acidic media, but rapidly hydrolysed in alkaline media.

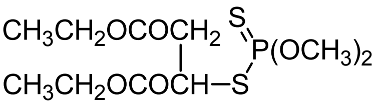
ENVIRONMENTAL FATE:
Plants: In plants, fenvalerate is split into two parts by cleavage of the ether group, followed by further hydroxylation in the 2- and 4- positions of the phenoxy ring, and hydrolysis of the nitrile group to amide and carboxyl groups. The majority of the acids and phenols thus formed are converted into glucosides.
Soil/Environment: In aqueous media, the ester bond is hydrolysed. In light, decarboxylation occurs, with recombination of the cleaved moieties. DT_{50} in soil *ca.* 75-80 days.

gamma-BHC



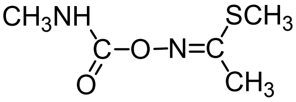
PHYSICAL CHEMISTRY:
Solubility: In water 8,52 (25 °C); 8,35 (pH 5 at 25 °C) (both in mg/ℓ). In acetone >200, methanol 29-40, xylene >250, ethyl acetate <200, *n*-heptane 10-14 (all in g/ℓ at 20 °C).
Stability: Extremely stable to light, air, temperatures up to 180 °C, and to acids. In alkalis, undergoes dehydrochlorination.
ENVIRONMENTAL FATE:
Plants: After uptake by the roots, chlorinated phenols were found.

MERCAPTOTHION (MALATHION)



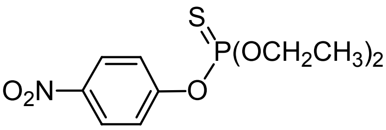
PHYSICAL CHEMISTRY:
Solubility: In water 145 mg/ℓ (25 °C). Miscible with most organic solvents, e.g. alcohols, esters, ketones, ethers, aromatic hydrocarbons. Slightly soluble in petroleum ether and some types of mineral oil.
Stability: Relatively stable in neutral, aqueous media. Decomposed by strong acids and by alkali; hydrolysis DT_{50} 107 days (pH 5), 6 days (pH 7), 0,5 days (pH 9) (all at 25 °C).
ENVIRONMENTAL FATE:
Plants: De-esterified to its mono- and di- carboxylic acids, which are cleaved to yield succinic acid, which is subsequently incorporated into plant constituents.
Soil/Environment: Under normal conditions, it is 99% degraded by hydrolysis within 7 days.

METHOMYL



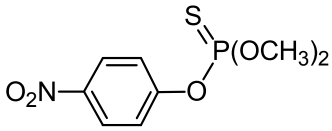
PHYSICAL CHEMISTRY:
Solubility: In water 57,9 g/ℓ (25 °C). In methanol 1 000, acetone 730, ethanol 420, isopropanol 220, toluene 30 (all in g/kg at 25 °C). Sparingly soluble in hydrocarbons.
Stability: Stable in water for 30 days (pH 5 and 7 at 25 °C); DT_{50} *ca*. 30 days (pH 9 at 25 °C). Stable up to 140 °C. Stable to sunlight when exposed for 120 days.
ENVIRONMENTAL FATE:
Plants: DT_{50} following leaf application *ca.* 3-5 days. Rapidly degraded to CO_2 and acetonitrile, with incorporation into natural plant components.
Soil/Environment: Rapidly degraded in soil. DT_{50} 4-8 days at 20°C and soil moisture pF 2-2,5 in soils with pH from 5,1 to 7,8 and with 1,2 to 3,6% organic matter. DT_{50} in groundwater samples <0,2 days. K_{oc} 72.

PARATHION



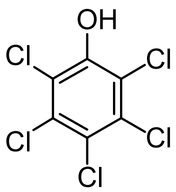
PHYSICAL CHEMISTRY:
Solubility: In water 11 mg/ℓ (20 °C). Completely miscible with most organic solvents, e.g. dichloromethane >200, isopropanol, toluene, hexane 50-100 (all in g/ℓ at 20 °C).
Stability: Hydrolysed very slowly in acidic media (pH 1-6), more rapidly in alkaline media; DT_{50} (22 °C) 272 days (pH 4), 260 days (pH 7), 130 days (pH 9). Isomerises on heating above 130 °C, to the *O,S*-diethyl analogue. $\mathbf{K_{ow}}$ logP = 3,83.
ENVIRONMENTAL FATE:
Plants: The major metabolites are paraoxon, diethylphosphate, 4-nitrophenol and photometabolites *S*-ethyl patathion and *S*-phenyl parathion.
Soil/Environment: Based on K_{oc} values and leaching studies, parathion can be classified as a compound with low mobility. In biologically-active soils, parathion is rapidly degraded under laboratory conditions as well as in the field. The degradation results in CO_2 via very short-lived intermediate products such as paraoxon, aminoparathion and 4-nitrophenyl.

PATATHION-METHYL



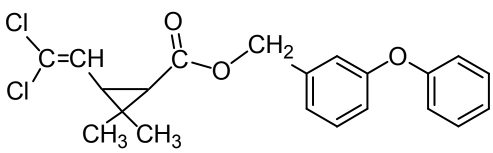
PHYSICAL CHEMISTRY:
Solubility: In water 55 mg/ℓ (20 °C). Readily soluble in common organic solvents, e.g. dichloromethane, toluene >200, hexane 10-20 (all in g/ℓ at 20 °C). Sparingly soluble in petroleum ether and some types of mineral oil.
Stability: Hydrolysed in alkaline and acidic media (*ca.* 5x more rapidly than parathion); DT_{50} (25 °C) 68 days (pH 5), 40 days (pH 7), 33 days (pH 9). Isomerises on heating, to the *O,S*-dimethyl analogue. Photodegrades in water.
K_{ow} logP = 3.0
ENVIRONMENTAL FATE:
Plants: The major metabolits formed in plants are 4-nitorphenol, 4-nitrophenyl glucopyranoside and *P-S*-demethyl parathion-methyl.
Soil/Environment: Based on the K_{oc} values and leaching studies, parathion-methyl can be classified as a compound with low/medium mobility. In biologically-active soils, parathion-methyl is rapidly degraded. As for phosphorothioates in general, metabolism is by oxidation to the phosphate, demethylation of the ester groups, and hydrolysis to phosphorothioic acid, phosphoric acid, and 4-nitrophenol.

PENTACHLOROPHENOL



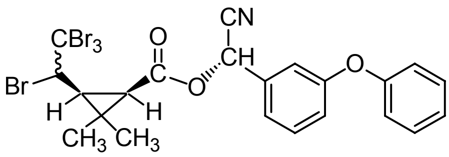
PHYSICAL CHEMISTRY:
Solubility: In water 80 mg/ℓ (30 °C). Soluble in most organic solvents, e.g. acetone 215 g/ℓ (20 °C). Slightly soluble in carbon tetrachloride and paraffins. The sodium, calcium and magnesium salts are soluble in water. **Stability** Relatively stable and non-hygroscopic. **K_{ow}** logP = 5.1 (25 °C, unionised)
ENVIRONMENTAL FATE:
Soil/Environment: Very persistent in the environment

PERMETHRIN



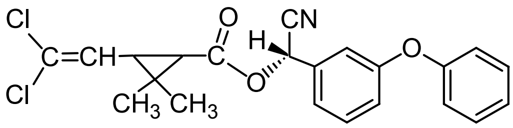
PHYSICAL CHEMISTRY:
Solubility: In water 6 x 10^{-3} mg/ℓ (pH 7 at 20 °C). In xylene, hexane >1000, methanol 258 (all in g/kg at 25 °C).
Stability: Stable to heat (≥2 years at 50 °C), more stable in acidic than alkaline media, with optimum stability *ca.* pH 4; DT_{50} 50 days (pH 9), stable (pH 5, 7) (all at 25 °C). Some photochemical degradation observed in laboratory studies, but field data indicate this does not adversely affect biological performance.
ENVIRONMENTAL FATE:
Soil/Environment In soil and water, degradation is rapid. DT_{50} in soil <38 days (pH 4,2-7,7 organic matter 1,3-51,3 %).

TRALOMETHRIN



PHYSICAL CHEMISTRY:
Solubility: In water 80 µg/ℓ. In acetone, dichloromethane, toluene, xylene >1 000, dimethyl sulfoxide >500, ethanol >180 (all in g/ℓ).
Stablility: Stable for 6 months at 50 °C. Acid media reduce hydrolysis and epimerization.
ENVIRONMENTAL FATE:
Plants: Tralomethrin is transformed into deltamethrin.
Soil/Environment: Strongly adsorbed in soil; DT_{50} 64-84 days. K_{oc} 43 796-675 667; highly immobile in various soils (sandy to clay loam).

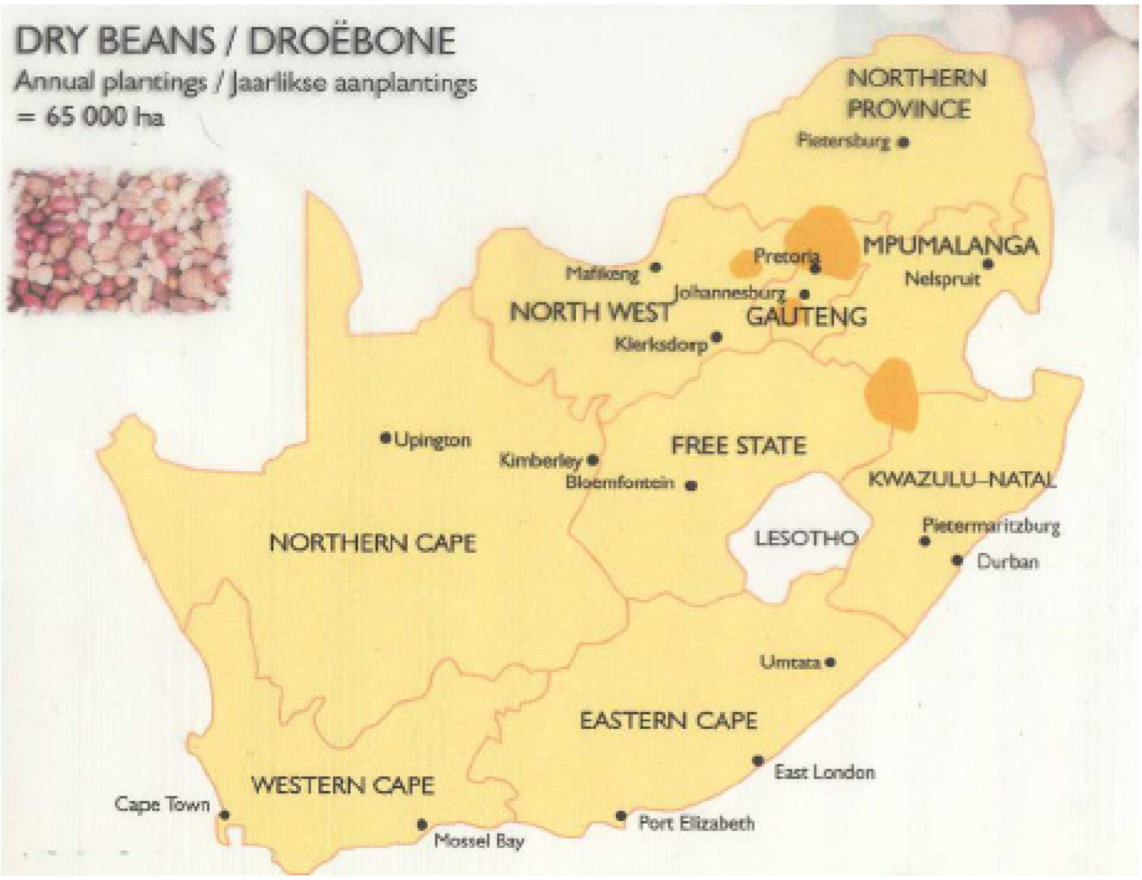
ZETA-CYPERMETHRIN

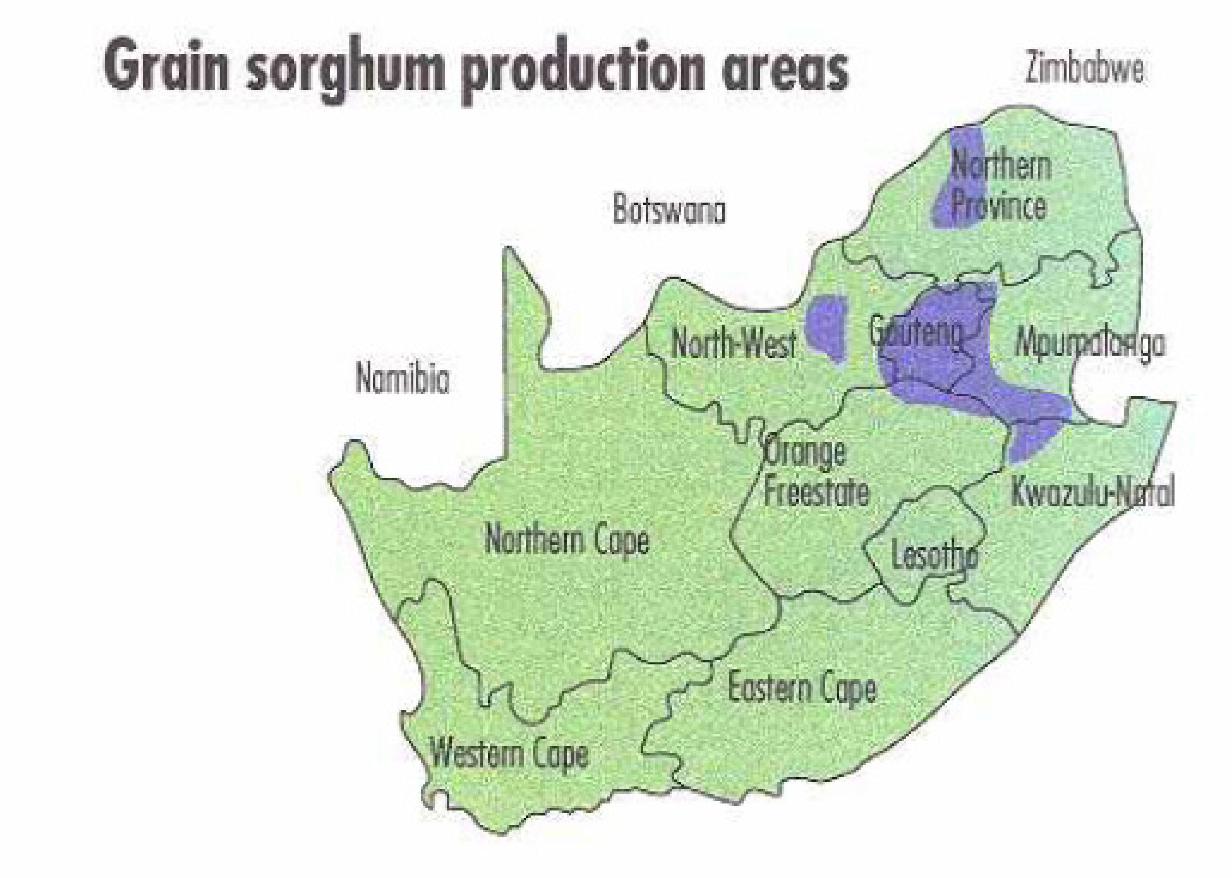


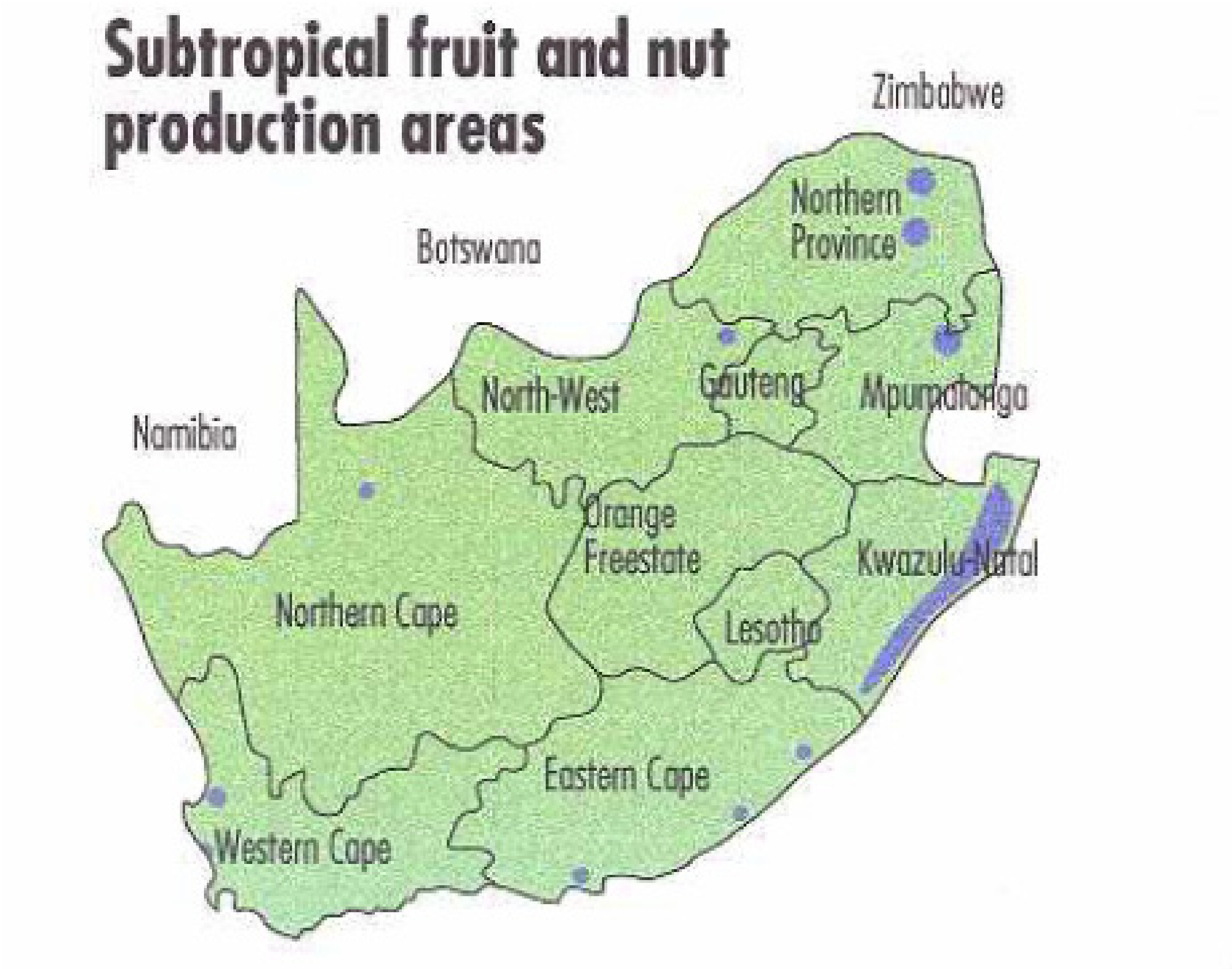
PHYSICAL CHEMISTRY:
Solubility: In water 0,045 mg/ℓ (25 °C). Miscible in most organic solvents.
Stability: Stable at 50 °C for 1 year. Photolysis DT_{50} (aqueous solution) 20,2-36,1 days (pH 7). Hydrolysis DT_{50} 508-769 days (pH 5), 188-635 days (pH 7), 2,9 days (pH 9).
ENVIRONMENTAL FATE :
Soil/Environment: DT_{50} 14-28 days in a typical fertile soil. Immobile; strongly adsorbs to organic material. K_{oc} 11 542-54 913.

