AN INVESTIGATION INTO THE PROBLEMS OF INEFFECTIVE CONTROL OF INVASIVE PLANTS IN SELECTED AREAS OF SOUTH AFRICA: A CASE STUDY OF *CAMPULOCLINIUM MACROCEPHALUM* (POMPOM WEED)

by

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DECLARATION

I, William Tlokotse Mashiloane (ID number 6306066556080), declare that this dissertation entitled, **“An investigation into the problems of ineffective control of invasive plants in selected areas of South Africa: a case study of *campuloclinium macrocephalum* (pompom weed)”,** is my own work and that all the sources that were used or quoted, have been indicated and acknowledged by means of complete references. Prior to the commencement of the research project, I conducted a literature search and ascertained as at the commencement of this study that no other similar research has been conducted or submitted for examination to the University of South Africa, prior to the registration of this project.

Signature:_____ Date:_____

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ABSTRACT

Interference of natural environment by invasive plants is a global concern. In South Africa and in particular Gauteng Province, interference of natural land by invasive plants that originated from other countries has been an endemic problem. These invasive plants pose a threat to biodiversity as a result of its wild and wide dispersion rate where it spreads into neighbouring Provinces such as Mpumalanga, Limpopo, North West and the Free State. Pompom weed is aggressive to control and can spread by means of both wind and water. This research project investigates problems associated with ineffective control of invasive plants in general and pompom weed in particular. State organs, Non Governmental Organisations (NGOs) and farming communities were identified as relevant respondents in this study. Three hundred (300) validated questionnaires were distributed to these stakeholders and 286 were adequately completed and received. These were analysed and the data interpreted. Results obtained showed that lack of coordination and teamwork from all stakeholders are responsible for ineffective control of invasive plants in the country. The use of biological control was recommended for the control and eradication of the invasive plants.

Key words: *Campuloclinium macrocephalum*, pompom weed, invasive plants, ineffective control, South Africa

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CHAPTER 1

1. BACKGROUND INFORMATION ON ALIEN AND INVASIVE PLANTS IN SOUTH AFRICA

1.1 INTRODUCTION

Alien and invasive plant species are those plant species that have been introduced into an area outside their normal distribution (South Africa), either by accident (unintentional) or on purpose (intentional) and have colonised or invaded their new home, threatening biological diversity, ecosystems, habitats and human wellbeing (McNeely et al., 2001; Chenge and Mohamed – Katerere, 2003).

Increased human and plant mobility has contributed significantly to the introduction of exotic plants into South Africa. These alien and invasive plants pose a severe threat to plant and animal diversity, water use and ecosystem integrity (Balance and King, 1999). The spread of these plants species (both intentionally and unintentionally) is a good example of the lack of understanding of ecosystem processes that has been a major cause of environmental degradation (Balance and King, 1999).

Sensitive and vulnerable, highly dynamic or stressed ecosystems such as coastal shores, estuaries, wetlands, grasslands and open savannah require specific attention in environmental management and planning procedures, especially where they are subjected to significant human resource usage and development pressures (DEAT, 2000a).

Millions of Rands on the control of invasive plants could have been saved if eradication programmes of plants species such as jointed cactus (*Opuntia aurantiaca*), pompom weed (*Campuloclinium macrocephalum*), triffid weed

(*Chromolena adorata*), syringa (*Melia azedararach*), black wattle (*Acacia mearsii*), grey ironbark (*Eucalyptus paniculata*), yellow bells (*Tecoma stans*), queen of the night (*Cerius jamacaru*), rooikrans (*Acacia cyclopes*), Port Jackson (*Acacia saligna*) and lantana (*Lantana camara*) had been initiated when they were first detected (Henderson, 2001; ARC, 2006a).

Among all the methods (such as mechanical, chemical and integrated), used to control alien and invasive plants, biological control has been identified as the most cost effective, sustainable and environmentally friendly (Simelane, 2004). In cases where alien and invasive species are biologically controlled, visits to the country of origin of the species in question have been taken in the past by researchers. The purpose of the visit is to identify natural predators or invaders, which can control the invasive species. The particular insect or disease is then kept in quarantine to test its host specificity. If the pest is found to be host specific, an application is made by the authority to release the pest. The Department of Environmental Affairs and Tourism (DEAT) grants an authority the right to release the pest and the Department of Agriculture (DoA) monitors the pest's performance.

In South Africa, the Conservation of Agricultural Resources Act (Act 43 of 1983) (CARA) governs the control of alien and alien invasive plants. The Department of Agriculture, through its Directorate: Land Use and Soil Management (DLUSM), is the custodian of the Conservation of Agricultural Resources Act. The Department of Agriculture makes provision for the conservation of South Africa's natural resources through:

- ✓ Maintaining the productive potential of land.
- ✓ Combating and preventing soil erosion.
- ✓ Preventing the degradation or destruction of water resources.
- ✓ Protecting the vegetation.
- ✓ Combating weeds and alien and invasive species.

The Conservation of Agricultural Resources Act (1983) lists alien and invader plants in several categories. The pompom weed for example falls into category 1, declared weeds. Category 1 plants are those which are prohibited and no longer tolerated on land or on water surfaces, either in rural or urban areas. Conservation of Agricultural Resource Act prohibits further planting or propagation and trade in seeds of these plants, cuttings or other propagating material. They may not be transported or allowed to disperse (Liebenberg, 2007; Moremi, 2010).

Since invasion by alien and invasive species is a global concern, South Africa is not alone in its experience of the economic and environmental challenges posed by these plants. Despite a lack of statistical information, it is commonly believed that approximately 10 million (m) hectares (ha), or 8.28 percent, of the surface area of the country is severely infested by these plants species (Henderson, *et al.*, 2006).

With the aid of the results of the analysis of the data, the shortfalls leading to problems and ineffective control of invasive plants will be investigated. After identifying the strengths and opportunities in the processes and the weaknesses and threats posed by ineffective control of invasive plants, emphasis will be placed on capitalising on strengths and opportunities and finding solutions to weaknesses and threats. Having analysed questionnaires and using information gained in this way to guide environmental managers and the farming community on current and future tendencies, a Strengths Weaknesses Opportunities and Threats (SWOT) analysis will be implemented in the Waterberg District of Limpopo Province, Nkangala District Municipality of Mpumalanga and the City of Tshwane Metropolitan Municipality of Gauteng.

In order to take effective control of alien and invasive plants, a participatory approach should be considered.

1.2 RESEARCH MOTIVATION-POMPOM WEED AS AN EXAMPLE

Campuloclinium macrocephalum (the pompom weed) is a plant species indigenous to South America, belonging to the daisy family (Asteraceae). The pompom is an unpalatable herb which grows up to 1.3 metres (m) in height (Liebenberg, 2007). The plant bears several erect green or purplish stems with light purplish to pink flower heads (Liebenberg, 2007). The fleshy, tuber-like roots deprive the soil of water and nutrients, inhibiting indigenous wild flowers and veld grasses in their vicinity (Moremi, 2010).

The earliest record of this plant in the Pretoria National Herbarium is of a specimen collected in Johannesburg in 1962. The initial record of its geographical existence in the wild comes from Fountains Valley in Pretoria in the early 1960s and Westville, near Durban, in 1972. In the 1980s, the pompom weed's geographical distribution expanded into the Pretoria area and it was also recorded in Hilton in KwaZulu-Natal and Wolkberg in Limpopo Provinces (Mc Key and Oleiro, 2007). In the 1990s, it spread further to Port St Johns in the Eastern Cape, Rooiberg in Limpopo and Nelspruit in Mpumalanga (ARC, 2007a). In the years 2000 to 2003, it infiltrated the Gauteng Province and was also recorded for the first time in Kroonstad in the Free State (ARC, 2006b). During this period, it also spread into the Nelspruit, White River and Barberton areas of Mpumalanga (ARC, 2007a). By the year 2006, it had spread even further to the Piet Retief area in south-eastern Mpumalanga and into Swaziland (ARC, 2006a). More surveys in December 2006 recorded new sites in the Waterberg in Limpopo Province, while surveys in January and February 2007 revealed other sites in Polokwane, Haenertsberg, Woodbush, Duiwelskloof, Tzaneen and Wolkberg in Limpopo Province (ARC, 2007a).

Government departments such as the Department of Environmental Affairs and Tourism (DEAT); the Department of Water Affairs and Forestry (DWAF), the Department of Defence (DOD) and the Department of Agriculture (DoA) have

some responsibility in environmental management. Some environmental challenges in the government sector have arisen because environmental management is the joint responsibility of national, provincial and local governments. Currently, ineffective law enforcement is a major obstacle in the achievement of effective environmental management (Mohamed, 1997).

The pompom grows in large numbers in areas where soil has been disturbed, such as roadsides, open urban spaces, abandoned fields and overgrazed lands (Liebenberg, 2007). It has invaded South Africa's wetlands, open savannah and grasslands. The Waterberg District in Limpopo Province and the Nkangala District in Mpumalanga and the City of Tshwane Metropolitan Municipality in Gauteng are wetlands and savannah respectively. Another invasive alien plant, *Verbena bonariensis* (Purple Top), is associated with the pompom weed and its presence is a good indication of a suitable habitat for this weed (ARC, 2006a).

Infestation by alien and invasive species such as the pompom weed is a worldwide challenge (ARC, 2007b). The pompom weed degrades the soil's productivity and edges out colonies of palatable indigenous grass species and wildflowers (Liebenberg, 2007).

Land degradation and desertification are serious challenges facing Africa in general and South Africa in particular, as the majority of the continent's people depend directly on land resources for their livelihoods. If natural resources are not managed in a sustainable manner, Africa will demand increased resources and accelerated intervention by the United Nations Convention on Combating Desertification (DEAT, 2006).

One third of the planet's surface and approximately one *billion* people in over a hundred countries are affected by desertification or land degradation. These processes turn productive land into desert, mainly as a result of poor land management. The areas affected most severely are semi-arid areas bordering on

deserts, generally called dry lands or desert margins and which have significant biological value (SANParks, 2006a).

According to South African Agenda 21 (1998), agriculture in South Africa has a central role to play in building a strong economy and in the process of reducing inequalities by increasing our inheritance of natural resources. Poorly managed cultivated and grazing lands, increased population mobility and uncontrolled introduction of alien and invasive plants and animals have resulted in over eight percent of South Africa's land surface being severely infested by alien and invasive vegetation, with a large portion being affected by bush encroachment. This has a detrimental effect on the carrying capacity of the land (Du P Bothma, 1996).

The continued existence of species and resources can only be guaranteed through the correct management and conservation of the natural environment. As the human population increases over time, so the demand for food and water grows. There is a limit to the availability of land and it is becoming increasingly important to optimise effective and efficient utilisation of natural resources (UNISA, 2007).

This research project investigates problems associated with ineffective control of the invasive plant specie in two biomes in South Africa; which are the grasslands biome found around the City of Tshwane Metropolitan Municipality in Gauteng and in the Nkangala district of Mpumalanga, and the savanna biome which occurs in the Waterberg district of Limpopo Province.

1.3 CONTEXTUALISATION OF RESEARCH PROBLEM

The purpose of this study was to assess the problems that contribute to or exacerbate the ineffective control of invasive plants in the selected areas of South Africa.

1.3.1 Hypothesis

Stakeholders involved in the management of alien invasive plants must have adequate knowledge into the effective management of alien invasive plants.

1.3.2 Research objectives and aims

The main objective of this research was to investigate and assess the problems that potentially contribute to or exacerbate the ineffective control of invasive plants and to examine environmental management challenges posed by these plants in South Africa.

In order to achieve this, the following specific objectives/activities would be conducted:

The aims of this research project were to:

a. To conduct a baseline survey of current management strategies adopted by various stakeholders with regard to invasive plants.
b. To analyse the strengths and weaknesses inherent in existing strategies.
c. To analyse current knowledge, competence and awareness in the management of invasive alien plants.
d. To suggest possible ways of overcoming deficiencies and to make recommendations.
e. To suggest new management approaches.

CHAPTER 2

2. LITERATURE REVIEW

2.1 INTRODUCTION

This study investigates the problems caused by ineffective control of invasive plants, in particular the pompom weed, which because of its fast spread, threatens biodiversity and the productive potential of land. Controlling this weed requires the joint efforts of all government departments, non-governmental organisations and farming communities that are responsible for environmental management. Hence, the focus of this study on these organisations/ institutions.

(Swarbrick *et al., 1995;* McNeely *et al*. 2001; Australian 2008) define biosecurity as the management of risks posed by organisms to the economy, environment and human health by exclusion, mitigation, adaptation, control and eradication.

The aim of control is to reach a point where the alien species in question no longer occur or exist in the environment. Where the species do occur, they would be in a position that they can no longer grow, produce viable seeds or spores, coppice, sprout or propagate themselves in any way or spread into other areas. If this is not possible, then the multiplication capability must be kept as low as possible (ARC, 2008a).

Von Braum, (2008) noted that the conservation of biodiversity is regarded by organisations such as the South African National Parks and South African Biodiversity Institute as the bedrock of their activities, to which other core functions such as tourism, people and conservation are anchored.

The South African Constitution provides for the right to a healthy environment, and protects it for the benefit of present and future generations through

reasonable legislation and other measures that prevent pollution and ecological degradation, promote conservation and secure ecologically sustainable development and the use of natural resources while promoting justifiable economic and social development (South Africa, 1996).

Environmental sustainability has been defined as the balance between the environment, economic viability and social acceptability that meets the needs of the present generation without compromising the ability of future generations to meet their own needs (Nahman and Mahfi 2004; Nahman, *et al*, 2009). Environmental concerns and the principle of sustainable development must be an integral part of all local governance, such as land use or structural plans for water and transport (South African Agenda 21, 1998).

This principle of viable environmental sustainability requires a constant overall stock of natural capital to be left for future generations. It is much more stringent than imbalanced sustainability since it requires that natural capital should not be replaced by any other form of capital. In other words, the environment must be conserved (DEAT, 1997). In general, South Africa's debate on how sustainability is to be achieved is taking place through the "Consultative National Environmental Policy Process" (Connepp), which has been given the task of formulating a new environmental policy for the country. This process is expected to lead to agreement on a set of immediate global environmental policy goals (DEAT, 1997).

Payment for Ecosystem Services (PES) in South Africa has come about largely through the establishment of the *Working for Water* programme that started in 1995 (Schreiner and Koopen, 2002). This programme was initiated in response to the realisation of the gravity of the threat that invasive alien plants pose to the water supply in South Africa. The idea of initiating this programme was presented by a group of environmental managers and scientists to the then late Minister of Water Affairs and Forestry, Prof. Kader Asmal. They proposed to address two

immediate challenges with one intervention, tackling the effects of invasive alien plants on South Africa's scarce water resources as well as job creation and economic empowerment (Turpie *et al.*, 2007).

The initial clearing cost was very high (as much as R7000/ha for densely infested areas) (R6.50-7.50: US$1), but the cost of subsequent follow-ups decreased with each treatment (Turpie *et al*., 2007). Care must be taken that seed banks or nearby seed sources from the invasive plants in question do not remain and maintenance must be a continuous process. Clearing costs are very low in this instance (less than R50.00/ha/treatment) but must be maintained at an interval of one to three years, depending on the species in question (Marais, 1998). Regular and proper treatment encourages indigenous vegetation to colonise from existing seed banks. Recovery is usually relatively rapid (within a decade, depending upon the vegetation type involved) (Turpie *et al*., 2007).

The main focus/method of eradication that is been used for the pompom weed, the species focused on in this study is biological control. Biological control is effected using floral fungi and viral pathogenic material from Argentina and Brazil, naturalised to the South African environment (Mitchell and Power, 2003). Infestation by native competitors is also important, e.g. root exudates of some invasive plants contain novel allelopathic agents that are highly toxic to unadapted native plants (Callaway and Aschehough, 2000; Callaway and Ridenour, 2004). A pictorial presentation of pompom weed in the environment is shown in Figure 2.1 below.

Fig 2.1: A pictorial presentation of full bloom of pompom weed in the environment (Photograph by researcher, 2008).

2.2 INVADER PLANTS

South Africa has a long history of problem plants which have been variously called “weeds”, “plant pests”, “plant invaders”, “invasive plants”, “bush encroachers”, “naturalised exotics or aliens”, “environmental weeds”, “transformers”, among others (Milton, 2004; Blignaud *et al.*, 2007). These terms have been used to describe both indigenous plants (native or belonging to South Africa) and non-indigenous plants (exotic, alien and invasive species introduced to South Africa) (Henderson, 2000).

These plants have become established in South Africa. Establishment refers to the process through which a species in a new habitat successfully reproduces at a level sufficient to ensure continued survival without infusion of the genetic material from outside the system (Cullis et al., 2007). Alien invasive plants are defined as plants, the establishment and spread of which threaten ecosystems,

habitats or species with economic or environmental value. These are addressed under Article 8 (h) of the Convention on Biological Diversity (CBD) (Henderson, 2000). Weeds are plants (not necessarily alien) that grow where they are not wanted and that have a detected economic or environmental effect (Henderson, 2000).

From the South African perspective, invaders are plants or animals which, for some reason, are judged to be undesirable in their new habitats. The Conservation of Agricultural Resource Act differentiates between two categories of problem plants, namely weeds and plant invaders (Hugo *et al*., 2000).

Alien invasive species are generally species that occur outside their country of origin and, owing to their ability to outperform and outgrow indigenous plants, establish themselves in these non-native habitats (Department of Agriculture and Environmental Affairs KwaZulu-Natal, 2005). The species that pose the greatest threat to the natural environment are generally those that have been planted most widely and for the longest period. The most affected areas are those with the longest histories of intensive planting, which in the case of the blue gum and pompom weed are Mpumalanga, KZN and Gauteng respectively (Richardson, 1998; Forsynth *et al*., 2004).

Research projects conducted on the management of biological invasion deal with aliens and invaders which are already established, or are aimed at preventing introduction of high risk species to non-infested areas (Tucker and Richardson, 1995; Le Maitre *et al.,* 2002; Nel *et al.*, 2004). In contrast, less attention has been given to developing systemic approaches for dealing with species which are already present and which have demonstrated invasive tendencies in the region or are well known to be invasive in similar environments elsewhere in the world, but have not yet invaded large areas here (Baars, J-R and Nasser, 1999; Mgidi *et al*., 2004).

When introduced into a new region, some plant species, for instance the pompom weed, thrive, out-compete indigenous species and exhibit an ability to overcome environmental constraints and, in the process, dominate the invaded area (Keane and Crawley, 2002; Chenge and Mohamed-Katerere, 2003; Milton, 2004).

The National Treasury allocates the budget and Medium Term Expenditure Framework (MTEF) for control of invasive alien plant species. This budget is based on three main criteria:

- ✓ Functional priority (e.g. water conservation, biodiversity and productive potential of the land).
- ✓ The impact of poverty alleviation and economic empowerment.
- ✓ The department's capacity to spend the budget effectively, efficiently and economically (Turpie *et al.*, 2007).

In the context of alien and invasive species, a quarantine policy not only protects cultivated crops from damage, but also protects the native ecosystem, communities and the political environment (Cook and Proctor, 2006). Alien and invasive species can transform the structure and species composition of the ecosystem by repressing or excluding native species, either directly by out-competing with them for resources or indirectly by changing the way nutrients are cycled through the entire system (McNeely *et al*., 2001).

In South Africa, the fight against alien invasive species is spearheaded by the Working for Water programme, which was launched in 1995 and is administered by the Department of Water Affairs and Forestry. Since its inception, this programme has fallen under the Extended Public Works Programme (Luwum, 2002; Cullis *et al.,* 2007). *Working for Water* is globally recognised as one of the most outstanding environmental conservation initiatives on the African continent. The programme enjoys sustainable political support for its job creation efforts

and the fight against poverty. *Working for Water* considers development of people an essential element of environmental conservation (van Wilgen, 2009).

Taking into account the history of alien plant invasion in South Africa, landowners/users cannot be held fully accountable for the control of alien invasive plants. The South African government plays a major role in the introduction of the majority of alien and invasive plants, as these species were often introduced for commercial purposes, natural resource rehabilitation as well as for ornamental horticultural purposes (Fig 2.2) (Milton, 2004; Blignaud *et al.*, 2007; Cullis *et al.*, 2007).

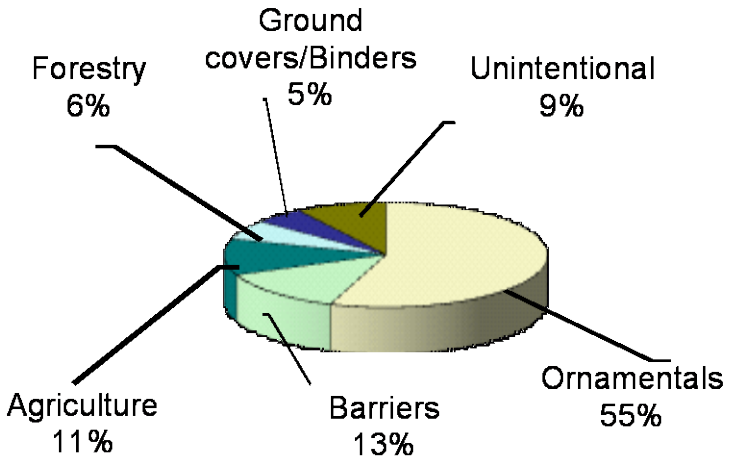

Fig 2.2: Schematic representation of how alien and invasive plant species were introduced to South Africa (source: Ramashala, 2008)

Paradoxically, the government makes a substantial contribution to the control of alien and invasive species through the Expanded Public Works Programme of the Department of Public Works. In 2007, when this literature survey was conducted, this programme was funded by an amount of R380 million in the form of Working for Water activities, plus contributions from Working on Fire (WoF) which received a portion of R44m, Working on Wetlands and received R30m (Cullis *et al.*, 2007). The Global Invasive Species Programme (GISP) was

initiated in January 1996 and established in 1997. The aim of Global Invasive Species Programme is to address the global threats posed by alien and invasive species and to provide support for the implementation of Article 8(h) of the Convention on Biological Diversity (CBD) (McNeely *et al.*, 2001).

Of the estimated 9000 plants introduced to South Africa, 198, including the pompom weed, are currently classified as invasive (Wildly, 2006). It is estimated that these plants cover about 10 percent of South Africa's land surface and they pose the threat of covering the entire country because of their alarming spread and growth rate (Wildly, 2006). The famine caused by alien and invasive species is already a constant global threat. The global human population is expected to reach 8.5 *billion* by the year 2025, with 83 percent living in developing countries. The demand for food is expected to increase by 50 percent by the year 2020. But the world's long-term ability to meet the growing demand for food and other agricultural products remains unchanged (South African Agenda 21, 1998).

Sustainable agriculture and rural development will require major adjustments in agricultural, environmental and economic policies in all countries, continents and at the international level. This necessitates cooperation among farming communities, national and provincial governments, the private sector and the international community (South African Agenda 21, 1998). The loss of the world's biodiversity continues as a result due to mainly habitat destruction, over harvesting, pollution and the inappropriate introduction of exotic plants and animal species. This decline in biological diversity is largely caused by humans and presents a serious threat to our development. Chapter 2 of Agenda 21 intends to improve the conservation of biological resources and to support the conservation of biological diversity (South African Agenda 21, 1998; Mohamed and Chenge-Kerere, 2003).

2.2.1 Threats posed by alien and invasive species

The battle to get rid of alien and invasive plant species in South Africa began in the early 1980s when government realised that, if unmanaged, they would double within decades (Liebenberg, 2007). Alien and invasive species pose a threat to the natural environment in the following ways:

- ✓ They compete with indigenous plants for nutrients such as phosphorus.
- ✓ They pose a threat to water security, i.e. they consume too much water.
- ✓ They disturb ecological functioning of the natural system.
- ✓ Weeds such as the pompom weed degrade the productive potential of the land.
- ✓ They intensify the intensity and spread of veld fires.
- ✓ Some plants, e.g. *Eucaliptus paniculata,* increase the intensity of desertification as they absorb too much water (Le Maitre *et al., 1995*).
- ✓ They increase the number of poisonous plants in the country and as such they increase the probability of livestock and game mortality, e.g. *Lantana camara*.
- ✓ Aquatic invasive alien plants such as water hyacinth affect agriculture, fishing, recreation and water supply (Luwum, 2002; Moremi, 2010).

2.3 LEGAL REQUIREMENTS REGARDING THE ENVIRONMENT

There are legal guidelines that affect the management of alien invasive weeds. These are as discussed below:

2.3.1 Constitution of the Republic of South Africa, 1996 (Act 108 of 1996)

Various sections of the Bill of Rights have major relevance to environmental policy. Section 24 of the Constitution attempts to right the wrongs of past practices which settled poor and disadvantaged communities near dirty and polluting industries, and on poor and degraded land. The Bill of Rights states that environmental justice must be done in such a manner that adverse

environmental impact are not distributed in a manner that unfairly discriminates against any person. Section 24 of the South African Constitution provides for the right of every South African citizen to a healthy environment, and protects the environment for the benefit of present and future generations through reasonable legislation and other measures that prevent pollution and ecological degradation, promote conservation and secure ecologically sustainable and social development (South Africa, 1996; Bernier *et al*., 2005).

In terms of Section 8 of the Bill of Rights, the government is obliged to give effect to these rights in the exercise of environmental governance. In terms of section 24 of the Bill of Rights, people can take legal action to protect their environment, even where government has no obligation in terms of any other statute to give effect to these rights. Section 24 obliges government to pass reasonable legislation to protect the environment, to prevent pollution and ecological degradation and to secure sustainable development. The government must comply with environmental legislation (White Paper on Environmental Policy, 1997) (on line file://E\EnvMgmt policy.htm 30/04/2007).

2.3.2 Conservation of Agricultural Resources Act (Act 43 of 1983) (CARA)

The Conservation of Agricultural Resources Act (Act 43 of 1983) is administered by the Department of Agriculture through its Directorate: Land Use and Soil Management (D LUSM). CARA makes provision for the conservation of the natural resources of South Africa through:

- ✓ Maintaining the productive potential of land.
- ✓ Combating and preventing soil erosion.
- ✓ Preventing the weakening or destruction of water resources.
- ✓ Protecting vegetation.
- ✓ Combating weeds and invasive species (Moremi, 2010).

Under CARA (Act 43 of 1983), Category 1 plants or declared weeds are those that will no longer be tolerated, neither in rural nor urban areas, except with the

written permission of the executive officer or of an approved bio-control agent (Forsyth *et al.,* 2004; ARC, 2008b; Moremi, 2010). These plants may no longer be planted or propagated and all trade in their seeds, cuttings or other propagating material is prohibited. They must not be transplanted or be allowed to disperse (Luwum, 2002; ARC, 2007f and Moremi, 2010).

Category 1 Plant or declared weeds are harmful to the natural environment by:

- ✓ Posing a serious health risk to both livestock and wild game because they are inedible, e.g. pompom weeds.
- ✓ Causing serious financial losses to land users because of the financial implications of their control.
- ✓ Their ability to invade undisturbed environments e.g. Pompom weeds, *Nasella trichotoma* (Nasella tussock) etc.
- ✓ Displacing indigenous plant communities, e.g. palatable indigenous grasses.
- ✓ Consuming more ground water than the plant communities they replace e.g. *Eucalyptus spp*.
- ✓ Being particularly difficult to control: the pompom weed survives fire and is mechanically impossible to control.
- ✓ Their ability to produce a copious number of wind dispersed seeds and have a highly efficient means of vegetative reproduction e.g. Pompom weeds (ARC, 2008b).

