INVESTIGATING THE CONCEPT OF A GAME MEAT SCHEME TO
PROMOTE SAFE GAME MEAT ON THE SOUTH AFRICAN
MARKET

by

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DECLARATION

“I hereby declare that the thesis submitted for the degree Doctor Technologiae: Environmental Health, at the Tshwane University of Technology, is my own original work and has not previously been submitted to any other institution of higher education. I further declare that all sources cited or quoted are indicated and acknowledged by means of a comprehensive list of references”

Maretha van der Merwe
DEDICATION

This study is dedicated to:

The President of Wildlife Ranching South Africa (WRSA): Dr Gert Dry and all game farmers and hunters with wildlife conservation at heart.
ACKNOWLEDGEMENTS

My research has been an investigation into practical methods on game ranches to obtain and render safe game meat, but it has also been a saturation of my passion and vision for the sustainable conservation of privately owned game ranches in South Africa through food security.

My sincere appreciation for:

- Professor Paul Jagals, Queensland University, Australia for his ability as life tutor (cogito ergo sum Professor).
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- All the game ranchers, professional hunters and members of Wildlife Ranching, South Africa for their time and financial assistance.
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• My wonderful Mother and Father for loving me and for fuelling the ambition in me. I am privileged and blessed to be your child; you are my solid foundation and always there when I need you.

• My son for being my life, my love and the reason I completed this study.

• My beloved late brother for his zest for life and ability to stay humble.

• Above all, my Heavenly Father for: “Our Secret”.

I conclude: “Life is too short not to pursue the things that interest you and not to explore the unknown”.

ABSTRACT

Implementation of existing meat hygiene legislation can be costly to the game farm owner in terms of slaughter facilities and human resources. This can consequently force farmers and processors to operate outside of the law when delivering game meat to the market. In answer to this a Game Meat Scheme was negotiated between Wildlife Ranching South Africa (WRSA), represented by the researcher and the Department of Agriculture, Forestry and Fisheries. Nevertheless, the Game Meat Scheme only offers a 5 year period of grace for legal compliance for game farmers producing for the local meat market. Concerns of WRSA on the implementation of such and other legal procedures on game farms motivated the comparative research on regulated and non-regulated game carcasses.

Dependent and independent variables were researched to compare game carcasses intended for the export market (aspiring to strict requirements), and game carcasses intended for the local market (no control measures). The swabbing sampling technique used by the researcher was verified against the excision method (used by the export market). The results of higher counts of index and indicator organisms for the local carcasses, were ascribed to compromised GHP’s and GMP’s. The results of this study have further led to a proposed innovation in the testing and verification of current legislation culminating in the Game Meat scheme and a new Game Meat Guide that could lead to the development of practical guidelines for the hunting process on the farm.
A popular trophy hunting farm was used in the study as a model and the knowledge acquired from accredited training modules in terms of hygiene and meat inspection were practically implemented. Consequently, the following three sub-populations were identified: game carcasses for export (System 1), game carcasses from the model farm referred to above (System 2) and game carcasses from various other hunting farms not conforming to any legislative protocol (System 3). Animal classes A (large animals, for example: Elephant (\{Loxodonta Africana\}), class B (Kudu \{Tragelaphus stepsicero\}) and class C (Impala \{Aepyceros melampus\}) were characterized by comparison of the meat hygiene. The results obtained placed System 2, but not System 3, on a par with System 1 in terms of compliance. The class results showed differences between and within the sub-populations. A ‘shelf-life by class’ test, conducted over a period of seven days, showed an initial decrease in index and indicator organisms, but shortly thereafter a steep incline in spoilage organisms. Analyses of the further independent variables showed full compliance for System 1, but not for Systems 2 and 3.

In conclusion, a practical, cost effective Game Meat Guide was proposed to bridge the gap that exists between the Game Meat Scheme and practical implementation on game farms when producing game meat for the local market.
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Publications:


Presentations at International and National Symposia and Conferences:

- **National Wildlife Management Symposium**; Theme: Wildlife Management: Ensuring Sustainability, Dates 13-16 September 2009; Location: Bloemfontein Black Mountain Hotel; 1. Oral Presentation: Title: A game meat scheme for game ranchers to supply safe game meat to local markets in South Africa;
  2. Poster Presentation: Title: Health related bacterial conditions on game carcasses intended for the local South African market compared to conditions on carcasses intended for export markets.
- **7th International Wildlife Ranching Symposium**; Theme: The business of conservation science, livelihoods and values; Dates: 10-14 October 2011;
Location: Kimberley Protea hotel; Oral presentation title: The health control of game meat in South Africa and the application of health and hygiene regulatory parameters
CHAPTER 1
GENERAL INTRODUCTION