ANNEXURE E

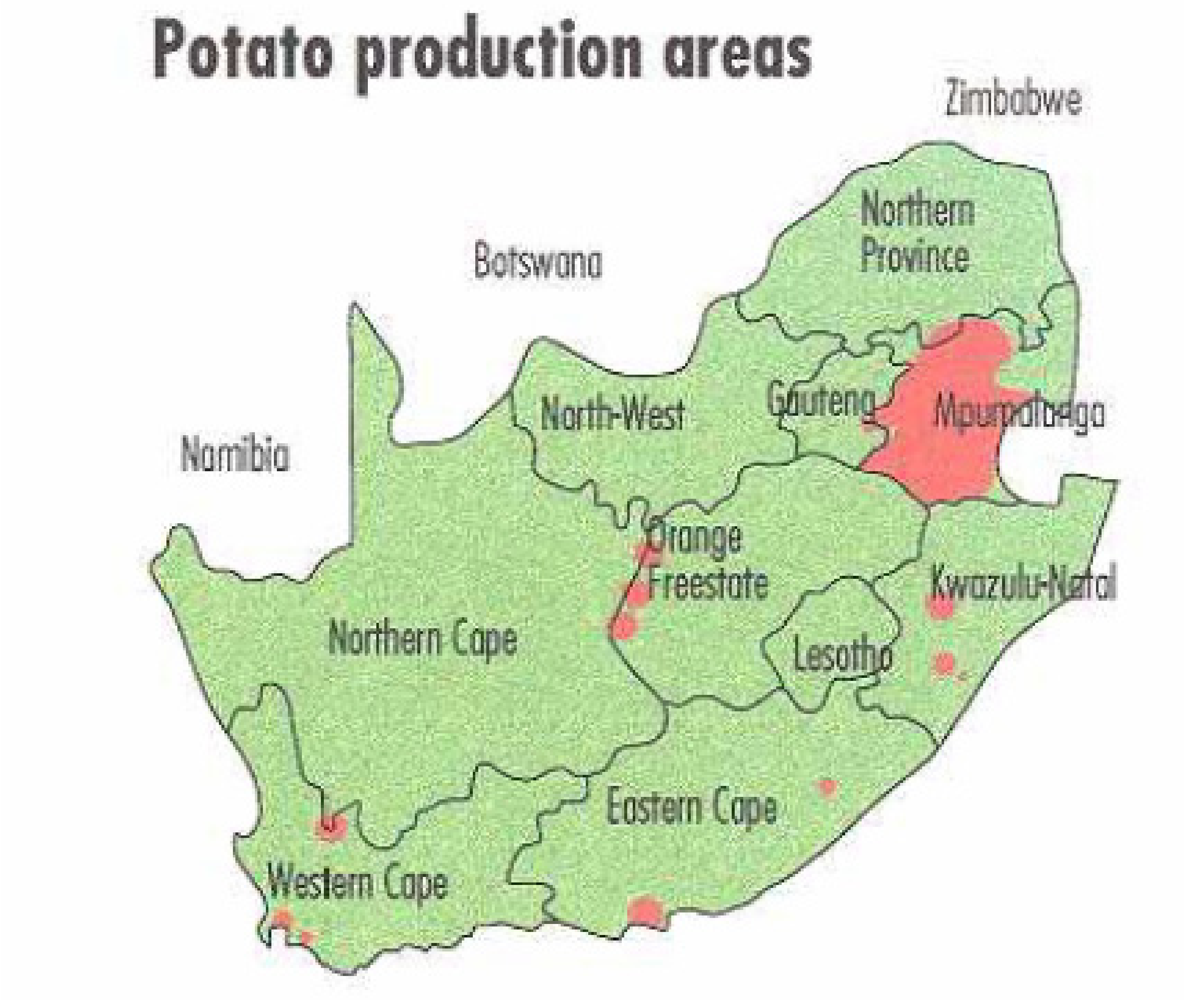
Production areas of selected crops



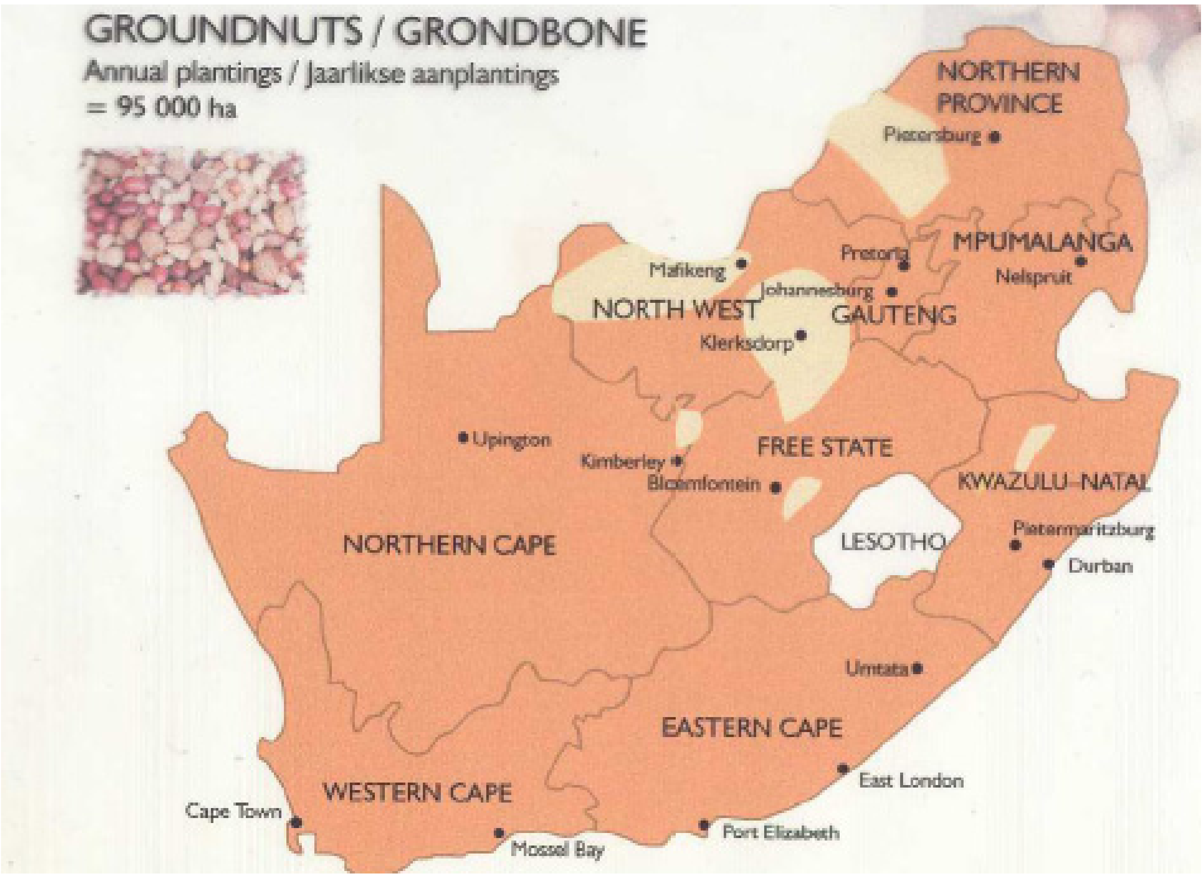

Grain sorghum production areas
Zimbabwe
Botswana
Northern
Province
Namibia
North-West
Gauteng
Mpumalanga
Orange
Freestate
Kwazulu-Natal
Northern Cape
Lesotho
Eastern Cape
Western Cape

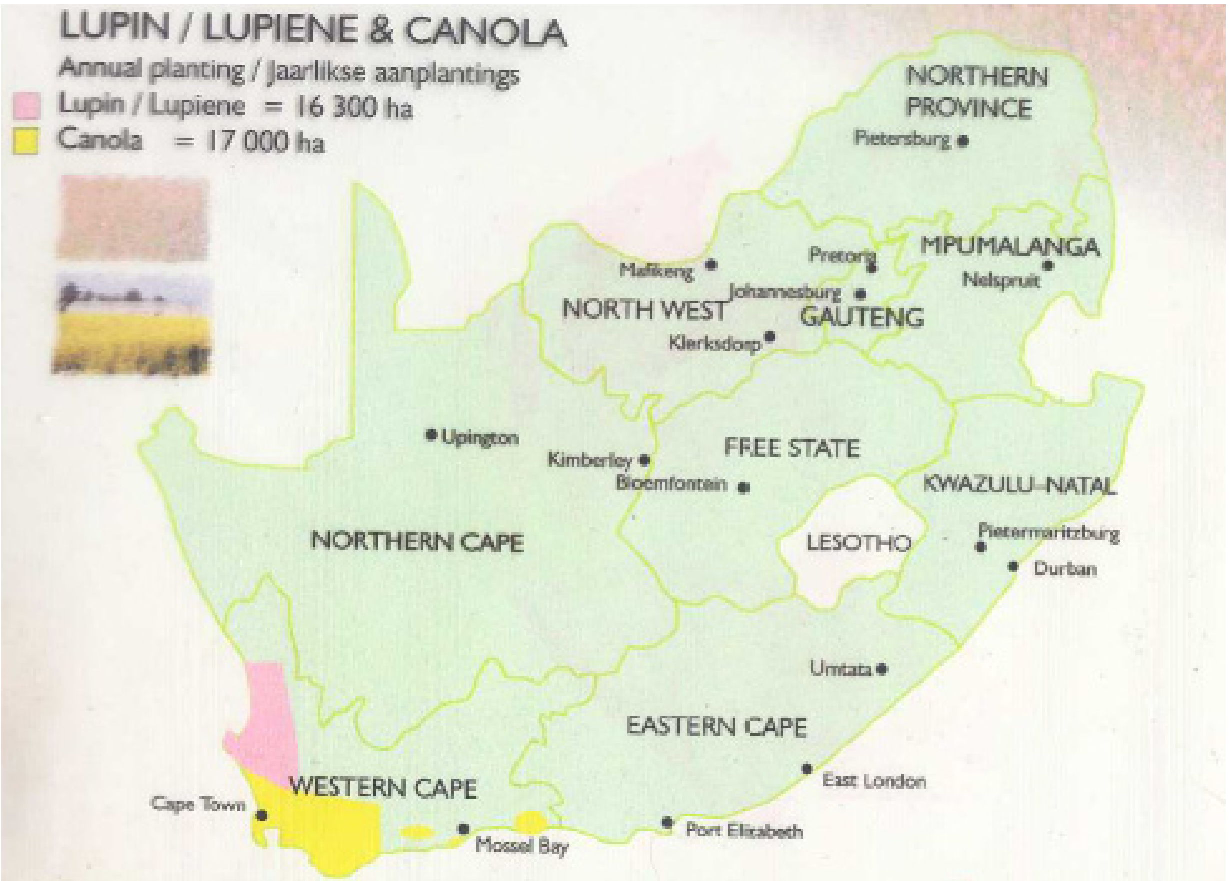

Subtropical fruit and nut production areas
Zimbabwe
Botswana
Namibia
Northern Province
North-West
Gauteng
Mpumalanga
Orange Freestate
Kwazulu-Natal
Lesotho
Northern Cape
Eastern Cape
Western Cape

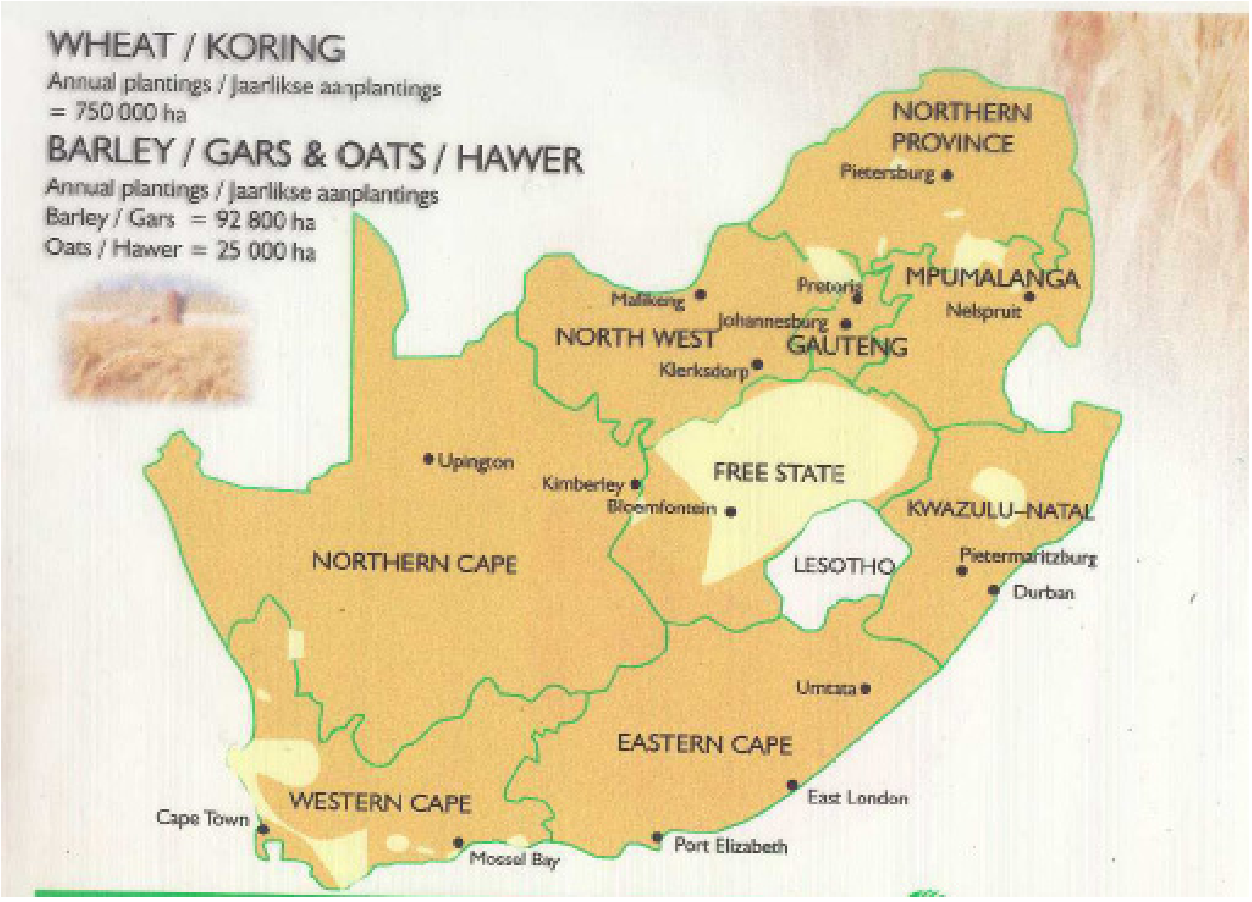

Sugar production areas
Zimbabwe
Northern Province
Botswana
North-West
Gauteng
Mpumalanga
Namibia
Orange Freestate
Kwazulu-Natal
Northern Cape
Lesotho
Eastern Cape
Western Cape