Some plants are dangerous because they are poisonous. For instance, parts of the nasella, lantana plant are toxic (Morton, 1994) and can cause poisoning when consumed. This results in an estimated annual stock loss to the South Africa farming community of about 1800 head of cattle (Kellerman *et al*., 1996).

Few plants can survive once alien and invasive plants such as *Pueraria montana* (kudzu) have been smothered by them. It covers the tree or shrub with a dense

canopy through which little light can penetrate (Britton *et al*., 2007). Regulation 15 of CARA is in the process of recognising rust fungus on which the Agricultural Research Council Plant Protection Research Institute has conducted research and which has resulted in the die-back of pompom weeds. Conservation of Agricultural Resource Act must now impose guidelines for the protection of this rust fungus.

The Resource Auditor (RA) of the Department of Agriculture, in the Directorate: Land Use and Soil Management and Municipal Weed Inspectors are authorised to visit any property at random at a reasonable time in order to inspect it for the presence of any declared weeds or invasive plants. If these plants occur at any specific rate in terms of Regulation 15 of the Conservation of Agricultural Resources Act, the land owner/user will be informed of the offence as well as the steps that should be taken to correct this situation. The time span in which to control the offending plant will be determined in consultation with the land owner/user. A written directive is issued by the Resource Auditor to confirm decisions taken during such a personal visit.

Follow-up visits will be made as the deadline approaches in order to ascertain whether the necessary control actions have been satisfactorily carried out. If not, the Resource Auditor has the power to prosecute offenders. The Municipal Weed Inspector does not have this power, and may issue a notice but may not prosecute offenders. In cases where the land owner/user does not comply with the action required by the notice, the case will be handed over to a Resource Auditor (ARC, 2008b). The penalty for non-compliance with the Conservation of Agricultural Resources Act could be a fine of up to R5000 or imprisonment for a period of up to two years, or both, for a first conviction (Wildly, 2006). A doubled penalty may be imposed in cases of subsequent conviction (ARC, 2008b).

In addition to those listed as declared weeds, a further 152 plant species have been included in the new list of declared alien and invasive plants (Wildly, 2006).

2.3.3 Environmental Conservation Act (Act 73 of 1989)

The purpose of this act is to provide for the effective protection and controlled utilisation of the environment and for matters incidental thereto.

2.3.4 National Environmental Management Act (Act 107 of 1998) (NEMA)

The purpose of this act is to provide for cooperative environmental governance by establishing principles for decision making on matters affecting the environment, institutions that will promote cooperative governance and procedures for coordinating environmental functions exercised by organs of the state and matters connected therewith.

Principles of National Environmental Management Act relevant to control of pompom weed

1. The principles set out by the National Environmental Management Act apply throughout the Republic of South Africa and to the actions of all organs of state that may significantly affect the environment (Gibson *et al*., 2008).
   - ✓ These principles shall apply alongside all other appropriate and relevant considerations including the state's responsibility to respect, protect, promote and fulfil the social and economic rights as stated in Chapter 2 of the Constitution of South Africa.
   - ✓ These principles serve as the general framework within which environmental management and implementation plans must be formulated.
   - ✓ The principles of the National Environmental Management Act serve as a guideline in accordance with which any organ of the state must exercise any functions when taking any decision in terms of this act or any statutory provisions concerning protection of the environment.
   - ✓ The National Environmental Management Act serves as a principle by reference to which a conciliator appointed under the act must make decisions.

- ✓ These principles guide the interpretation, administration and implementation of this act and any other law concerned with the protection or management of the environment (Gibson *et al.*, 2008).

2. Environmental management must place people and their needs at the forefront of its concern and serve their physical, psychological, developmental, cultural and social interests equitably.

3. Development must be socially, environmentally and economically sustainable.

4. a. Sustainable development requires the consideration of all relevant factors including the following:

- ✓ The disturbance of the ecosystem and loss of biodiversity, for instance from severe infestation by pompom weed, must be avoided, and where complete avoidance is not possible, this should be minimised and remedied.
- ✓ Pollution and land degradation such as that caused by uncontrolled infestation by pompom weed must be avoided and, where this is not possible, this should be minimised and remedied.
- ✓ Non-renewable natural resources must be utilised in a responsible manner and the user must take into account the consequences of their depletion.
- ✓ Development, use and exploitation of renewable resources and the ecosystem of which they form part should not exceed a level beyond which their integrity is jeopardised.
- ✓ A risk-averse and cautious approach should be applied, which takes into account the limits of current knowledge of the consequences of decisions and actions.
- ✓ Negative impact on the environment and on people's environmental rights should be anticipated and prevented and avoided at all costs; where complete avoidance is impossible, this should be minimised and remedied.

b. Environmental management should be integrated, acknowledging that all elements of the environment are linked and interrelated; it should be kept in mind

that decisions have effects for all aspects of the environment and all people in the environmental option.

c. Environmental justice must be pursued so that adverse environmental impacts are not widespread.

d. Participation of all interested and affected parties in environmental management should be promoted, e.g. state organs, NGOs and farming communities.

e. Decision makers must take into account the interests, needs and values of all interested and affected parties and this should include recognising all forms of knowledge, including traditional and ordinary knowledge.

f. Community empowerment and well-being must be promoted through environmental education and awareness and the sharing of appropriate knowledge and experience.

g. The social, economic and environmental impact of activities, including disadvantages and benefits, must be considered, assessed and evaluated and decisions should be appropriate in the light of these considerations and assessments.

h. Occupational Health and Safety standards, norms and procedures must be adhered to during environmental management operations, e.g. workers must wear protective clothing during the control of pompom weeds.

i. Global and international responsibilities relating to environmental management must be discharged in the national interest.

j. Actual and/or potential conflicts of interest between organs of state, relating to environmental management, must be resolved through conflict resolution procedures.

k. The costs incurred in remedying pompom weed infestation must be the responsibility of landowners or users.

l. Organisations such as *Working for Water* must consider involving previously disadvantaged groups in the community, such as women, the youth and the disabled, in activities such as the eradication of pompom weeds.

Chapter 5 of the National Environmental Management Act deals with integrated environmental management. Its purpose is to promote the application of appropriate environmental management tools to ensure this integration.

General objectives of integrated environmental management as stated in the National Environmental Management Act

The objectives of integrated environmental management as stated in this act are:

- ✓ To promote the integration of the principles of environmental management set out in Section 2 of the National Environmental Management Act in all decisions which may have a significant effect on the environment.
- ✓ To identify, predict and evaluate the actual and potential impact of pompom weed infestation on the environment, on socio-economic and cultural heritage, its risks and the consequences and alternative options for mitigation, with a view to bringing pompom weed infestation to an end; to maximise the biodiversity population and productive potential of the land; and to promote compliance with the principles of environmental management as stated in Section 2 of the National Environmental Management Act.
- ✓ To advise environmental managers and land users in order to ensure that infestation of pompom weed on their land is dealt with before action is taken against them, as set out in Section 23 (2) (c) of the National Environmental Management Act.
- ✓ To ensure that there is adequate and appropriate opportunity for public participation in decisions that may affect the environment.
- ✓ To ensure the consideration of environmental attributes in management and decision-making which may have a significant effect on the environment.
- ✓ To identify and employ the models of environmental management best suited to ensuring that a particular activity is pursued in accordance with the principles of the National Environmental Management Act as set out in Section 2.

In order to give effect to the general objectives of integrated environmental management as laid down in Chapter 5 of the National Environmental Management Act. Issues such as potential human impact on the environment, socio-economic conditions and cultural heritage activities requiring authorisation or permission by law are addressed. Issues that may significantly affect the environment, must be considered, investigated and assessed prior to their implementation and reported to the relevant organs of the state.

The Minister for Environmental Affairs and Tourism may, with the concurrence of the Member of the Executive Committee, or vice versa, in a prescribed manner:

- ✓ Identify activities which may not be initiated without prior authorisation from the Minister or member of the Executive Committee.
- ✓ Identify geographical areas in which specified activities may not be initiated without prior authorisation from the Minister or member of the Executive Committee, and specify such activities.
- ✓ Make regulations in accordance with subsection 24 (3) and (4) of the National Environmental Management Act in respect of these authorisations.
- ✓ Identify existing authorised and permitted activities, which must be considered, assessed, evaluated and reported on.
- ✓ Prepare a compilation of information and mapping of geographical areas infested with alien invasive plants such as pompom weeds. In cases where infestation overlaps with another Minister's area of jurisdiction, a decision in terms of bullet number 1 and 2 above must be taken in consultation with the Minister in question.
- ✓ The investigation, assessment, and communication of the potential impact of alien invasive plants such as the pompom weed contemplated in Section 24 (1) must take place in accordance with procedures and must comply with Section (24) (7) (a-i) of the National Environmental Management Act.

- ✓ Any Minister or Member of the Executive Committee of the department entrusted with the responsibility by law to authorise, permit or otherwise allow an activity to manage alien and invasive species such as pompom weeds contemplated in Section 24 (1), may prescribe regulations laying down procedures to be followed and for the report to be prepared for the purpose of complying with bullet number 1 above.
- ✓ Any regulation made in terms of this subsection or any other law that contemplates the assessment of the potential impact of pompom weeds on the environment must, notwithstanding any other law, comply with Section 24 (7) (a-i) of the National Environmental Management Act.

Section 24 (7) (a-i) of the National Environmental Management Act states that procedures for the investigation, assessment and communication of the potential impact of infestation of land by alien and invasive plants, such as the pompom weed, must ensure the following:

- ✓ Investigation of the land likely to be infested by pompom weed.
- ✓ Investigation of the potential impact that pompom weeds could have on the land, the chemicals and biological means to control them and the potential harmfulness to the biodiversity of these and their socio-economic effects on the environment.
- ✓ Investigation of potential mitigation of measures and the ultimate choice of the most environmentally friendly option.
- ✓ Public information and participation, independent review, perception and views on management of pompom weeds.
- ✓ Investigation and formulation of arrangements for the monitoring and management of pompom weeds and the assessment of the effectiveness of such arrangements after implementation.
- ✓ Cooperation and coordination of state organs in the consideration of management of pompom weeds as the responsibility for control of this weed falls under more than one state organ.

- ✓ Findings and recommendations flowing from the investigations, general objectives of integrated environmental management involving effective eradication of alien invasive plants laid down in the National Environmental Management Act, and the principles laid down in Section 2 of the Act are taken into account in any decision made by organs of state in relation to proposed policy, programme, plan or project.
- ✓ Pompom infestation is identified in the compilation of information, and the mapping of infested areas as contemplated in Section 24 2(e) of National Environmental Management Act must be considered.

The National Environmental Management Act states that, as organs of the state, the activities of the Department of Environmental Affairs and Tourism, Department of Land Affairs, Department of Agriculture, Department of Trade and Industries, Department of Water Affairs and Forestry, Department of Transport and Department of Defence have an impact on the environment.

The National Environmental Management Act also states that the Departments of Environmental Affairs and Tourism, of Water Affairs and Forestry, of Minerals and energy, of Land Affairs, of Housing and of Labour are state organs that exercise functions that involve management of the environment.

2.3.5 National Environmental Management: Biodiversity Act (Act 10 of 2004) (NEMBA)

The purpose of this act is to provide for the management and conservation of South Africa's biodiversity within the framework of the National Environmental Management Act, 1998. This includes the protection of species and ecosystems that warrant national protection; the sustainable use of indigenous biological resources; the fair and equitable sharing of benefits arising from the biosphere involving indigenous biological resources; and the establishment and functions of the South African National Biodiversity Institute and for matters connected therewith.

Chapter 3 of this act concerns biodiversity planning and monitoring and its purpose is to:

- ✓ Provide for integration and co-ordination of biodiversity planning.
- ✓ Monitor and conserve the status of various components of South Africa's biodiversity.
- ✓ Promote research on biodiversity.

Part 1 of chapter 3 of the act deals with biodiversity planning, which involves the national biodiversity framework through which the Minister for Environmental Affairs and Tourism must:

- ✓ Prepare and adopt a national biodiversity framework within three years of the date on which this act took effect.
- ✓ Monitor the manner of implementing a biodiversity framework.
- ✓ Review the framework at least every five years and make amendments where necessary.

The Minister for Environmental Affairs and Tourism must, by notice in the Government Gazette, publish the national framework and each amendment to this framework.

2.3.6 National Environmental Management: Protected Areas Act (Act 57 of 2003) (NEMPAA)

This act provides for the protection and conservation of ecologically viable areas representative of South Africa's biodiversity and its natural landscape and seascape. This is to be done through the establishment of a national register of all national, provincial and local protected areas to allow for the management of those areas in accordance with national norms and standards for intergovernmental co-operation and public consultation in matters concerning protected areas and for matters connected therewith.

Section 17 (a-l) of this act concerns the purpose of protected areas, which is as follows:

- ✓ To protect ecologically viable areas representative of South Africa's biodiversity and its natural landscape in a system of protected areas.
- ✓ To protect the ecological integrity of those areas by, for instance, controlling pompom weeds.
- ✓ To conserve biodiversity in these areas.
- ✓ To protect areas representative of all ecosystems, habitats and indigenous species.
- ✓ To protect South Africa's threatened and endangered species.
- ✓ To protect an area that is vulnerable or ecologically sensitive.
- ✓ To assist in ensuring the sustainable supply of environmental goods and resources.
- ✓ To provide for the sustainable use of natural and biological resources.
- ✓ To create or augment the destination for nature-based tourism.
- ✓ To manage the interrelationship between natural environmental diversity, human settlement and economic development.
- ✓ To contribute generally to human, social, cultural, spiritual and economic development.
- ✓ To rehabilitate and restore degraded ecosystems and promote endangered and vulnerable species.

Section 23 (1) (ai-ii b) and (2) of the National Environmental Management: Protected Areas Act concerns the declaration of nature reserves. Subsection (1) (1ai-ii and b) states that the Minister or member of the Executive Committee may, by notice in the Gazette, specify an area as a nature reserve or as part of an existing nature reserve and assign a name to the reserve.

2.4 DISPERSION OF ALIEN INVASIVE PLANTS

In South Africa, alien plants have invaded an area of 10 million hectares (Marais, 1998). The Western Cape (WC) is the most seriously affected, followed by Mpumalanga (MP), KwaZulu-Natal and Limpopo Provinces (Turpie *et al*., 2007).

In the 1980's, the pompom weed was recorded in the Waterberg District of Limpopo Province, constituting a serious threat to indigenous grasses and other non-woody plants, rapidly displacing native species and reducing the biological diversity.

2.4.1 Factors contributing to the rapid dispersion of alien invasive plants

The pompom weed has wide-ranging natural distribution agents and is considered a dangerous invasive weed in South Africa. Factors contributing to its rapid and wide dispersal include:

- ✓ Prolific seed production
- ✓ Efficient wind dispersal of the seeds, combined with enormous reproductive potential, allowing the weed to encroach on large areas.
- ✓ Long distance seed dispersal by flower pickers, roadside grass cutters and vehicles.
- ✓ The weed is ornamental and is planted and spread by gardeners who are ignorant of the dangers of doing so.
- ✓ Vigorous growth from seed to flowering in one growth season.
- ✓ Ability to produce new stems from a rootstock e.g. pompom weed.
- ✓ The tuber-like food storage organ enables the weed to recover rapidly after winter or damage (As reflected in figure 2.3 below).
- ✓ The weed retreats underground during winter and people tend to forget about it.
- ✓ Ability to geminate under a range of environmental conditions e.g. drought tolerant (Montana, 1990).

- ✓ Ability to establish itself in disturbed or denuded areas after fires (As reflected in figure 2.5 below).
- ✓ It can establish itself and survive in a wide range of habitats at altitudes of 0–1900m or more (ARC 2007d, Liebenberg, 2007;).

Fig 2.3: **Tuber-like food storage organs of pompom weed (source: Krynauw, 2007)**

The pompom weed is usually found together with another invasive plant, purple top (*Verbena bonariensis*), which may serve as an indicator of areas that are suitable for the establishment of pompom weed (ARC 2007d).

Internationally, the laws governing the release of agents to control alien and invasive species are becoming stricter (Winder, 1980). In South Africa's

regulatory bodies have rightfully likewise become stricter over the years in allowing the release of biological agents. The release of these agents has therefore been slow (Heystek, 2006). The distribution and intensity of infestation of the pompom weed is as shown in Figure 2.4 below:

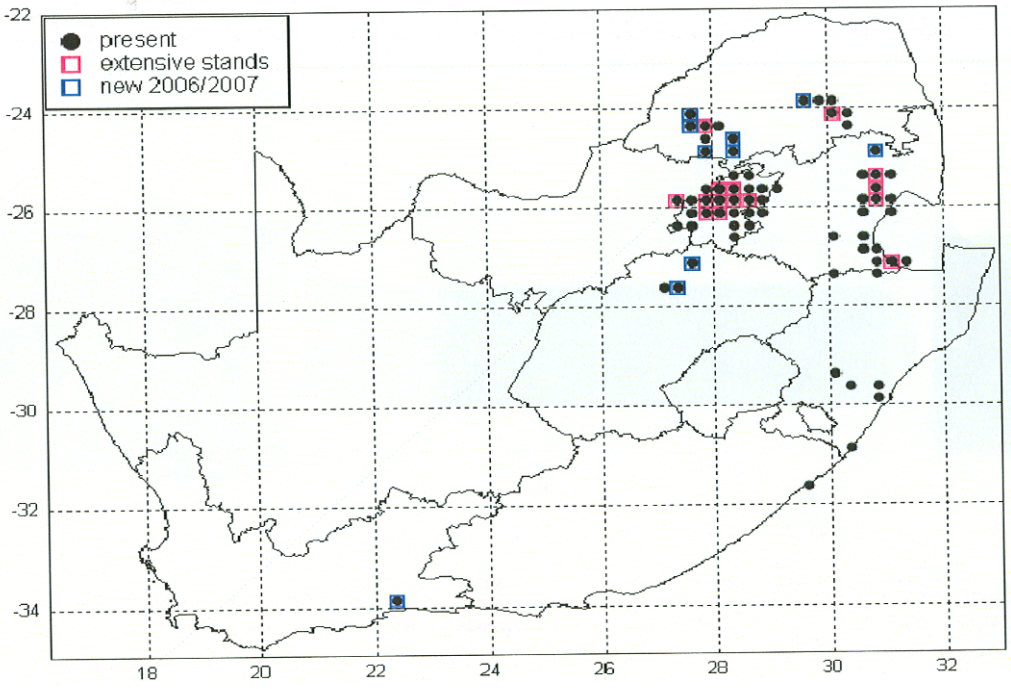

Fig 2.4: Distribution and intensity of pompom weed infestation (source: Krynauw, 2007)

2.5 METHODS OF CONTROLLING ALIEN AND INVASIVE PLANTS

Eradication is defined as the extirpation of the entire population of an alien and invasive species in a managed area (Henderson, 2000) or the complete elimination of alien and invasive plants (DoA, 1998). Over the years, the management of the Kruger National Park has utilised all available methods in an effort to bring alien and invasive plants under control (Foxcroft *et al.*, 2007). These methods have differed in their degree of success (Lotter and Hoffman, 1998). In order to prioritise these control methods, the areas at greatest risk of invasion must be identified and mapped (Foxcroft *et al.*, 2007). Herbicidal and mechanical controls have the disadvantage of being expensive, unsustainable

and damaging to non-target plants (Forno and Harley 1977; Pemberton *et al.*, 2002).

Chemical and integrated methods of environmental restoration are the most costly methods (Forno and Harley 1977; Liebenberg, 2007). These methods involve the removal of plants with handsaws, chainsaws or chemicals. Follow-up visits to the same site must be made several times over subsequent years in order to remove new growth. In some instances, especially in mountainous areas, access to these areas requires climbing ropes, additional skills and high costs (Turpie *et al.*, 2007).

2.5.1 Mechanical methods

Mechanical methods can be executed by felling, removing or burning alien and invasive species. In the case of the pompom weed, burning is ineffective because the plant has an underground structure which stores nutrients during drought and winter. Re-growth is thus possible in the new growth season. Removing these plants in this way is effective only in small scale treatments (Henderson *et al.*, 2006).

Mechanical control is not an option as it causes too much soil disturbance and stimulates further vegetative growth and, given the rate at which the pompom weed is spreading, mechanical control will soon become impractical and unaffordable (Mc Key and Oleiro, 2008).

Fig 2.5: A pictorial representation of Pompom weeds thriving after burning (source: Krynauw, 2007)

2.5.2 Chemical methods

Chemical control of the weed is generally effected by using environmentally friendly herbicides. *Brush-Off* by Du Pond is recommended for pompom weed. This is the only herbicide currently registered for pompom control and it was registered only in 2005. It provided 80 percent control of pompom weed in the field trials. However, the pompom weed is expanding at such a rate that chemical control is becoming impractical and unaffordable (ARC, 2007g).

2.5.3 Biological methods

The practice of biological control is the use of scientifically selected, tested and safe agents (usually plant-feeding insects or plant pathogens) to curtail the spread and damage caused by invasive alien plants (As reflected in figure 2.6 and 2.7 below). The first of these projects in South Africa was in 1913. Initially, invasive cactus species were targeted. By the early 1960s, the emphasis had expanded to include problem plants in the “fynbos” biome and more recently invasive species in other types of natural habitats have also been subjected to biological control (ARC, 2008a). Since the inception in the 1960s of the biological control programme against invasive weeds, in particular *L. Camara,* several biological control agents have been introduced (Julien and Griffiths, 1998; Williams, 2003).

Weeds are controlled by using species-specific insects or diseases brought from the alien plant's country of origin (Broughton, 1999). To date, 76 biological agents have been released in South Africa in campaigns against 40 weed species. However, there is no identified or certified biological control for pompom weeds.

The Agricultural Research Council's Plant Protection Research Institute (ARC PPRI) has undertaken three exploratory trips to Argentina and one to Brazil to survey for potential biological control agents for pompom weeds. The surveys were conducted in the weed's natural habitat. One rust fungus (*Puccina eupatorii*) is presently being reared and tested in quarantine. Insects which could potentially control the weed include a stem-galling thrip (*Liothrip spp*) and a flower-feeding lepidopteran; *Cochylis campuloclinium* and *Adian prop cimplicius* (Cilliers, 1987; Henderson *et al.*, 2006).

In every host specificity test done, as a procedure, once the ARC PPRI is satisfied with the agent's host-specificity, its safety to release and the significance of the damage it can do to the alien and invasive species in question. The ARC PPRI make an application to the Department of Environmental Affairs and Tourism for permission to release it (ARC, 2008a).

Although the Enemy Release Hypothesis (ERH) is commonly assumed to be a principal explanation for plant invasiveness, review has concluded that evidence for it is equivocal. Few data quantify the degree to which naturalised plants are released from the natural enemies relative to their native range (Mitchell and Power, 2003). In addition, a central prediction of the Enemy Release Hypothesis that naturalised plants that are more completely released from enemies will have a greater impact remains untested (Mitchell and Power, 2003). An example of biological control is that of *Acacia Cyclopes,* first initiated in the early 1990s using the *Melanterius servulus* seed-feeding weevil (Impson *et al.*, 2004).

If a species is already widespread, biological control may be the only practical way of going on the offensive (Cilliers, 1982). Considering the previous trials, biological control is thought to have been completely successful in 10 to 15 percent of efforts against arthropods, while 30 to 40 percent have achieved their objectives against weeds (McNeely *et al.*, 2001). Biological control is the only sustainable option against the pompom weed (Luwum, 2002; Simelane, 2004 and ARC, 2008a). Biological control of invasive plants will not, however, replace the need for physical clearing until the time when all the most important species are under biological control and are in significant decline (Turpie *et al.*, 2007).

Zeale nigromaculatus is a stem-boring insect which was found feeding on the pompom weed in Argentina. This constitutes a new host record for pompom weed. The main disadvantage *of Z. nigromaculatus* is that it is not host specific as it was also found feeding on other asteraceae in Argentina. Considering its broader host range, if considered as a biological agent in South Africa, it will pose a risk to indigenous South African Asteraceae species (Mc Key and Oleiro, 2008).

Recently, research has discovered that a rust fungus, *Puccinia spp,* delays the development and existence of pompom weed by infecting its leaves and stems. During the research study, plants identified to have been infested with rust fungus were not seen again until late in the following December, in 1996. The level of infestation of the pompom weed by the fungus increased in the ensuing months despite good rains in January 2007. The most advantageous aspect of this biological control agent is that it survives winter and is notoriously host specific thus posing no threat to other plants (ARC, 2007e). This rust fungus kills the seedlings of the pompom weed (ARC, 2007e). Pompom plants spontaneously invaded by the *Puccinia spp* became yellow (ARC, 2007e).

Other possible biological control methods are also being investigated. The larvae of the *Carmenta spp*, a clearwing moth, were found boring into both medium and

large sized pompom plants (Mc Key and Oleiro, 2008). A thrip has also been found damaging leaves and stem tips of the pompom. Stems of infested plants suffer a shortening of their internodes and bear no flowers. In autumn, when aerial plant parts die, thrips continue to feed on the shoots of the perennial rootstock (Mc Kay and Oleiro, 2008).

Many of the South African control projects have been innovative and highly successful. Resent research analysis has demonstrated exceptionally high cost-effective returns on investment in biological control. The inception of the Working for Water programme in 1995 has significantly enhanced biological control in South Africa (ARC, 2008a).

Fig 2.6: Rust fungi on the leaves of pompom weed SAPIA News (source: ARC, 2007e)

Fig 2.7: Rust fungus on pompom stem and leaf SAPIA News (source: ARC, 2007e)

2.5.4 Integrated control methods

Integrated control is achieved by combining two or more of the abovementioned approaches. An integrated approach is often required to prevent the enormous impact of invader species (City Press, 2006).

2.6 ENVIRONMENTAL ECONOMICS

It is now generally recognised that, in order to achieve a greater measure of economic sustainability, more attention must be given to environmental sustainability (Adil-Khan, 1995). As earlier pointed out in 2.1 above, environmental, cultural and economic sustainability are all interrelated (Kotzé, 1997).

Throughout the Southern African Developing Countries (SADC), nature-based tourism is fast becoming the basis of a major economic sector. In many developing countries, such as South Africa, nature-based tourism is one of the largest foreign currency earners (CSIR, 2005; Tourism South Africa, 2010). It has been estimated that economic losses caused by invasive alien species account for almost five percent of the world's combined gross national product, or US$ 1,4 trillion a year, and this situation is expected to worsen rapidly with increased movement of species around the world through trade, transport, travel and tourism (CSIR, 2005; SANParks 2006b; Tourism South Africa, 2010).

It is important to keep the following facts on environmental economics in mind:

- ✓ The consumption rate of renewable resources must be kept within generation limits (Kotzé, 1997).
- ✓ The impact on non-renewable resources must to be considered and it may well be asked whether there has been too much reliance on technology to come to the rescue (Kotzé, 1997).
- ✓ Waste emissions should be controlled and kept within the assimilative capacity of the environment without impairing it (Adil-Khahn, 1995).

Alien and invasive species such as lantana, pompom weeds etc pose an insidious threat, not just to biodiversity and tourism, but also to livelihoods and the long-term development of our country (Richardson and van Wilgen, 2004; SANParks 2006b).

Land degradation also affects urban areas as the impact of urban sprawl on natural resources is not taken cognisance of and, as a result, the price of food, water and electricity rises owing to increasing demand. As the land degrades, more fertilisers, machinery and supplementary feeds become necessary and production costs increase. Small scale and subsistence farmers are often unable to meet these extra costs, and even large scale, commercial farmers find it difficult to run their farms. As a result farm workers lose their jobs and migrate to

the city in search of employment (The Presidency of the Republic of South Africa, 2006 - 2008).