1.1 BACKGROUND

Intensive game meat production is currently described as the fastest growing marketable resource for the wildlife ranching industry in South Africa (Hoffman, 2003; Webb, 2003; Bothma, 2005b; van der Merwe, 2005; Bothma, 2006; Carruthers, 2008; Bekker et al., 2011). From a broad environmental health perspective, Webb (2003) and Watkinson et al. (2004) concluded that the wildlife ranching industry will have to invest in research into various aspects of the industry such as the incidence of diseases in wild animals, reliable data on the nutritional value, as well as the hygienic preparation and presentation of the meat of every type of wild herbivore hunted in South Africa. The reason for this is that reliable information is not easily obtained since such databases do not exist (Bothma, 2005b, van der Merwe et al., 2011).

The president of Wildlife Ranching South Africa (WRSA) puts the total of game ranches that participate in farming with game animals in South Africa at 10,000 (Dry, 2012). In addition to this, the South African Department of Environment and Tourism (DEAT) published a figure of 200,000 resident hunters and related outfitters that hunted nationwide in 2005 (Anon, 2007). They also specified that the preferred hunting location was the Province of Limpopo with 36,000 animals that were hunted there during the 2003-04 hunting season.
A decade ago, trophy animals, while being a part of the game meat stock, rarely exceeded 5% of the total game population (Grossman, 1988). van der Merwe and Saayman (2008) found that the recorded number of trophy animals hunted in South Africa in 2007 was 39768. They also noted that 55% of the trophy animal meat was processed by the hunters themselves, 41% being taken to butcheries to be processed and 4% made use of other people to do the processing. The figures published by African Development Economic Consultants (Anon, 2007), indicate that this market is escalating at more than 60% annually. From these figures it can be concluded that the trophy hunting industry, as commercial hunting, can contribute substantially to the game meat pool available for commercial processing and retail outlets. In addition, game meat generated by biltong hunters in Limpopo Province in 2005 added up to 5.300 tons (Anon, 2007). It seems clear then that unregulated game meat is becoming a substantial and valuable source of protein in the local consumer market. What is not clear is to what extent the environmental health-related safety of the game meat produced on the various ranches is ensured.

From a regulatory perspective, the Meat Safety Act (MSA) 40 of 2000 (South Africa, 2000) which replaced the Abattoir Hygiene Act 121 of 1992 (South Africa, 1992), was promulgated in 2000. The MSA was initially only applied to red meat, but was subsequently extended in five different sets of regulations to control poultry, ostrich, crocodile and game meat in the same manner. The draft Game Regulations are to be promulgated under the MSA at a yet to be determined point in the future. These rules are to-date untested in the local market and could take years to adapt and promulgate (Bergh, 2005). Furthermore, these rules are seen
by Wildlife Ranching South Africa (WRSA), an organisation that is the official mouthpiece for game farmers in South Africa, to have the potential to over-regulate the local game meat industry (Bothma, 2005b). While current legislation and other mechanisms to ensure the delivery of safe game meat to the local market could be implemented at some uncertain date in the future, it is even more uncertain whether these requirements could prove to be practical on a game farm. It might even be costly to the farm owner in terms of the slaughter facilities (slaughter is inclusive of all the processes to procure a carcass) and human resources. This could consequently mean that the farmers and processors could find themselves operating outside of the law when delivering meat to the market. Hence the question can be posed as to whether the effective application of a practical game meat scheme for game ranchers can provide safe game meat in the local market?

On the other hand, the South African export game meat industry follows a set of elaborate meat safety rules dictated by markets in foreign countries. The Department of Agriculture, Forestry and Fisheries (hereafter DAFF) promulgates Veterinary Procedural Notices (VPN) to comply with the requirements of the countries of import (South Africa, 2007; South Africa, 2010a; South Africa, 2010b; South Africa, 2010c and South Africa, 2010d). These health and hygiene related rules have been tested and amended over the years and are well accepted by the import countries. While the VPN do not have regulation status, they nevertheless imply that game meat production intended for export is well controlled according to the demands of the clients. The export market sometimes spills over into the local market when exportation of meat is prohibited until further notice under the
international control procedures of diseases such as foot-and-mouth disease (Paton et al., 2009). This scenario of regulatory control could have been applied to the local game meat market, but due to the intervention of WRSA; a game meat scheme was approved after a process of negotiations with DAFF. The Game Meat Scheme has been brought in as an interim arrangement for five years, allowing the production of game meat for commercial purposes on condition that compliance with the draft Game Regulations will be obtained in the interim.