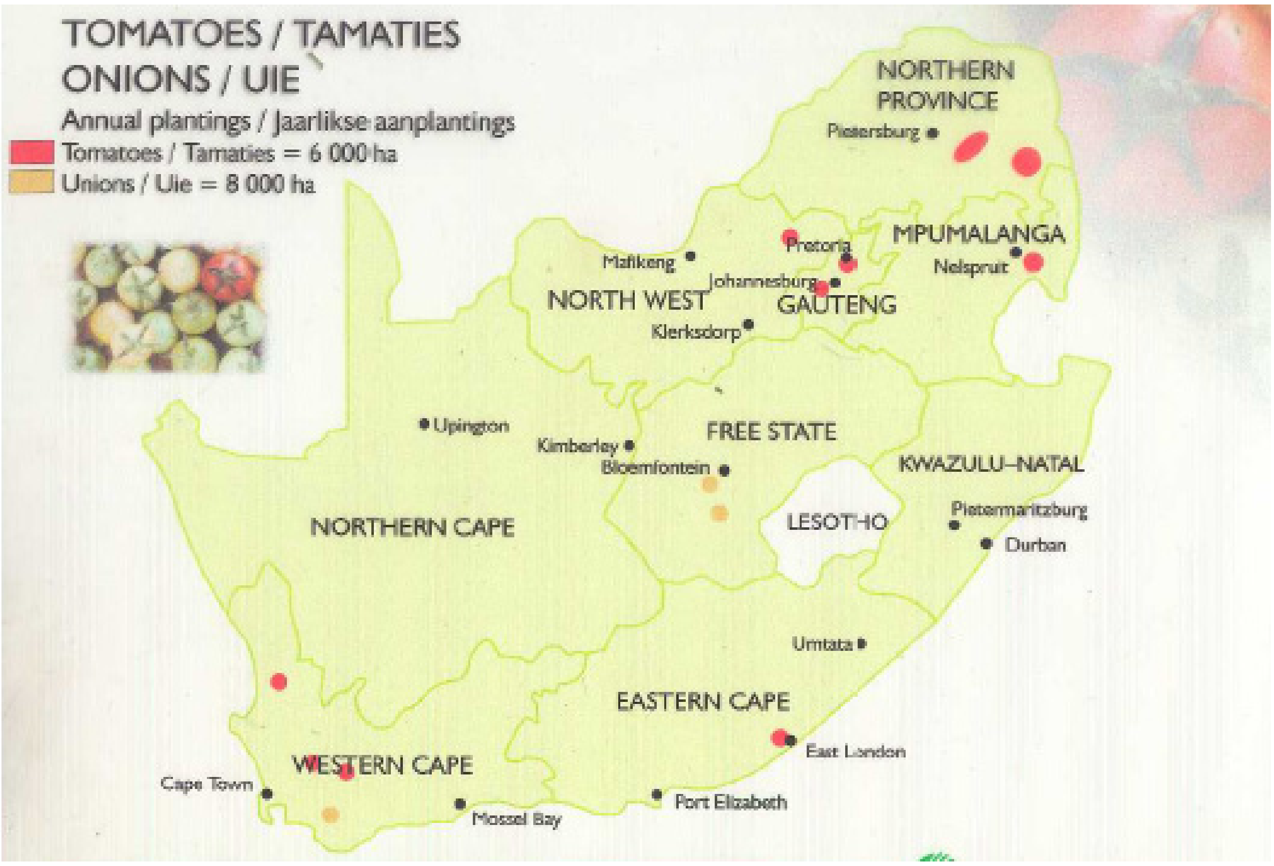

Potato production areas
Zimbabwe
Northern Province
Botswana
North-West
Gauteng
Namibia
Orange Freestate
Kwazulu-Natal
Northern Cape
Lesotho
Eastern Cape
Western Cape


LUCERNE SEED / LUSERNSAAD
NORTHERN PROVINCE
Pietersburg
MPUMALANGA
Nelspruit
Pretoria
Mafikeng
Johannesburg
NORTH WEST
GAUTENG
Klerksdorp
FREE STATE
Upington
Kimberley
Bloemfontein
KWAZULU-NATAL
LESOTHO
NORTHERN CAPE
Pietermaritzburg
Durban
Umtata
EASTERN CAPE
East London
WESTERN CAPE
Port Elizabeth
Mossel Bay

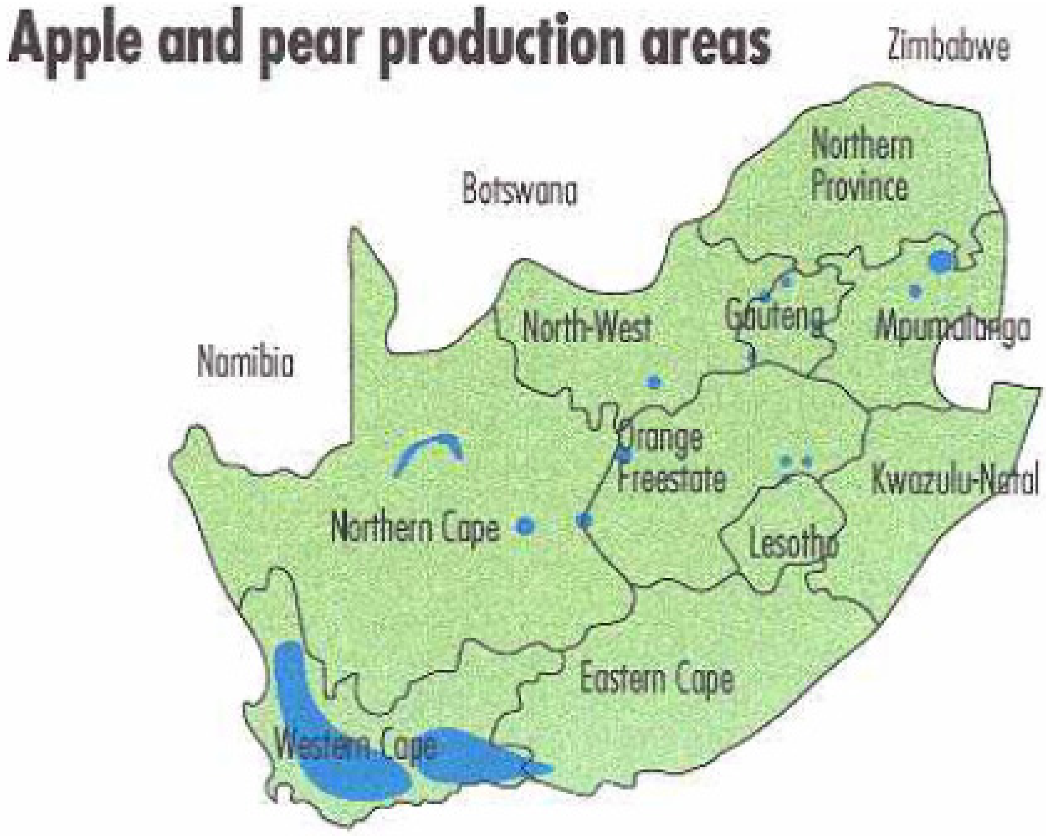

GROUNDNUTS / GRONDBONE
Annual plantings / Jaarlikse aanplantings
= 95 000 ha
NORTHERN
PROVINCE
Pietersburg
MPUMALANGA
Pretoria
Nelspruit
Mafikeng
Johannesburg
NORTH WEST
GAUTENG
Klerksdorp
Upington
FREE STATE
Kimberley
Bloemfontein
KWAZULU-NATAL
LESOTHO
Pietermaritzburg
NORTHERN CAPE
Durban
Umtata
EASTERN CAPE
East London
WESTERN CAPE
Cape Town
Port Elizabeth
Mossel Bay


LUPIN / LUPIENE & CANOLA
Annual planting / Jaarlikse aanplantings
Lupin / Lupiene = 16 300 ha
Canola = 17 000 ha
NORTHERN PROVINCE
Pietersburg
Pretoria
MPUMALANGA
Nelspruit
Mafikeng
Johannesburg
NORTH WEST
GAUTENG
Klerksdorp
Upington
Kimberley
FREE STATE
Bloemfontein
KWAZULU-NATAL
NORTHERN CAPE
LESOTHO
Pietermaritzburg
Durban
Umtata
EASTERN CAPE
East London
WESTERN CAPE
Cape Town
Mossel Bay
Port Elizabeth

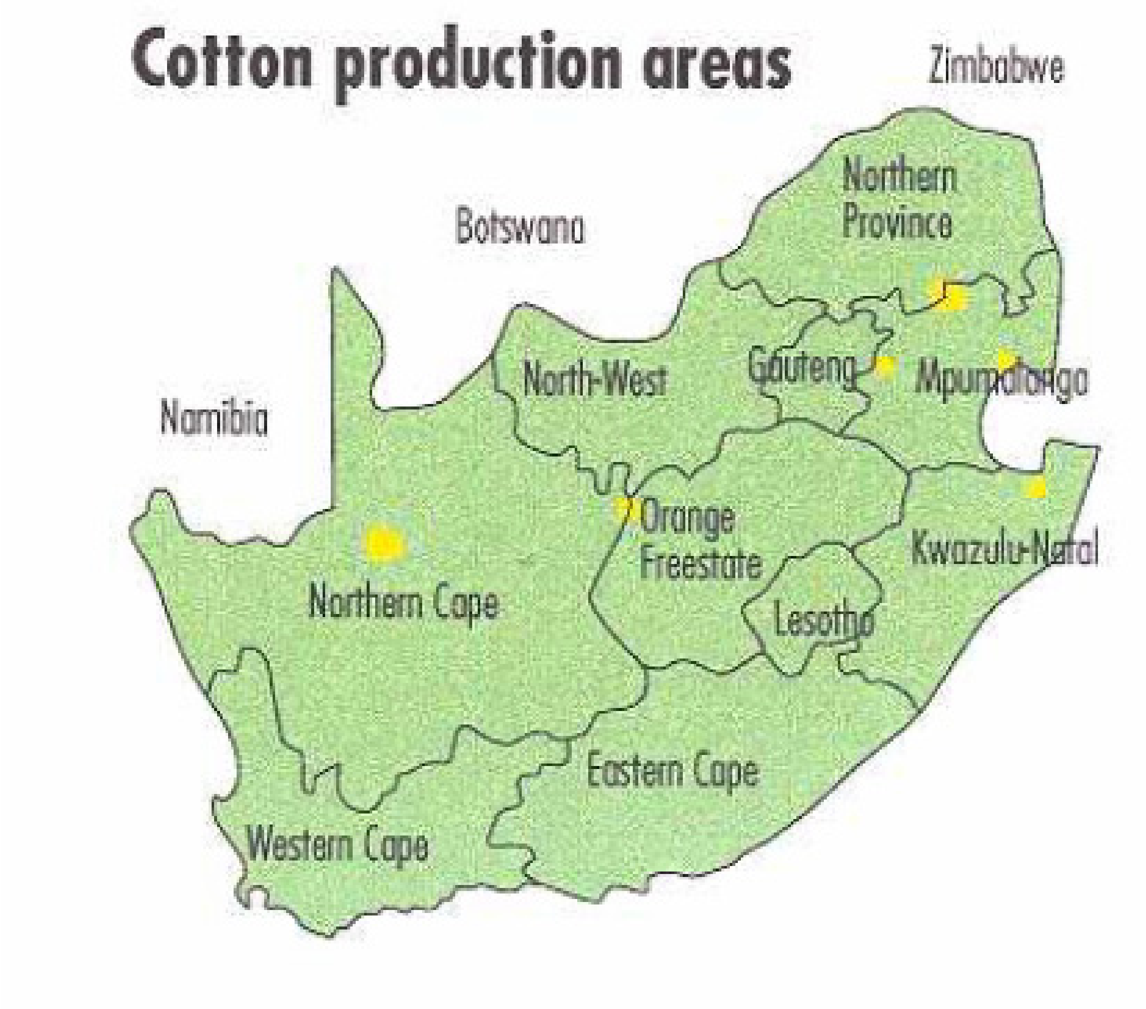

WHEAT / KORING
Annual plantings / Jaarlikse aanplantings
= 750 000 ha
BARLEY / GARS & OATS / HAWER
Annual plantings / Jaarlikse aanplantings
Barley / Gars = 92 800 ha
Oats / Hawer = 25 000 ha
NORTHERN PROVINCE
Pietersburg
Mafikeng
Pretoria
MPUMALANGA
Nelspruit
Johannesburg
NORTH WEST
GAUTENG
Klerksdorp
Upington
Kimberley
FREE STATE
Bloemfontein
KWAZULU-NATAL
NORTHERN CAPE
LESOTHO
Pietermaritzburg
Durban
Umtata
EASTERN CAPE
East London
Cape Town
WESTERN CAPE
Mossel Bay
Port Elizabeth

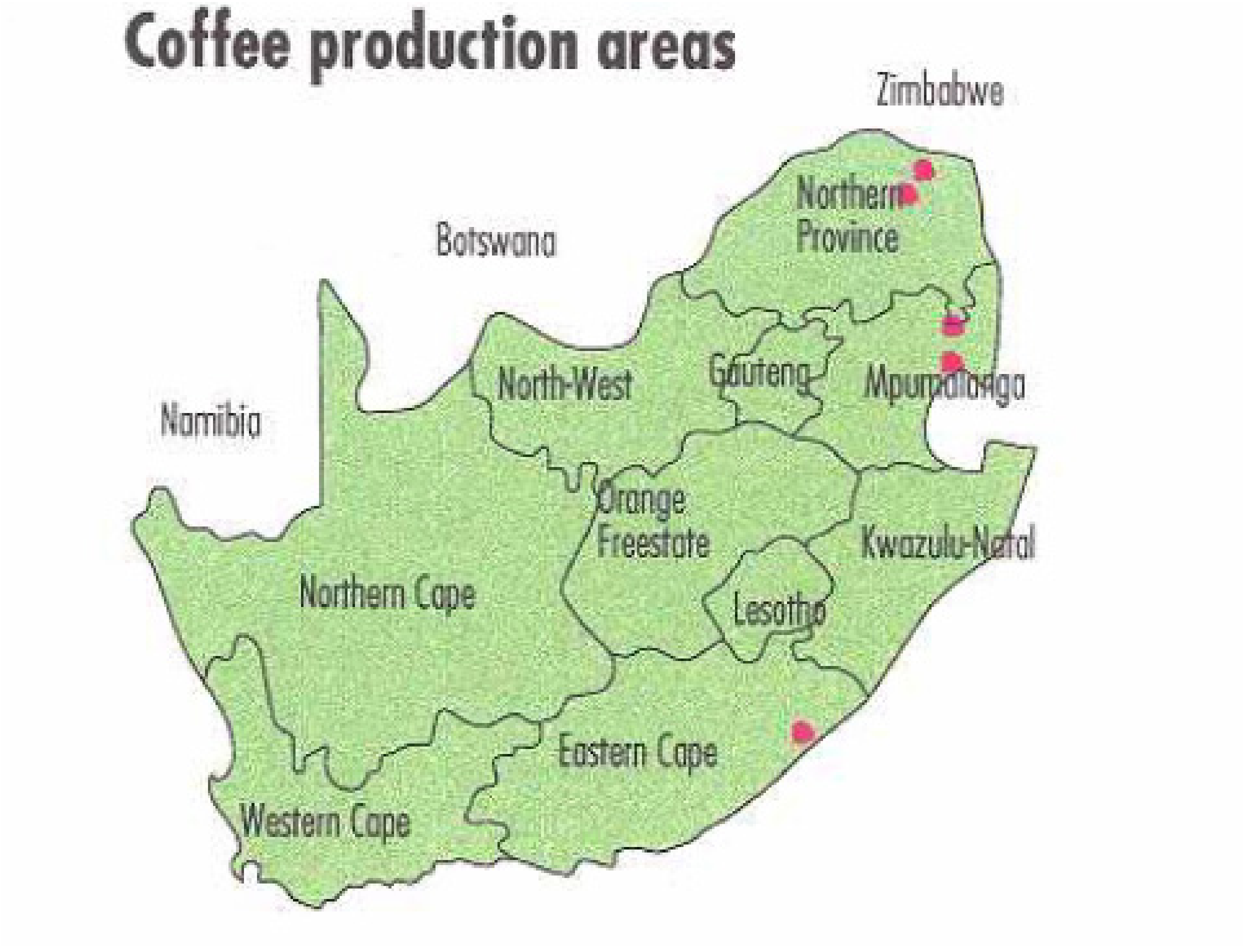

TOMATOES / TAMATIES
ONIONS / UIE
Annual plantings / Jaarlikse aanplantings
Tomatoes / Tamaties = 6 000 ha
Unions / Uie = 8 000 ha
NORTHERN PROVINCE
Pietersburg
MPUMALANGA
Nelspruit
Pretoria
Mafikeng
Johannesburg
NORTH WEST
GAUTENG
Klerksdorp
Upington
Kimberley
FREE STATE
Bloemfontein
KWAZULU-NATAL
LESOTHO
Pietermaritzburg
Durban
NORTHERN CAPE
Umtata
EASTERN CAPE
East London
WESTERN CAPE
Cape Town
Port Elizabeth
Mossel Bay