2.6.1 Environmentalism and sustainable development

Industrial growth in the early 20th century led to serious environmental degradation. In the 1960s these emerging environmental problems generated a debate between those in favour of greater development and conservationists. Towards the end of the 1980s, it became clear that development theory and practice had reached a turning point. At first it largely promoted westernisation in many ways and this overlooked development in poor areas. The process of westernisation had been threatening the delicate balance between social and ecological systems in most non-western societies. These non-western information systems were to a large extent regarded as inferior and the view was often held that they should be replaced with western systems (De Beer and Swanepoel, 2000).

The 1980 report of the International Union for the Conservation of Nature (IUCN) originated the concept of sustainable development. This concept grew in prominence in the late 1980s and gained further publication after the World Commission on Environment and Development, also known as the Brutland report (De Beer and Swanepoel, 2000).

Despite materialistic reasons for preserving the natural environment by activities such as effective management of the pompom weed, it must be borne in mind that a certain type of environment may be conducive to a certain quality of life. Moral and ethical reasons for advocating sustainable development should be considered. Other species, especially non-problematic species and other forms of life also have the right to share the earth with mankind, quite apart from the issue of interdependence of species (Kotzé, 1997).

2.6.2 Principles of sustainable development

The principles of sustainable development are presented below in tabular form.

Table 2.1 Principles of sustainable development (Hugo *et al.*, 2000)

A. ECOLOGICAL PROCESSES

1. Set aside good and fertile farming areas for crop production.
2. Crop production areas must be managed according to high standards based on ecological principles, e.g. crop rotation.
3. Game and livestock farming areas must be managed according to high standards based on ecological principles, e.g. overgrazing must be avoided, rotational grazing must be adhered to.
4. Water efficient irrigation systems and irrigation schedules must be properly adhered to.
5. Water loss and water pollution should be prevented where fishing is a farming system.

B. GENETIC DIVERSITY

1. Prevent extinction of indigenous plants by managing pompom weeds in your area.

2. Conserve maximum number of agricultural crops, grazing, natural indigenous vegetation, livestock, animals for aquaculture, microbes and other domestic organisms and their wild family members that are genetically true to type.

3. Make certain that local conservation programmes protect the following:

- ✓ Wild vegetation and associated species that have an economic value as well as useful plants such as medicinal plants, and animals and their habitats.
- ✓ The habitats of threatened and unique species.

- ✓ Urban ecosystems.
- ✓ Representative examples of typical ecosystems.

4. Standards for protected areas must be set in terms of size and distribution. These areas must be managed according to the needs and requirements of the ecosystems and the plant and animal communities to be protected.

5. National and international programmes whose function is to protect the environment must be properly coordinated.

C. SUSTAINABLE DEVELOPMENT

1. Production capacity of useful species and ecosystems must be determined and it must be ensured that the carrying capacity is complied with.

2. Devise nature conservation and management goals for the use of species and ecosystems.

3. The use of resources must be kept on par with the level of sustainability.

4. Use of resources must be kept at a minimum until sustainability levels are reached.

5. Small scale and commercial farmers must be encouraged to use natural resources such as water in such a way that high production is achieved at lower cost.

6. Habitats for species that could serve as resources must be maintained.

7. International trade in wild game and plants as well as their products, such as horns, hides, skin, furs etc., must be regulated.

8. Award natural vegetation concessions with greater circumspection and manage them to a very high standard.

9. Limit and regulate the consumption of firewood to levels where sustainability is possible.

10. Good pasture management must be adhered to, such as rotational grazing to ensure that the carrying capacity of an area is maintained.

11. Use indigenous wild herbivores for biological bush encroachment, either in isolation or together with livestock.

2.6.3 Social sustainability and alleviation of poverty

There are convincing arguments in favour of linking social disequilibria to environmental decay. Improper management of invasive plants like the pompom weed may lead to sustained poverty, which may ultimately lead to sustained exploitation of the natural environment. The converse is not necessarily true, namely that a wider range of choices would lead to greater care of environment; it may, however, make greater care possible (Kotzé, 1997)

The welfare and prosperity of the South African nation depends on the condition and management of its natural resources. However, sustainable conservation of viable ecosystems necessitates a broad understanding of the ecological processes involved. This is a true reflection of the concept that ecosystems react differently to different management practices. In the interests of sound land-use planning and management, it is important to develop management practices, such as detailed description, identification, classification and mapping of vegetation in the area (UNISA, 2007).

2.6.4 Economic sustainability and economics of environment

Economic growth will remain a priority for societies with explosive population growth and where people want to improve their quality of life (Kotzé, 1997). Within the sustainable development debate, economic growth and development may be approached differently:

- ✓ Technologists and economists hold the view that economic growth will promote the power of technology and increase wealth, which in turn will help to replenish whatever natural resources are lost in the process (Adil Khan, 1995).

- ✓ Ecologists believe that natural resources should be utilised optimally and that the limits of the natural environment should be noted. It is therefore essential to change the consumption patterns of scarce resources and to investigate other avenues to improve the quality of life (Kotzé, 1997).

Angling and hunting have a traditional role in that they provide food for people and generate money. In developed societies, they are now regarded as an important form of sports and recreation (Hugo *et al.*, 2000). South Africa hosts 200 000 recreational hunters per annum. This realises an income of more than R 4 *billion* per annum (Animal Rights Africa, 2010).

The consumption rate of renewable natural resources such as fauna and flora must be kept within generational limits. Too great a reliance on technology to solve problems should be avoided (Kotzé, 1997).

2.6.5 Environmental sustainability and objectives of sustainable development

It is generally accepted that to achieve a greater measure of economic sustainability, one should pay attention to environmental sustainability by managing it properly, for instance by managing pompom weeds (Adil-Khan, 1995).

Environmental and ecological issues, which have been of growing concern since the 1950s, began more directly to shape development thinking in the 1970s (De Beer and Swanepoel, 2000). The 1987 Report of the World Commission on Environment and Development, more usually referred to as the Brutland Commission, stimulated the international debate on environment and development and ensured that environmental issues no longer remained on the margins of development theories (De Beer and Swanepoel, 2000). The Brutland Commission popularised the notion of “sustainable development” which is described as development which should be viable over a longer term, thus

meeting the needs of the present without compromising the ability of future generations to meet their own needs. Deforestation, for example, should be accompanied by reforestation, and pollution should not exceed the atmosphere's ability to absorb it (Rapley, 1996).

- ✓ Essential ecological processes must be maintained by preserving biological diversity.
- ✓ The use of species and ecosystems must be sustained, some of which support important industries, for example the farming industry.
- ✓ Diverse opportunities for non-material use (spiritual, recreational, aesthetic) of natural resources must be created and developed.
- ✓ The quality of life must be maintained and improved for communities.
- ✓ A long-term sustainable economy must be developed (Hugo *et al.*, 2000).

2.7 SOUTH AFRICAN BIOMES THAT FORM THE GEOGRAPHICAL COMPONENT OF THE RESEARCH PROJECT

2.7.1 The grassland and savanna biomes of South Africa

Grassland makes up approximately 13.3 percent of the surface of the Southern African subcontinent (Fuggle and Rabie, 1999). This particular biome has a summer rainfall of between 250 mm to 2000 mm and the vegetation can be defined as "grassland". Winters are very dry with heavy frost and day and night temperatures differ vastly. These conditions (Dry winters, heavy frosts and vast day and night temperature difference) are unfavourable for tree growth (Hugo, *et al., 2000*). Most of the grass species die off during winter (South Africa. 2004/05; Hugo, *et al.*, 2000) and this condition enhances occurrence of veld fires (Fuggle and Rabie, 1999).

The grassland biome which forms part of the geographical area of this research study is found on the high interior plateau of South Africa, extending from the

south western part of Gauteng Province into much of the Free State, eastwards into western KwaZulu-Natal and into Mpumalanga and the eastern Cape (As reflected in figure 2.8 below) (Fuggle and Rabie, 1999). Up to 60 percent of South Africa's grasslands have been irreversibly transformed and less than two percent are currently formally conserved (The Presidency of the Republic of South Africa, 2006 – 2008; South Africa, 2004/05). Pompom weed is rapidly becoming the most serious threat to the conservation of grasslands in South Africa (ARC, 2007c).

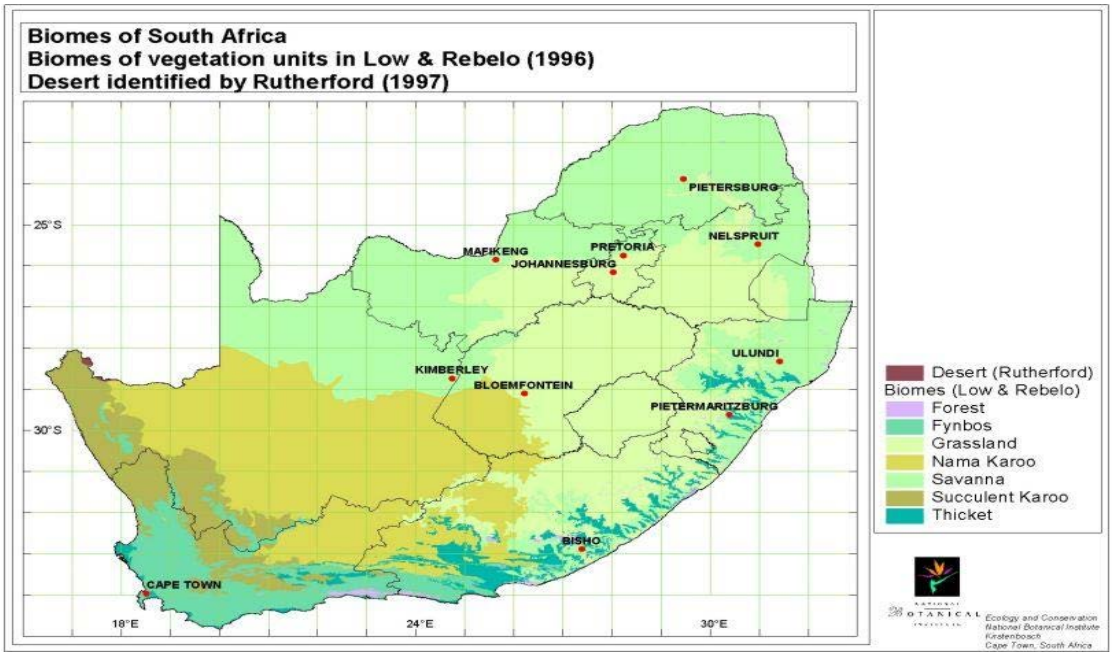

Fig 2.8: Map of the grassland biome of South Africa (source: Hugo, et al., 2000)

From an agricultural perspective, grassland is important because it provides the most suitable areas for both crop and animal production. Annual rainfall determines the specific type of farming in a specific area: where it is higher, the area is suitable for crop production, while where it is lower the area will be suitable for livestock farming (Hugo *et al.*, 2000). Overgrazing, fire and invasive plants such as the pompom weed have the most significant impact on grassland (Fuggle and Rabie, 1999).

The greatest threat to grassland in South Africa is the commercial forestry industry. The largest area of the grassland, which is the habitat of many animal and bird species such as the blue swallow (*Hirundo atrocaenulea*), has been transformed into commercial forestry (Hugo *et al.*, 2000). Although planting trees within 50 metres of a watercourse is illegal, little attention is paid to this set standard and this affects aquatic life. Many perennial rivers have become seasonal because of non-compliance with this standard, especially in the river catchment areas (Hugo et al., 2000). Although pompom weed is aesthetically pleasing and create a habitat conducive to certain indigenous invertebrates, some species might be lost if the grasslands habitat continues to be invaded by pompom weeds (Wolmarans, 2007).

Savanna is the largest biome in the Southern African region, occupying 46 percent of the area and over 33, 3 percent of South Africa (As reflected in figure 2.9 below). It is particularly well developed in the Lowveld and Kalahari regions of South Africa (ARC, 2009). This biome is characterised by a grassy ground layer and a distinct upper layer of woody plants. Where this upper layer is near the ground, it is referred to as shrub veld, and where it is dense it is referred to as woodland. The intermediate areas are referred to as bushveld (ARC, 2009; South Africa, 2004/05).

Hui *et al.* (2008) found that of all the ecosystems (biomes) in South Africa, the greatest uncertainty is associated with the Biodiversity Intactness Index (BII) estimate for savanna, with a 95 percent confidence interval ranging from 78.5 to 95.4 percent. The grassy layer is dominated by C 4-type, which are at an advantage where the growing season is hot, but where rainfall has a stronger winter component, C 3-type dominates the savannah (Hui *et al.*, 2008). Savanna is a highly conserved biome in South Africa. Much of this area is used for game farming and can be considered effectively preserved, provided sustainable stock

levels are maintained (ARC, 2009; Scholes and Walters, 1993; South African, 2004/05).

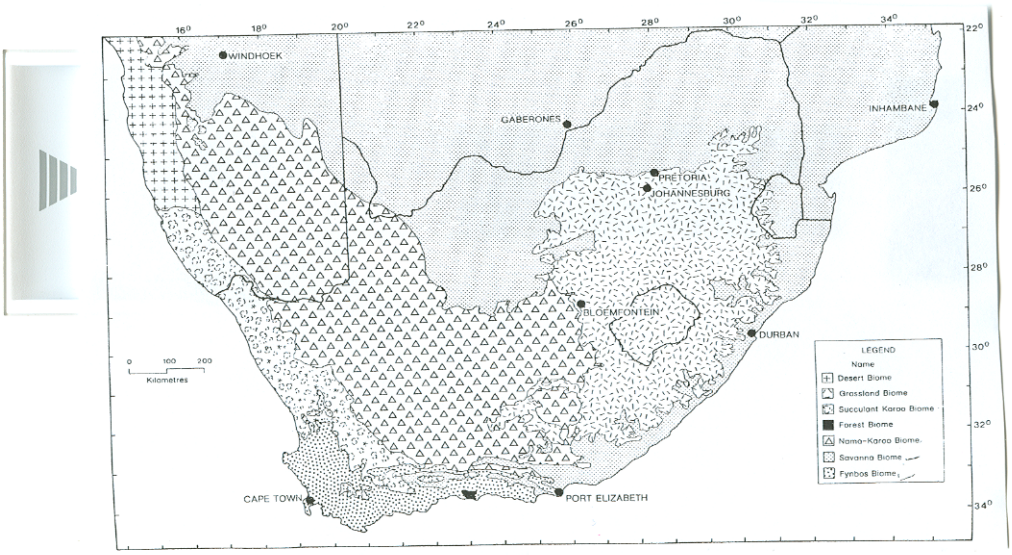

Fig 2.9: Map indicating the overlapping of savannah biome across South African borders (source: Fuggle and Rabie, 1999).

2.8 NATURAL RESOURCES MANAGEMENT

The scope of biodiversity conservation comprises both ecological and economic aspects. Genetic and ecosystem diversity is a broad dimension that can be considered a service that provides benefits in a variety of ways, such as medicinal value, food security and raw materials and indicator functions (Gaikwad and Chavan, 2006).

The species composition of an ecosystem in any given location and at any one time depends on current environmental conditions, levels and types of disturbance, balance of extinction and recruitment and composition of the regional pool of species (McNeely *et al.*, 2001). De Beer and Swanepoel (2000),

Rapley (1996) both noted that environmental issues did not have a significant effect on the development debate in the 1970s and early 1980s. However, the situation changed dramatically in the late 1980s when certain phenomena such as ozone depletion, global warming, loss of biodiversity, acid rain and other environmental issues started to dominate the development debate.

The occurrence of fauna in Africa is closely linked to the vulnerability of the natural environment. The difference between these aspects (management of natural resources and the theory of climate) is that they focus on sustainable processes and on events such as soil erosion that are related to management and degradation of natural resources (Devereux, 1993).

Plants are indispensable in South Africa to both animal and human life, because they provide us with oxygen. They also provide basic food, the first trophic level (T1) in any food chain, for animals (Hugo *et al.*, 2000).

People use plants on a large scale and in many forms. The most important use is as a source of food, either directly, as is the case with grains, fruits and vegetables, or indirectly by means of grass for grazing. The use of wood and wood products also plays a major role in human activities. Wood is used in the construction, mining and furniture industries or as a raw material for a variety of other products, e.g. paper (Hugo *et al.*, 2000). Plants also fulfil an important aesthetic role in people's cultural activities. They are used to ornament public and private open spaces and for roofing, e.g. *Hyperhinia hirta* (thatch grass). Plants have over a long period been utilised for medicinal purposes: aspirin was originally obtained from the leaves of the common willow tree (S*alix babylonica*) (Hugo *et al.*, 2000). Plants are renewable resources as they can be propagated by means of sexually or asexually (Hugo *et al.*, 2000).

Animals are heterotrophic feeders and occupy all the trophic levels, from herbivore to the level of decomposers (T1 – T5). Animals are therefore directly or

indirectly dependent on plants for their nutritional requirements. The domestication of animals to serve mankind has played a major role in economic development; for instance, using horses, donkeys and cattle as draught animals increased the availability of energy significantly (Hugo *et al.*, 2000).

Animals are a very valuable resource to humans as they are an important source of food. From early times, animal products have satisfied many of our needs. Wool, hides for leather articles, eggs, meat, dairy products such as milk, cheese and butter are all indispensable to modern society. Animals, like plants, serve an important aesthetic role in human cultural activities. Cats, dogs, birds, rats and white mice are kept as pets. Horses and dogs are used in various sporting activities. Some wild animals are used for entertainment purposes, e.g. *Panthera leo* (lion) in circus.

Most animals depending on species and body size have a high reproductive rate and as a result they are considered to be a renewable resource. However, once a species becomes extinct, it is lost forever and no human skill or technological development can bring it back (Fuggle and Rabie, 1999).

The aim of conserving animals should be to maintain genetic diversity. However, most conservation efforts centre on the utilitarian value of animals (Du P Bothma, 1996). Nature conservation, aided by the proliferation of game farming during the past decades, has played a significant role in managing and conserving wildlife (Hugo *et al.*, 2000). From an ecological point of view, conservation of wildlife should not concentrate only on the “big and hairy” but also on invertebrates and reptiles because these are as important as any species in an ecosystem and any individual or community. Wildlife cannot be preserved apart from their environment. A healthy ecological system provides ample habitat for wildlife (Hugo *et al.*, 2000).

Only a few of the 70 veld types in the world have been adequately conserved and 50 percent of these velds have no proper nature reserves (Fuggle and Rabie, 1999). It is thus not surprising that so many species are endangered. The future management of wildlife reserves is inextricably linked to the human perception of the value of wildlife (Du P Bothma, 1996). People living in areas infested by invasive plants such as pompom weeds, as in the case of the Waterberg District in Limpopo Province, should be asked to engage themselves in managing and controlling the spread of these plants for the sake of ecological sustainability (Hugo *et al.*, 2000).

Managing soil as a natural resource is a good example of managing resources from a three-tier point of view: ecological, economic and social. Ecologically, soil is the cornerstone of food production in the entire ecosystem. Economically, it needs to be utilised in such a way that it is viable, for instance as a source of income (Vink, 1983). From an environmental and social perspective, there are a number of perceptions of the issue of soil management, and “Environmental Education Training and Awareness” has been found to be the best tool in this respect (Hugo *et al.*, 2000).

In South Africa, effective management of soil resources through legislation has not been successful because programmes such as farmer training specialising in land care, on-site training, financial assistance and law enforcement have been ineffective. These programmes could have helped to avoid the threat of losing soil through erosion and the depletion of its productive potential (Hugo *et al.*, 2000). Soil composition is indeed very diverse. Soil consists of an eroded and partially eroded unconsolidated layer of material which covers the rock that forms the earth’s crust. Mineral fractions, eroded rock particles, organic remains of plants and animals, a living micro and meso - fauna elements, water in the form of capillary and free water and a gas component (air between the soil particles) constitute the soil.

In South Africa, soil is formed at an average rate of 11.7 t/ha/year, although this varies greatly from region to region (Vink, 1983). The most important factors influencing soil formation are parent rock material, climate, relief, biological activities and time. Recently people, as the ecologically dominant component, have played a major role in changing soil conditions generally caused by careless and injudicious soil utilisation practices and the introduction of exotic plants such as the pompom weed to South Africa.

2.9 LAND DEGRADATION

Land degradation occurs when the economic and biological productive potential of the land is lost, primarily through human activities and poor land management. This can happen when

- ✓ Fertile topsoil erodes away.
- ✓ Indigenous vegetation is removed.
- ✓ Alien and invader plants, e.g. pompom weeds, invade an area.
- ✓ Soil becomes salty through poor irrigation.
- ✓ Farmland is used for housing (The Presidency of the Republic of South Africa, 2006 – 2008; Rossouw *et al.,* 2003).

The loss of productive soil affects livestock farming, game farming, agronomy and horticultural farming.

Desertification or land degradation affects 33.3 percent of the planet's surface and ± one billion people in over a hundred countries (The Presidency of the Republic of South Africa, 2006 – 2008). It is a process which turns productive land into unproductive desert, mainly as a result of poor land management. The areas that most affected are semi-arid areas bordering on deserts, which are generally called dry lands or desert margins and have great biological value (SANParks, 2006b). Dry lands or desert margins are the original home to many of the world's most important food grains, medicinal plants, animals and bird

species. This biodiversity is also unusually susceptible to land degradation, as the dry topsoil is easily eroded (SANParks, 2006b).

Land degradation can arise from climatic change, human misuse of land and severe infestation of land by alien and invasive plants such as the pompom weed. Infestation by alien invasive plants is the second greatest cause of land degradation and it follows overgrazing (SANParks, 2006b).

It is a vicious circle: desertification and invasive plant infestation cause a reduction in plant cover, which in turn leads to further donga erosion and sheet erosion. South Africa is losing approximately 300 – 400 tons of fertile topsoil per year, leading to the agricultural sector adopting the ironic catch phrase “Topsoil, our greatest export” (SANParks, 2006b). Land degradation is a major obstacle not only to regional economic development, but it also poses a threat to biodiversity, which provides a natural base for sustainable human well-being (SANParks, 2006b).

Wildlife and livestock also damage the environment. When populations of these animals are at normal levels, there is little problem. When populations of Wildlife and livestock become too large, overgrazing is experienced (Camp and Daugherty, 1997).

Desertification occurs when land loses its natural indigenous vegetative cover through overgrazing, unmanaged veld fires, severe infestation by alien and invasive plants such as the pompom weed, soil erosion and deforestation (The Presidency of the Republic of South Africa, 2006 - 2008).

Deforestation refers to the loss of natural vegetation. South Africa’s trees are used for construction, medicinal purposes and fuel. Up to 99 percent of rural households use firewood for energy, despite electrification projects by government departments such as the Department of Provinces and Local

Government (DPLG) and Eskom. About 38 percent households in townships use firewood for energy. Shortages are already being experienced and it is estimated that, if not controlled and at the current rate of wood harvesting, natural vegetation will have disappeared from communal areas within 20 years (Blignaut, 2006). The rapid rate of wood harvesting both in rural and urban areas, the introduction of exotic plants and the use of plants for medicinal purposes is the main concerns in terms of deforestation. Deforestation makes life harder for both rural and urban people and animals as it destroys habitats for biodiversity and contributes to soil depletion and erosion (The Presidency of the Republic of South Africa, 2006–2008; Botes, 2006).

Soil erosion is defined as the removal of topsoil by either water or wind as agents of erosion. Topsoil is the most fertile soil horizon in which plants grow. Eroded soil can cause eutrophication of dams and rivers, and this process has an impact on aquatic life. Environmental issues that face us today are usually the result of a complex chain reaction because they have an economic impact. Farmers have to increase the quantity of fertilisers they apply to their fields per hectare and they will be compelled to opt for a zero grazing farming system. This will cost the South African agricultural sector an estimated R1.5 *billion* per year (The Presidency of the Republic of South Africa, 2006 – 2008).

Soil loses quality through infestation by invasive plants such as pompom weeds, pollution by heavy metals and acids from mines and power stations. Again, the loss of soil productivity is expensive to mitigate; for example, it has cost about R 25 million to neutralise the effect of acid rain in Mpumalanga Province (The Presidency of the Republic of South Africa, 2006 - 2008).

Alien and invasive plants are plants species that are not indigenous to South Africa but which grow so prolifically that they threaten indigenous plants and decrease the land's biological productivity. Of the 161 classified invasive plants, *A. Cyclopes, A. mearsii*, *A. Saligna, C. jamacaru*, *C. macrocephalum*, *E.*

paniculata, *L. Camara M. azedararach*, *T. stans and* are the most common alien and invasive plant species in South Africa and they cover an area larger than the Gauteng Province, i.e. 1.4 percent of South Africa. They spread or invade very quickly because local environmental personnel have very limited resources with which to manage them. As they do so, they displace indigenous plants and reduce biodiversity. In addition, invading plants contribute to soil erosion, reduce the carrying capacity of grazing land and reduce the capacity of indigenous plants to reproduce. Some alien and invasive plants burn easily and intensify fire more than indigenous vegetation, thus increasing the risk of fire damage. Some consume more water than indigenous plants, e.g. woody alien invader plants like the (*E. paniculata*) use about 3 300 cubic litres per year (The Presidency of the Republic of South Africa, 2006 - 2008).

2.10 THE DANGER OF LAND DEGRADATION

In Southern Africa, food security is still a problem and in many parts such as the Eastern Cape, Northern Cape and Limpopo children suffer from malnutrition (The Presidency of the Republic of South Africa, 2006 - 2008). The Earth Policy Institute predicts that, globally, unsecured food supplies will become an even more widespread source of conflict and hardship in the future. Only 13 percent of South Africa's land surface area is considered arable, or suitable for food production. Every year, an estimated 34 000 ha of farm land is converted for other purposes to other uses such as urban expansion. It is estimated by experts that, by 2050, there will be no more than 0.2 ha per person available for food production. This is considerably less than international norms. Imported and processed foods are expensive and like other environmental problems, they hit the poorest people the hardest (The Presidency of the Republic of South Africa, 2006 - 2008).

Even if it is difficult to estimate the extent of the problem of land degradation, there is no doubt that it is a global environmental effect. The term "environmental

refugees" has been coined to refer to people who have abandoned their homes because they have degraded their land and it has lost its capacity to sustain them (The Presidency of the Republic of South Africa, 2006 - 2008).

Globally, a staggering 70 percent of all dry lands or non-tropical regions are already classified as environmentally degraded (The Presidency of the Republic of South Africa, 2006 - 2008). This represents 14 percent of the earth's surface. Africa may be the worst affected continent, as 73 percent of its agricultural dry lands are thought to be degraded. The number of people affected is vast, for it is estimated that more than 70 percent of Africa's 500 million people depend directly on the environment for their livelihoods (The Presidency of the Republic of South Africa, 2006 - 2008).

The United Conference on Environment and Development (UCED) has drawn up a convention, the function of which is to combat desertification and to address problems of land degradation. As a signatory, South Africa is a member of the convention and was tasked to develop a National Action Programme that will combat desertification, and to commission a survey of the extent and causes of land degradation in the country (The Presidency of the Republic of South Africa 2006 - 2008).

2.11 SUMMARY

Preventing the establishment of invasive species in a specific area is always the best method of control. The government of South Africa is trying its best to control and monitor entry of these species into the land, using thorough inspections of international shipments, customs checks and proper quarantine regulations. The general public can also participate in invasive species prevention by educating themselves about invasive species and by making informed decisions (Wikipedia, 2008).