1.2 DEVELOPMENT OF A GAME MEAT SCHEME IN SOUTH AFRICA

In the case of unregulated meat provision, the MSA provides for the promulgation of interim meat schemes to facilitate the safety of meat of different types of animals and the minister of Agriculture, Forestry and Fisheries may make such schemes applicable to the whole of the Republic or to specific areas (provinces) of the Republic. Such a game meat scheme (GMS) can ensure, directly or indirectly, a game meat supply to the local market that is traceable to its origin that can be controlled and is ultimately safe for human consumption. The format, as well as the specific requirements of a game meat scheme, is also prescribed by the MSA. It nevertheless offers an interim opportunity to provide a more practical, yet safe, set of rules that will be acceptable to the industry while ensuring the safety of game meat in the local market.

The first meeting with DAFF was requested and initiated by the researcher on behalf of WRSA in 2006 in a letter to the Director of Animal Health at DAFF. A follow-up letter from WRSA (drafted by the researcher) proposing specific health and hygiene guidelines initiated the formally recorded negotiation process. During
the negotiation process issues of *inter alia* compulsory Environmental Impact Studies (EIA) and the on-going problem of independent meat inspection were clarified. On 16 March 2009 changes made to the Game Meat Scheme by the researcher (representing WRSA) and which were unacceptable to the Department of Agriculture, were discussed and discarded. The amended and agreed upon Game Meat Scheme was submitted to the Legal Department of DAFF in March 2009 for legal formatting and final approval by the Minister of DAFF. The researcher was then requested by WRSA to investigate and develop a game meat scheme containing practical guidelines for the game rancher. She also decided to measure its effectiveness in comparison with the standards of the approved GMS and the export VPN. The health and hygiene status of game meat available from ranches is currently unknown and this triggered the investigation of the “cradle to grave” concept with specific reference to the production of game meat. The study did not include the subsequent processing line to the consumer since this is regulated by Regulation R962 of 2012, *that governs the general hygiene requirements for food premises and the transport of food* as promulgated under the Foodstuffs, Cosmetics and Disinfectants Act 54 of 1977 (South Africa, 1977). The study did however include all the activities involved in obtaining a game carcass on the ranch. A benchmark protocol was developed, based on the approved VPN standard, to use as a measuring tool for health and hygiene compliance. Three systems for obtaining game carcasses, all intended for commercial purposes, were identified as models to which these benchmarks could be applied. System one (Sys1) was typical of a system supplying the game export market and that conforms to the strict requirements of the European Union (EU). System 2 (Sys2) and system three (Sys3) both supply game meat uncontrolled to
the local market. However, Sys2 differed from Sys3 in that management team and staff from a hunting ranch for international clients in the popular Limpopo Province were specifically trained in game meat hygiene and meat inspection. System three (Sys3) provided game meat for the local market in a manner not subject to any regulation, meat hygiene training or meat inspection. Thus, dependent bacteriological and quality variables as well as independent environmental variables were developed and used to measure and compare the level of compliance of all three systems.

1.3 RESEARCH QUESTION

This study has followed the prescriptions in the MSA to enhance the possibility of the proposed scheme becoming a part of, if not replacing, the draft Game Regulations. Taking into consideration the current absence of regulations or guidelines by which game ranchers could implement proper control of game meat, WRSA requested the researcher to develop and possibly test, in terms of provision made in the MSA, a game meat scheme that game farmers could apply practically and that will enable them to produce safe game meat. The research question that motivated this study is as follows: Will a scientifically tested, farm based scheme assist in the safe production of game meat for the local market?
1.4 OBJECTIVES

The study envisaged the following objectives:

- To conclude the promulgation process of the Game Meat Scheme for WRSA under the Meat Safety Act 40 of 2000 (South Africa, 2000). The GMS will be congruent with the objectives of game meat schemes (in the MSA) as listed in Section 1.1 above. The GMS as negotiated and approved by WRSA and DAFF is currently awaiting the signature of the Minister of DAFF and will then be published in the Government Gazette under the MSA.

- To develop benchmarks based on the standards followed by the export market on game ranches with specific reference to the following three areas of the present study:
  - The process of obtaining the carcasses from ante-mortem to culling and including factors such as ante-mortem inspection, shot placement and exsanguination;
  - Transportation from the veld/bush to the slaughter facility on the farm, including the vehicle equipped with sterilizer, position of the animal (hanging), and the duration of transportation;
  - Slaughter: that includes functions such as the removal of heads and feet, evisceration, meat inspection and chilling. This area includes verification activities performed at the slaughter facility such as bacteriological tests for meat safety, pH and temperature readings. Qualitative research will include subjective observation and reporting of the slaughter procedures at the different slaughter facilities of the export and local groups; to implement these benchmarks on a
selected game ranch, after training of the ranch management and staff; and to demonstrate its effects through an empirical study while allowing for amendments of relevant aspects that may arise during the practical application.