COFFEE, TEA & ROOIBOS TEA /
KOFFIE, TEE & ROOIBOSTEE
Annual plantings / Jaarlikse aanplantings
= 15 000 ha / 1 700 t
Coffee /Koffie
Tea /Tee
Rooibos
Coffee & Tea
Koffie & Tee
NORTHERN PROVINCE
Pietersburg
MPUMALANGA
Nelspruit
Pretoria
Mafikeng
Johannesburg
NORTH WEST
GAUTENG
Klerksdorp
Upington
Kimberley
Bloemfontein
FREE STATE
KWAZULU-NATAL
LESOTHO
Pietermaritzburg
Durban
NORTHERN CAPE
Umtata
EASTERN CAPE
East London
WESTERN CAPE
Port Elizabeth
Mossel Bay



Apple and pear production areas
Zimbabwe
Botswana
Namibia
Northern Province
North-West
Gauteng
Mpumalanga
Orange Freestate
Kwazulu-Natal
Northern Cape
Lesotho
Eastern Cape
Western Cape


Cotton production areas
Zimbabwe
Northern
Province
Botswana
North-West
Gauteng
Mpumalanga
Namibia
Orange
Freestate
Kwazulu-Natal
Northern Cape
Lesotho
Eastern Cape
Western Cape


Coffee production areas
Zimbabwe
Northern Province
Botswana
North-West
Gauteng
Mpumalanga
Namibia
Orange Freestate
Kwazulu-Natal
Northern Cape
Lesotho
Eastern Cape
Western Cape

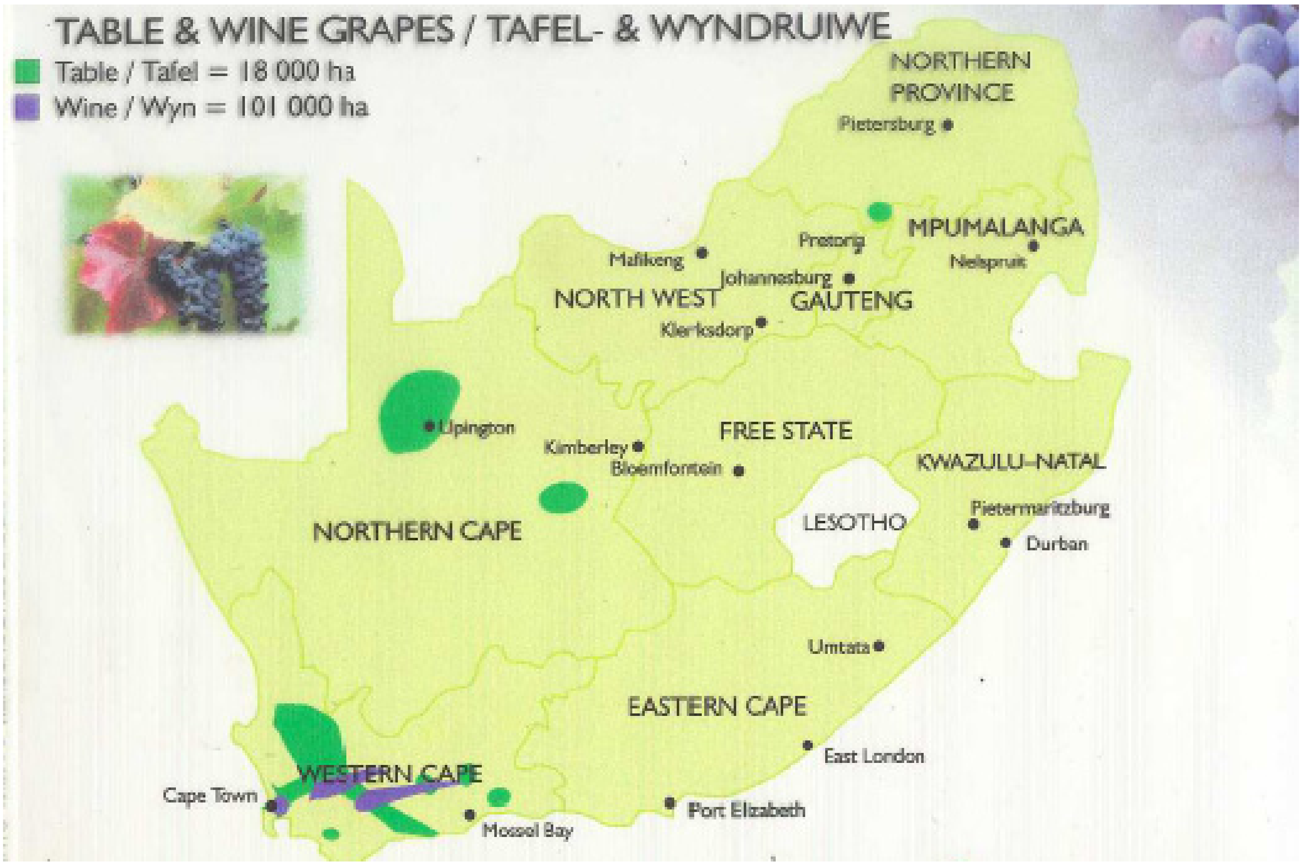
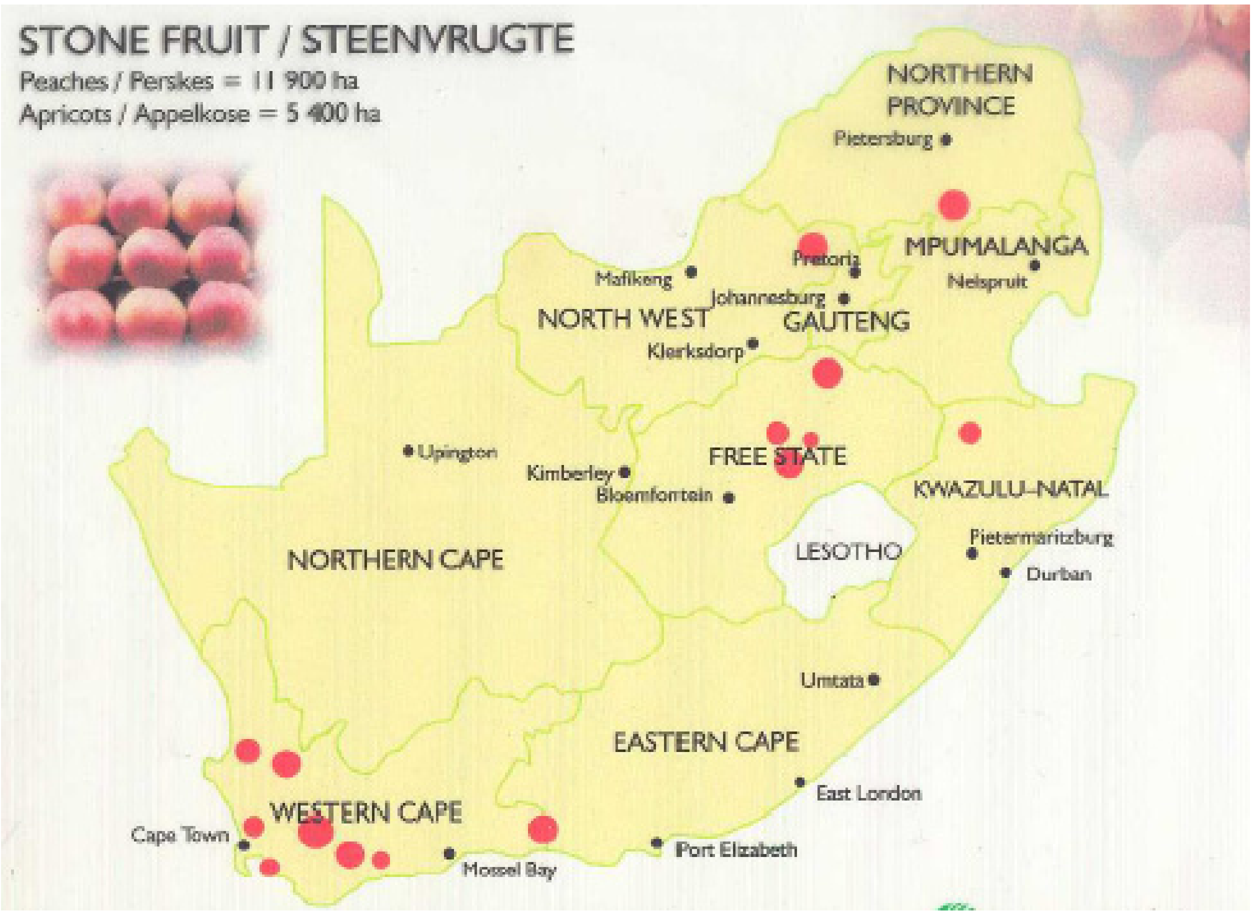
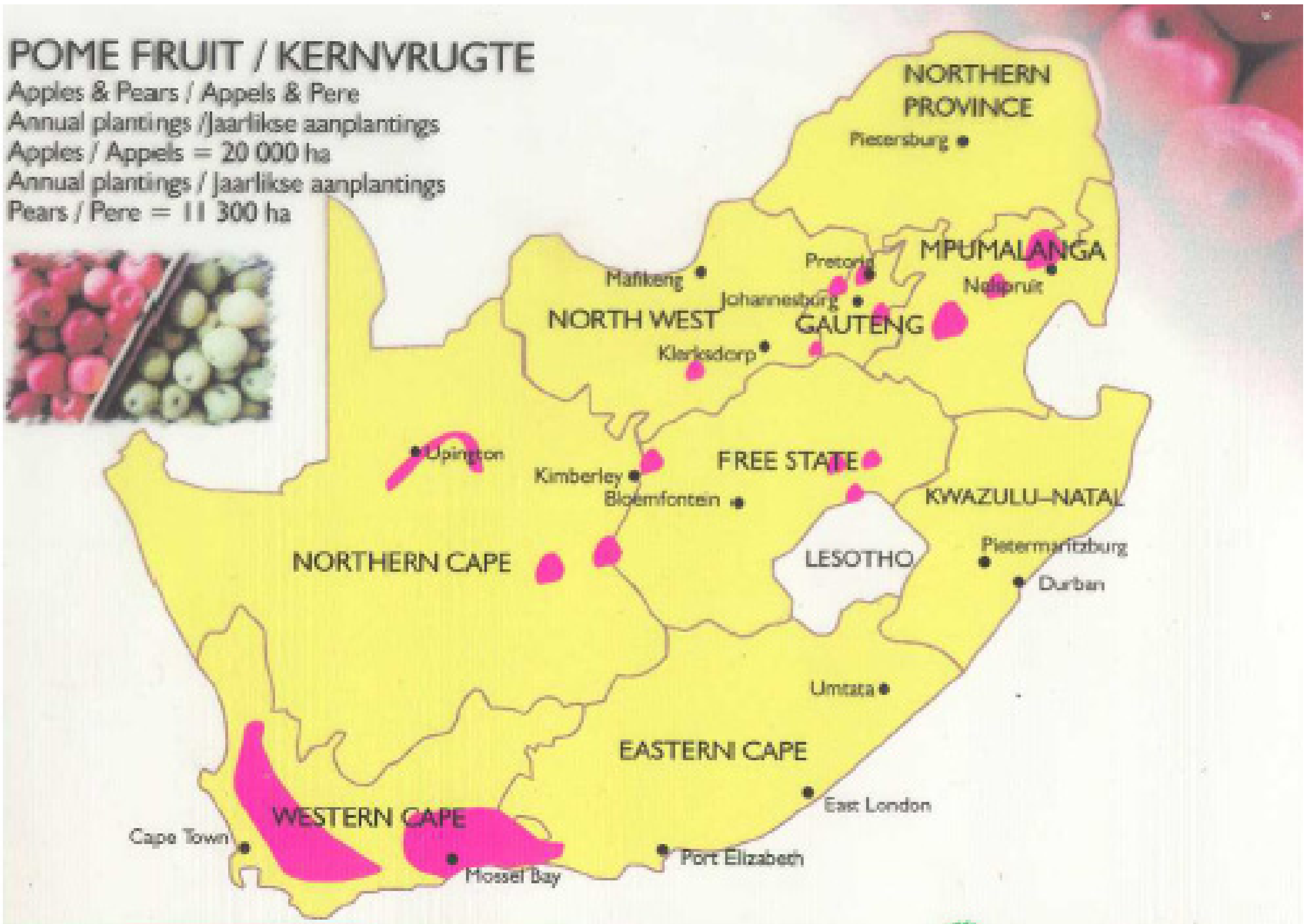


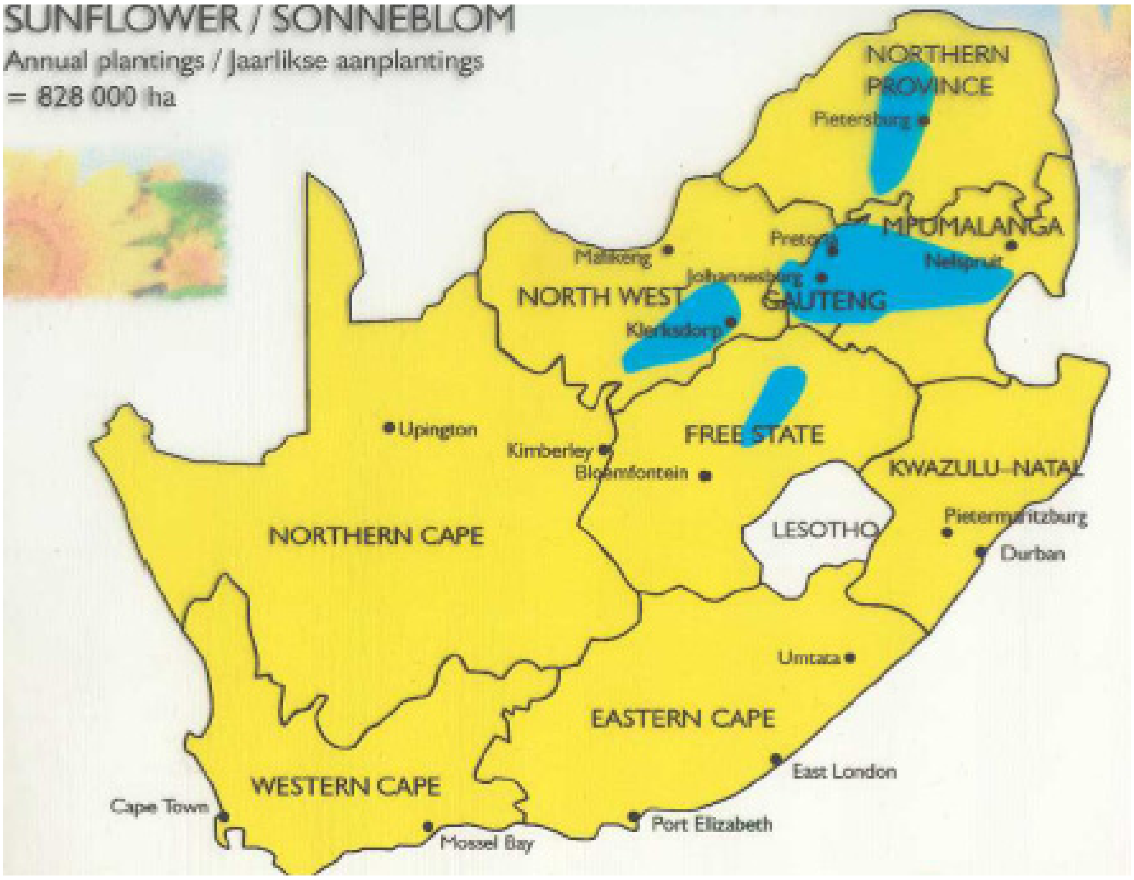
TABLE & WINE GRAPES / TAFEL- & WYNDRUIWE
Table / Tafel = 18 000 ha
Wine / Wyn = 101 000 ha
NORTHERN PROVINCE
Pietersburg
MPUMALANGA
Pretoria
Nelspruit
Mafikeng
Johannesburg
NORTH WEST
GAUTENG
Klerksdorp
Upington
Kimberley
FREE STATE
Bloemfontein
KWAZULU-NATAL
LESOTHO
Pietermaritzburg
Durban
NORTHERN CAPE
Umtata
EASTERN CAPE
East London
WESTERN CAPE
Cape Town
Mossel Bay
Port Elizabeth