The Working for Water programme, the Department of Agriculture, Gauteng Department of Agriculture, Conservation and Environment and KwaZulu-Natal Department of Agriculture and Environmental Affairs are the main stakeholders in the control of alien and invasive species such as the pompom weed (Department of Agriculture and Environmental Affairs KwaZulu-Natal, 2005).

South African society can benefit from the Working for Water programme in that

- ✓ The programme receives a substantial amount of funds from the international bodies.
- ✓ A considerable amount of money has been invested in research (now more than R12m/annum).
- ✓ Working for Water has improved international collaboration, especially in Africa and in concert with the New Partnership for Africa's Development programmes.
- ✓ Biological control personnel have recently been reorganised into five co-operative research teams that include entomologists, plant pathologists, ecologists and resource economists (ARC, 2006a)

Mgidi *et al.* (2004) suggest that a more pro-active approach is required to maximise the success of management efforts in the control of, importantly, emerging alien and invasive plants and the areas they are likely to infest. For instance, in areas where *V.bonariesis* exists there is the likelihood of pompom weed invasion. These preventative approaches require that emerging alien and invasive plant species and the invaded areas are identified, mapped, prioritised and then managed.

Alien and invasive species have caused substantial changes to the structure and function of the ecosystem in many parts of the world. This is brought into place displacing native plant species and altering vegetation structure. Plant inversions potentially drive changes in community patterns, soil nutrient status, species

interactions, ecosystem services and disturbance regimes (Hobb and Mooney, 1986; Richardson and van Wilgen, 2004; Traveset and Richardson, 2006). The tendency of alien and invasive plants to become spatially and numerically dominant in their new areas may contribute to homogenisation of biotas (Mc Kenny and Lockwood, 1999).

Spatial patterns in plant communities have been attributed to a range of processes such as:

- ✓ Interactions between individuals of different plant species.
- ✓ Localised dispersal abilities.
- ✓ Disturbance regime.

Pauchard and Shea (2006), state that the most important challenge posed by alien and invasive species is competition for nutrient resources at their vicinity. The prospects for the control of pompom weed in South Africa are encouraging. South African provinces with limited levels of infestation (Free State, North West, Eastern Cape, Northern Cape and Western Cape) must be able to contain the spread and eradicate some infestations. Those with high levels of infestation (Gauteng, Limpopo, KwaZulu-Natal and Mpumalanga) must look forward to reducing further spread of the weeds by controlling infested areas and improving land management practices by adhering to carrying capacity standards (ARC, 2007c). The current methods used to control pompom weeds (chemical, mechanical and integrated methods) should also go a long way to containing the pompom weed until biological control can be implemented (ARC, 2008a).

Evaluations were conducted by the *Working for Water* programme in 2007, when data for this research project was conducted. It was estimated that the cost of removing all existing alien and invasive plants (excluding the impact of biological control on the spread of some species) amounts to approximately R 1.6 *billion*. According to the Conservation of Agricultural Resources Act, the landowner/user

is the one responsible for the control of alien and invasive species (Cullis *et al.*, 2007).

CHAPTER 3

3. RESEARCH METHODOLOGY

3.1 INTRODUCTION

The main aim of this research work was, as stated in Chapter 1, to conduct a baseline investigation into the level of knowledge of various industry stakeholders into the effect and management of alien invasive plants in the selected areas of South Africa. As part of this research project, it is vital to determine the perceptions of the stakeholders - environmental managers in the identified government departments, the Non-Governmental Organisations and the farming communities - of how alien and invasive plants in their area can be effectively controlled.

This chapter deals with the methodology used to determine the level of commitment of these role players in investigating the problems associated with the control of these plants, and their ideas on how these problems can be effectively solved.

3.2 RESEARCH ETHICS

The rights of participants were protected and properly explained in terms of all data collection processes and procedures. Participation was not compulsory and participants were able to withdraw at any stage of the process. In terms of the organisation(s) research philosophy, prior approval was obtained and the organisations' identity was protected if this is preferred. Protection of respondents/participants was ensured under the following code of ethics.

3.2.1 Right to informed consent

The researcher ensured that respondents/participants fully comprehend what the research in which they are asked to participate is concerned with. This entailed:

- ✓ Explaining what the findings would be used for.
- ✓ Explaining what was expected of respondents/participants, and
- ✓ Communicating what would be done with their contributions to the study.

3.2.2 Right to anonymity

The respondents/participants were informed that their identity was protected, as their names would not be divulged.

3.2.3 Right to confidentiality

The respondents/participants were informed of which authorised officials will have access to the information they provided, and of the security and confidentiality granted to the information they were providing.

3.2.4 Right to discontinue participation

Respondents/participants were informed that they might withdraw their participation at any time without providing any reasons.

3.3 RESEARCH DESIGN, DATA COLLECTION METHOD AND ANALYSIS

This section provides a discussion of the structure of the research article, research population, data collection method, materials used for data collection, research method, validity and reliability of data collection material as well as analysis of data.

3.3.1 Research design

The description of the research process is divided into five chapters.

Chapter 1 of this research report provides the research background and brief literature content for the effective control of invasive alien plants.

Chapter 2 contains a review of the literature on the management of alien invasive plants.

Chapter 3 presents the research methodology, the research design as well as the methods of data collection, processing of collected data and the analysis of the data.

Chapter 4 presents the results. The challenges, threats and weaknesses that environmental managers should work on to mitigate the problems caused by the ineffective control of invasive plants are discussed.

Chapter 5 presents the discussion of findings. The stakeholders' strengths and opportunities to develop new strategies for the effective control of these plants are also examined. This is followed by recommendations and the conclusion.

With the aid of knowledge obtained from analysing the questionnaires on the challenges, threats, weaknesses, strengths and opportunities pertaining to the control of invasive plants, recommendations are made. It will also be determined if problems associated with alien invasive plants arose by virtue of inadequacy of existing guidelines, lack of knowledge of land users of the threat posed by invasive plants or the ineffective and inefficient management of the natural environment.

3.3.2 Population

The first aspect that was taken into account was the design of the questionnaire and selection of the sample and the sampling procedure. How the selected respondents per sample group perceived the questionnaire was regarded as important. It must be determined whether the respondents/participants think completing the questionnaire and assisting in the research study is worth their

while. This is referred to as face validity. Face validity is based on the subjective judgement of the researcher and respondents/participants for whom a specific instrument is intended (Henderson et al, 1978; Henderson et al, 1996 and Brynard and Hanekom, 1997). Members of farming communities in the Waterberg District, the Nkangala District and the Tshwane Metropolitan Municipality, senior and junior staff members from specifically identified government departments (Agriculture, Department of Water Affairs and Forestry and Department of Environmental Affairs and Tourism) and non-governmental organisations (NGOs) (Working for Water, Agricultural Research Council and South African National Biodiversity Institute) made up the respondents.

3.3.3 Data collection methods

A snowball method was used as a kick-start to data collection. A comprehensive questionnaire was used to collect data from the environmental officers/technicians, i.e. fieldworkers from identified government departments (Agriculture, Water Affairs and Forestry and Environmental Affairs and Tourism), non-governmental organisations (Working for Water, Agricultural Research Council and South African National Biodiversity Institute) and farming communities in the identified geographical areas mentioned above. Junior and senior managers responsible for environmental management in their respective organisations were interviewed.

3.3.4 Research method

This study followed a qualitative methodology. Qualitative research is used to elicit data about personal experiences and the meaning behind social actions (Leedy, 1989). Emphasis is placed on how large-scale structures affect people rather than on individual experience. In the context of this study, researchers and statisticians must analyse the impact of invasive plants on natural biodiversity and the productive potential of the land and initiate actions to control them effectively.

Qualitative research is a process of enquiry to establish an understanding based on distinct methodological traditions of enquiry that explore a social or human problem (Brynard and Hanekom, 1997). This study was exploratory in its attempt to describe the attitudes, behaviours, knowledge, trends and relationships of respondents. The objective of this exploratory study was to explore the following aspects of an area of research:

- ✓ Preparedness and readiness of environmental managers to manage the spread of invasive plants.
- ✓ Preparedness and readiness of environmental managers to effectively control alien invasive plants on infested lands.
- ✓ Identification of the consequences of challenges facing environmental managers.
- ✓ Confirmation of environmental managers' anticipation of the impact of alien invasive on their land (Nel, 2007).

3.4 APPLIED PRINCIPLES FOR RESPONDENT IDENTIFICATION

In order to ensure the applicability and relevance of the identified governmental departments, Non-Governmental Organisations and farming communities to investigate the problems associated with the control of alien and invasive plants and how these problems can be effectively solved, the following principles/criteria and aims were set for the research project:

- ✓ To compare knowledge of environmental managers and farming communities as far as effective control of alien and invasive plants is concerned.

- ✓ To compare the attitudes of environmental managers and farming communities on effective control of alien and invasive plants.

- ✓ To determine whether, in the opinion of environmental managers and local farming communities, the current efforts to control alien and invasive plants are effective in protecting biodiversity and productive potential of the land.
- ✓ To determine whether there is any documentation that would enhance the objective of maintaining biodiversity and productive potential of the land.
- ✓ To determine the difference between environmental managers and local farming communities, and which issues carry more weight in terms of decision making pertaining to effective control of alien and invasive plants.
- ✓ To compare the perceptions of environmental managers and communities on the current status of invasive infestation in the Waterberg District of Limpopo Province, Nkangala District Municipality of Mpumalanga and the City of Tshwane Metropolitan Municipality of Gauteng.
- ✓ To determine the success of a joint effort by government departments, Non-Governmental Organisations and farming communities to control alien and invasive plants.
- ✓ To determine the failure of a joint effort by government departments, Non-Governmental Organisations and farming communities to control alien and invasive plants.

3.5 RESEARCH TYPE

The study is based on descriptive or *ex post facto* research. This type of research precedes other types because, before a researcher can make progress in solving sub-problems, he must understand the existing facts and the prevailing conditions (Mouton and Marais, 1996a; Haycock, 2002). Behr, 1983, Haycock, 2002 define descriptive research as “concerned with conditions that exist, practices that prevail, beliefs and attitudes that are held, processes that are ongoing and trends that are developing”.

Qualitative research is defined as research in which a researcher starts a project with more general questions, collects extensive amounts of verbal data from a

small number of participants/respondents and presents their findings in words/descriptions that are intended to accurately reflect the situation under study (Leedy, 1997)

Descriptive research can be classified into three main types, namely survey, developmental study and case study (Behr 1983). A survey is a process of gathering data from a relatively large number of participants/respondents at a particular time and is concerned, not with the characteristics of individual cases, but with overall statistics from which abstractions and conclusions are drawn (Behr, 1983; Mouton and Marais, 1996b).

Determining the commitment and perceptions of an individual has to do with attitudes. This research project sets out to determine the commitment of the environmental managers making up the sample to investigating the problems associated with ineffective control of alien and invasive plants. Attitude reflects people's feelings, values and beliefs (Henderson, *et al.,* 1978). An attitude is sometimes not measurable: for example, an attitude cannot be measured in the same way as the rate at which "Sonia Rose" plants respond to a controlled irrigation rate and frequency. It can only be inferred that a person has a particular attitude from his or her words or actions (Henderson, *et al.,* 1978)

Qualitative methodology, as followed in this research project, refers to research that produces descriptive data; in general, people's own written or spoken words. No numbers or counts are made of observations on which the conclusion is formulated (Brynard and Hanekom, 1997).

3.6 VALIDITY AND RELIABILITY OF MEASURING INSTRUMENT

In order to enhance crosschecks during data processing in this study, the researcher distributed the questionnaires to all parties involved in environmental management and farming communities. A comparison was drawn between the

responses of selected officials from both government departments, Non-Governmental Organisations and farming communities in order to test validity (see Appendix: 1).

Correctness and appropriateness, known as ‘content validity’, was taken into account in the questionnaire design (Brynard and Hanekom, 1997). A pre-test was conducted with the assistance of the identified government departments and NGOs together with the farming communities in the focus area of this study.

Content validity is the third aspect that received attention in questionnaire design. A questionnaire had high construct validity if it elicits the information it is designed to uncover (Brynard and Hanekom, 1997). The questionnaire in this study will therefore be specifically designed to obtain the desired information.

The focus area of this research project includes two different biomes, i.e. grasslands, which occur both in Gauteng and Mpumalanga, and savanna, which occurs in Limpopo Province.

This research project provides scientific knowledge which can be used to determine the effective and efficient utilisation of resources, provided measuring instruments are viable and reliable.

A structured questionnaire was designed to make provision for criterion-related validity involving testing whether an instrument (A) selected for data collection measures what it is expected to measure and whether it can be compared to another instrument (B) which is known to be valid. If the data collected through both these instruments matches closely, then it is taken that the instruments are valid (Brynard and Hanekom, 1997). Validity was of the utmost importance in designing the questionnaire used as a measuring instrument in this study and in the selection of the sample and the sampling procedure. Correctness and

appropriateness, known as “content validity”, were also taken into account in the design of the questionnaire.

For the purpose of this study, a questionnaire was designed and administered to the participating group in the sample. This group include the environmental managers in the identified government departments, the Non-Governmental Organisations and the farming communities, in order to allow for cross-checking during data processing.

The third aspect of validity that receives attention in the design of questionnaires is construct validity. A questionnaire has construct validity if it elicits the information it was designed to uncover. Questions must therefore be designed specifically to elicit the desired information.

The last aspect that was taken cognisance of in designing the questionnaire and choosing the sample and procedure, was the question of credibility. How do the participants/respondents regard the questionnaire? Do they think it is a waste of time completing the questionnaire and assisting in this research project? This is referred to as face validity and it is based on the subjective judgement of the researcher and participants/respondents for whom a specific instrument is intended (Henderson *et al.,* 1978; Mouton and Marais 1996b; Brynard and Hanekom 1997).

3.7 QUESTIONNAIRE DESIGN

The first step in the design of the questionnaire was to link the key concept in the problem statement to phenomena that could be measured in empirical terms (Haycock, 2002). The activity of finding measurable variables is called “operationalisation”. The link of abstract concepts to concrete and measurable variables was accomplished in the questionnaire used as a measuring instrument

in this research project (Behr, 1983; Bouma and Atkins, 1995; Mouton and Marais, 1996b).

For the purpose of this study, the following types of question were used:

- ✓ Closed-ended, structured questions, which contain specific mutually exclusive categories of response from which the participants/respondents will select one that best suits their response.
- ✓ Open-ended, structured questions, although limited, where participants/respondents might consider their opinions/answers to fall outside the options provided.
- ✓ Rankings, where a number of options are ranked.
- ✓ Matrix, where participants/respondents select the options that best reflect their perceptions/judgements or opinions.

Four categories of questions were compiled, based on the type of information required, namely:

- ✓ Factual information.
- ✓ Knowledge of the impact of pompom infestation on the land.
- ✓ Attitude/perception of participants/respondents.
- ✓ Behavioural patterns of respondents.

Pre-testing of questionnaires as suggested by Nell, Rader and Laubscher (1988) and Breen (1989) was done to evaluate the appropriateness and applicability of the questionnaires.

A pre-test of the questionnaire was approved by the supervisor and co-supervisor respectively with data capture and analysis by an analyst at the University of South Africa. A number of errors were identified and rectified before distribution of the questionnaires to the participants/respondents.

3.8 QUESTIONNAIRES TO TEST HYPOTHESIS

One of the most important purposes of the questionnaire was to obtain information to test the following hypothesis.

- ✓ Environmental managers in the identified government departments, the Non-Governmental Organisations and the farming communities in the Waterberg District of Limpopo Province, Nkangala District Municipality of Mpumalanga and the City of Tshwane Metropolitan Municipality of Gauteng do not have methodologies for the control of the fast spreading pompom weed that poses a threat to South African biodiversity and degrades the productive potential of the land.
- ✓ Pompom weed recorded in this area has a negative impact on the maintenance of biodiversity and the productivity of the land.

The knowledge obtained from the questionnaire regarding the strengths, weaknesses, opportunities and threats of current policies and frameworks could assist in formulating recommendations, comments and suggestions to improve the approach followed in controlling invasive plants in South Africa.

As mentioned earlier in chapter one, the aim of conducting this research project is to investigate the problems associated with proliferation and hence, ineffective control of invasive plants as well as environmental management challenges posed by these plants focusing on pom-pom weed. Hence, the overall intention was to generate possible solutions to the problems associated with control of invasive plants. This will be derived from captured data; reflecting the perspectives on environmental management of the environmental managers in the identified government departments, the Non Governmental Organisations and the farming communities in the sample.

Information will assist in making recommendations to improve the criteria for handling the challenges posed by the control of alien invasive plants in the sample areas.

3.9 DATA COLLECTION

The problem statement identifies the degree of preparedness of environmental managers in the identified Non-Governmental Organisations, government departments and farming communities in investigating the problems hindering the achievement of effective control of alien and invasive plants.

The questionnaire aimed at collecting data in order to:

- ✓ Analyse the current level of commitment of environmental managers and farming communities in the Waterberg District of Limpopo Province, Nkangala District of Mpumalanga and the City of Tshwane Metropolitan Municipality of Gauteng to effective control of alien and invasive plants.
- ✓ Determine the perceptions of environmental managers and farming communities in these areas in terms of the threat posed by alien and invasive plants to biodiversity and productive potential of the land.
- ✓ Determine whether there are adequate resources to address these challenges.

3.10 QUESTIONNAIRE COMPILATION

Questions were categorised on the basis of the type of information required, namely:

- ✓ Factual information.
- ✓ Knowledge of alien invasive plants infestation in the area.
- ✓ Attitude/perception of participants/respondents.
- ✓ Behavioural patterns of participants/respondents.
- ✓ Biographical information of participants/respondents.
- ✓ Background information on organisation.
- ✓ In-depth knowledge of alien and invasive plants

- ✓ Strategies and methods of control of invasive plants.

3.11 THE QUESTIONNAIRE

The structured questionnaire used in this study is attached as Appendix A. This questionnaire was compiled for the purpose of circulation to the environmental managers in the identified government departments, the Non-Governmental Organisations and the farming communities in the selected districts.

Questionnaires were personally delivered to and collected from the heads of directorates/divisions who served as co-ordinators by distributing and collecting completed questionnaires. This method of data collection was decided upon for the following reasons:

- ✓ The target groups were not too wide.
- ✓ Detailed information was obtained since participants/respondents completed the questionnaires in their own time and at their own pace.
- ✓ Personal handing out of questionnaires by various heads of departments/divisions ensured better response to questionnaires than if they had been mailed to individuals. If this had been the case, questionnaires might have been regarded as “junk mail” (Technikon Pretoria, 1998).
- ✓ Questionnaires provide greater uniformity across measurement situations than interviews. Each participant/respondent responded to exactly the same questions.
- ✓ In view of the extent of the study, data were more easily analysed and interpreted than it would have been with a general responses (Henderson *et al.,* 1998; Technikon Pretoria, 1998).

The purpose of the structured questionnaire was to conduct the baseline investigation into level of knowledge of various industry stakeholders into the effect and management of alien invasive plants in the selected areas of South

Africa and the impact of these plants on the environment, biodiversity and productive potential of the land.

Respondents/participants were requested to answer each question by marking the relevant block with an “X” as required.

SECTION A: BIOGRAPHICAL INFORMATION

1. Participants/respondents were requested to indicate their designation in their respective organisations.

These designations include: Director, Deputy Director, Assistant Director, Chief/ Principal Environmental/Agricultural Officer, Senior Environmental/Agricultural Officer. They were also requested to specify whether their designation differed from all of the above.

2. Participants/respondents were requested to indicate the period of time they had been involved in environmental management.

The period of time was indicated as follows: Not at all, 5 years or less, 6 – 10 years, 11 – 15 years, 16 – 20 years, 21 – 25, and more than 25 years.

3. In question 3, participants/respondents were requested to indicate their respective age group.

The age groups were as follows: 20 years or younger, 21 – 30 years, 31 – 40 years, 41 – 50 years, 51 – 60 years, and older than 60 years.

4. In question 4, the researcher requested the participants/respondents to provide the names of their places of employment:

These organisations were the Department of Agriculture, Department of Water Affairs and Forestry, Department of Environmental Affairs and Tourism, Working for Water, Agricultural Research Council, South African National Biodiversity Institute, or farming communities.

SECTION B: BACKGROUND INFORMATION ON ORGANISATION

Participants/respondents were asked whether there was an existing plan or guidelines to guide them in the effective control of alien and invasive plants. The participants/respondents were asked to state “Yes” if they had an existing plan or guideline, “No” if they did not and “Uncertain” if they were not sure of the existence of a plan or guideline.

Based on question 5, it was expected of participants/respondents who answered “No” to indicate if there was the probability that their department/institution/group would develop a plan or guidelines for the effective control of alien and invasive plants in the future (see Question 6). The participants/respondents were expected to state “Yes” if there was a probability that their respective departments/institutions/groups would develop a plan or guideline, “No” if there was no probability of this to happening and “Uncertain” if they were not sure.

The researcher wanted to know from the participants/respondents whether their organisation gave sustainability preference with regard to natural resources management and maintaining fertility of the soil (See question 7).
The participants/respondents chose “Yes” if their respective organisations did give sustainability preference with regard to natural resources management and maintaining the fertility of the soil, “No” if their organisations did not and “Uncertain” if they were not sure.
In question 8, the researcher wanted to elicit information from the participants/respondents on whether their organisation had measures in place to

address the threats associated with invasive plants. The participants/respondents selected a “Yes”, “No” or “Uncertain” answer where applicable.
In question 9, the participants/respondents whose answer to question 8 was “Yes” were expexted to name or list those measures.

In question 10, those participants/respondents whose answer to question 8 was “Yes” were expected to indicate whether those measures included all the stakeholders or not; if they were not sure they would select “Uncertain”.

In question 11, participants/respondents whose answer to question 8 was “No” were expected to indicate whether their organisations were making any effort to devise measures against the threats, and if they were not sure then they would choose the option “Uncertain”.

In question 12, the researcher expected participants/respondents to name or mention the efforts made. In cases where the participants’/respondents’ organisations was making an effort to devise measures against the threat, they were asked to name the members and provide the name of their organisations (see question 13).

In question 14, the participants/respondents were asked to state “Yes” if they were satisfied with the approaches/measures taken by respective organisations to manage invasive plants in their particular geographical areas, a “No” answer if they were not satisfied and “Uncertain” if they were not sure whether they were satisfied with the approaches/measures taken.

SECTION C: IN-DEPTH KNOWLEDGE OF INVASIVE PLANTS

In question 15, the researcher wanted to know the opinions of the participants/respondents of the factor(s) that pose major threats to the effective control of invasive plants in their georgraphical wards. The factor(s) referred to were financial constraints, poor legal compliance, lack of expertise, lack of

human resources, lack of proper monitoring, and inadequacy of guidelines. In the column headed “Others”, participants/respondents could specify whether there were other factors that had not been mentioned in the questionnaire.

In question 16, the researcher wanted to know the resources for which invasive and indigenous plants compete. The questionnaire listed the following resources: light, readily available nutrients and space.

Question 17 concerned participants’/respondents’ current knowledge of acts, regulations and guidelines aimed at managing effective control of alien and invasive plants. The acts, regulations and guidelines referred to are the Constitution of the Republic of South Africa, Environmental Conservation Act, Conservation of Agricultural Resources Act, National Environmental Management Act, National Environmental Management Biodiversity Act, National Environmental Management of Protected Areas Act, and Agenda 21 – South African Version.

Participants/respondents were required to specify whether there were other acts, regulations or guidelines of importance to them which had not been mentioned in the questionnaire. They were asked to use the following scale to rate their knowledge: no knowledge, fair, good, very good and excellent.

In question 18 participants/respondents were asked to indicate which invasive plants occurred in their respective geographical areas. The listed plants included *Lantana camara* (lantana), *Campuloclinium macrocephalum* (pompom weed), *Datura ferox* (large thorn apple), *Ricinus communis* (castor oil plant) and *Verbena bonariensis* (purple top). Based on their experience, respondents/participants were asked to specify whether any of these ocurred, and to list any others that had not been mentioned in the questionnaire.

Significant challenges to the natural environment posed by invasive plants were investigated in question 20. All applicable challenges were to be marked and their severity indicated. Challenges were extinction of indigenous biodiversity,

deterioration of land's productive potential, desertification, land degradation, increased rate of encroachment, and increased rate of soil erosion. The severity was indicated by using a scale from 1 to 6, with 1 the least severe and 6 the most severe. In cases where other challenges existed that had not been mentioned in the questionnaire, the participants/respondents were requested to list them.

SECTION D: STRATEGIES AND METHODS FOR CONTROL OF INVASIVE PLANTS

In question 21, the researcher wanted to establish which methods of controlling pompom weed the participants/respondents considered to be most effective. Paricipants/respondents chose one of the following: chemical method, mechanical method, biological method, and integrated method. Participants/respondents were asked to specify and list any other control methods that had not been mentioned in the questionnaire.

In question 22, the researcher intends to determine respondents' perceptions on decision making. Would they base their decisions on any or a combination of effects mentioned in question 23 below? Participants/respondents were requested to answer "Yes", "No" or "Uncertain".

Question 23 applied to those whose answer to 22 was "Yes". These participants/respondents were asked to state which effect they would choose. These were to be stated in order of importance, where 1 was the least and 4 the most important. The effects were: the effect of alien and invasive plants on the natural biodiversity, the effect of invasive plants on the productive potential of the land, the effect of invasive plants on eco-tourism, and the aesthetic effect of invasive plants on the natural environment.

Question 24 concerned the main objectives of participants/respondents should they be in a situation where they would consider complying with the national initiative for controlling pompom weeds. These objectives were sustainable

management of the productive potential of the land, conservation of natural resources for future generations and prevention of loss of biodiversity.

Question 25 dealt with preparedness and readiness of participants/respondents to report to the relevant authorities any newly identified invasive plants, in particular pompom weeds, in their respective geographical areas. Those who were prepared to do so should select a “Yes” answer, those who were not prepared to should answer “No” and those who were not sure should select “Uncertain”.

Question 26 concerned teamwork. The researcher wanted to know whether participants/respondents were of the opinion that if national and provincial government departments and non-governmental organisations worked together with farming communities as land owners/users, they would be able to solve issues regarding invasive plants.
Participants/respondents who were of the opinion that teamwork would be effective would give a “Yes” answer, those who thought that teamwork would be ineffective would answer “No” and those who were not sure would answer “Uncertain”.

Question 27 covered management strategies used by participants/respondents to overcome problems caused by ineffective control of invasive plants. These strategies were: wait until they get instructions from management, take the lead and be pioneers, and learn more about invasive plants.

Participants/respondents were given space to add comments and/or suggestions in question 28.

Lastly, the researcher thanked the participants/respondents sincerely for their valuable time and effort in participating.

3.12 RELIABILITY OF SAMPLE

It is generally accepted that a minimum of 70 percent of questionnaires must be returned to constitute a reliable sample (Leedy, 1989). For a reliable sample to be achieved for this study, this meant that 210 questionnaires had to be returned. In the event, a total of 286 participants/respondents returned their questionnaires: government departments returned 85 (94.4%), non-governmental organisations returned 81 questionnaires (90%), and land owners/users returned 120 (100%). A total of 286 (of 300) questionnaires were returned, constituting 95.3%.

In a very small sample, more reduction errors may occur than in the case of a larger and therefore more representative sample (Watt and van den Berg, 1995). The researcher, however, avoided this potential difficulty by distributing questionnaires to environmental managers in the identified government departments, NGOs and farming communities.

3.13 SUMMARY

A questionnaire was designed to collect data from environmental managers of various institutions and the farming communities. This questionnaire required four separate and distinctive analyses of collected data:

- ✓ To determine the factual information with which the participants/respondents provided the researcher with their personal information.
- ✓ To have participants/respondents acquire knowledge of the impact of invasive plants on the Waterberg District of Limpopo Province, Nkangala District Municipality of Mpumalanga and the City of Tshwane Metropolitan Municipality of Gauteng geographical areas.

- ✓ To measure the attitudes/perceptions and the degree of commitment of environmental managers in various institutions and farming communities to dealing with the challenges of pompom infestation in their regions.
- ✓ To determine the behavioural responses of participants/respondents to effective control of invasive plants.

Aspects explored that were expected to produce results included:

- ✓ The level of confidence of the joint effort between the involved parties in achieving effective control of invasive plants.
- ✓ The level of difference in opinions on the most significant challenges posed by invasive plants to the natural environment.
- ✓ Whether there were teams dealing with management of invasive plants that would enhance a joint effort.
- ✓ The most significant challenges with regard to effective control of invasive plants.
- ✓ The most effective method of controlling invasive plants.

CHAPTER 4

4. RESULTS AND DISCUSSION

4.1 QUESTIONNAIRES DISTRIBUTED AND RECEIVED FROM RESPONDENTS FROM THE EVALUATED GROUPS

A total number of three hundred (300) questionnaires were distributed to the different groups of respondents that were involved in this study. Figure 4.1 below revealed that out of the 120 questionnaires distributed among the farming communities in the identified geographical areas, all 120 (100%) were returned completed. Of the 90 questionnaires distributed among identified government departments, 85 were returned (94.44%) and 81 of the 90 questionnaires distributed to the identified non-governmental organisations were returned (90.00%).

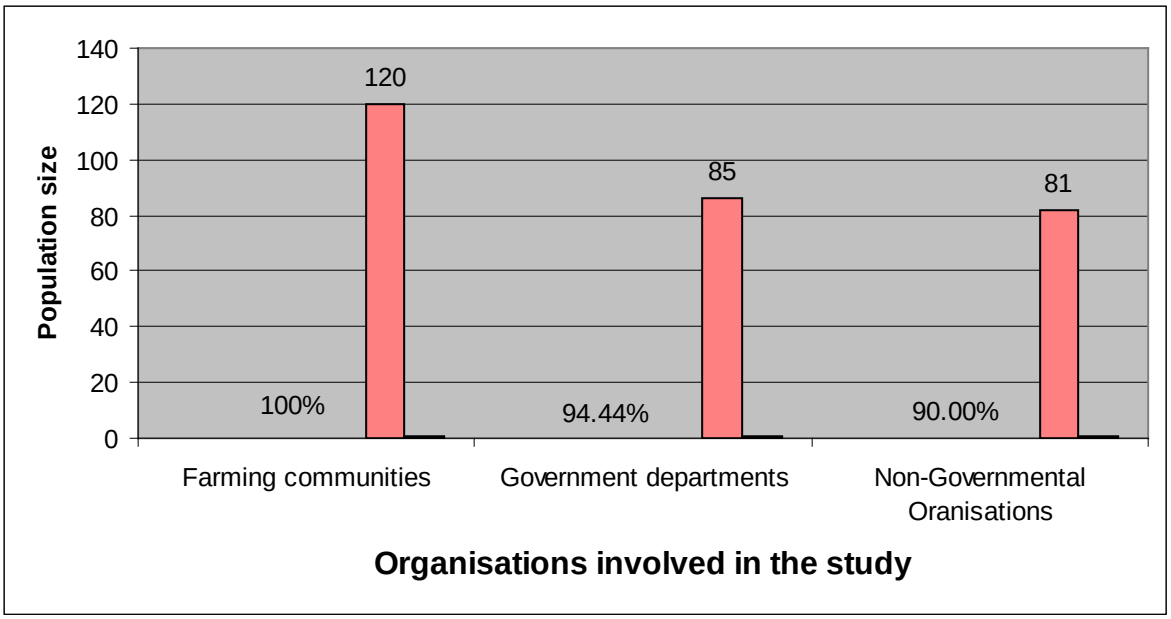

Fig 4.1: Questionnaires received from respondents from the evaluated groups

For the purpose of this study, only the most salient information extracted from responses to the questionnaires was used to investigate the shortfall in effective control of invasive plants in the identified geographical areas.

4.1.1 Responses to the questionnaires

Responses obtained from the research instrument were processed according to the type of question/enquiry as contained in questionnaire, i.e. biographical information, background information on respective organisations, in-depth knowledge of alien and invasive plants and strategies and methods used to control alien and invasive plants.

4.2 BIOGRAPHICAL QUESTIONS

4.2.1 Designation distribution of respondents

Respondents/participants were asked to indicate their designation in their respective government department or non-governmental organisations and their commitments within their respective communities (Question 1 refers).

10 (3.5%) of the respondents are directors, 19 (6.6%) are Deputy Directors, 20 (6.9%) are Assistants Directors, 56 (19.6 %) are Chief/Principal Environmental/Agricultural Officers, 58 (20.4%) are Senior Environmental/Agricultural Officers and 120 (41.9%) are farming communities. 3 (1.05%) of the respondents did not indicate their designations.

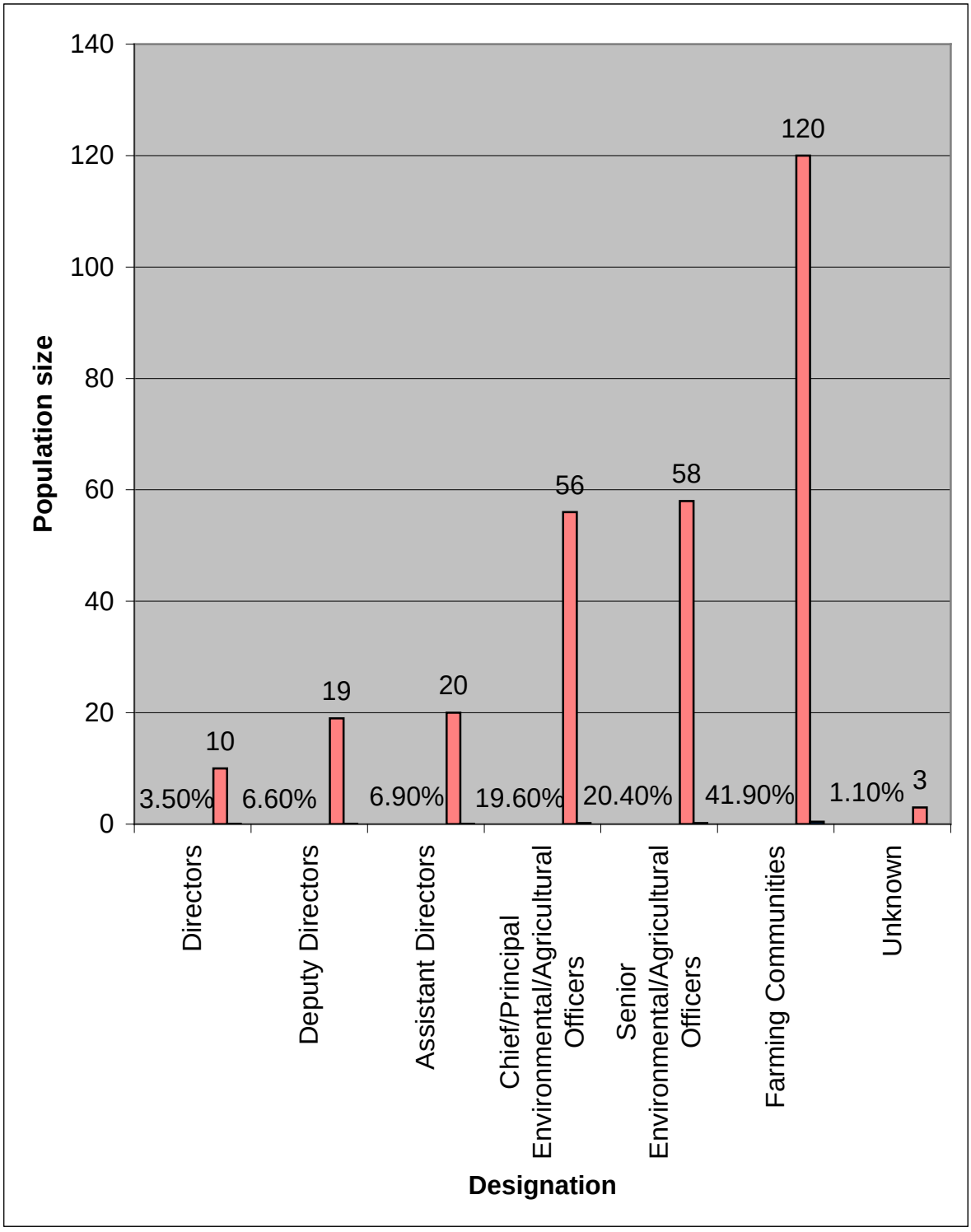

Fig 4.2: Designation distribution of respondents involved in the study

4.2.2 Duration/length of service of respondents on their current job

Table 4.1: Length of service of respondents on their current job

Not involved at all	0
5 years or less	127
6 to 10 years	76
11 to 15 years	42
16 to 20 years	29
21 to 25 years	9
More than 25 years	3
TOTAL	**286**

The results indicated that 159 (55.59%) of the respondents/participants had more than five years' experience whilst 127 (44.41%) had five years or less experience.

4.2.3 Duration of the age group/range of respondents in the study

Table 4.2 Respondents/participants' age groups

20 years or younger	1
21 to 30 years	81
31 to 40 years	106
41 to 50 years	61
51 to 60 years	27
Older than 60 years	10

The results obtained indicate that 188 (65.73%) of the respondents/participants were under the age of 40 whilst 98 (34.27%) were over 40 at the time of data collection.

4.2.4 Percentage distribution of respondents from government departments (Department of Agriculture, Department of Water Affairs and Forestry and Department of Environmental Affairs and tourism), non-governmental organisations (Working for Water, Agricultural Research Council and South African National Biodiversity Institute) and from farming communities

Data indicated that from 30 questionnaires distributed among the Department of Agriculture officials i.e. resource auditors, 28 (93.3%) returned theirs being completed, Response from the Department of Water Affairs and Forestry indicates that 27 (90%) out of 30 questionnaires distributed among the appropriate official were returned completed, Department of Environmental Affairs and tourism officials returned 29 (96.67%) completed questionnaires out of 30 which was distributed among them, from 30 questionnaires distributed among the relevant Working for Water officials, 27 (90%) returned theirs being completed, 30 questionnaires were distributed among the relevant officials of the Agricultural Research Council and 28 (93.3) were returned completed, the relevant officials of the South African National Biodiversity Institute returned 27 (90%) completed questionnaires out of 30 which was distributed among them and the farming communities returned 120 (100%) completed questionnaires.

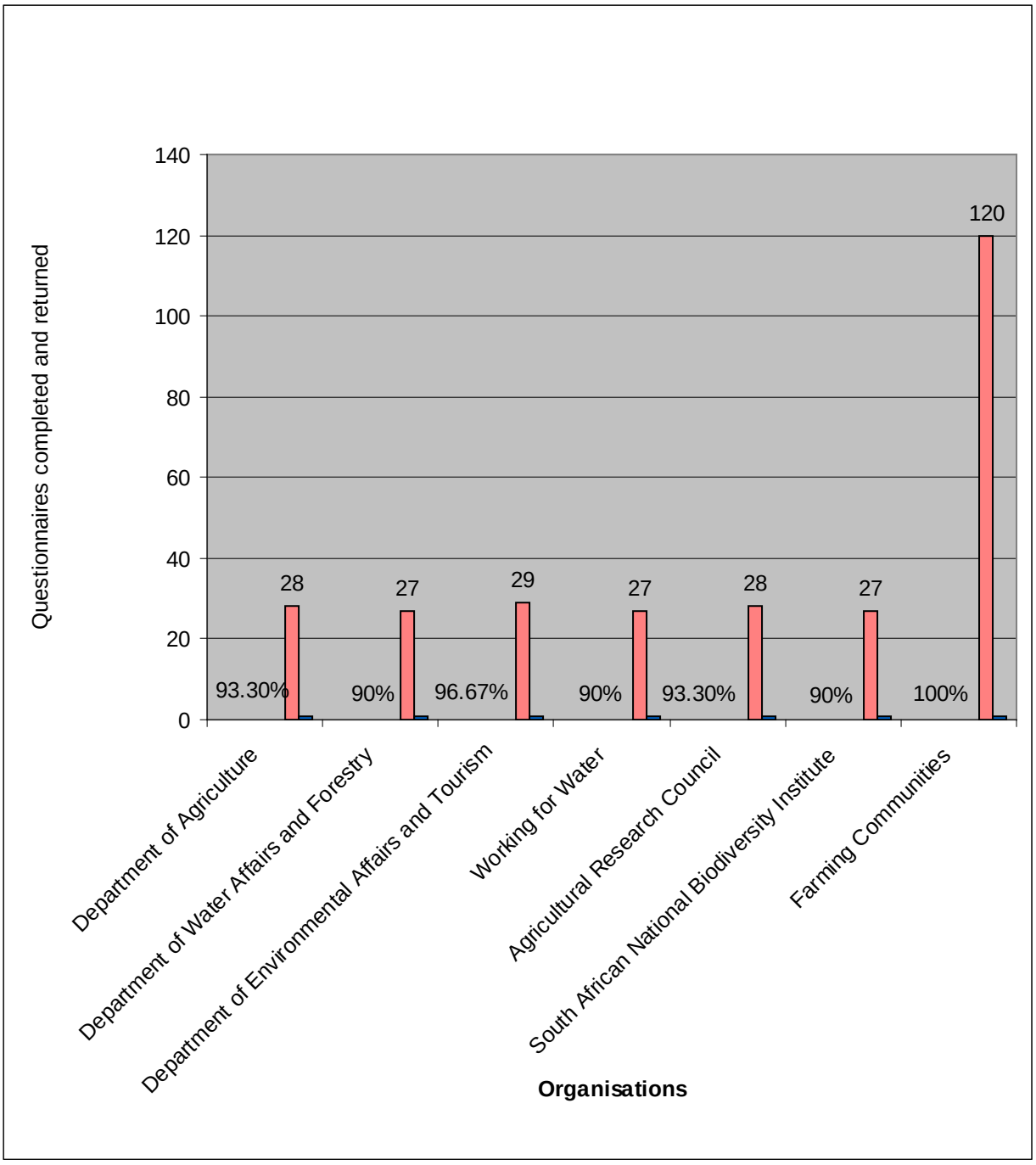

Fig 4.3: Distribution of respondents from governmental departments (Department of Agriculture, Department of Water Affairs and Forestry and Department of Environmental Affairs and tourism); non-governmental organisations (Working for Water, Agricultural Research Council and South African National Biodiversity Institute) and from farming communities

4.3 BACKGROUND INFORMATION ON ORGANISATIONS

4.3.1 Availability of existing plan for control of invasive plants by organisations involved in the study

Fig 4.4 presents the outcome of the enquiry whether the institutions involved in this study do have existing management plans with respect to the control of alien and invasive plants. It also reflects on the possibility of development of a management plan by these organisations if they do not have these plans. 195 (68.2%) of the respondents indicated that their institutions had an existing plan or guidelines for the effective control of alien and invasive plants, 53 (18.5%) did not have plan or guidelines for the effective control of alien and invasive plants and 38 (13.3%) are not sure if their organisations have those plans or guidelines.

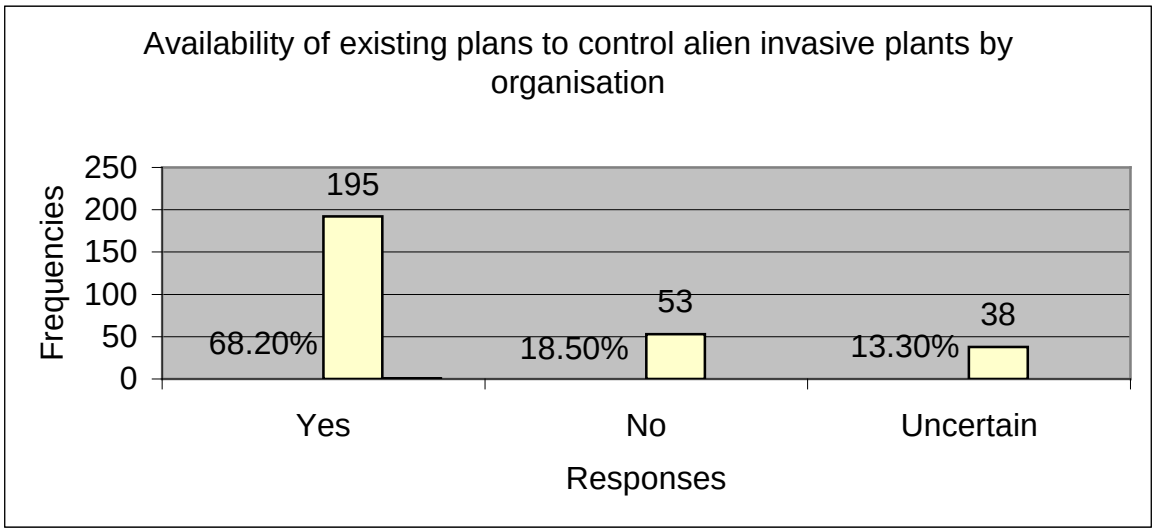

Fig 4.4: Availability of existing plan for control of invasive plants by organisations involved in the study

4.3.2 Sustainability as a preference in the effective control of alien invasive plants

Fig 4.5 indicated that 8% of the respondents indicated that sustainability was given first preference in the effective control of alien and invasive plants, 34% did

not and 58% were not certain as to whether sustainability was given first preference in the effective control of alien and invasive plants.

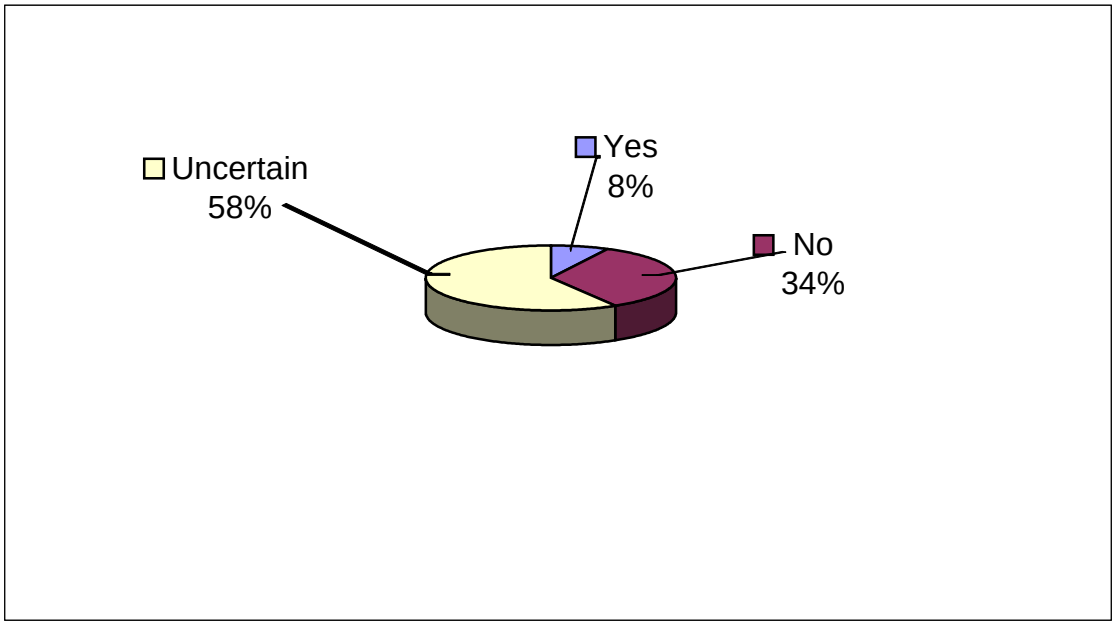

Fig 4.5: Sustainability as a preference in the effective control of alien invasive plants

4.3.3 Existence of measures in sampled organisations to address the threats posed by alien and invasive plants

Fig 4.6 indicate that 77% of the respondents indicated that their organisations had measures in place to address the threats posed by alien and invasive plants, 12% indicated that they do not have and 11% were not certain as to whether their organisations had measure in place to address threats posed by alien and invasive plants.

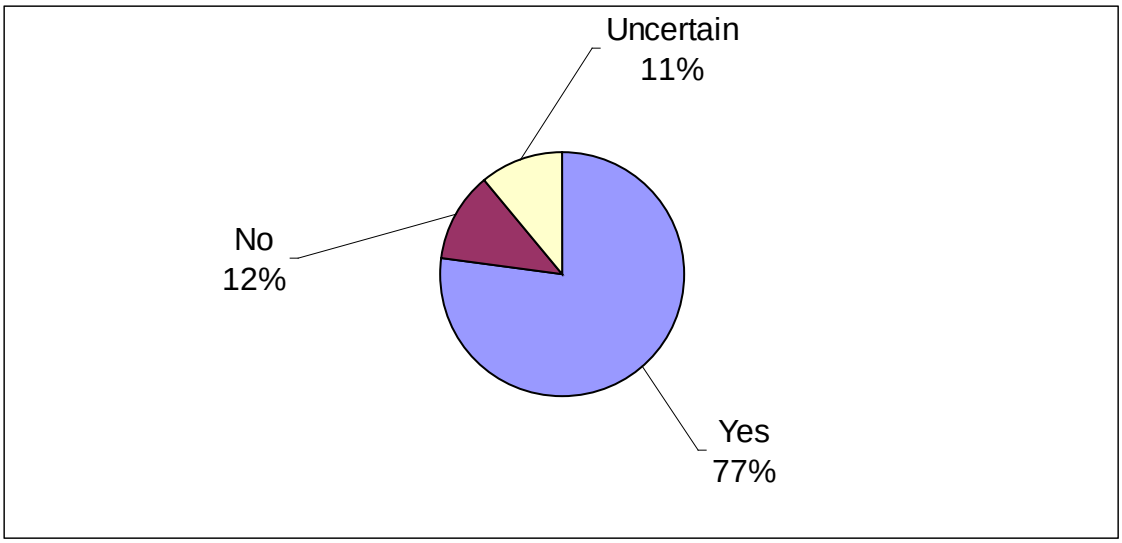

Fig 4.6: Existence of measures in sampled organisations to address the threats posed by alien and invasive plants

In question 9, information was requested on which measures were used to deal with alien and invasive plants, and the responses are indicated in the section below.

4.3.4 Farming Communities

- ✓ Mechanical methods;
- ✓ Combination of both chemical and mechanical control of invasive plants;
- ✓ Avoidance of overgrazing;
- ✓ Propagation of indigenous plants;
- ✓ Rehabilitation of damaged areas;
- ✓ Reporting newly identified invasive plants in their respective areas to the relevant authorities;
- ✓ Herbicides in-place at all times;
- ✓ Maintain adequate manpower;
- ✓ Remove alien invasive plants on an annual basis;
- ✓ Eradicate and remove invasive plants;

- ✓ Annual spraying and removal programme in conjunction with state organs and non-governmental organisations.

4.3.5 Government Departments

- ✓ Enforcement of Conservation of Agricultural Resource Act. The act prohibits the occurrence of declared weeds and, if any occur, land users are bound to control these by various methods: biological, mechanical, chemical and integrated;
- ✓ Integration of all these methods;
- ✓ Integration of strategies to control alien invasive species;
- ✓ Presence of weed schemes and the existing work relationship with Working on Wetlands (WoW);
- ✓ Expanding projects aimed at removal of alien invasive species;
- ✓ Availability of support programmes such as Working on Wetlands;
- ✓ Reporting newly identified areas of infestation by alien plants;
- ✓ Administration of Conservation of Agricultural Resources Act and Regulation 15 and 16;
- ✓ Budgeting for clearing of alien and invasive plants and partnering with other stakeholders to achieve the same goal;
- ✓ Legislative framework and assistance through weed schemes;
- ✓ Chemical, mechanical, biological and integrated control methods;
- ✓ Compliance with Conservation of Agricultural Resources Act and establishment of new committees;
- ✓ Establishment of working committees for various water resources, e.g. Hartebeespoort and Vaal dams;
- ✓ Land care, junior land care programmes, law enforcement, public awareness and farm visits;
- ✓ Removal of alien invasive plants from water sources and water distribution systems;
- ✓ Legal compliance and partnering with provincial departments, e.g. Gauteng Department of Agriculture Conservation and Environment;

- ✓ Engaging Working for Water in projects and condoning biological control methods;
- ✓ Partnering with other stakeholders, e.g. Provincial Declare Weeds and Invasive Plants (DWIP);
- ✓ Involvement of local communities and other stakeholders;
- ✓ Involvement of Department of Agriculture, Department of Water Affairs and Forestry and local communities;
- ✓ Environmental education of farming communities;
- ✓ Department of Environmental Affairs and Tourism assisting Department of Water Affairs and Forestry in funding Working for Water programme;
- ✓ Conducting more environmental education programmes, environmental awareness days and open days;
- ✓ Complying with National Environmental Management: Biodiversity Act and Draft Alien Invasive Species Regulations;
- ✓ Identification and control of alien and invasive plants.

4.3.6 Non-Governmental Organisations

- ✓ Mapping of infested areas, collection and promotion of threatened plants;
- ✓ Conducting environmental education;
- ✓ Conducting annual monitoring of land for infestation;
- ✓ More frequent site visits by Working for Water and Department of Agriculture;
- ✓ Management of alien and invasive species to be incorporated into environmental education programme;
- ✓ Training South African National Biodiversity Institute members in control of alien invasive species;
- ✓ Mechanical control methods implemented by Working for Wetlands*;*
- ✓ Undertaking of research projects to develop new, host-specific, effective insect and fungal biological control agents for invasive alien plants in Republic of South Africa;

- ✓ Monitoring distribution and spread of alien and invasive plants, assessing their impact on environment, researching their control (mechanical, chemical, biological and integrated), publishing scientific and popular articles on awareness, control and management;
- ✓ Biological and mechanical control research projects;
- ✓ Undertaking research into the biological control of invasive plants and, in some cases, conducting research into chemical and mechanical control methods;
- ✓ Biological and chemical control research or both;
- ✓ Reporting of new pockets of infestation in new areas;
- ✓ Using biological and integrated control methods;
- ✓ Using research to test potential biological control agents for use against many invasive species, i.e. host-specificity tests;
- ✓ Inclusion of post-release evaluation in these projects;
- ✓ Implementation of research results of all or a combination of herbicides, manual, mechanical, physical and biological control and the reclamation of land or water when alien and invasive vegetation has been removed or brought into balance with indigenous vegetation;
- ✓ Spreading of research stations countrywide;
- ✓ Teaching students and school pupils about the dangers of alien and invasive plants and explaining various methods of control;
- ✓ Promoting biological methods for their sustainability and environmental friendliness;
- ✓ Establishing biological and chemical control research projects;
- ✓ Distributing information to raise awareness.

4.3.7 Involvement of stakeholders in an effort to control invasive plants

Fig 4.7 shows that 154 (53.85%) of the respondents indicated that their organisations involved all stakeholders in the effective control of alien and invasive plants, 47 (16.43%) indicated that their institutions did not involve all

stakeholders in the process, 31(10.84%) are not certain whether their institutions involved stakeholders in their effort to control alien and invasive plants and 54 (18.88) opted not to respond to this question.