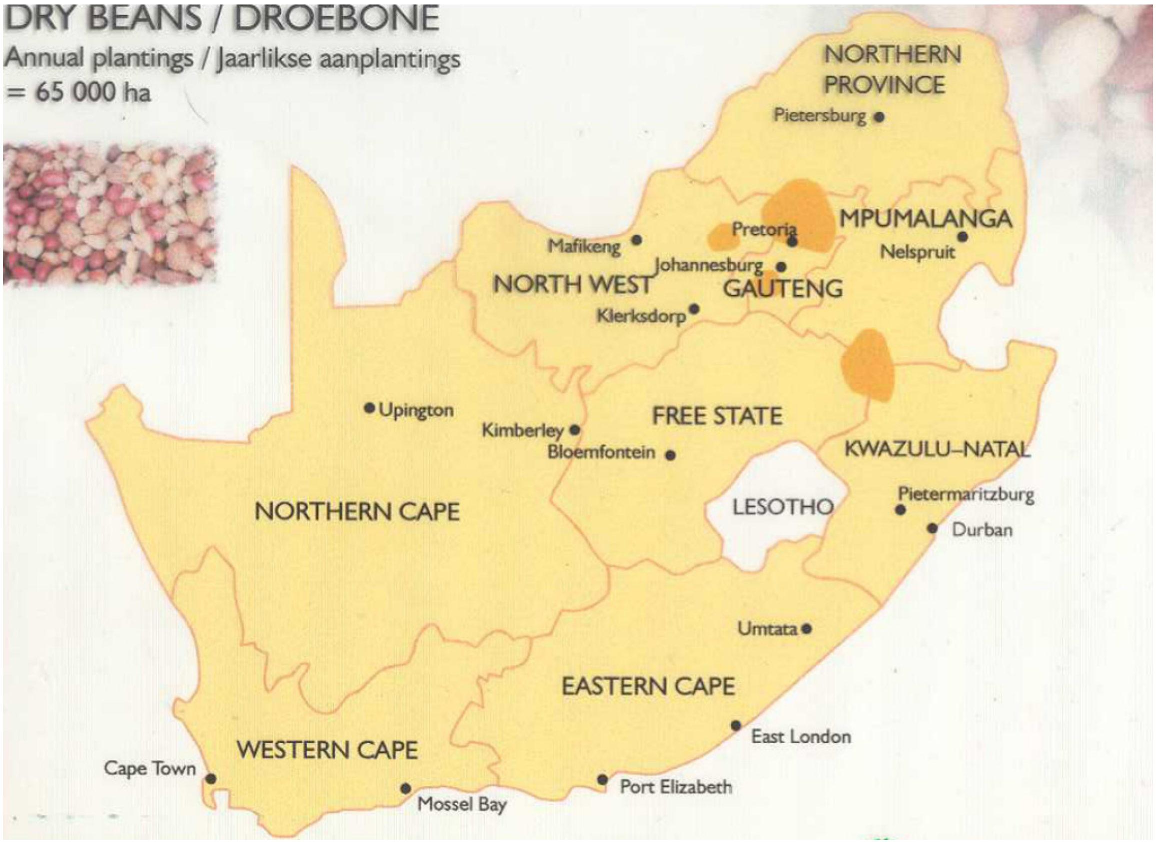

CHERRIES / KERSIES
Annual production / Jaarlikse produksie
= 600 t
NORTHERN PROVINCE
Pietersburg
MPUMALANGA
Nelspruit
Pretoria
Mafikeng
Johannesburg
NORTH WEST
GAUTENG
Klerksdorp
FREE STATE
Upington
Kimberley
Bloemfontein
KWAZULU-NATAL
NORTHERN CAPE
Ficksburg
LESOTHO
Pietermaritzburg
Durban
Umtata
EASTERN CAPE
Ceres
WESTERN CAPE
East London
Cape Town
Port Elizabeth
Mossel Bay

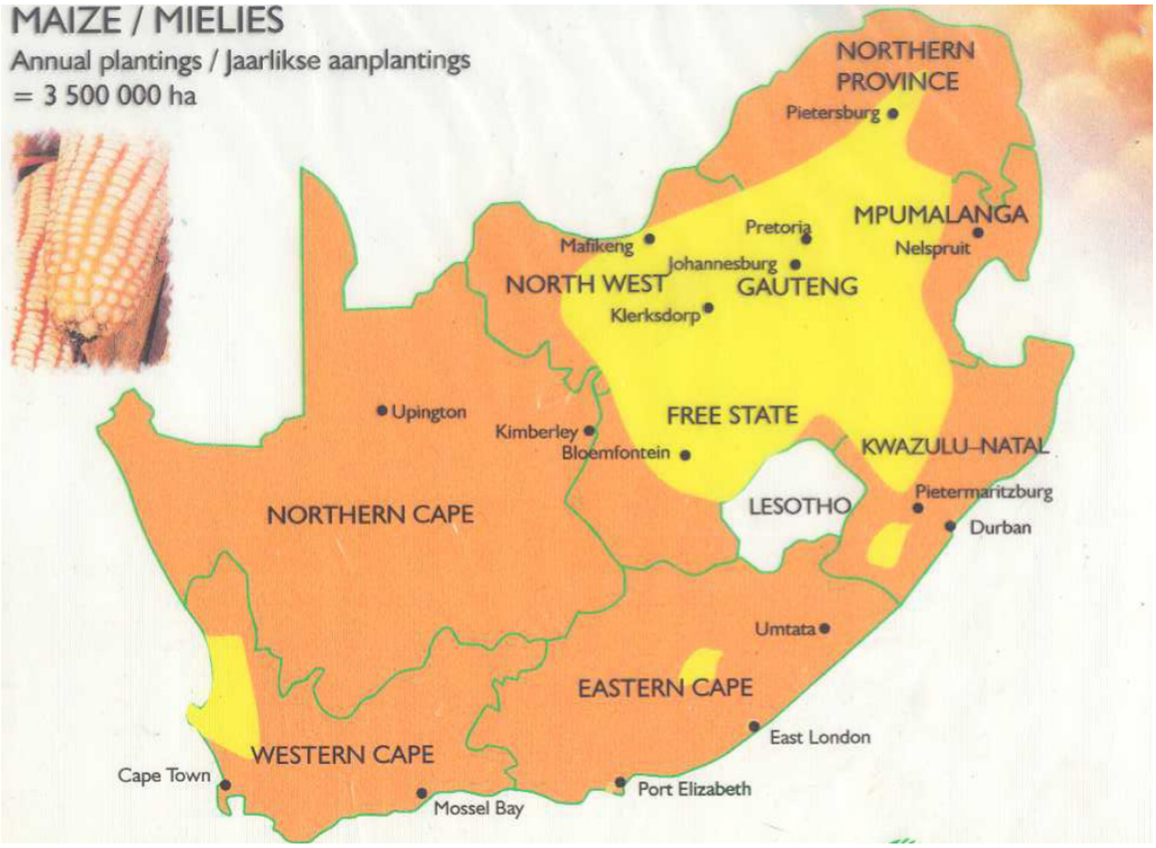

STONE FRUIT / STEENVRUGTE
Peaches / Perskes = 11 900 ha
Apricots / Appelkose = 5 400 ha
NORTHERN PROVINCE
Pietersburg
MPUMALANGA
Pretoria
Nelspruit
Mafikeng
Johannesburg
NORTH WEST
GAUTENG
Klerksdorp
Upington
Kimberley
FREE STATE
Bloemfontein
KWAZULU-NATAL
LESOTHO
Pietermaritzburg
Durban
NORTHERN CAPE
Umtata
EASTERN CAPE
East London
WESTERN CAPE
Cape Town
Port Elizabeth
Mossel Bay


CITRUS / SITRUS
Annual plantings / Jaarlikse aanplantings
= 30 000 ha
NORTHERN PROVINCE
Pietersburg
MPUMALANGA
Nelspruit
Pretoria
Mafikeng
Johannesburg
NORTH WEST
GAUTENG
Klerksdorp
Upington
Kimberley
FREE STATE
Bloemfontein
KWAZULU-NATAL
LESOTHO
Pietermaritzburg
Durban
NORTHERN CAPE
Umtata
EASTERN CAPE
East London
WESTERN CAPE
Cape Town
Mossel Bay
Port Elizabeth


POME FRUIT / KERNVRUGTE
Apples & Pears / Appels & Pere
Annual plantings /Jaarlikse aanplantings
Apples / Appels = 20 000 ha
Annual plantings / Jaarlikse aanplantings
Pears / Pere = 11 300 ha
NORTHERN PROVINCE
Pietersburg
MPUMALANGA
Nelspruit
Pretoria
Johannesburg
GAUTENG
Mafikeng
NORTH WEST
Klerksdorp
Upington
Kimberley
FREE STATE
Bloemfontein
KWAZULU–NATAL
NORTHERN CAPE
LESOTHO
Pietermaritzburg
Durban
Umtata
EASTERN CAPE
East London
WESTERN CAPE
Cape Town
Mossel Bay
Port Elizabeth


SUNFLOWER / SONNEBLOM
Annual plantings / Jaarlikse aanplantings
= 828 000 ha
NORTHERN PROVINCE
Pietersburg
MPUMALANGA
Nelspruit
Pretoria
Johannesburg
GAUTENG
NORTH WEST
Klerksdorp
FREE STATE
Upington
Kimberley
Bloemfontein
KWAZULU-NATAL
Pietermaritzburg
Durban
LESOTHO
NORTHERN CAPE
Umtata
EASTERN CAPE
East London
WESTERN CAPE
Cape Town
Mossel Bay
Port Elizabeth


DRY BEANS / DROEBONE
Annual plantings / Jaarlikse aanplantings
= 65 000 ha
NORTHERN
PROVINCE
Pietersburg
MPUMALANGA
Nelspruit
Pretoria
Mafikeng
Johannesburg
NORTH WEST
GAUTENG
Klerksdorp
FREE STATE
Upington
Kimberley
Bloemfontein
KWAZULU-NATAL
LESOTHO
Pietermaritzburg
Durban
NORTHERN CAPE
Umtata
EASTERN CAPE
East London
WESTERN CAPE
Cape Town
Mossel Bay
Port Elizabeth


MAIZE / MIELIES
Annual plantings / Jaarlikse aanplantings
= 3 500 000 ha
NORTHERN
PROVINCE
Pietersburg
MPUMALANGA
Pretoria
Nelspruit
Mafikeng
Johannesburg
NORTH WEST
GAUTENG
Klerksdorp
Upington
Kimberley
Bloemfontein
FREE STATE
KWAZULU-NATAL
LESOTHO
Pietermaritzburg
Durban
NORTHERN CAPE
Umtata
EASTERN CAPE
East London
WESTERN CAPE
Cape Town
Mossel Bay
Port Elizabeth

ANNEXURE F

European Commission: Endocrine Disrupters Strategy

Annex 10: List of 564 substances with their selection criteria

Return to Content of Annexes

Annex 10

List of 564 substances with their selection criteria

Annex 10: List of 564 substances with their selection criteria

Presented are all substances and the 4 selection steps.
It was decided to select the HPV-chemicals, the highly persistent chemicals and the metals. The following selection criteria have been applied:

HPV

- High production volume chemicals (HPV) selected by combining the working list of potential Endocrine disrupters (EDS) with the EU HPV chemicals list (directive EC/793/93) (2465 substances).

Persistence
- Highly persistent substances were selected on basis of Quantitative Structural Analysis Relationships (QSAR) derived from the Syracuse Estimation program. Combining two biodegradation models (the linear probability model and the ultimate degradation model), substances are considered as highly persistent that have a low probability of degradation ($P<0.1$) when applying the linear probability model and ultimately biodegrade in more than months when applying the ultimate degradation model. For the list only the highly persistent substances were selected with an ultimate degradation of more than months. This group was supplemented with a number of PCBs, polychlorinated -dioxins and -dibenzofurans, polybrominated -biphenyls and -biphenylethers, which were considered as very persistent by the expert group.

- Other substances added to the list were metals from the EDS working list.

In the list four categories are distinguished on persistence:

Highly persistent substances (Pers+)	SRC calculations fulfilling the most stringent criteria
Persistent substances (Pers)	SRC calculations fulfilling less stringent criteria
Not persistent (Not pers)	SRC calculations not fulfilling criteria for persistence.
Metal	Substance is a metal (SRC calculations not used)
No data	Biodegradation not calculated

ED evaluation
In the list 3 ED categories are distinguished:

Category 1.	At least one study providing evidence of endocrine disruption in an intact organism. Not a formal weight of evidence approach.
Category 2.	Potential for endocrine disruption. In vitro data indicating potential for endocrine disruption in intact organisms. Also includes effects in-vivo that may, or may not, be ED-mediated. May include structural analyses and metabolic considerations
Category 3.	No scientific basis for inclusion in list

Additionally category 3 distinguishes 3 subcategories:

A(w,m)	no data available on wildlife relevant and/or mammal relevant endocrine effects;
B	some data are available but the evidence is insufficient for identification.
C	data available indicating no scientific basis for inclusion in list

* In a number of cases the substance was identified on the basis of additional information from industry

Exposure concern

In the list ED category 1 substances are identified with high, medium or low exposure concern, applying the following criteria:

High concern	Human exposure is expected, due to environmental concentrations and those in food or consumer products, also taking into consideration exposure of vulnerable groups *And/Or* Wildlife exposure is expected, due to use and emission patterns, and the chemical is persistent and bioaccumulative
Medium concern	Human exposure is not expected *And* Wildlife exposure is expected, due to use and emission patterns, but the chemical is readily biodegradable and not bioaccumulative
Low concern	No human exposure *And* No wildlife exposure

Working list of substances and their selection criteria

No	CASNR	Name	HPV	Persist	ED Cat.	Exposure Concern
11	12789-03-6	Chlordane		Pers+	1	High
12	57-74-9	Chlordane (cis- and trans-)		Pers+	1	High
20	143-50-0	Kepone (Chlordecone)		Pers+	1	High
21	2385-85-5	Mirex		Pers+	1	High
24	8001-35-2	Toxaphene = Camphechlor		Pers+	1	High
42	50-29-3	DDT (technical) = clofenotane	HPV	Pers	1	High
56	No CAS 008	p,p'-DDT = clofenotane	HPV	Pers	1	High
57	3563-45-9	Tetrachloro DDT = 1,1,1,2-Tetrachloro-2,2-bis(4-chlorophenyl)ethane		Pers+	1	High
63	50471-44-8	Vinclozolin	HPV	Pers	1	High
69	12427-38-2	Maneb	HPV	Not pers	1	High
70	137-42-8	Metam Natrium	HPV	Not pers	1	High
73	137-26-8	Thiram	HPV	Not pers	1	High
74	12122-67-7	Zineb	HPV	Not pers	1	High
78	58-89-9	Gamma-HCH (Lindane)	HPV	Pers	1	High
87	330-55-2	Linuron (Lorox)	HPV	Not pers	1	High
142	1912-24-9	Atrazine	HPV	Pers	1	High
163	34256-82-1	Acetochlor	HPV	Not pers	1	High
164	15972-60-8	Alachlor	HPV	Not pers	1	High
191	100-42-5	Styrene	HPV	Not pers	1	High
198	118-74-1	Hexachlorobenzene (HCB)	HPV	Pers	1	High
278	85-68-7	Butylbenzylphthalate (BBP)	HPV	Not pers	1	High
279	117-81-7	Di-(2-ethylhexyl)phthalate (DEHP)	HPV	Not pers	1	High
286	84-74-2	Di-n-butylphthalate (DBP)	HPV	Not pers	1	High
326	80-05-7	2,2-Bis(4-hydroxyphenyl)propan = 4,4'-isopropylidenediphenol = Bisphenol A	HPV	Not pers	1	High
396	1336-36-3	PCB		Pers	1	High
408	35065-27-1	PCB 153 (2,2',4,4',5,5'-Hexachlorobiphenyl)		Pers	1	High
410	32774-16-6	PCB 169 (3,3',4,4',5,5'-Hexachlorobiphenyl)		Pers	1	High
417	2437-79-8	PCB 47 (2,2',4,4'-Tetrachlorobiphenyl)		Pers	1	High
422	32598-13-3	PCB 77 (3,3',4,4'-Tetrachlorobiphenyl)		Pers	1	High
427	53469-21-9	PCB Aroclor 1242		Pers	1	High
428	12672-29-6	PCB Aroclor 1248		Pers	1	High
429	11097-69-1	PCB Aroclor 1254		Pers	1	High
430	11096-82-5	PCB Aroclor 1260 (Clophen A60)		Pers+	1	High
438	No CAS 140	PBBs = Brominated Biphenyls (mixed group of 209 Congeners)		Pers	1	High
467	40321-76-4	1,2,3,7,8-Pentachlorodibenzodioxin		Pers	1	High
472	1746-01-6	2,3,7,8-Tetrachlorodibenzo-p-dioxin (2,3,7,8-TCDD)		Not pers	1	High
487	57117-31-4	2,3,4,7,8-Pentachlorodibenzofuran (2,3,4,7,8-PeCDF)		Pers	1	High
511	No CAS 050	Tributyltin compounds		metal	1	High
512	688-73-3	Tributyltin hydride		metal	1	High
513	56-35-9	Tributyltin oxide = bis(tributyltin) oxide	HPV	metal	1	High
514	26354-18-7	2-propenoic acid, 2-methyl-, methyl ester = Stannane, tributylmeacrylate		metal	1	High
515	No CAS 100	Methoxyetylacrylate tinbutyltin, copolymer		metal	1	High
516	4342-30-7	Phenol, 2-[[(tributylstannyl)oxy]carbony		metal	1	High
517	4342-36-3	Stannane, (benzoyloxy)tributyl-		metal	1	High
518	4782-29-0	Stannane, [1,2-phenylenebis(carbonyloxy)		metal	1	High
519	36631-23-9	Stannane, tributyl = Tributyltin naphtalate		metal	1	High
520	85409-17-2	Stannane, tributyl-, mono(naphthenoyloxy		metal	1	High
521	24124-25-2	Stannane, tributyl[(1-oxo-9,12-octadecad		metal	1	High
522	3090-35-5	Stannane, tributyl[(1-oxo-9-octadecenyl)		metal	1	High
523	26239-64-5	Stannane, tributyl[[[1,2,3,4,4a,4b,5,6,1		metal	1	High
524	1983-10-4	Stannane, tributylfluoro-		metal	1	High
525	2155-70-6	Tributyl[(2-methyl-1-oxo-2-propenyl)oxy]stannane		metal	1	High
526	No CAS 099	Tributyltincarboxylate		metal	1	High
527	26636-32-8	Tributyltinnaphthalate		metal	1	High
528	No CAS 101	Tributyltinpolyethoxylate		metal	1	High
529	2279-76-7	Tri-n-propyltin (TPrT)		metal	1	High
531	No CAS 051	Triphenyltin		metal	1	High
532	900-95-8	Fentin acetate = triphenyltin acetate		metal	1	High
536	95-76-1	3,4-Dichloroaniline	HPV	Not pers	1	High
560	108-46-3	Resorcinol	HPV	Not pers	1	High
141	61-82-5	Amitrol = Aminotriazol	HPV	Not pers	1	Medium
182	1836-75-5	Nitrofen	HPV	Pers	1	Medium
216	140-66-9	4-tert-Octylphenol=1,1,3,3-Tetramethyl-4-butylphenol	HPV	Not pers	1	Medium
254	25154-52-3	Phenol, nonyl-	HPV	Not pers	1	Medium