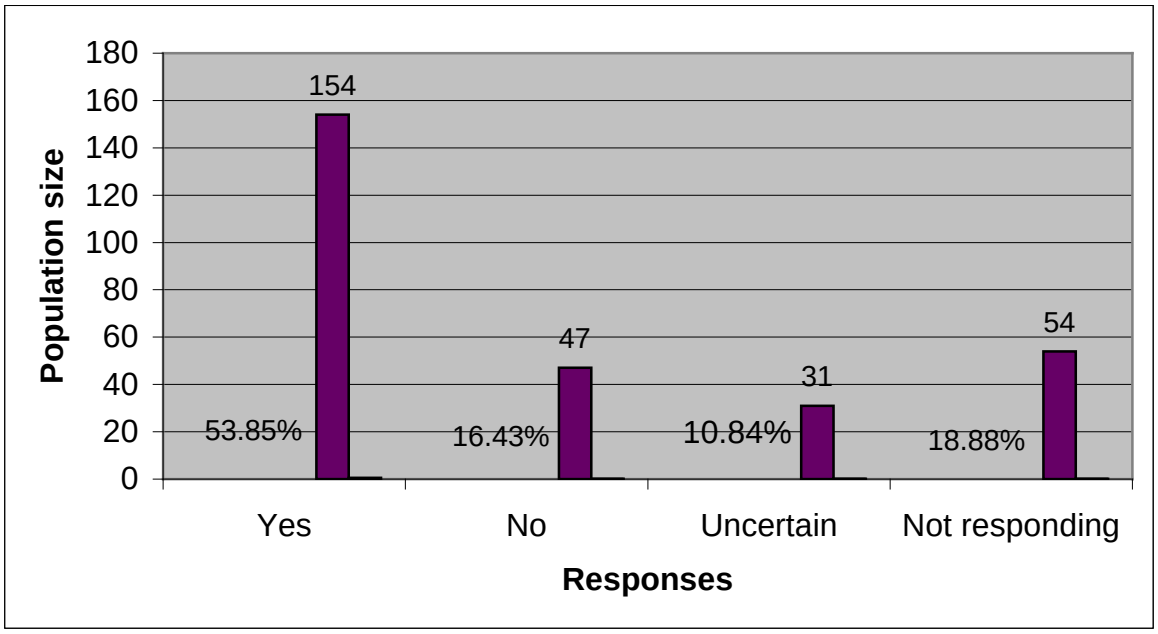

Fig 4.7: Involvement of stakeholders in an effort to control invasive plants

4.3.8 Availability of measures to resist threats posed by invasive plants

Fig 4.8 shows that 78 (27.30%) of the respondents indicated that their organisations were making some effort to device measures to resist the threats, 19 (6.60%) indicated that theirs did not have measures to resist the threats, 52 (18.2%) are uncertain if their organisations have measures to resist these threats and 137 (47.90%) opted not to respond to this question.

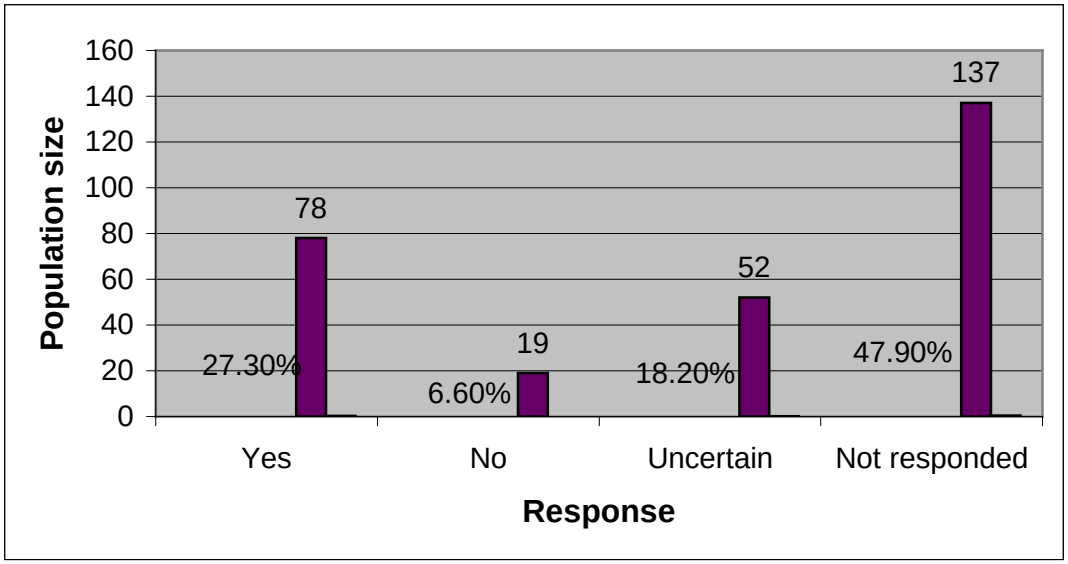

Fig 4.8: Availability of measures to resist threats posed by invasive plants

The categories of response to the type of effort being made included:

4.3.9 Farming communities

- ✓ Controlling pompom weeds
- ✓ Providing more training on control of invasive plants and involvement of Farmer Training Programme
- ✓ Conservation of Agricultural Resource Act legislation
- ✓ Invasive plant control
- ✓ Uprooting of invasive plants
- ✓ Farmer information sharing
- ✓ Mechanical control
- ✓ Invasive plant control
- ✓ Farm visits
- ✓ Weed and invasive plant control
- ✓ Farmer Training Programme, including training on management of alien invasive species
- ✓ Discouraging landowners from introducing alien invasive species into their facilities

- ✓ Encouraging farmers to remove those plants that had been wrongfully planted in the past
- ✓ Seeking assistant from Working for Water through Gauteng: Department of Agriculture Conservation and Environment
- ✓ Learning about invasive plants
- ✓ Biological control

4.3.10 Government Departments

- ✓ Management of invasive species and environmental education
- ✓ Resource mobilisation
- ✓ Capacity building in local farming and communities
- ✓ Develop a regulation on management of alien and invasive species
- ✓ Integrated approach
- ✓ Develop International Alien and Invasive Species Regulation of which the National Strategy will form part
- ✓ Environmental conservation
- ✓ Environmental capacity building and education
- ✓ Capacity building in communities
- ✓ Stakeholder engagement
- ✓ Joint site inspection with other stakeholders

4.3.11 Non-Governmental Organisations

- ✓ Delegation of scientists to conduct taxonomy studies on invasive plants
- ✓ Undertaking of research projects on biological control of invasive alien plants and, in some cases, mechanical and chemical control methods
- ✓ Biological control methods

From question 13, the researcher wished to elicit information team members were making efforts to devise measures against the threat of alien and invasive plants. The categories of responses are listed below:

4.3.12 Farming Communities

- ✓ Moretele Communal Property Association (CPA)
- ✓ Cyferskuil Disabled Co-operation
- ✓ Department of Agriculture
- ✓ Department of Environmental Affairs and Tourism
- ✓ Mmamerogo Vegetable Project
- ✓ Bele-Bela CPA
- ✓ Department of Water Affairs and Forestry
- ✓ Durok Agricultural Project
- ✓ Working for Water and Agricultural Research Council
- ✓ Kwalata Nature Reserve
- ✓ Dinokeng management
- ✓ Department of Water Affairs and Forestry, Department of Agriculture
- ✓ Working on Wetlands
- ✓ South African Police Services (SAPS) Ecological Services
- ✓ Fertiliser and herbicide manufacturing companies
- ✓ Seed companies
- ✓ Masibambisane Care of the Aged

4.3.13 Government Departments

- ✓ Farming communities
- ✓ Department of Agriculture, educators and learners
- ✓ Department of Environmental Affairs and Tourism
- ✓ Department of Agriculture and Department of Water Affairs and Forestry
- ✓ Community Land Care Groups
- ✓ Interested groups on land care
- ✓ South African National Parks, Isimangaliso Wetland Park
- ✓ Naniselana Environmental Consulting
- ✓ South African National Biodiversity Institute
- ✓ Dinokeng Local Municipality
- ✓ Limpopo Declared Weeds and Invasive Plants and Limpopo Economic Development, Environment and Tourism

- ✓ People and Conservation
- ✓ Department of Public Works and Gauteng: Department of Agriculture Conservation and Environment
- ✓ Lesedi Local Municipality and Dinokeng tša Taemane Local Municipality
- ✓ Rand Water
- ✓ Department of Minerals and Energy (DME)
- ✓ Irrigation boards and water use associations
- ✓ Department of Trade and Industries
- ✓ Department of Roads and Transport
- ✓ Agricultural Research Council
- ✓ Department of Land Affairs
- ✓ Spoornet, Trans African Conservancies
- ✓ DWIP Workgroup

4.3.14 Non-Governmental Organisations

- ✓ University of Stellenbosch, Cedara College of Agriculture, Tshwane University of Technology, Wits University, Rhodes University and University of Cape Town
- ✓ Council for Scientific and Industrial Research
- ✓ Kruger National Park

4.3.15 Satisfaction about approach/measures to manage invasive plants

The researcher wanted to know whether respondents/participants were satisfied with the approach/measures taken by their respective organisations in managing invasive plants in their areas (Question 14 refers). These responses are illustrated graphically in Figure 4.9 below:

Fig 4.9 highlighted that 171 (59.80%) are satisfied, 77 (26.92) are not satisfied, 31 (10.84%) about approach/measures to manage invasive plants, whilst 7 (2.44) opted not to answer this question.

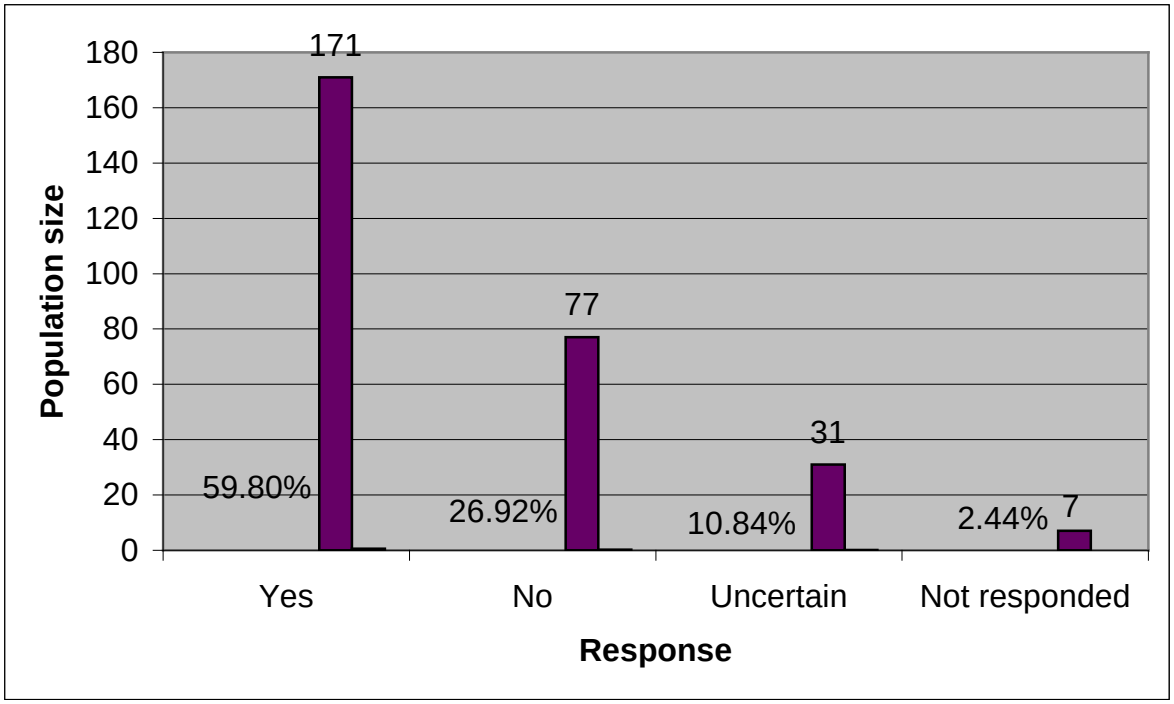

Fig 4.9: Satisfaction about approach/measures to manage invasive plants

4.4 IN-DEPTH KNOWLEDGE OF INVASIVE PLANTS

4.4.1 Factors that pose major threats to effective control of invasive plants

Table 4.3 below presents the opinions of respondents/participants regarding the factors that pose a major threat to the effective control of alien and invasive plants in their particular areas. Lack of expertise was the biggest of them all with 168 (65.03%), the second biggest was financial constraints with 124 (43.36%), followed by lack of proper monitoring 123 (43%), poor legal compliance amounted to 122 (42.66%), lack of human resources amounted to 116 (40.56%), inadequacy of guidelines was the second least, amounting to 67 (23.43%) and 8 (2.8%) had other threats and they specified them as follows:

- ✓ Lack of adequate involvement of government departments, e.g. Agriculture and Environmental Affairs and Tourism.
- ✓ Lack of information: Environmental Education is still required.
- ✓ Poor participation by farming communities.

- ✓ Lack of understanding among private land users of the dangers posed by alien invasive species to the natural environment, and the importance of removing them.

Table 4.3: Factors that pose major threats to effective control of invasive plants

THREAT	***RESPONDENTS/PARTICIPANTS***
Financial constraints	124 (43.36%)
Poor legal compliance	122 (42.66%)
Lack of expertise	168 (65.03%)
Lack of human resources	116 (40.56%)
Lack of proper monitoring	123 (43%)
Inadequacy of guidelines	67 (23.43%)
Other (specify)	8 (2.8%)

4.4.2 Resources for which invasive and indigenous plants compete

Figure 4.10 reflects the respondents'/participants' opinions on the resources for which alien and invasive plants and indigenous plants compete. 224 (78.32%) indicated that these plants (indigenous and invasive plants) compete for nutrients, 187 (65.40) highlighted that the competition is on space and 143 (50%) indicated that resource they are competing for is light.

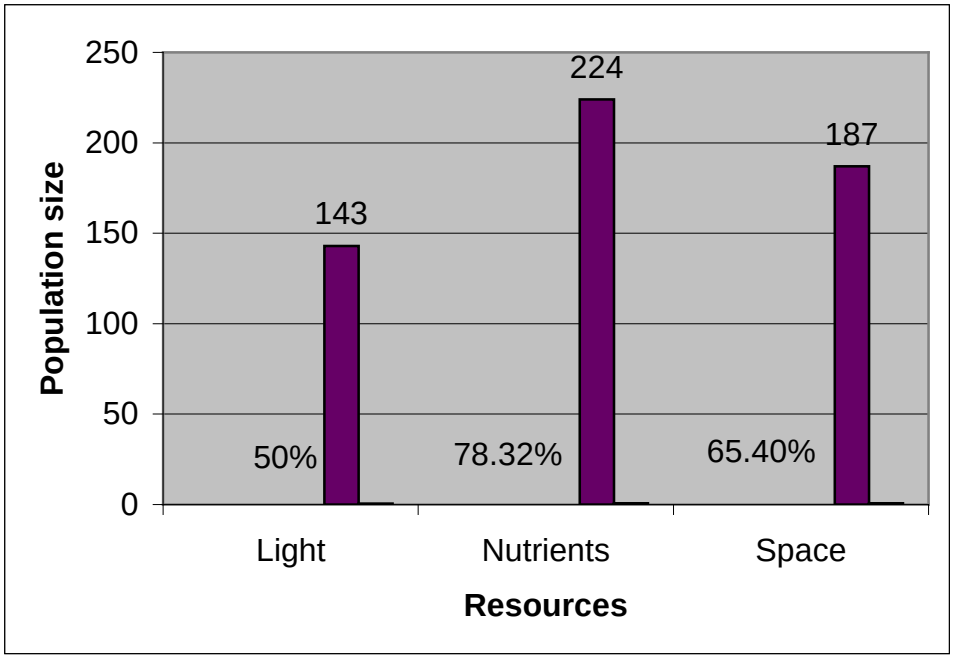

Fig 4.10: Resources for which invasive and indigenous plants compete

4.4.3 Respondents'/participants' current knowledge of regulations and guidelines aimed at establishing effective control of invasive plants in South Africa

Table 4.4 Respondents'/participants' current knowledge of regulations and guidelines aimed at establishing effective control of invasive plants in RSA. Ratings range from 1 to 5, with 1 indicating that the respondent/participant has no knowledge and 5 that his or her knowledge is excellent.

Respondents'/participants' current knowledge of regulations and guidelines aimed at effective management of invasive plants in SA					
	No knowledge	**Fair**	**Good**	**Very good**	**Excellent**
Constitution of Republic of South Africa	55 (19.23%)	68 (23.78 %)	98 (34.27 %)	48 (16.78 %)	9 (3.21%)
Environmental Conservation Act	83 (29.02%)	77 (26.92 %)	76 (26.57 %)	27 (9.44%)	14 (4.90%)
Conservation of Agricultural Resources Act	90 (31.47%)	80 (27.97 %)	59 (20.63 %)	47 (16.43 %)	25 (8.74%)
National Environmental Management Act	93 (34.58%)	66 (23.08 %)	59 (20.63 %)	41 (14.34 %)	14 (4.90%)
National Environmental Management: Biodiversity Act	111 (38.81%)	59 (20.63 %)	57 (19.93 %)	38 (13.29 %)	10 (3.50%)

National Environmental Management: Protected Areas Act	134 (46.85%)	64 (22.38 %)	48 (16.78 %)	31 (10.84 %)	8 (2.80%)
Republic of South Africa Agenda 21	183 (63.99%)	55 (19.23 %)	19 (6.64%)	13 (4.55%)	3 (1.05%)

4.4.4 Invasive plants that occur in respondents'/participants' areas of jurisdiction

Table 4.5 Lists of invasive plants that occur in respondents'/participants' areas of jurisdiction.

Name of plant	**Number of respondents**
Lantana camara (Lantana)	190
*Campuloclenium macrocephalum (*Pompom weed*)*	145
*Datura ferox (*Large thorn apple*)*	103
Rhisinus communis (Castor oil)	135
*Vebena bonariensis (*Purple top*)*	72
Argemone ochroleuca (Mexican poppies)	13
Eucalyptus paniculata (Ironbark)	1
Acacia mearnsii (Black wattle)	4
Opuntia aurantiaca (Jointed cactus)	1
Cerus jamacaru (Queen of the night)	7

Tecoma stans (Yellow bells)	12
Elymus repens(Couch grass)	16
Stoebe vulgaris (Bankrupt bush)	7
Chromolaena odorata (Triffid weed)	*2*
*Jacaranda mimosifolia (*Jacaranda*)*	3
Acacia cyclops (Red eyes)	3
Acacia seligna (Port Jackson willow)	3
Opuntia imbricata (Impricated prickle pear)	3
Opuntia ficus indica (Mission prickle pear)	3
Solanum eleagnifolium (Silver-leaf bitter apple)	8
Solanum mauritianum (Bugweed)	1
Sesbania elaeagnifolium	1

4.4.5 Degree of infestation by alien invasive plants in the focus geographic areas of the research project

Fig 4.11 shows that no area in the geographic area of the research project was not infested by alien and invasive plants, 0 (0.00%) respondents indicated that his/her area is not infested at all, 115 (40.21%) indicated that their areas are mildly infested, 114 (39.86%) indicated that theirs are moderately infested, 55 (19.23%) of the respondents indicated theirs are severely infested and 2 (0.70%) opted not to answer this question

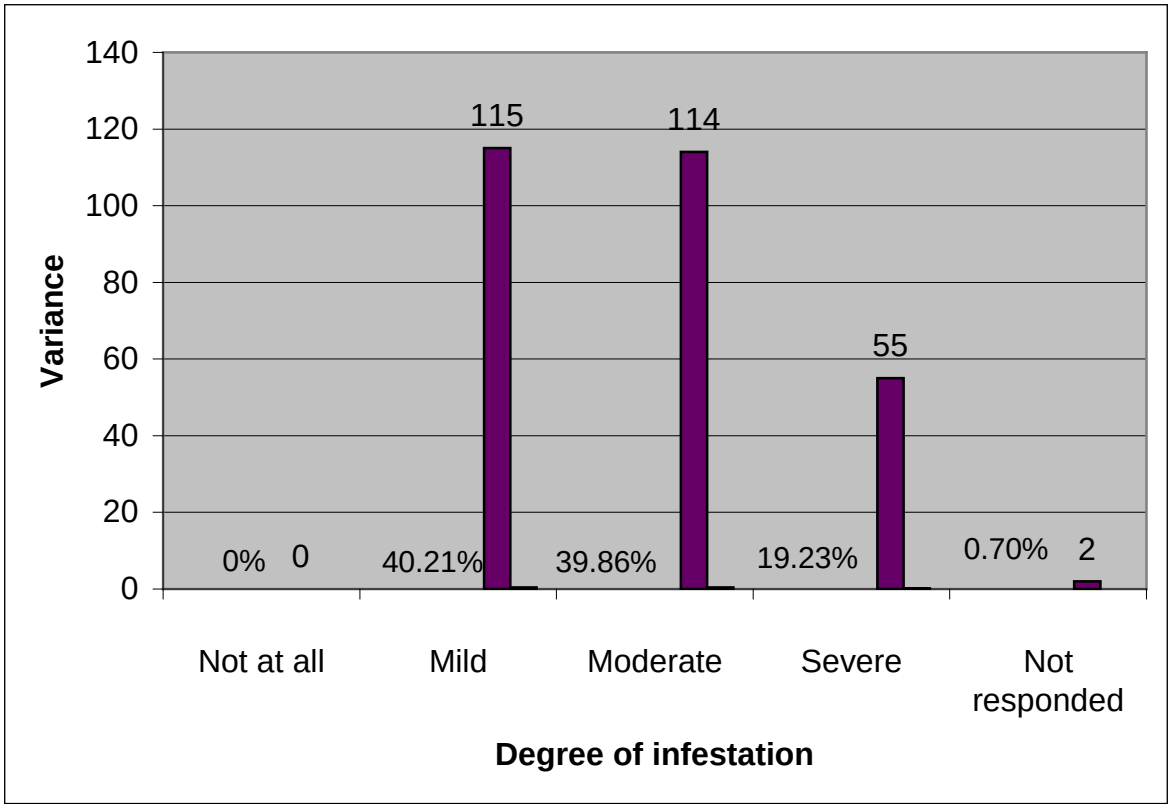

Fig 4.11: Degree of infestation by alien invasive plants in the focus geographic area of the research project

4.4.6 Rating of challenges posed by alien invasive plants to the environment

Fig 4.12a below indicates respondents'/participants' current knowledge of challenges posed by alien invasive plants to the natural environment. Their knowledge ranges from 2 to 21 at score rate of 1, 19 to 67 at score range of 2 and 47 to 73 at the score rate of 3.

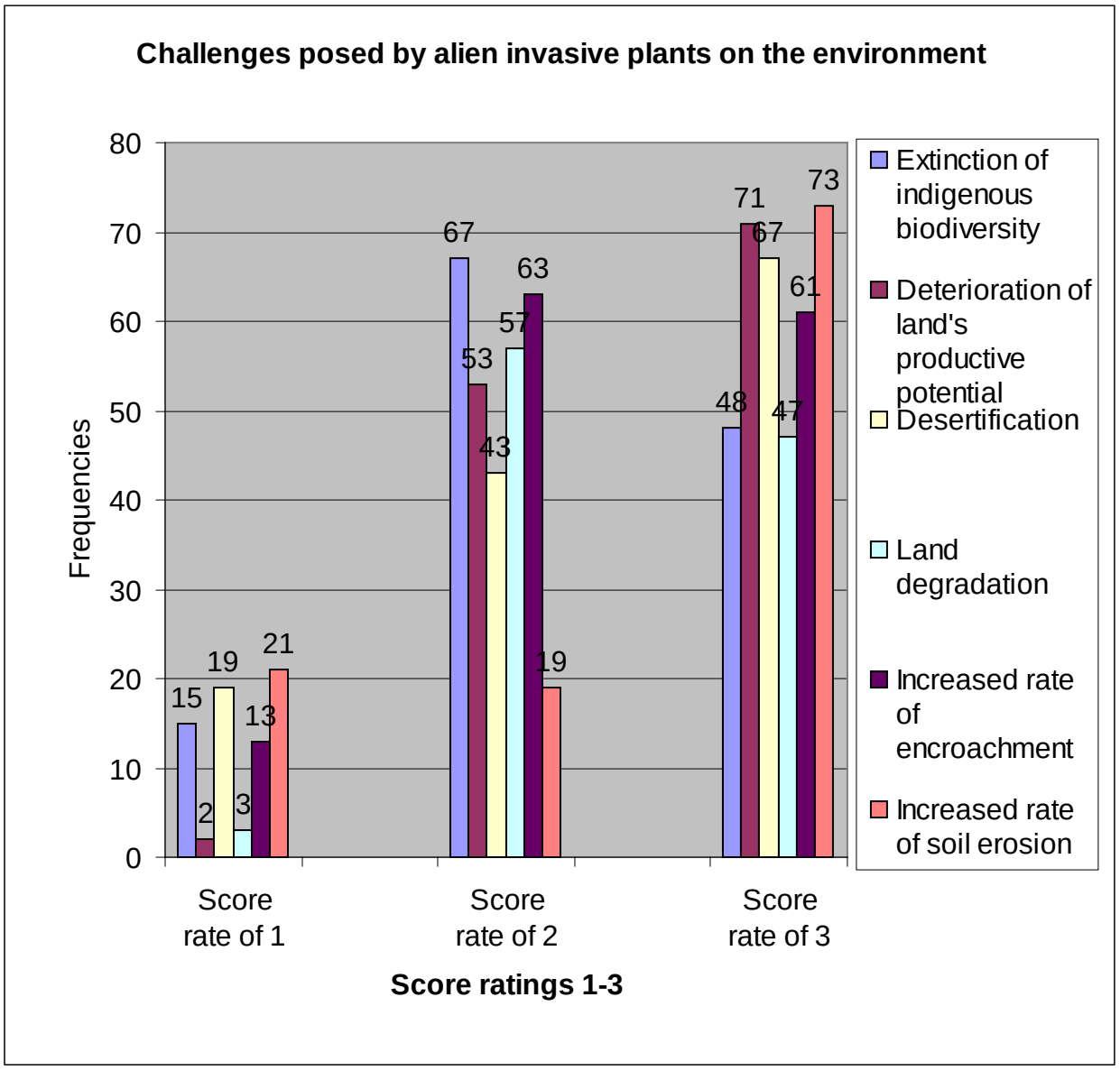

Fig 4.12a: Respondents'/participants' current knowledge of challenges posed to the natural environment by alien invasive plants.

Fig 4.12b below indicates respondents'/participants' current knowledge of challenges posed by alien invasive plants to the natural environment. Their knowledge ranges from 53 to 76 at score rate of 4, 47 to 70 at score rate of 5 and 11 to 56 at score rate of 6.

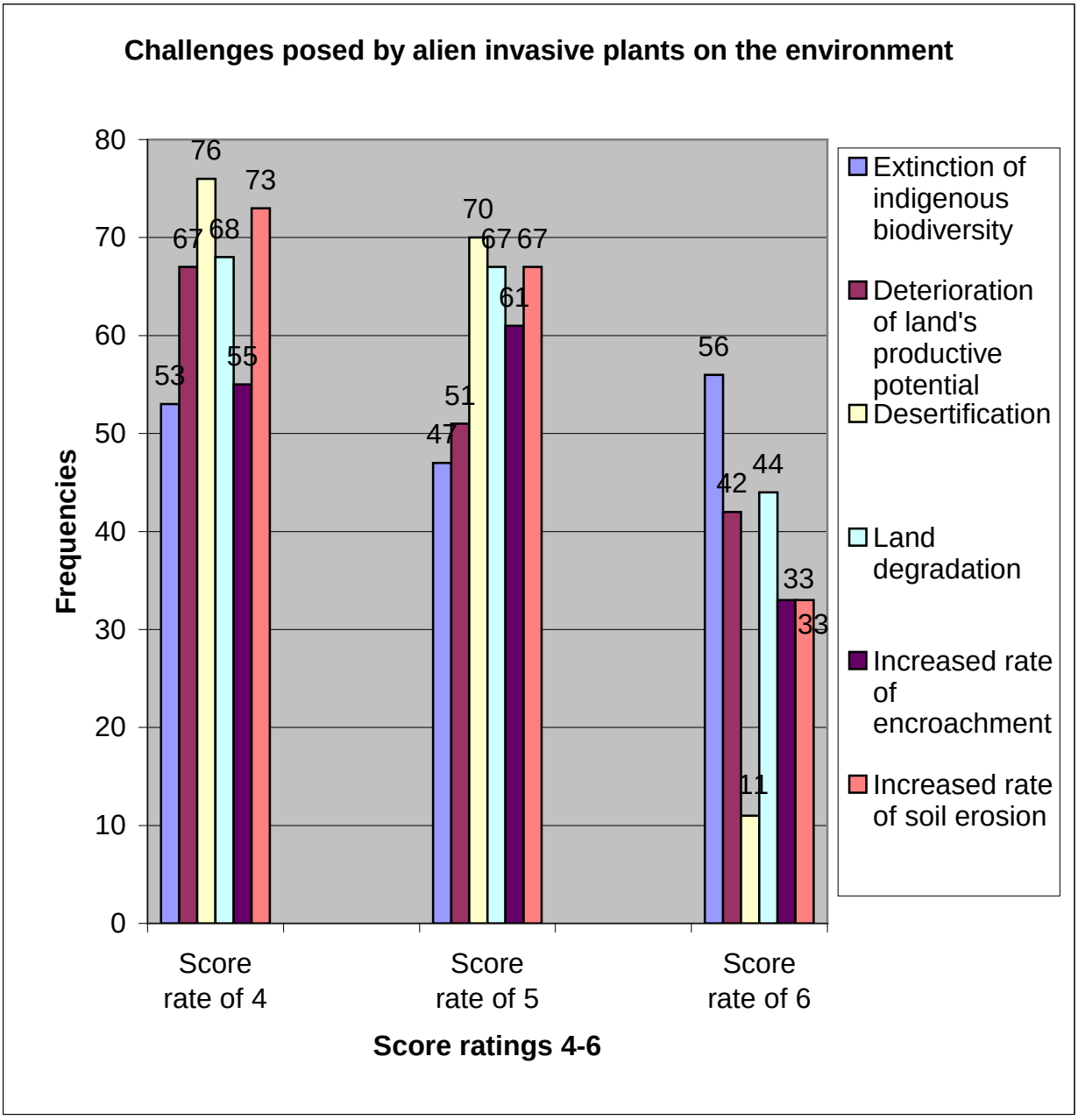

Fig 4.12b: Respondents'/participants' current knowledge of challenges posed by alien invasive plants to the natural environment.

Fig 4.12 Rating of challenges posed by alien invasive plants to the environment

4.5 STRATEGIES AND METHODS OF CONTROL OF INVASIVE PLANTS

4.5.1 Methods of controlling alien invasive plants

Fig 4.13 reflects respondents'/participants' opinions on the most effective method of controlling pompom weed. 146 respondents/participants indicated that chemical method is the best method of controlling alien invasive plants, followed by 126 who opted for integrated method, 112 indicated that mechanical is the best, whilst 54 opted for biological method as the best method of controlling alien invasive plants.

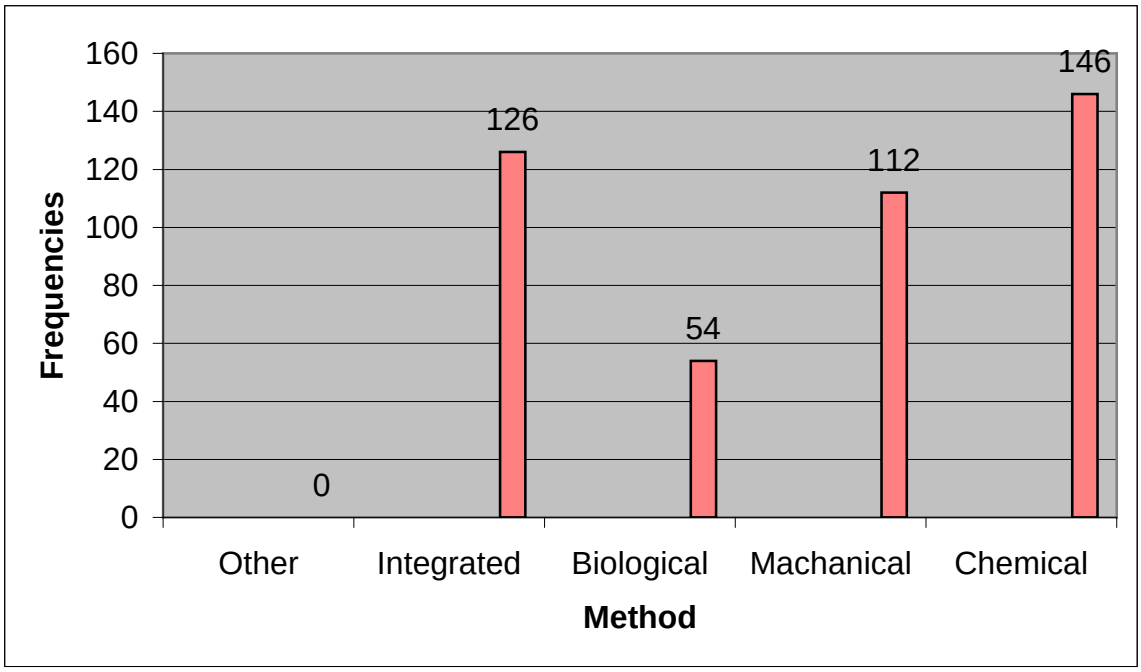

Fig 4.13: Methods of controlling alien invasive plants

4.5.2 The effects of alien invasive plants on natural environment

Fig 4.14 reflects the impact of alien invasive plants on the natural environment. 85 respondents indicated that they will cause extinction of indigenous biodiversity, 98 indicated that they would affect the productive potential of the land, 55 highlighted that they would impact eco-tourism whilst 63 indicated that they would affect the aesthetical features of the natural environment.

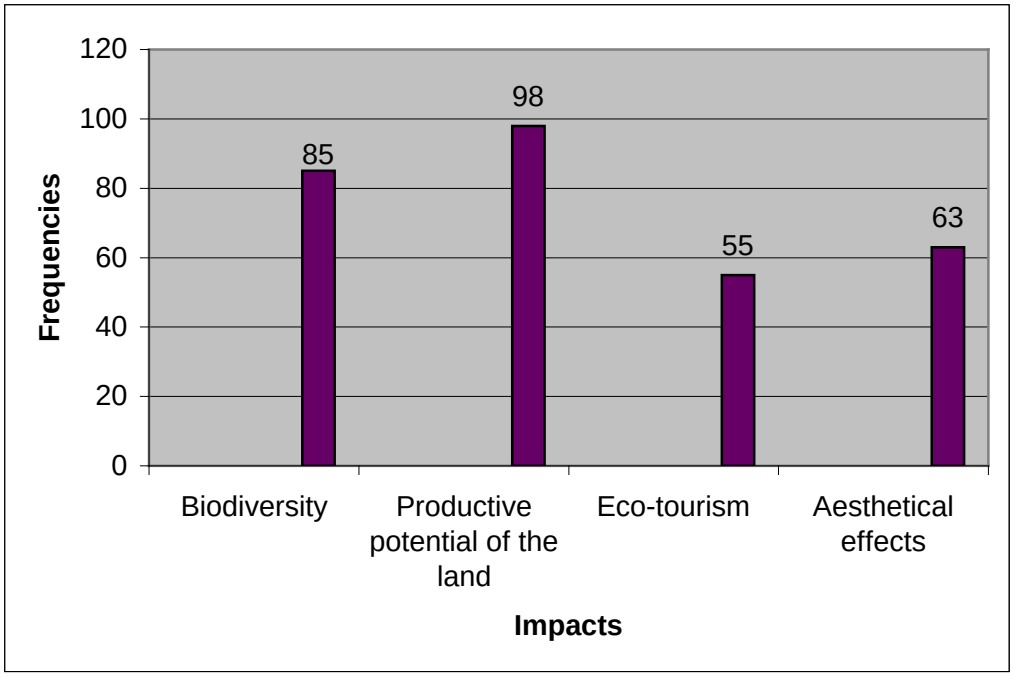

Fig 4.14: The effects of alien invasive plants on natural environment

4.5.3 Respondents who rated the effects of alien invasive plants on natural environment as least important

Fig 4.14 highlights the results for respondents/participants who rated the effects as 1(least important) (Question 23 refers). 18 (6.29.) respondents posed their rating on natural biodiversity, 9 (3.15) on the productive potential of the land, 31 (10.84) on eco-tourism whilst 58 (20.28) the aesthetical features of the natural environment and 170 (59.44) opted not to answer the question.

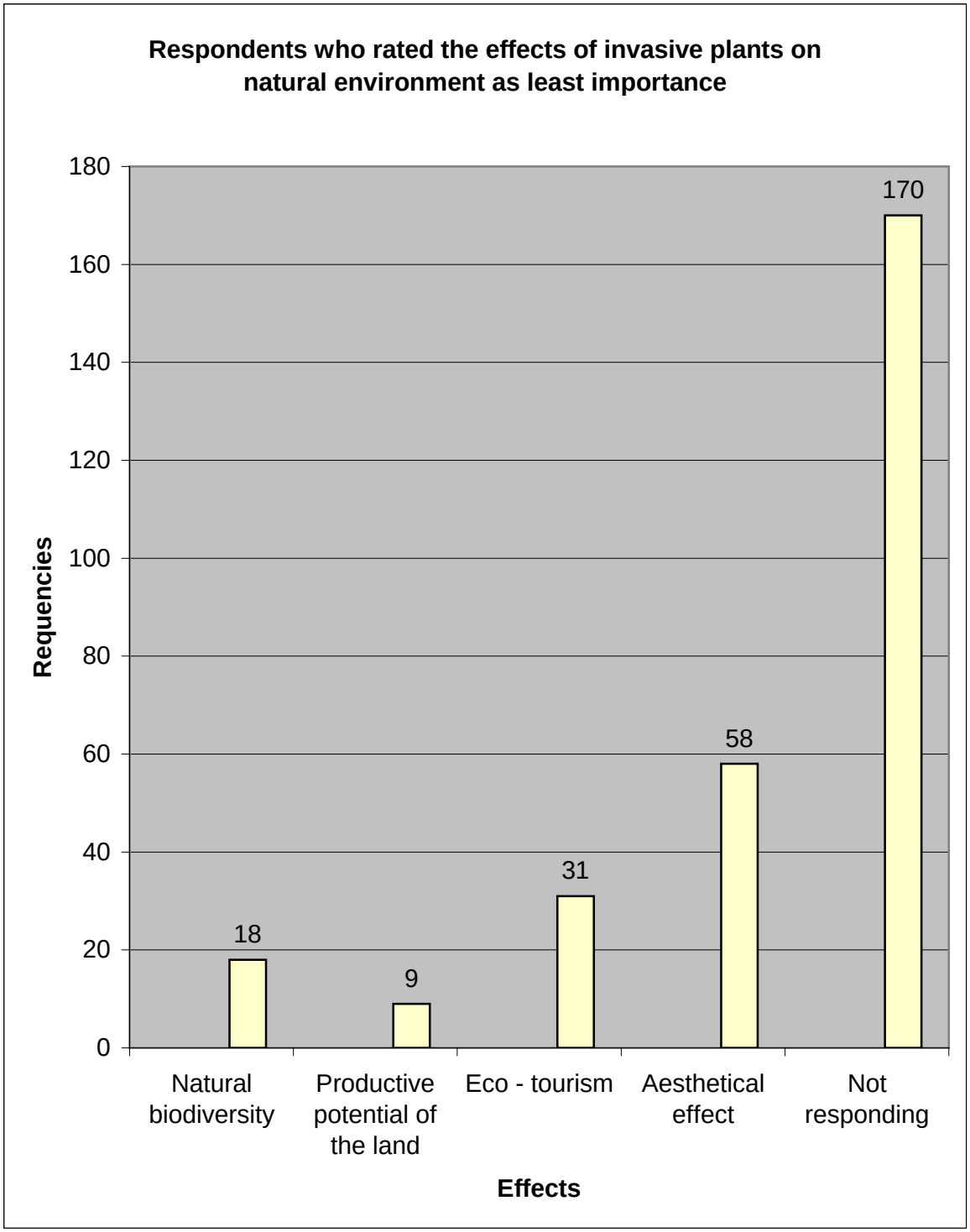

Fig 4.15: Respondents who rated the effects of alien invasive plants on natural environment as least important

4.5.4 Main objectives for complying with national initiatives for controlling pompom weed

Figure 4.15 presents the main objectives of respondents/ participants, should they consider complying with the national initiatives for controlling pompom weed (Question 24 refers). 65 respondents highlighted that the main purpose of complying with national initiatives for controlling the pompom weed is to prevent loss of biodiversity, 134 indicated that it is to conserve natural resources for future generations and 110 highlighted that it is manage the productive potential of the land.

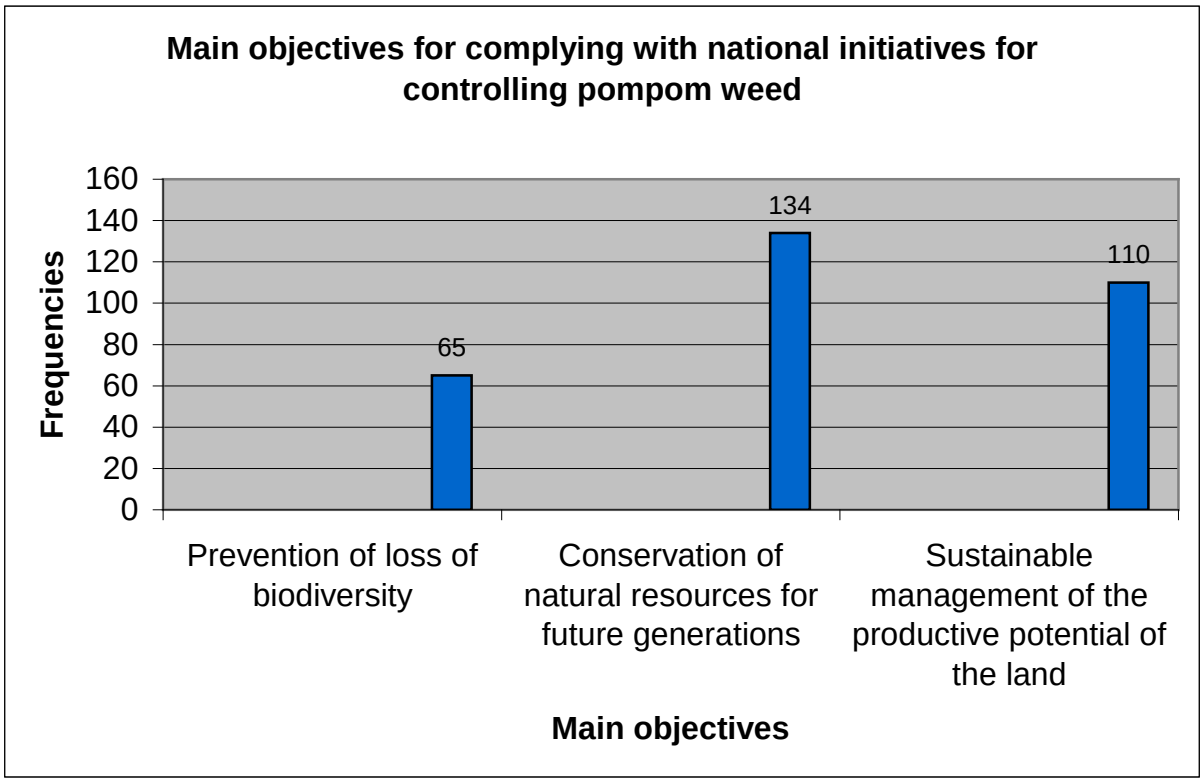

Fig 4.16: Main objectives for complying with national initiatives for controlling pompom weed

4.5.5 Preparedness and readiness of respondents/participants to report newly identified invasive plants

Fig 4.16 depicted that 252 (88.11%) of the respondents are prepared and ready to report any newly identified alien and invasive plants to the relevant authorities, 5 (1.75%) are not ready and prepared to report them, 15 (5.24%) are to certain as to whether they will report them or not and 14 (4.90%) of the respondents opted not to answer this question.

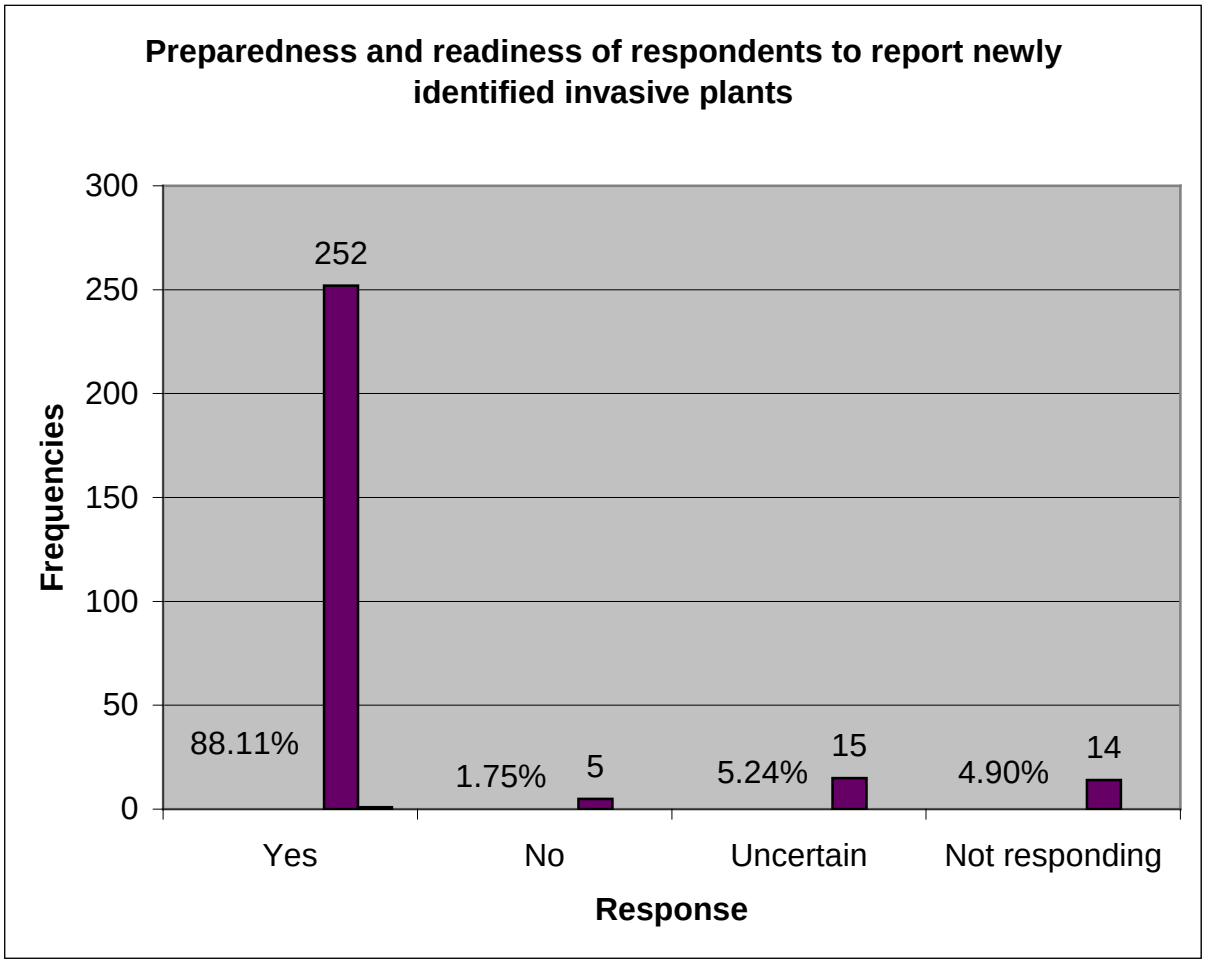

Fig 4.17: Preparedness and readiness of respondents/participants to report newly identified invasive plants

4.5.6 Belief of respondents/participants from all categories that they could solve issues of alien and invasive plants if they work together as a team.

Fig 2.17 indicated that 251 (87.76%) of the respondents believe effective control of alien and invasive plants can be achieved through teamwork, 5 (1.75%) teamwork will not solve the issue of alien and invasive plants, 16 (5.59%) are uncertain of their of the possible solution whilst 14 (4.9%) opted not to respond to this question.

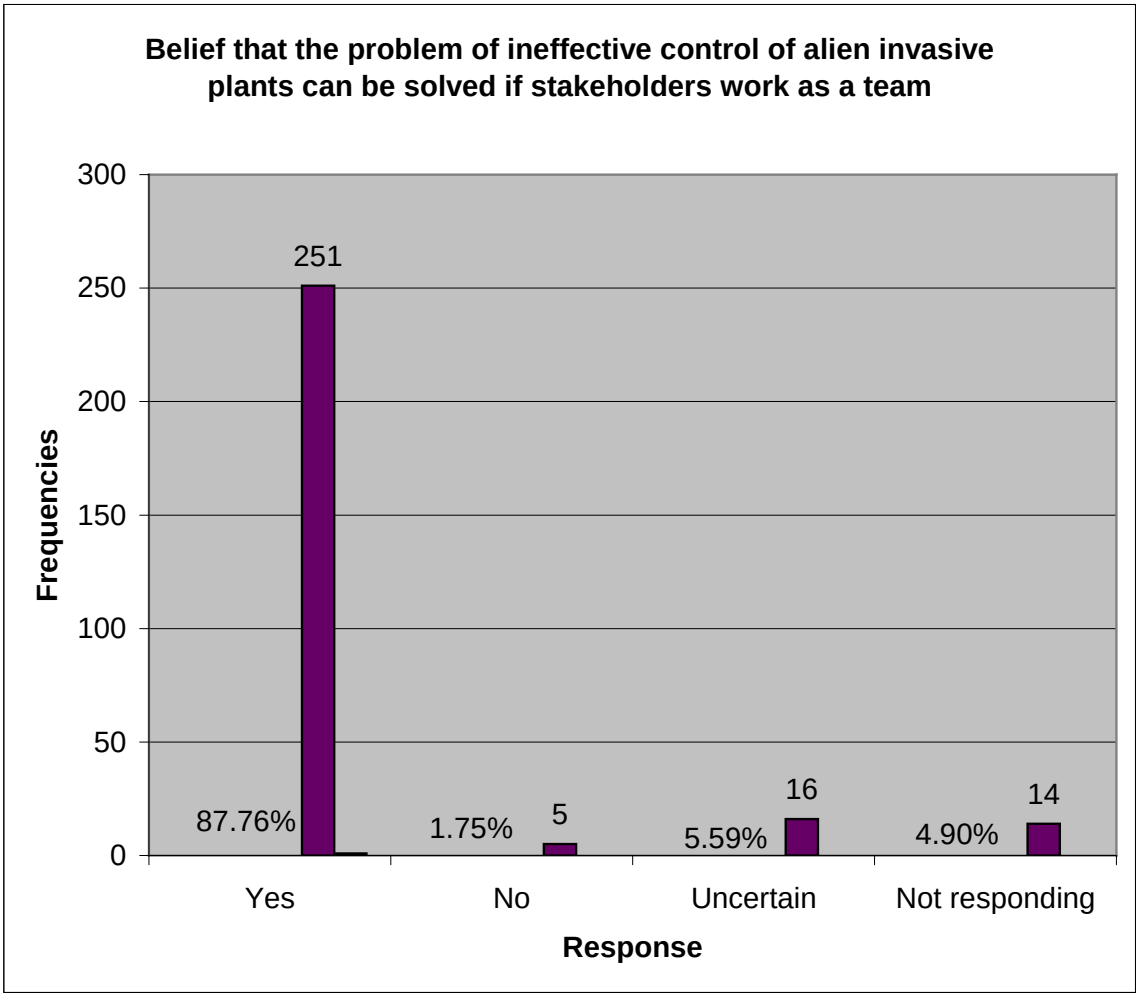

Fig 4.18: The belief that the problem of ineffective control of alien invasive plants can be solved if stakeholders work as a team

4.5.7 Strategies to determine whether respondents/ participants were knowledgeable about the strategies with respect to effective control of invasive plants

Figure 4.19 depicted that 63 (22.03%) will wait for instructions from management, 128 (44.76%) will take the lead and be the pioneers, 87 (30.41%) will learn more about invasive plants whilst 8 (2.80%) opted not to answer the question.

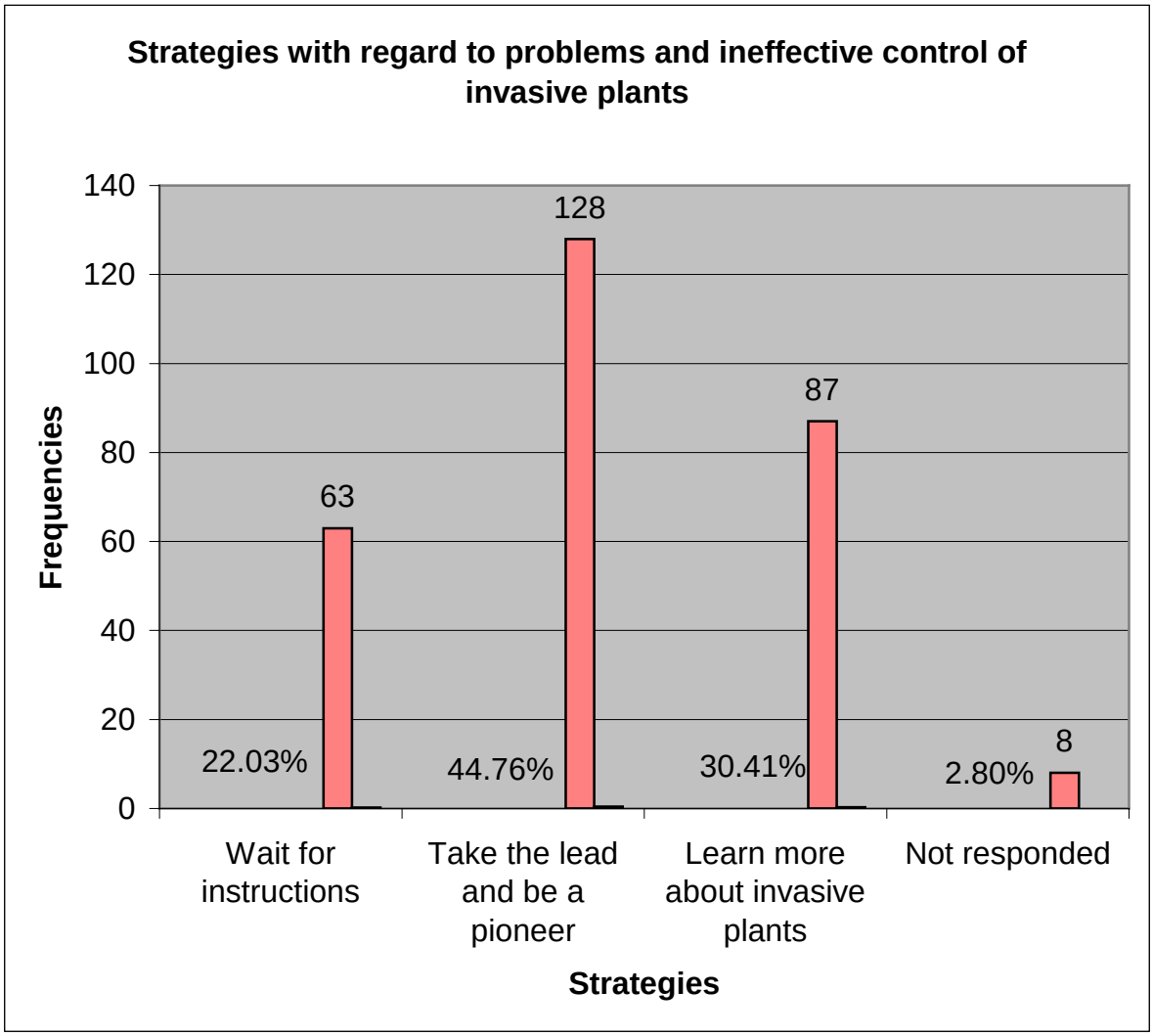

Figure 4.19: Strategies with regard to ineffective control of invasive plants.