No	CASNR	Name	HPV	Persist	ED Cat.	Exposure Concern
530	1461-25-2	Tetrabutyltin (TTBT)	HPV	metal	1	Low
538	99-99-0	4-Nitrotoluene	HPV	Not pers	1	Low
2	10605-21-7	Carbendazim	HPV	Not pers	2	
10	309-00-2	Aldrin		Pers+	2	
15	60-57-1	Dieldrin		Pers+	2	
16	115-29-7	Endosulfan	HPV	Pers+	2	
17	959-98-8	Endosulfan (alpha)		Pers+	2	
18	33213-65-9	Endosulfan (beta)		Pers+	2	
19	72-20-8	Endrin		Pers+	2	
22	27304-13-8	Oxychlordane		Pers+	2	
23	39801-14-4	Photomirex		Pers+	2	
27	94-75-7	2,4-Dichlorophenoxy acetic acid (2,4-D)	HPV	Not pers	2	
29	67747-09-5	Prochloraz	HPV	Not pers	2	
44	115-32-2	Dicofol = Kelthane	HPV	Pers	2	
60	36734-19-7	Iprodione	HPV	Not pers	2	
75	137-30-4	Ziram	HPV	Not pers	2	
85	330-54-1	Diuron	HPV	Not pers	2	
104	333-41-5	Diazinon	HPV	Not pers	2	
106	60-51-5	Dimethoate	HPV	Not pers	2	
113	121-75-5	Malathion	HPV	Not pers	2	
115	298-00-0	Methylparathion	HPV	Not pers	2	
119	56-38-2	Parathion = Parathion(-ethyl)	HPV	Not pers	2	
156	122-34-9	Simazine	HPV	Not pers	2	
159	43121-43-3	Triadimefon	HPV	Not pers	2	
176	76-44-8	Heptachlor		Pers+	2	
179	74-83-9	Methylbromide (bromomethane)	HPV	Not pers	2	
187	709-98-8	Propanil	HPV	Not pers	2	
194	120-83-2	2,4 Dichlorophenol	HPV	Not pers	2	
195	1570-64-5	4-chloro-2-methylphenol	HPV	Not pers	2	
196	59-50-7	4-chloro-3-methylphenol	HPV	Not pers	2	
215	98-54-4	4-tert-Butylphenol	HPV	Not pers	2	
283	26761-40-0	Diisodecyl phthalate	HPV	Not pers	2	
284	28553-12-0	diisononyl phthalate = 1,2-Benzenedicarboxylic acid, diisononyl ester (DINP)	HPV	Not pers	2	
318	1675-54-3	2,2'-bis(4-(2,3-epoxypropoxy)phenyl)propane = 2,2'-[(1-methylethylidene)bis(4,1-phenyleneoxymethylene)]bisoxirane	HPV	Not pers	2	
371	90-43-7	o-phenylphenol	HPV	Not pers	2	
406	38411-22-2	PCB 136 (2,2',3,3',6,6'-Hexachlorobiphenyl)		Pers	2	
409	38380-08-4	PCB 156 (2,3,3',4,4',5-Hexachlorobiphenyl)		Pers	2	
418	70362-47-9	PCB 48 (2,2',4,5-Tetrachlorobiphenyl)		Pers	2	
420	33284-53-6	PCB 61 (2,3,4,5-Tetrachlorobiphenyl)		Pers	2	
421	32598-12-2	PCB 75 (2,4,4',6-Tetrachlorobiphenyl)		Pers	2	
483	57117-41-6	1,2,3,7,8-Pentachlorodibenzofuran		Pers	2	
484	83704-53-4	1,2,3,7,9-Pentachlorodibenzofuran		Pers	2	
485	58802-20-3	1,2,7,8-Tetrachlorodibenzofuran		Pers	2	
486	71998-72-6	1,3,6,8-Tetrachlorodibenzofuran		Pers	2	
488	67733-57-7	2,3,7,8-Tetrabromodibenzofuran		Pers	2	
489	51207-31-9	2,3,7,8-Tetrachlorodibenzofuran		Pers	2	
503	106340-44-7	Tetrabromodibenzofuran (TeBDF)		Pers	2	
543	75-15-0	Carbon disulphide	HPV	Not pers	2	
557	127-18-4	Perchloroethylene	HPV	Not pers	2	
435	No CAS 046	2,2',4,4'-Tetrabrominated diphenyl ether (2,2',4,4'-tetraBDE)		No data	2	
436	No CAS 044	Decabrominated diphenyl ether (decaBDE)		No data	2	
437	No CAS 043	Octabrominated diphenyl ether (octaBDE)		No data	2	
439	No CAS 045	Pentabrominated diphenyl ether (pentaBDE)		No data	2	
190	29082-74-4	Octachlorostyrene		Pers+	3 A(w,m)	
253	11081-15-5	Phenol, isooctyl-	HPV	No data	3 A(w,m)	
541	119-61-9	Benzophenone	HPV	Not pers	3 A(w,m)	
545	68-12-2	Dimethylformamide (DMFA)	HPV	Not pers	3 A(w,m)	
169	106-93-4	Dibromoethane (EDB)	HPV	Not pers	3 A(w,m)	
348	106-89-8	Epichlorohydrin (1-chloro-2,3-epoxypropane)	HPV	Not pers	3 A(w)	
419	35693-99-3	PCB 52 (2,2';5,5'-Tetrachlorobiphenyl)		Pers	3 A(w)	
13	3734-48-3	Chlordene		Pers+	3 B*	
25	39765-80-5	Trans-Nonachlor		Pers+	3 B*	
177	1024-57-3	Heptachlor-epoxide		Pers+	3 B*	
183	4685-14-7	Paraquat = 1,1'-dimethyl-4,4'-bipyridinium	HPV	Not pers	3 B*	
277	103-23-1	Bis(2-ethylhexyl)adipate	HPV	Not pers	3 B*	
280	84-61-7	Dicyclohexyl phthalate (DCHP)	HPV	Not pers	3 B*	
281	84-66-2	Diethyl phthalate (DEP)	HPV	Not pers	3 B*	
370	92-52-4	Diphenyl	HPV	Not pers	3 B*	

No	CASNR	Name	HPV	Persist	ED Cat.	Exposure Concern
405	38380-07-3	PCB 128 (2,2',3,3',4,4'-Hexachlorobiphenyl)		Pers	3 B*	
444	135-19-3	2-Naphthol	HPV	Not pers	3 B*	
482	107555-93-1	1,2,3,7,8-Pentabromodibenzofuran		Pers	3 B*	
564	108-05-4	Vinyl acetate	HPV	Not pers	3 B*	
504	7429-90-5	Aluminum	HPV	metal	3 C	
505	7440-43-9	Cadmium	HPV	metal	3 C	
506	1332-40-7	Copper oxychlor		metal	3 C	
507	7758-98-7	Copper sulfate	HPV	metal	3 C	
508	7439-92-1	Lead	HPV	metal	3 C	
509	7439-97-6	Mercury		metal	3 C	
510	22967-92-6	Methylmercury		metal	3 C	
558	108-95-2	Phenol	HPV	Not pers	3 C	
109	55-38-9	Fenthion	HPV	Not pers	3 C*	
275	68515-49-1	1,2-Benzenedicarboxylic acid, di-C9-11-branched alkyl esters, C10-rich (DIDP)	HPV	Not pers	3 C*	
548	107-21-1	Ethylene glycol (ethane-1,2-diol)	HPV	Not pers	3 C*	
1	17804-35-2	Benomyl		Not pers		
3	116-06-3	Aldicarb		Not pers		
4	No CAS 001	Carbamate		No data		
5	63-25-2	Carbaryl		Not pers		
6	1563-66-2	Carbofuran		Not pers		
7	72490-01-8	Fenoxycarb		Not pers		
8	16752-77-5	Methomyl		Not pers		
9	2597-11-7	1-Hydroxychlordene		No data		
14	No CAS 002	Cis-Nonachlor		No data		
26	93-76-5	2,4,5-T = 2,4,5-Trichlorophenoxyaceticacid		Not pers		
28	69806-50-4	Fluazifop-butyl		Not pers		
30	76578-14-8	Quizalofop-ethyl		Not pers		
31	2971-22-4	1,1,1-Trichloro-2,2-bis(4-chlorophenyl)ethane		Not pers		
32	65148-76-7	3-MeO-o,p'-DDA		No data		
33	65148-80-3	3-MeO-o,p'-DDE		No data		
34	43216-70-2	3-OH-o,p'-DDT		No data		
35	65148-81-4	4-MeO-o,p'-DDE		No data		
36	65148-72-3	4-MeO-o,p'-DDT		No data		
37	65148-77-8	5-MeO-o,p'-DDA		No data		
38	65148-75-6	5-MeO-o,p'-DDD		No data		
39	65148-82-5	5-MeO-o,p'-DDE		No data		
40	65148-74-5	5-MeO-o,p'-DDT		No data		
41	65148-73-4	5-OH-o,p'-DDT		No data		
43	No CAS 003	DDT metabolites		No data		
45	4329-12-8	m,p'-DDD		No data		
46	34113-46-7	o,p'-DDA		Not pers		
47	65148-83-6	o,p'-DDA-glycinat = N-[(2-chlorophenyl)(4-chlorophenyl)acettyl]glycin		No data		
48	53-19-0	o,p'-DDD		Pers		
49	3424-82-6	o,p'-DDE		Pers		
50	14835-94-0	o,p'-DDMU		Not pers		
51	789-02-6	o,p'-DDT		Pers		
52	No CAS 084	p,p'-DDA		No data		
53	72-54-8	p,p'-DDD		Pers		
54	72-55-9	p,p'-DDE		Pers		
55	No CAS 085	p,p'-DDMU		No data		
58	3563-45-9	Tetrachloro DDT = 1,1,1,2-Tetrachloro-2,2-bis(4-chlorophenyl)ethane		Pers+		
59	88378-55-6	3,5-Dichlorophenylcarbaminacid-(1-carboxy-1-methyl)-allyl		No data		
61	83792-61-4	N-(3,5-Dichlorophenyl)-2-hydroxy-2-methyl-3-butenacidamid		No data		
62	32809-16-8	Procymidon		Pers		
64	40487-42-1	Pendimethalin		Pers		
65	29091-21-2	Prodiamine		Pers		
66	1582-09-8	Trifluralin		Pers		
67	79-44-7	Dimethyl carbamyl chloride		Not pers		
68	8018-01-7	Mancozeb		Not pers		
71	9006-42-2	Metiram (Metiram-complex)		Not pers		
72	142-59-6	Nabam		Not pers		
76	319-85-7	Beta-HCH		Pers		
77	319-86-8	Delta-HCH		Pers		
79	608-73-1	Hexachlorocyclohexane = HCH mixed		Pers		
80	1689-84-5	Bromoxynil		Not pers		
81	1689-83-4	Ioxynil		Not pers		
82	17356-61-5	1-(3,4-Dichlorophenyl)-3-methoxyurea		No data		

No	CASNR	Name	HPV	Persist	ED Cat.	Exposure Concern
83	3567-62-2	1-(3,4-Dichlorophenyl)-3-methylurea		Not pers		
84	35367-38-5	Diflubenzuron		Pers		
86	96-45-7	Ethylene Thiourea (ETU)		Not pers		
88	No CAS 096	1,1-trichloro-2,2-bis(4-hydroxyphenyl)ethane (HPTE)		No data		
89	30668-06-5	1,3-Dichloro-2,2-bis(4-methoxy-3-methylphenyl)propane		No data		
90	14868-03-2	Bis-OH-MDDE		Not pers		
91	2971-36-0	Bis-OH-Methoxychlor = 1,1,1-trichloro-2,2-bis(4-hydroxyphenyl)ethane (HTPE)		Not pers		
92	2132-70-9	MDDE		Not pers		
93	72-43-5	Methoxychlor		Not pers		
94	75938-34-0	Mono-OH-MDDE		No data		
95	28463-03-8	Mono-OH-Methoxychlor		No data		
96	72-43-5	p,p'-Methoxychlor		Not pers		
97	No CAS 108	1-methyl-2-methylcarbamoylvinyldimethyl phosphate		No data		
98	30560-19-1	Acephate		Not pers		
99	470-90-6	Chlorfenvinphos		Not pers		
100	2921-88-2	Chlorpyrifos		Not pers		
101	50-18-0	Cyclophosphamide		Not pers		
102	682-80-4	Demefion		Not pers		
103	919-86-8	Demeton-s-methyl		Not pers		
105	62-73-7	Dichlorvos		Not pers		
107	2597-03-7	Elsan = Dimephenthoate		Not pers		
108	122-14-5	Fenitrothion		Not pers		
110	2540-82-1	Formothion		Not pers		
111	51276-47-2	Glufosinate		Not pers		
112	70393-85-0	Glufosinate-ammonium		No data		
114	No CAS 122	Metalodemeton		No data		
116	7786-34-7	Mevinphos = Phosdrin		Not pers		
117	1113-02-6	Omethoate		Not pers		
118	301-12-2	Oxydemeton-methyl		Not pers		
120	13171-21-6	Phosophamidon		Not pers		
121	13593-03-8	Quinalphos = Chinalphos		Not pers		
122	299-84-3	Ronnel = fenchlorfos		Not pers		
123	22248-79-9	Tetrachlorvinphos = Gardona		Not pers		
124	52-68-6	Trichlorfon = Dipterex		Not pers		
125	No CAS 005	Pyrethrin		No data		
126	82657-04-3	Bifenthrin (@Talstar)		Pers		
127	584-79-2	Bioallethrin = d- trans allethrin		Not pers		
128	91465-08-6	Cyhalothrin (@Karate)		Not pers		
129	52315-07-8	Cypermethrin		Not pers		
130	52918-63-5	Deltamethrin		Not pers		
131	66230-04-4	Esfenvalerate		Not pers		
132	26002-80-2	Fenothrin = sumithrin		Not pers		
133	51630-58-1	Fenvalerate		Not pers		
134	69409-94-5	Fluvalinate		Not pers		
135	52645-53-1	Permethrin		Not pers		
136	10453-86-8	Resmethrin		Not pers		
137	No CAS 123	Synthetic pyrethroids		No data		
138	314-40-9	Bromacil		Not pers		
139	60168-88-9	Fenarimol		Pers		
140	1918-02-1	Picloram		Pers		
143	No CAS 120	Bitertanol		No data		
144	21725-46-2	Cyanazine		Not pers		
145	94361-07-6	Cyproconazole		Not pers		
146	119446-68-3	Difenoconazole		Pers		
147	No CAS 121	Epiconazol		No data		
148	No CAS 008	Epoxiconazole		No data		
149	2593-15-9	Etridiazole		Not pers		
150	No CAS 130	Febuconazole		No data		
151	No CAS 009	Indole(3.2-b)carbazole (ICZ)		No data		
152	65277-42-1	Ketoconazol		Pers		
153	21087-64-9	Metribuzin		Not pers		
154	66246-88-6	Penconazole		Not pers		
155	60207-90-1	Propiconazole		Pers		
157	107534-96-3	Tebuconazole		Not pers		
158	886-50-0	Terbutryn		Pers		
160	123-88-6	Triadimenol		Not pers		
161	No CAS 007	Triazines (e.g. atrazine)		No data		
162	71751-41-2	Abamectin		No data		
165	33089-61-1	Amitraz		Not pers		