4.6 SUMMARY

This research study revealed the following significant information:

- ✓ The largest group of respondents/participants were fieldworkers. They executed surveys and observed the invasive nature of these plants and reported this to management.

- ✓ Most of the respondents/participants were fairly experienced. Those whose period of involvement in their current careers ranged from five to over 25 years constituted 159, 55.59% of the sample.

- ✓ Respondents/participants aged between under 20 and 40 years made up 65.73% of the sample.

- ✓ The majority of respondents/participants indicated that their organisations had a plan or guidelines for effective control of alien and invasive plants: 195 (55.59%) responded with a ”yes” answer.

- ✓ In the case of those respondents/participants whose organisations did not have a plan or guidelines for effective control of alien and invasive plants, 85 (29.7%) indicated that they were presently in a process of developing such plans.

- ✓ The majority of the respondents/participants (221 (77.28%) in all three categories indicated that their organisations gave sustainability preference when it came to management of natural resources and maintenance of soil fertility.

- ✓ 199 (69.58%) respondents/participants indicated their respective organisations had measures in place to address threats associated with alien and invasive plants.

- 78 of respondents/participants in all the three categories indicated that they had made a team effort to devise measures against these threats.
- 171 respondents/participants from all the three categories indicated that they were satisfied with the approaches/measures that their organisations were taking to manage invasive plants in their respective areas.
- 168 respondents/participants indicated that a lack of expertise poses a major threat to the effective control of invasive plants whilst 67 respondents/participants indicated that inadequacy of guidelines poses only a minor threat.
- 224 respondents/participants indicated that alien and invasive plants compete with indigenous plants particularly for readily available nutrients but less so for light.
- Most respondents/participants highlighted the fact that their knowledge in terms of regulations and guidelines mostly went only as far as the Conservation of Agricultural Resources Act; only a few expressed a good knowledge of the Republic of South Africa's Agenda 21 for effective management of alien and invasive plants.
- 190 of respondents/participants indicated that the most pervasive invasive plant in their area was *Lantana camara* and the least pervasive *Verbena bonariensis*.
- 40.2 percent respondents/participants indicated that their area of jurisdiction was mildly infested with alien and invasive plants.
- Of all respondents/participants on score 1 on question 20, the 21 respondents/participants indicated that the increased rate of erosion was the most significant challenge posed by invasive plants, whilst deterioration of the land's productive potential of land was the least significant with 2 respondents/participants.

- Of respondents/participants on score 6 on question 20, 56 respondents/participants believed that extinction of indigenous biodiversity is the most significant challenge posed by invasive plants, whilst desertification is the least with 11 respondents/participants.
- 46 respondents/participants considered chemicals to be the most effective method of controlling the pompom weed, whilst biological method was considered by 54 respondents/participants the most effective.

Almost all respondents/participants based their decisions on one or a combination of the factors listed below:

- ✓ The effects that alien and invasive plants have on natural biodiversity.
- ✓ The effects that alien and invasive plants have on the productive potential of the land.
- ✓ The effects that invasive plants have on eco-tourism.
- ✓ The aesthetic effects that alien and invasive plants have on the natural environment.

- Conservation of natural resources for future generations was considered by most respondents/participants as their main objective in their compliance with national initiatives for controlling pompom weed, whilst prevention of loss of biodiversity was considered to be the least important objective. The data is 134 and 65 respectively.
- 88.1 percent respondents/participants were prepared to report any newly identified alien and invasive plants, particularly pompom weed, in their particular area.

- The 87.7 percent of respondents/participants were of the opinion that government departments, provincial government departments, non-

governmental organisations and land users could solve issues related to alien and invasive plants if they worked together.

- Taking the lead and being pioneers was the strategy chosen to deal with the ineffective control of alien and invasive plants by 44.75 percent of the respondents/participants.

CHAPTER 5

5. DISCUSSION AND RECOMMENDATION

5.1 INTRODUCTION

The purpose of this dissertation as stated in Chapter 1, section 1.3 was to conduct an investigation into the problems related to the ineffective control of invasive plants, with special emphasis on the pompom weed, in selected district municipalities of South Africa. These were the Waterberg District in Limpopo Province, Nkangala District in Mpumalanga and City of Tshwane Metropolitan Municipality in Gauteng. The scope of this study included government departments (Department of Agriculture, Department of Water Affairs and Forestry and Department of Environmental Affairs and Tourism) as well as non-governmental organisations (Working for Water, Agricultural Research Council and South African National Biodiversity Institute).

In this dissertation it was intended that:

- ✓ The problems stemming from ineffective control invasive plants would be investigated.
- ✓ The intensity of infestation in various locations would be determined.
- ✓ Participation of the sample in this research project in the control of alien and invasive plants would be evaluated.
- ✓ The existence of a team of farming communities and government departments and Non-Governmental Organisations whose activities involve management of alien and invasive plants have an impact on the environment would be investigated.
- ✓ The development of guidelines on the management of alien and invasive plants would be encouraged.
- ✓ Adherence to legislation on management of alien and invasive plants would be encouraged.

To achieve the abovementioned objectives, the focus was on:

- ✓ The benefits associated with the formation of teams by the affected parties.
- ✓ The development of national guidelines on management of alien and invasive plants.
- ✓ Adherence of land users and land administrators to environmental legislation.

This dissertation focuses specifically on Conservation of Agricultural Resource Act, the purpose of which is to maintain the productive potential of the land in a sustainable manner.

5.2 DISCUSSION OF RESEARCH STATEMENT

As indicated in Chapter 1, the aim was to investigate the problems arising from the ineffective control of alien and invasive plants in selected areas of South Africa. Owing to the geographical differences that this research project focuses on, the researcher recommends that legal compliance with environmental legislation, set standards on management of alien and invasive species are properly monitored and teams should be established to deal with the management of alien and invasive plants.

The study set out to investigate whether farming communities, government departments and non-governmental organisations have adequate guidelines in place to secure effective control of alien and invasive plants. The first phase of the investigation was to determine whether problems exist that hinder the effective control of alien and invasive plants in the identified geographical areas. The second phase analysed whether land users and land administrators were working together to control alien and invasive plants.

The strengths and weaknesses of current initiatives taken by land users and administrators within the study areas were investigated to analyse the success in the control of alien and invasive plants in the Waterberg District in Limpopo Province, Nkangala District in Mpumalanga and City of Tshwane Metropolitan Municipality in Gauteng.

Data gathered from the questionnaire highlights that:

- ✓ The majority of respondents/participants were of the opinion that effective control of invasive plants could be achieved by teamwork among farming communities, government departments and non-governmental organisations.
- ✓ Most respondents/participants were of the opinion that effective control of alien and invasive plants could be achieved by integration of environmental education and awareness sessions with land users.
- ✓ It was commonly believed by most respondents/participants that effective control of alien and invasive plants could be achieved by increased funding for environmental management.
- ✓ Most of the respondents/participants indicated that they were not knowledgeable about environmental legislation.
- ✓ Both farming communities and officials indicated that alien and invasive plants, other than those mentioned in question 18 of the questionnaire, occurred in their areas. These plants included *Argemone ochroleuca (*Mexican poppies), *Eucalyptus paniculata* (Ironbark), *Acacia mensii (*Black wattle), *Opuntia aurantiaca* (Jointed cactus), *Cerus* jamacaru (Queen of the night), *Tecoma* stans (Yellow bells) and *Elymus* repens (Couch grass).

5.3 IMPORTANCE OF PRESERVING PRODUCTIVE LAND

According to Simelane (2004), biological control is still considered to be the only cost effective, long term and sustainable option for effective control of lantana. Productive potential of the land is maintained in order to achieve environmental sustainability, which is the balance between environment, economic viability and social acceptability that meets the needs of the present generation without compromising the ability of future generations to meet their own needs.

Botes (2006), indicates that Agenda 21, the South African version, is regarded as a green agenda, but not a development or a quality of life agenda. It concerns using existing local and global resources in modern, sustainable ways and to improve quality of life. According to this guideline, short term greening is important but not the sole agenda: sustainable greening is considered across a number of sectors. Ecological sustainability, sustainable economical development and social development are all dependent on each other for sustainable development. This is to be effected through reasonable legal compliance and other measures that prevent pollution and ecological degradation, promote conservation and secure ecologically sustainable development and the use of natural resources while promoting justifiable economic and social development.

Crawling *et al.,* (2003) notes that one of the best ways to prepare for the future lies in understanding the trends and patterns of the past. It is important for South Africa policy makers and communities to learn from the mistakes of the past and not to ignore ecological importance. Considering the focus of this research project, we need to understand the spread and impact of alien invasive plants on agricultural land and the degradation this weed causes to its productive potential.

Land reform programmes such as Land Redistribution for Agricultural Development (LRAD) that seek to redistribute underutilised, privately owned land and to make state owned land available for emerging and small scale farmers, could enhance effective utilisation of available land as well as sustainable

maintenance of its productive potential. Since eco-tourism is potentially a major generator of revenue in SA, funding land care projects would be a sound investment.

Economic development need not be implemented at the expense of natural resources and social development or natural resources management at the expense of economic and social development; that is, no single issue should be implemented at the expense of another.

5.4 EVALUATION OF CARA LEGISLATION IN VIEW OF SURVEY AND RECOMMENDATIONS

The Department of Agriculture is the custodian of Conservation of Agricultural Resource Act (43 of 1983) through the Directorate: Land Use and Soil Management. As such, it makes provision for the conservation of South African natural resources through:

- ✓ Maintaining the productive potential of land.
- ✓ Combating and preventing soil erosion.
- ✓ Preventing the damage or destruction of water resources.
- ✓ Protecting the vegetation.
- ✓ Combating weeds and invasive species.

5.4.1 Evaluation of CARA Legislation

Environmental legislation and policies promulgated both before and since 1989 have led to a reduction in the exploitation of natural resources. However, exploitation is still at unacceptable levels (this is clear from the questionnaire survey distributed to government departments and Non-Governmental Organisations and farming communities–refer to question 14 on the questionnaire) and is just the beginning of the road to sustainable maintenance of the productive potential of the land and the control of invasive plants.

As noted above, the Department of Agriculture administers Conservation of Agricultural Resource Act (43 of 1983) through Directorate: Land Use and Soil Management. This department must develop corporate governance with other government departments whose activities have an impact on the environment and whose responsibilities include environmental management. Such departments include the departments of Defence, Safety and Security, Water Affairs and Forestry and Environmental Affairs and Tourism.

Both farming communities and officials who participated in the questionnaire survey indicated that “lack of expertise” was the factor that posed the major threat to the effective control of invasive plants in their respective areas.

Conservation of Agricultural Resource Act is the foundation of this research project. The respondents/participants indicated that they had adequate knowledge of the act and responded as follows:

5.5 CONCLUSION

In conclusion, it was evident from the results obtained in the study that ineffective management has been one of the factors leading to the spread of invasive pompom weed in the sampled environment.

Out of a total of 300 questionnaires that were distributed, 286 questionnaires were duly completed and returned which constitute 95.3% of the 300 that were distributed. Fourteen (14) questionnaires were not returned. This amount is quite significant, representative and applicable for discussion and interpretation of data.

Respondents in this research project differs in terms of designations in their respective organisations, 10 (3.5%) of them are directors, 19 (6.6%) are Deputy Directors, 20 (6.9%) are Assistants Directors, 56 (19.6 %) are Chief/Principal

Environmental/Agricultural Officers, 58 (20.4%) are Senior Environmental/Agricultural Officers and 120 (41.9%) are farming communities. 3 (1.05%) of the respondents did not indicate their designations.

Based on the outcomes of the enquiry on the availability of existing plan for control of invasive plants by organisations involved in study, 65 indicated that they have it, 21.6 does not have whilst 12.6 were not sure as to whether they have it or not. In case where there is no plan, it must be developed and where these people are not sure of the availability of the plan, these people must be made aware of the state of affairs and the stakeholders must work according to plan.

In the event of sustainable giving sustainability first preference, from the results indicated in chapter 4, figure 4.9, the research results depicts that the identified departments, non-governmental organisations and farming communities gave sustainability first preference in the effective control of alien and invasive plants (Question 7 refers).

The research highlighted good results in Fig 4.4.8 in that 77 percent of the respondents had measures in place to address the threats posed by alien and invasive plants. For those whose organisations do not have measures in place, indicated that they were making some effort to device measures to resist the threats posed by alien and invasive plants.

Since the challenges posed by alien and invasive plants is not just a national or continental but a global concern. However, there is a need for team work and involvement of all stakeholders in an effort to curb menace that might be caused by alien and invasive plants. The government of South Africa established Working for Water as a national programme to intervene into this challenge.

Fig 4.4.8 in chapter 4, indicated that 77 percent of the respondents' organisations had measures in place to address the threats posed by alien and invasive plants, 12 percent indicated that they do not have and 11 percent were not certain as to whether their organisations had measure place to address threats posed by alien and invasive plants

Community participation is of utmost importance where they will report newly identified alien and invasive plants to the relevant authorities (Question 25 refers). The research study also indicated that the majority of the respondents 128 will take the lead and be pioneers, followed by those who want to learn more about alien and invasive plants. The minority of them are those who will just wait for instructions and follow.

The Department of Agriculture through Directorate: Land Use and Soil Management must strengthen its relationship with Working for Water in an effort to achieve effective control of invasive plants. Directorate: Land Use and Soil Management would benefit as an indirect beneficiary in a relationship with Working for Water as this non-governmental organisations enjoys political support. From an economic development point of view, control of invasive plants by the Working for Water programme of Department of Water Affairs and Forestry could create significant job opportunities. With properly maintained productive potential of the land, food production would be maintained over a longer period of time.

It is imperative that biological control of alien and invasive plants be enhanced as it sustainable, environmentally friendly and cost effective. Landowners/users should be made aware of these advantages through land care projects which are monitored by the Department of Agriculture through Directorate: Land Use and Soil Management.

5.6 RECOMMENDATION

- ✓ In line with the outcomes of this study, both state organs, NGOs and farming communities must work together as a team in an effort to achieve effective control of alien and invasive plants.
- ✓ Both environmental managers and land users must be made aware of the advantages and benefits of opting for biological control method of alien and invasive plants.
- ✓ From economic point of view, productive potential of the land must be secured to provide for sustainable food production from this land.
- ✓ Extinction of indigenous biodiversity is a serious threat posed by alien and invasive plants and adversely affect nature based tourism.
- ✓ Legal compliance and enforcement must be brought into place
- ✓ South Africans must take responsibility of reporting newly identified alien and invasive plant to relevant authorities.
- ✓ More Environmental Education campaigns must be conducted to make farming communities more aware of the impact of alien and invasive plants on natural environment and productive potential of the land.

5.6.1 Recommendations Securing Effective Control of Invasive Plants

The following issues will have to be dealt with in order to comply with Conservation of Agricultural Resource Act legislation and its implementation as part of the process to ensure feasible control of alien and invasive plants.

- ✓ Frequent checking, monitoring and evaluation of infestations of land by alien and invasive plants.
- ✓ Increased environmental education and awareness campaigns.
- ✓ Improved training for farmers on effective and sustainable methods of controlling alien and invasive plants.
- ✓ More seminars, workshops, information days and presentations for farmers.

- ✓ Research institutions, training institutions and land users and their organisations (National African Farmers Union) and local authorities should be regarded as stakeholders and must be represented in decision-making processes.
- ✓ Provision must be made in the budget for basic needs in the communities and for education on the threats posed by alien and invasive plants and the advantages of controlling them.
- ✓ Farming communities and officials from government departments and non-governmental organisations are still unaware of the economic benefits related to the control of invasive plants in their respective areas. This should be remedied.
- ✓ The Department of Agriculture in the Directorate: Land Use and Soil Management should appoint environmentalists, not agriculturists, as Resource Auditors to avoid a series of environmental training programmes for officials. This is the reason for respondents/participants regarding “lack of expertise” as the major threat to the effective control of invasive plants in their respective areas.
- ✓ The Department of Agriculture in the Directorate: Land Use and Soil Management should investigate imposing penalties for violations of Conservation of Agricultural Resource Act legislation in order to motivate land users to comply fully.
- ✓ Teamwork should be enhanced in an effort to effectively control alien and invasive plants.
- ✓ The Department of Agriculture in the Directorate: Land Use and Soil Management should provide either a toll free number or an email address in order to encourage members of the public to report newly identified infestations and/or infestations that a landowner/user has not identified. This will encourage Resource Auditors to visit infested areas.
- ✓ The Department of Agriculture as the custodian of Conservation of Agricultural Resource Act should establish land care projects with committees at local municipal level, e.g. Dr J.S. Moroka Local Municipality

and Mogalakwena Local Municipality in Mpumalanga and Limpopo Provinces respectively.

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APPENDIX 1

QUESTIONNAIRE

SECTION A: BIOGRAPHIC INFORMATION	V1

1. Indicate your designation in your department/institution:

Director	1
Deputy Director	2
Assistant Director	3
Chief/Principal Environmental/Agircultural Officer	4
Senior Environmental/Agricultural Officer	5
Other (Please specify): …….....	6

2. Indicate the period of time over which or during which you have been involved in environmental management:

Not involved at all	1
5 years or less	2
6 to 10 years	3

11 to 15 years	4	
16 to 20 years	5	
21 to 25 years	6	
More than 25 years	7	V2

3. Indicate your age group:

20 years or younger	1	
21 to 30 years	2	
31 to 40 years	3	
41 to 50 years	4	
51 to 60 years	5	
Older than 60 years	6	V3

4. Provide the name of your organisation of employment:

Department of Agriculture (DOA)	1	
Department of Water Affairs and Forestry (DWAF)	2	
Department of Environmental Affairs and Tourism (DEAT)	3	
Working for Water (WfW)	4	
Agricultural Research Council (ARC)	5	
South African National Biodiversity Institute (SANBI)	6	
Farming	7	
Other (Please specify): …….....	8	V4
SECTION B: BACKGROUND INFORMATION ON ORGANISATION		

5. Does your organisation/institution/group have existing plan or guidelines for the effective control of invasive plants?

Yes	1	
No	2	
Uncertain	3	V5

6. If your answer to 5 is “No”, is there a probability that your department/institution/group will develop a plan or guidelines for the effective control of invasive plants in the future?

Yes	1	
No	2	
Uncertain	3	V6

7. Does your organisation give sustainability first preference with regards to natural resources management and maintaining fertility of the soil?

Yes	1	
No	2	
Uncertain	3	V7

8. Does your organisation have measures in place to address the threats associated with invasive plants?

Yes	1	
No	2	
Uncertain	3	V8

9. If your answer to 8 is “Yes”, what are those measures?

.....

.....

..... V9

10. If your answer to 8 is “Yes”, does it involve all the stake holders in your area?

Yes	1
No	2
Uncertain	3

V10

11. If your answer to 8 is “No”, is your organisation making any effort to device measures against the threat?

Yes	1
No	2
Uncertain	3

V11

12. If your answer to 11 is “Yes”, what do you call this effort?

V12

13. If your organisation is making an effort to device measures against the threat, who are the members of the team (name the organisations)?

V13

14. Are you satisfied with the approach/measures that your organisation is taking to manage the invasive plants in your area?

Yes	1
No	2
Uncertain	3

V14

SECTION C: IN-DEPTH KNOWLEDGE ON INVASIVE

PLANTS	

15. In your opinion, which of the following factor(s) poses major threat to the effective control of invasive plants in your area or ward? Mark all applicable.

Financial constraints	1	V15.1
Poor legal compliance	2	V15.2
Lack of expertise	3	V15.3
Lack of human resources	4	V15.4
Lack of proper monitoring	5	V15.5
Inadequacy of guidelines	6	V15.6
Other (Please specify):	7	V15.7

16. Which of the factor(s) does the invasive plants compete with indigenous plants? Mark all applicable.

Light	1	V16.1
Readily available nutrients	2	V16.2
Space	3	V16.3

17. How would you describe your current knowledge on regulations and guidelines aimed at managing effective control of invasive/alien plants in your area or ward?

Use the following scale:

1 : No knowledge

2 : Fair

3 : Good

4 : Very good

5 : Excellent

Describe your current knowledge on the following acts, regulations or guidelines:	No knowledge	Fair	Good	Very good	Excellent	
Constitution of the Republic of South Africa	1	2	3	4	5	V17.1
Environmental Conservation Act	1	2	3	4	5	V17.2
Conservation of Agricultural Resources Act	1	2	3	4	5	V17.3
National Environmental Management Act	1	2	3	4	5	V17.4
National Environmental Management Biodiversity Act	1	2	3	4	5	V17.5
National Environmental Management Protected Areas Act	1	2	3	4	5	V17.6
Agenga 21 – South African Version	1	2	3	4	5	V17.7
Other (Please specify):						
	1	2	3	4	5	V17.8
	1	2	3	4	5	V17.9
	1	2	3	4	5	V17.10

18 Which invasive/alien plants exist in your area of

. jurisdiction? Mark all applicable.

Lantana camara (lantana)	1	V18.1
Campuloclinium macrocephalum (pompom weed)	2	V18.2
Datura ferox (large thorn apple)	3	V18.3
Ricinus communis (castor oil plant)	4	V18.4
Verbena bonariensis (purple top)	5	V18.5
Other (Please specify):	6	V18.6

19 . Indicate the degree to which your area of jurisdiction is infected with invasive plants?

Not at all	1	
Mildly infested	2	
Moderately infested	3	
Severelly infested	4	V19

20 . What would you say are the significant challenges posed by invasive plants to the natural environment? Mark all applicable. Please indicate also the severity of each by using a scale from 1 to 6 where 1 being the least and 6 the most severe.

Challenges			Severity		
Extinction of indigenous biodiversity	1				V20.1 S1
Deterioration of land's production potential	2				V20.2 S2
Desertification	3				V20.3 S3
Land degradation	4				V20.4

					S4
Increased rate of encroachment	5				V20.5 S5
Increased rate of soil erosion	6				V20.6 S6
Other (Please specify):	7				V20.7

SECTION D: STRATEGIES AND METHODS OF CONTROL OF INVASIVE PLANTS			
21. Which method do you consider the most effective in controlling alien invasive plants?			
Chemical Method	1		
Mechanical Method	2		
Biological Method	3		
Integrated Method	4		
Other (Specify):	5		V21

22. If you were a policy maker who had to make decisions about management of invasive plants, would you consider to base your decisions on any or combination of <u>effects</u> mentioned in question 23 below?

Yes	1	
No	2	
Uncertain	3	V22

23. If your answer to 22 is “Yes”, then among those mentioned below, which would you prefer? In order of importance, indicate by means of 1 to 4 in the relevant block (1 being the least and 4 the most important).

Effects	Importance	
The effect that invasive plants will have on the natural biodeversity		V23.1
The effect that invasive plants will have on the productive potential of the land		V23.2
The effect that invasive plants will have on eco-tourism		V23.3
The aesthetical effect that invasive plants will have on the natural environment		V23.4

24. What would be your main objective if you should consider complying with the national initiative for controlling pompom weeds?

Sustainable management of the productive potential of the land	1
Conservation of natural resources for future generations	2
Prevention of loss of biodiversity	3

V24

25. Are you prepared to report any newly identified invasive plant, particularly pompom weed in your area to the relevent authorities?

Yes	1
No	2
Uncertain	3

V25

26 Are you of the opinion that both national and provincial

. government departments and non-govermental organisations could solve issues of invasive plants if they work together including the farming communities?

Yes	1
No	2
Uncertain	3

V26

27 . What would your strategy be with respect to the problems and ineffective control of invasive plants?

Wait until you get instruction from management	1
Take the lead and be a pioneer	2
To learn more about invasive plants	3

V27

28 . Any other comments and/or suggestions you may wish to add:

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APPENDIX 2

LIST OF TABLES

APPENDIX 3

LIST OF FIGURES

APPENDIX 4

LIST OF ABBREVIATIONS

ARC	Agricultural Research Council
B	Billions
BII	Biodiversity Intactness Index
CARA	Conservation of Agricultural Resources Act
CBD	Convention on Biological Diversity
CONNEPP	Consultative National Environmental Policy Process
CPA	Communal Property Association
CTMM	City of Tshwane Metropolitan Municipality
DEAT	Department of Environmental Affairs and Tourism
DLUSM	Directorate Land Use and Soil Management
DME	Department of Minerals and Energy
DoA	Department of Agriculture
DOD	Department of Defence
DPLG	Department of Provinces and Local Government
DTI	Department of Trade and Industries
DWAF	Department of Water Affairs and Forestry
DWIP	Declared Weeds and Invasive Plants
ECA	Environmental Conservation Act (73 of 1989)
EPWP	Extended Public Works Programme

ERH	Enemy Release Hypothesis
GISP	Global Invasive Species Programme
IAPs	Invasive alien plants
ISCA	International Scholar Communication Alliance
IUCN	International Union for the Conservation of Nature
KZN	KwaZulu-Natal
LRAD	Land Redistribution for Agricultural Development
M	Metres
MEC	Member of the Executive Committee
MTEF	Medium Term Expenditure Framework
NAFU	National African Farmers Union
NEMA	National Environmental Management Act (107 of 1998
NEMBA	National Environmental Management: Biodiversity Act (10 of 2004)
NEMPAA	National Environmental Management: Protected Areas Act (57 of 2003)
NW	North West
OAI	Open Archives Initiatives
PES	Payment for Ecosystem Services
PLOS	Public Library of Science,
PPRI	Plant Protection Research Institute
RA	Resource Auditor
RSA	Republic of South Africa
SA	South Africa
SANBI	South African National Biodiversity Institute
SANParks	South African National Parks
T1	Trophic level one
T1 – T5	Trophic level one to five
t/ha/year	Tons per hectares per year
UCED	United Conference on Environment and Development

UNISA	University of South Africa
WfW	Working for Water
WoF	Working on Fire