No	CASNR	Name	HPV	Persist	ED Cat.	Exposure Concern
166	6164-98-3	Chlordimeform		Not pers		
167	74115-24-5	Clofentezine = chlorfentezine		Not pers		
168	96-12-8	Dibromochloropropane (DBCP)		Not pers		
170	25550-58-7	Dinitrophenol		Not pers		
171	88-85-7	Dinoseb		Not pers		
172	80844-07-1	Ethofenprox		Not pers		
173	No CAS 132	Fipronil		No data		
174	76674-21-0	Flutriafol		Pers		
175	2439-99-8	Glyphosate		Not pers		
178	3555-44-0	Imazalil		No data		
180	2212-67-1	Molinate		Not pers		
181	88671-89-0	Myclobutanil		Not pers		
184	82-68-8	Pentachloronitrobenzene (PCNB)		Pers		
185	51-03-6	Piperonyl butoxide		Not pers		
186	7287-19-6	Prometryn		Not pers		
188	NO CAS 129	Thiazopyr		No data		
189	104-51-8	n-Butylbenzene		Not pers		
192	No CAS 010	Styrenes (e.g. dimers and trimers)		No data		
193	12002-48-1	Trichlorobenzene		Not pers		
197	25167-81-1	Dichlorophenol		Not pers		
199	608-93-5	Pentachlorobenzene		Pers		
200	87-86-5	Pentachlorophenol (PCP)		Pers		
201	87-26-3	2-sec-Pentylphenol = 2-(1-Methylbutyl)phenol		Not pers		
202	53792-11-3	4-(4-Hydroxyphenyl)-2,2,6,6-tetramethylcyclohexanecarbonacid		No data		
203	1131-60-8	4-Cyclohexylphenol		Not pers		
204	No CAS 133	4-hydroxy alkylphenol		No data		
205	1009-11-6	4-Hydroxy-n-butyrophenone		Not pers		
206	70-70-2	4-Hydroxypropiophenone		Not pers		
207	1805-61-4	4-iso-Pentylphenol = 4-(3-Methylbutyl)phenol		No data		
208	104-40-5	4-Nonylphenol (4-NP)		Not pers		
209	20427-84-3	4-Nonylphenoldiethoxylate (NP2EO)		Not pers		
210	14409-72-4	4-Nonylphenolnonaethoxylat (Tergitol NP 9)		No data		
211	3115-49-9	4-nonylphenoxy acetic acid		Not pers		
212	No CAS 016	4-Nonylphenoxycarboxylic acid (NP1EC)		No data		
213	99-71-8	4-sec-Butylphenol = 4-(1-Methylpropyl)phenol		Not pers		
214	94-06-4	4-sec-Pentylphenol = 4-(1-Methylbutyl)phenol = p-sec-amylphenol		Not pers		
217	No CAS 013	4-tert-Pentylphenol = p-tert-Amylphenol		No data		
218	7786-61-0	4-vinylguaiacol (4-VG)		Not pers		
219	2628-17-3	4-vinylphenol (4-VP)		Not pers		
220	27986-36-3	Ethanol, 2-(nonylphenoxy)-		Not pers		
221	1322-97-0	Ethanol, 2-(octylphenoxy)- = Octylphenolethoxylate		Not pers		
222	9040-65-7	Formaldehyde, polymere with nonylphenol		No data		
223	9036-19-5	Glycols, polyethylene, mono((1,1,3,3-tet = Poly(oxy-1,2-ethanediyl), .alpha.-[(1,1,3,3-tetramethylbutyl)phenyl]-.omega.-hydroxy-		Not pers		
224	9002-93-1	Glycols, polyethylene, mono(p-(1,1,3,3-t = Octoxynol = Poly(oxy-1,2-ethanediyl), alpha-(4-(1.1.3.3.-tetramethyl-butyl)phenyl)-omega-hydroxy-		Not pers		
225	26027-38-3	Glycols, polyethylene, mono(p-nonylpheny		Not pers		
226	2717-05-5	Heptaoctatrikosan-1-ol, 23-(nonylphenoxy)3,6,9,12,15,18,21-nonylphenolmonoethoxylate		No data		
227	No CAS 102	malein..anhydride, monoester with ethoxylated nonylphenol, nutrilized with reaction products like dipropylenetriamine		No data		
228	No CAS 015	Nonylphenolcarboxylic acid		No data		
229	9016-45-9	Nonylphenolethoxylate		Not pers		
230	No CAS 017	Nonylphenolethoxylate carboxylic acid		No data		
231	No CAS 104	Nonylphenolethoxylate with 9<EO<19		No data		
232	No CAS 103	Nonylphenolethoxylate with EO<9		No data		
233	No CAS 105	Nonylphenolethoxylate with EO>19		No data		
234	No CAS 106	Nonylphenolethyleneoxyphosphate		No data		
235	No CAS 014	Octylphenol-5-ethoxylate		No data		
236	9004-87-9	OP-7 = Poly(oxy-1,2-ethanediyl), alpha-(iso-octylphenyl)-omega-hydroxy-		No data		
237	No CAS 012	Penta to Nonyl-Phenols		No data		
238	27193-28-8	Phenol, (1,1,3,3-tetramethylbutyl)- = Octylphenol		Not pers		
239	27985-70-2	Phenol, (1-methylheptyl)-		Not pers		
240	1331-54-0	Phenol, (2-ethylhexyl)-		No data		
241	3884-95-5	Phenol, 2-(1,1,3,3-tetramethylbutyl)-		Not pers		
242	17404-44-3	Phenol, 2-(1-ethylhexyl)-		Not pers		

No	CASNR	Name	HPV	Persist	ED Cat.	Exposure Concern
243	18626-98-7	Phenol, 2-(1-methylheptyl)-		Not pers		
244	37631-10-0	Phenol, 2-(1-propylpentyl)-		Not pers		
245	949-13-3	Phenol, 2-octyl-		Not pers		
246	26401-75-2	Phenol, 2-sec-octyl-		No data		
247	3307-00-4	Phenol, 4-(1-ethylhexyl)-		Not pers		
248	1818-08-2	Phenol, 4-(1-methylheptyl)-		Not pers		
249	3307-01-5	Phenol, 4-(1-propylpentyl)-		Not pers		
250	27013-89-4	Phenol, 4-isooctyl-		No data		
251	1806-26-4	Phenol, 4-octyl-		Not pers		
252	27214-47-7	Phenol, 4-sec-octyl-		No data		
255	67554-50-1	Phenol, octyl-		No data		
256	93891-78-2	Phenol, sec-octyl-		No data		
257	52623-95-7	Poly(oxy-1,2-ethanediyl), alpha-((1.1.3.3.-tetramethyl-butyl)phenyl)-omega-hydroxy-phosphate		No data		
258	81642-15-1	Poly(oxy-1,2-ethanediyl), alpha-(3-octylphenyl)-omega-hydroxy		No data		
259	51651-58-2	Poly(oxy-1,2-ethanediyl), alpha-(4-isooctylphenyl)-omega-hydroxy-		No data		
260	68891-21-4	Poly(oxy-1,2-ethanediyl), alpha-(dinonylphenyl)-omega-hydroxy-forgrenet		No data		
261	37205-87-1	Poly(oxy-1,2-ethanediyl), alpha-(iso-nonylphenyl)-omega-hydroxy-phosphate		No data		
262	51811-79-1	Poly(oxy-1,2-ethanediyl), alpha-(nonylphenyl)-omega-hydroxy-forgrenet		Not pers		
263	68412-54-4	Poly(oxy-1,2-ethanediyl), alpha-(nonylphenyl)-omega-hydroxy-forgrenet		No data		
264	9036-89-2	Poly(oxy-1,2-ethanediyl), alpha-(octylphenyl)-omega-hydroxy-		No data		
265	68987-90-6	Poly(oxy-1,2-ethanediyl), alpha-(octylphenyl)-omega-hydroxy-forgrenet		No data		
266	60864-33-7	Poly(oxy-1,2-ethanediyl), alpha-(phenylmethyl)-omega-((1.1.3.3.-tetramethyl-butyl)-phenoxy)		No data		
267	9014-90-8	Poly(oxy-1,2-ethanediyl), alpha-sulfo-omega-nonylphenoxy		Not pers		
268	55348-40-8	Poly(oxy-1,2-ethanediyl), alpha-sulpho-omega-((1.1.3.3.-tetramethyl-butyl)-phenoxy)		No data		
269	109909-39-9	Poly(oxy-1,2-ethanediyl), alpha-sulpho-omega(2,4,6-tris(1-methylpropyl)phenoxy)-sodium salt		No data		
270	69011-84-3	Poly(oxy-1,2-ethanediyl), alpha-sulpho-omega-(octylphenyl)-forgrenet, sodium salt		No data		
271	25013-16-5	tert.-Butylhydroxyanisole (BHA)		Not pers		
272	No CAS 020	Intermediate chain chlorinated parafins		No data		
273	No CAS 021	Long chain chlorinated parafins		No data		
274	No CAS 019	Short chain chlorinated parafins		No data		
276	117-84-0	1,2-Benzenedicarboxylic acid, dioctyl ester		Not pers		
282	89-69-5	Diisobutylphthalate		No data		
285	No CAS 024	Dioctylphthalate (DOP)		No data		
287	84-75-3	Di-n-hexyl phthalate (DnHP) = Dihexylphthalate (DHP)		Not pers		
288	No CAS 022	Di-n-octylphthalate (DnOP)		No data		
289	131-18-0	Di-n-pentylphthalate (DPP) = Dipentylphthalate		Not pers		
290	131-16-8	Di-n-propylphthalate (DprP) = Dipropylphthalate		Not pers		
291	4376-20-9	Mono 2 ethyl hexylphthalate (MEHP)		Not pers		
292	131-70-4	Mono-n-butylphthalate		Not pers		
293	No CAS 023	Phthalates		No data		
294	31751-59-4	2,4-trans-Diphenyltetramethylcyclotrisiloxane - 2,4-trans-[(PhMeSiO)2(Me2SiO)]		No data		
295	33204-76-1	2,6-cis-Diphenylhexamethylcyclotetrasiloxane - 2,6-cis-[(PhMeSiO)2(Me2SiO)2][		Not pers		
296	33204-77-2	2,6-trans-Diphenylhexamethylcyclotetrasiloxane - 2,6-trans-[(PhMeSiO)2(Me2SiO)2]		No data		
297	30026-85-8	Diphenylhexamethylcyclotetrasiloxane [(PhMeSiO)2(Me2SiO)2]		Not pers		
298	51134-25-9	Diphenyltetramethylcyclotrisiloxane [(PhMeSiO)2(Me2SiO)]		No data		
299	56-33-7	Diphenyltetramethyldisiloxane PhMe2-SiOSiMe2Ph		Not pers		
300	35964-76-2	o-Tolylheptamethylcyclotetrasiloxane [(o-TolylMeSiO)(Me2SiO3)]		No data		
301	10448-09-6	Phenylheptamethylcyclotetrasiloxane [(PhMeSiO)(Me2SiO)3]		Not pers		
302	17156-72-8	Phenylhexamethylcyclotetrasiloxane [(PhHSiO)(Me2SiO)3]		No data		
303	17964-44-2	PhMe[SiCH2CH2SiMePhO]		No data		
304	28994-41-4	Phenyl-2-hydroxyphenylmethane = 2-Benzylphenol = o-Benzylphenol		Not pers		
305	101-53-1	Phenyl-4-hydroxyphenylmethane = 4-Benzylphenol = p-Benzylphenol		Not pers		
306	92569-29-4	1,1-Bis(4-hydroxyphenyl)-2-ethyl-n-butane		No data		
307	No CAS 025	1,1-Bis(4-hydroxyphenyl)-2-n-propylpentane		No data		
308	2081-08-5	1,1-Bis(4-hydroxyphenyl)ethane		Not pers		

No	CASNR	Name	HPV	Persist	ED Cat.	Exposure Concern
309	1844-00-4	1,1-Bis(4-hydroxyphenyl)-iso-butane		No data		
310	2081-32-5	1,1-Bis(4-hydroxyphenyl)-iso-pentane		Not pers		
311	4731-84-4	1,1-Bis(4-hydroxyphenyl)-n-butane		Not pers		
312	3373-03-3	1,1-Bis(4-hydroxyphenyl)-n-heptane		Not pers		
313	24362-98-9	1,1-Bis(4-hydroxyphenyl)-n-hexane		Not pers		
314	1576-13-2	1,1-Bis(4-hydroxyphenyl)-n-propane		Not pers		
315	7615-24-9	2,2,5,5-Tetra(4-hydroxyphenyl)-n-hexane		No data		
316	No CAS 027	2,2,6,6-Tetramethyl-4,4-bis(4-hydroxyphenyl)-n-heptan		No data		
317	25036-25-3	2,2'-bis(2-(2,3-epoxypropoxy)phenyl)-propane		Pers		
319	3555-19-9	2,2-Bis(4-hydroxyphenyl)-3-methyl-n-butane		No data		
320	6807-17-6	2,2-Bis(4-hydroxyphenyl)-4-methyl-n-pentane		Not pers		
321	77-40-7	2,2-Bis(4-hydroxyphenyl)-n-butan = Bisphenol B		Not pers		
322	41709-94-8	2,2-Bis(4-hydroxyphenyl)-n-heptane		No data		
323	14007-30-8	2,2-Bis(4-hydroxyphenyl)-n-hexane		Not pers		
324	6052-90-0	2,2-Bis(4-hydroxyphenyl)-n-octane		No data		
325	4204-58-4	2,2-Bis(4-hydroxyphenyl)-n-pentane		No data		
327	131-54-4	2,2'-Dihydroxy-4,4'-dimethoxybenzophenon		Not pers		
328	52479-85-3	2,3,4,3',4',5'-Hexahydroxybenzophenon		Not pers		
329	31127-54-5	2,3,4,4'-Tetrahydroxybenzophenon		No data		
330	131-56-6	2,4-Dihydroxybenzophenon = Resbenzophenone		Not pers		
331	10196-77-7	3,3-Bis(4-hydroxyphenyl)-n-hexane		No data		
332	3600-64-4	3,3-Bis(4-hydroxyphenyl)-n-pentane		No data		
333	7425-79-8	4,4-Bis(4-hydroxyphenyl)-n-heptane		No data		
334	No CAS 026	4,4-Bis(4-hydroxyphenyl)-n-octane		No data		
335	611-99-4	4,4'-Dihydroxybenzophenon		Not pers		
336	21388-77-2	4-Hydroxyphenyl-4'-methoxyphenylmethane		No data		
337	57547-76-9	5,5-Bis(4-hydroxyphenyl)-n-nonane		No data		
338	59176-75-9	6,6-Bis(4-hydroxyphenyl)-n-undekane		No data		
339	10193-50-7	Bis(3-hydroxyphenyl)methane		No data		
340	620-92-8	Bis(4-hydroxyphenyl)methane		Not pers		
341	36425-15-7	Bisphenol A-(epichlorhydrin) .. metacrylate polymer		No data		
342	25068-38-6	Bisphenol A-(epichlorhydrin) polymer		No data		
343	25085-99-8	Bisphenol A-diglycidylether polymer (mw<700)		Not pers		
344	105839-18-7	C16 or C18 polymerized bisphenol-A, butylglydiocylether, epichlorhydrine or 1AN,N'-bis(2aminoethyl)ethane-1,2-diamin		No data		
345	No CAS 098	cresol-bisphenol-A formaldehyde polymer		No data		
346	66070-77-7	Dehydrated Castor oil polymere with bisphenol-=A of epichlorhydrine		No data		
347	98824-88-5	Epichlorhydrin-bisphenol A/F, reactionproducts, C12-C14 aliphatic ... (DER 353)		No data		
349	25085-75-0	Formaldehyde, polymer with 4,4'-(1-methylidene)bis(phenol)		No data		
350	93572-41-9	Linseed oil, reaction products with 1-[[2-[(2-aminoethyl)amin)-3-phenoxy-2-propanol, bisphenol A-diglycidylether, formaldehyde or pentaethylenehexamnine		No data		
351	No CAS 028	Tetrabromobisphenol A (TBBP-A)		No data		
352	115489-12-8	1,1-Bis(4-hydroxyphenyl)-1-(4-methoxyphenyl)ethane		No data		
353	1571-75-1	1,1-Bis(4-hydroxyphenyl)-1-phenylethane		No data		
354	No CAS 029	2,4-Dihydroxytriphenylmethancarbonacidlacton		No data		
355	81-92-5	2-[Bis(4-hydroxyphenyl)methyl]benzylalkohol = Phenolphthalol		Not pers		
356	77-09-8	3,3'-Bis(4-hydroxyphenyl)phthalid = Phenolphthaleine		Not pers		
357	135505-63-4	4-Hydroxyphenyl-di-a-naphthylmethane		No data		
358	791-92-4	4-Hydroxy-triphenylmethane		No data		
359	115481-73-7	Bis(4-hydroxyphenyl)[(2-phenoxysulfonyl)phenyl]methane		No data		
360	4081-02-1	Bis(4-Hydroxyphenyl)phenylmethane		Not pers		
361	630-95-5	Diphenyl-a-naphthylcarbinol		No data		
362	4865-83-2	1,3-Bis(4-hydroxyphenyl)pentane		No data		
363	2549-50-0	1,3-Bis(4-hydroxyphenyl)propane		No data		
364	85-95-0	2,4-Bis(4-hydroxyphenyl)-3-ethylhexane		No data		
365	No CAS 030	2,4-Bis(4-hydroxyphenyl)-3-ethylpentane		No data		
366	140131-31-3	3,5-Bis(4-hydroxyphenyl)heptane		No data		
367	1806-29-7	2,2'-Dihydroxybiphenyl = 2,2'-Biphenol		Not pers		
368	92-88-6	4,4'-Dihydroxybiphenyl = 4,4'-Biphenol		Not pers		
369	92-69-3	4-Hydroxybiphenyl = 4-Phenylphenol		Not pers		
372	No CAS 127	2,4-6-trichlorobiphenyl		No data		
373	No CAS 124	2,5-Dichlorobiphenyl		No data		
374	53905-30-9	2-Hydroxy-2',5'-dichlorobiphenyl		Not pers		
375	No CAS 128	3,4',5-trichlorobiphenyl		No data		
376	No CAS 125	3,5-Dichlorobiphenyl		No data		
377	67651-37-0	3-Hydroxy-2',3',4',5'-tetrachlorobiphenyl		No data		
378	53905-29-6	3-Hydroxy-2',5'-dichlorobiphenyl		Not pers		

No	CASNR	Name	HPV	Persist	ED Cat.	Exposure Concern
379	100702-98-5	4,4'-Dihydroxy-2,3,5,6-tetrachlorobiphenyl		No data		
380	56858-70-9	4,4'-Dihydroxy-2'-chlorobiphenyl		No data		
381	13049-13-3	4,4'-Dihydroxy-3,3',5,5'-tetrachlorobiphenyl		No data		
382	53905-33-2	4-Hydroxy-2,2',5'-trichlorobiphenyl		No data		
383	67651-34-7	4-Hydroxy-2',3',4',5'-tetrachlorobiphenyl		No data		
384	14962-28-8	4-Hydroxy-2',4',6'-trichlorobiphenyl		No data		
385	53905-28-5	4-Hydroxy-2',5'-dichlorobiphenyl		Not pers		
386	79881-33-7	4-Hydroxy-2',6'-dichlorobiphenyl		No data		
387	23719-22-4	4-Hydroxy-2-chlorobiphenyl		Not pers		
388	No CAS 040	4-Hydroxy-3',3',4',5'-tetrachlorobiphenyl		No data		
389	4400-06-0	4-Hydroxy-3,4',5-trichlorobiphenyl		Not pers		
390	No CAS 126	4-hydroxy-3,5-dichlorobiphenyl		No data		
391	28034-99-3	4-Hydroxy-4'-chlorobiphenyl		Not pers		
392	No CAS 097	4-OH-2,2',4',5,5'-pentachlorobiphenyl		No data		
393	54991-93-4	Clophen A30		No data		
394	8068-44-8	Clophen A50		No data		
395	No CAS 038	Mixture of 2,3,4,5-tetrachlorobiphenyl (PCB 61), 2,2',4,5,5'-octachlorobiphenyl (PCB 101) and 2,2',3,3',4,4',5,5'-octachlorobiphenyl (PCB 194)		No data		
397	2051-60-7	PCB 1 (2-Chlorobiphenyl)		Not pers		
398	No CAS 039	PCB 104 (2,2',4,6,6'-Pentachlorobiphenyl)		No data		
399	No CAS 041	PCB 105 (2,3,3',4,4' -Pentachlorobiphenyl)		No data		
400	2050-67-1	PCB 11 (3,3'-Dichlorobiphenyl)		Not pers		
401	No CAS 092	PCB 114 (2,3,4,4',5-pentachlorobiphenyl)		No data		
402	No CAS 111	PCB 118 (2,3',4,4',5-pentachlorobiphenyl)		No data		
403	No CAS 042	PCB 122 (2,3,3',4,5 -Pentachlorobiphenyl)		No data		
404	No CAS 037	PCB 126 (3,3',4,4',5-Pentachlorobiphenyl)		No data		
407	2050-68-2	PCB 15 (4,4'-Dichlorobiphenyl)		Not pers		
411	37680-65-2	PCB 18 (2,2',5-Trichlorobiphenyl)		Not pers		
412	2051-61-8	PCB 2 (3-Chlorobiphenyl)		Not pers		
413	55702-46-0	PCB 21 (2,3,4-Trichlorobiphenyl)		Not pers		
414	No CAS 110	PCB 28 (2,4,4'-trichlorobiphenyl)		No data		
415	2051-62-9	PCB 3 (4-Chlorobiphenyl)		Not pers		
416	13029-08-8	PCB 4 (2,2'-Dichlorobiphenyl)		Not pers		
423	34883-43-7	PCB 8 (2,4'-Dichlorobiphenyl)		Not pers		
424	No CAS 036	PCB Aroclor 1016		No data		
425	11104-28-2	PCB Aroclor 1221		Not pers		
426	11141-16-5	PCB Aroclor 1232		Not pers		
431	No CAS 035	PCB hydroxy metabolites		No data		
432	No CAS 087	PCB138		No data		
433	No CAS 088	PCB180		No data		
434	No CAS 134	Polychlorinated diphenyl ether		No data		
440	12642-23-8	PCT Aroclor 5442		No data		
441	617883-33-8	Polychlorinated terphenyls PCT (mixture)		No data		
442	90-15-3	1-Naphthol		Not pers		
443	553-39-9	2-Hydroxy-6-naphthylpropionacid		No data		
445	1125-78-6	5,6,7,8-Tetrahydro-2-naphthol = 6-Hydroxytetralin		Not pers		
446	15231-91-1	6-Bromo-2-naphthol		Not pers		
447	No CAS 031	Halowax 1014		No data		
448	No CAS 032	Mixture of 1,2,3,5,6,7-hexachloronaphthalene and 1,2,3,6,7-hexachloronaphthalene		No data		
449	530-91-6	Tetrahydronaphthol-2		Not pers		
450	20291-73-0	1,9-Dimethylphenanthrene		No data		
451	573-22-8	1-Oxo-1,2,3,4-tetrahydrophenanthrene		No data		
452	58024-06-9	2,8-Dihydroxy-4b,5,6,10b,11,12-hexahydrochrysene		No data		
453	No CAS 089	2,8-dihydroxy-5,6,11,12,13,14-hexahydrochrysene		No data		
454	56614-97-2	3,9-Dihydroxybenz(a)anthracene		No data		
455	56-49-5	3-Methylcholanthrene		Not pers		
456	7099-43-6	5,6-Cyclopento-1,2-benzanthracene		No data		
457	57-97-6	7,12-Dimethyl-1,2-benz(a)anthracene		Pers		
458	No CAS 047	9,10-Dihydroxy-9,10-diethyl-9,10-dihydro-1,2,5,6-dibenzanthracene		No data		
459	63041-53-2	9,10-Dihydroxy-9,10-di-n-butyl-9,10-dihydro-1,2,5,6-dibenzanthracene		No data		
460	63041-56-5	9,10-Dihydroxy-9,10-di-n-propyl-9,10-dihydro-1,2,5,6-dibenzanthracene		No data		
461	56-55-3	Benz(a)anthracene		Pers		
462	50-32-8	Benzo[a]pyrene		Pers		
463	5684-12-8	Dehydrodoisynolacid = Bisdehydrodoisynolacid		No data		
464	53-96-3	n-2-fluorenylacetamide		Not pers		

No	CASNR	Name	HPV	Persist	ED Cat.	Exposure Concern
465	No CAS 048	PAHs		No data		
466	109333-34-8	1,2,3,7,8-PeBDD		Not pers		
468	No CAS 112	1,2,4,7,8-PeCDD		No data		
469	No CAS 115	1,3,7,8-TeBCDD		No data		
470	50585-46-1	1,3,7,8-Tetrachlorodibenzodioxin		Not pers		
471	50585-41-6	2,3,7,8-TeBDD		Not pers		
473	50585-40-5	2,3-Dibromo-7,8-dichlorodibenzodioxin		Not pers		
474	109333-32-6	2,8-Dibromo-3,7-dichlorodibenzodioxin		No data		
475	131167-13-0	2-Bromo-1,3,7,8-tetrachlorodibenzodioxin		No data		
476	No CAS 093	2-Bromo-3,7,8-trichlorodibenzodioxin		No data		
477	97741-74-7	7-Bromo-2,3-dichlorodibenzodioxin		No data		
478	112344-57-7	8-Methyl-2,3,7-trichlorodibenzodioxin		No data		
479	No CAS 049	Dioxins/Furans = PCDDs/PCDFs		No data		
480	No CAS 113	TeBCDD		No data		
481	103456-39-9	TeBDD		Not pers		
490	125652-16-6	6-Ethyl-1,3,8-trichlorodibenzofuran		No data		
491	125652-13-3	6-i-Propyl-1,3,8-trichlorodibenzofuran		No data		
492	118174-38-2	6-Methyl-1,3,8-trichlorodibenzofuran		No data		
493	139883-51-5	6-Methyl-2,3,4,8-tetrachlorodibenzofuran		No data		
494	172485-97-1	6-Methyl-2,3,8-trichlorodibenzofuran		No data		
495	125652-14-4	6-n-Propyl-1,3,8-trichlorodibenzofuran		No data		
496	125652-12-2	6-t-Butyl-1,3,8-trichlorodibenzofuran		No data		
497	103124-72-7	8-Bromo-2,3,4-trichlorodibenzofuran		No data		
498	139883-50-4	8-Methyl-1,2,4,7-tetrachlorodibenzofuran		No data		
499	172485-96-0	8-Methyl-1,3,6-trichlorodibenzofuran		No data		
500	172485-98-2	8-Methyl-1,3,7-trichlorodibenzofuran		No data		
501	172486-00-9	8-Methyl-2,3,4,7-tetrachlorodibenzofuran		No data		
502	172485-99-3	8-Methyl-2,3,7-trichlorodibenzofuran		No data		
533	303-38-8	2,3-dihydroxybenzoicacid (2,3-DHBA)		Not pers		
534	94-82-6	2,4-dichlorophenoxybutyric acid = 2,4-DB		Not pers		
535	490-79-9	2,5-dihydroxybenzoicacid (2,5-DHBA)		Not pers		
537	106-47-8	4-chloroaniline		Not pers		
539	No CAS 052	Allenolic acid		No data		
540	No CAS 056	Azadirachtin		No data		
542	No CAS 055	Biochanin A		No data		
544	57-12-5	Cyanide		Not pers		
546	482-49-5	Doisynolic acid		Not pers		
547	64529-56-2	Ethiozin		Not pers		
549	537-98-4	Ferulic acid (FA)		Not pers		
550	No CAS 054	Formononetin		No data		
551	533-73-3	Hydroxyhydroquinone		Not pers		
552	No CAS 135	Iodine, radioactive		No data		
553	72-33-3	Mestranol		Not pers		
554	No CAS 091	methyl tertiary butyl ether (MTBE)		No data		
555	19044-88-3	Oryzalin		Pers		
556	7400-08-0	p-Coumaric acid (PCA)		Not pers		
559	23950-58-5	Pronamide		Not pers		
561	No CAS 109	TEPA		No data		
562	No CAS 136	Tetrachloro benzyltoluenes		No data		
563	463-56-9	Thiocyanate		Not pers		

ANNEXURE G

European Commission: Endocrine Disrupters Strategy

Annex 15: List of 66 Category 1 substances with categorisation high, medium or low exposure concern

NR	CASNR	Name	HPV/pers	ECO	HUM	Total	Concern
11	12789-03-6	Chlordane	Highly pers	2	1	1	High
12	57-74-9	Chlordane (cis- and trans-)	Highly pers	2	1	1	High
20	143-50-0	Kepone = Chlordecone	Highly pers	2	1	1	High
21	2385-85-5	Mirex	Highly pers	2	1	1	High
24	8001-35-2	Toxaphene=Camphechlor	Highly pers	2	1	1	High
42	50-29-3	DDT (technical)=clofonotane	HPV	1	1	1	High
56	50-29-3	p,p'-DDT = clofenotane	HPV	1	1	1	High
57	3563-45-9	Tetrachloro DDT = 1,1,1,2-Tetrachloro-2,2-bis(4-chlorophenyl)ethane	Highly pers	1	2	1	High
63	50471-44-8	Vinclozolin	HPV	3	1	1	High
69	12427-38-2	Maneb	HPV	3	1	1	High
70	137-42-8	Metam Natrium	HPV	3	1	1	High
73	137-26-8	Thiram	HPV	3	1	1	High
74	12122-67-7	Zineb	HPV	3	1	1	High
78	58-89-9	Gamma=HCH=Lindane	HPV	2	1	1	High
87	330-55-2	Linuron (Lorox)	HPV	3	1	1	High
142	1912-24-9	Atrazine	HPV	2	1	1	High
163	34256-82-1	Acetochlor	HPV	3	1	1	High
164	15972-60-8	Alachlor	HPV	2	1	1	High
191	100-42-5	Styrene	HPV	3	1	1	High
198	118-74-1	Hexachlorobenzene=HCB	HPV	3	1	1	High
270	85-68-7	Butylbenzylphthalate (BBP)	HPV	3	1	1	High
279	117-81-7	Di-(2-ethylhexyl)phthalate (DEHP) = Dioctylphthalate (DOP)	HPV	3	1	1	High
286	84-74-2	Di-n-butylphthalate (DBP	HPV	3	1	1	High
326	80-05-7	2,2-Bis(4-hydroxyphenyl)propan = 4,4'-isopropylidenediphenol = Bisphenol A	HPV	1	1	1	High
396	1336-36-3	PCB	Pers.		1	1	High
408	35065-27-1	PCB153	Pers.		1	1	High
410	32774-16-6	PCB169	Pers.		1	1	High
417	2437-79-8	PCB47	Pers.		1	1	High
422	32598-13-3	PCB77	Pers.		1	1	High
427	53469-21-9	Aroclor 1242	Highly Pers.		1	1	High
428	12672-29-6	Aroclor 1248	Pers.		1	1	High
429	11097-69-1	Aroclor 1254	Highly Pers.		1	1	High
430	11096-82-5	Aroclor 1260	Pers.		1	1	High
438	59536-65-1	PBBs = Brominated Biphenyls (mixed group of 209 Congeners)	Pers.		1	1	High
NR	**CASNR**	**Name**	**HPV/pers**	**ECO**	**HUM**	**Total**	**Concern**
467	40321-76-4	1,2,3,7,8 Pentachlorodibenzodioxin	Pers.		1	1	High
472	No CAS 140	2,3,7,8 Tetrachlorodibenzo-p-dioxin	Pers.		1	1	High

		(TCDD)					
487	57117-31-4	2,3,4,7,8 Pentachlorodibenzofuran	Pers.		1	1	High
525	688-73-3	Tribityltin	Metal	1	2	1	High
526	No CAS 050	Tributyltin compounds	Metal	1	2	1	High
527	56-35-9	Tributyltin oxide=bis(tributyltin) oxide	HPV/Metal	1	2	1	High
504	26354-18-7	2-propenoic acid, 2-methyl-, methyl ester = Stannane, tributylmeacrylate	Metal	1	2	1	High
512	No CAS 100	Methoxyetylacrylate tinbutyltin, Copolymer	Metal	1	2	1	High
514	4342-30-7	Phenol, 2-[[(tributylstannyl)oxy]carbony	Metal	1	2	1	High
515	4342-36-3	Stannane, (benzoyloxy)tributyl-	Metal	1	2	1	High
516	4782-29-0	Stannane, [1,2-phenylenebis(carbonyloxy)	Metal	1	2	1	High
517	36631-23-9	Stannane, tributyl = Tributyltin naphtalate	Metal	1	2	1	High
518	85409-17-2	Stannane, tributyl-, mono(naphthenoyloxy	Metal	1	2	1	High
519	24124-25-2	Stannane, tributyl[(1-oxo-9,12-octadecad	Metal	1	2	1	High
520	3090-35-5	Stannane, tributyl[(1-oxo-9-octadecenyl)	Metal	1	2	1	High
521	26239-64-5	Stannane, tributyl[[[1,2,3,4,4a,4b,5,6,1	Metal	1	2	1	High
522	1983-10-4	Stannane, tributylfluoro-	Metal	1	2	1	High
524	2155-70-6	Tributyl[(2-methyl-1-oxo-2-propenyl)oxy]stannane	Metal	1	2	1	High
528	No CAS 099	Tributyltincarboxylate	Metal	1	2	1	High
529	26636-32-8	Tributyltinnaphthalate	Metal	1	2	1	High
530	No CAS 101	Tributyltinpolyethoxylate	Metal	1	2	1	High
531	2279-76-7	Tri-n-propyltin (TPrT)	Metal	1	3	1	High
532	No CAS 051	Triphenyltin	Metal	1	3	1	High
509	900-95-8	Fentin acetate	Metal	1	3	1	High
536	95-76-1	3,4-Dichloroaniline	HPV	1	2	1	High
560	108-46-3	Resorcinol	HPV	3	1	1	High
141	61-82-5	Amitrol = Aminotriazol	HPV	3	1	1	Medium
182	1836-75-5	Nitrofen	HPV	3	1	1	Medium
216	140-66-9	4-tert-Octylphenol=1,1,3,3-Tetramethyl- 4-butylphenol	HPV	1	1	1	Medium
254	25154-52-3	Phenol, nonyl-	HPV	1	1	1	Medium
523	1461-25-2	Tetrabutyltin (TTBT)	HPV/Metal	1	2	1	Low
538	99-99-0	4-Nitrotoluene	HPV	3	1	1	Low