- To conduct a comparative study between the three selected systems, namely game carcasses cropped for export purposes, carcasses from the ranch with applied health and hygiene guidelines and game carcasses from a farm not complying with any regulatory or other health and hygiene guidelines but where meat production is secondary to the experience of the hunt.
- To compile a research note on the two laboratory sampling techniques used during the study.
- To finally propose a simpler, more cost effective Game Meat Guide and provide recommendations in terms of further research, to the game industry (WRSA) as well as to DAFF as the responsible Department for the legal control of farms producing game meat.

The next chapter will deal with a literature review providing the necessary background to place the study into perspective.
CHAPTER 2
BACTERIOLOGICAL AND QUALITY STANDARDS FOR
GAME MEAT - A LITERATURE REVIEW

2.1 GAME MEAT AS FOOD SOURCE

Game meat in South Africa contributes to the human dietary requirement of 50 gram of protein per day. To meet this protein need in Central Africa would require 2.5 million metric tons of meat per day for 30 million consumers. This is an unsustainable demand for meat from wild animals only, because it is equivalent to 500 million category C (e.g. smaller size game animals such as: impala or springbuck) game animals (Shack, 2008). According to the Red Meat Producers Organization, the global proportional consumption of domesticated animals includes pork (39 %), chicken (31 %), beef (23 %) and lamb (7 %). In South Africa the corresponding consumption is pork (7 %), chicken (59 %), beef (27 %) and lamb (7 %) (South African Meat Industry Company, 2009). The global consumption of meat is the highest in terms of pork while in South Africa; pork is virtually the least consumed type of meat. In terms of game meat, the preference of foreign trophy hunters for warthog and bush pig could be explained by the prevalent consumption of pork in their home countries (Naya et al., 2003). It is however, estimated that during the hunting season the local consumption of game meat represents 20 % of total unprocessed red meat consumption (SAMIC, 2009). It was stated by Hoffman et al. (2004) that game meat should be regarded as complementary to the total consumption of meat and that it does not compete with meat from domestic animals. There is, therefore, an urgent need for more research into the basic difficulties of introducing fresh game meat into the
sophisticated marketing of meat from domestic animals. SAMIC (2009) further reported that game meat, during the hunting season, fulfills a supplementary role in the existing fresh red meat market, which currently struggles to provide sufficient meat for the increasing demand in South Africa.

Game meat in South Africa is referred to as such and not as “venison” since this is the term used in European countries. Venison refers to farmed wild animals such as elk and deer which are subjected to special treatments such as castration, vaccination against various diseases and feed supplementation with various products (Shack, 2008). Game meat is regarded as being obtained from free roaming herds of wild animals under extensive and controlled conditions. Game animals (as farmed in South Africa), fall into this category and are not usually treated with any kind of medication like antibiotics, growth stimulants and vaccines (Reilly, Sutherland & Harley, 2003). Furthermore, as far as “safe for the environment” is concerned, the output of greenhouse gases is much lower in game animals than in domesticated animals like cattle and sheep (Paulsen et al., 2011).

Game farmers in South Africa have progressed from world leaders in extensive sustainable utilisation of game species to full-fledged suppliers of game meat, both to the local and international meat markets (Ebedes & Meyer, 2008; Reilly et al., 2003). For many years now game lodges and restaurants in South Africa are increasingly serving game meat dishes and are promoting the “African experience” (Hoffman et al., 2005; van der Merwe, 2005).
According to Hoffman et al. (2004) and Aidoo and Haword (1995) outstanding health characteristics of game meat; *inter alia* includes a low kilojoule value in terms of fat (lower than 3 % compared to 14 % for domesticated species). Lower levels of cholesterol are measured for game meat (in terms of milligrams per 100 gram of meat), where the average levels for game meat vary between 46.05 to 56.9 mg/100 g of meat compared to levels of 50 to 81 for domesticated species. These health attributes increasingly contribute to the popularity of game meat with the modern consumer. Du Buisson (2006) indicated that the protein value for game meat is more than 20 % in comparison with meat from domesticated species which contains less than 20 %. Such studies as mentioned above, confirm the nutritional value of game meat.

In the past consumers believed that game meat was tougher and drier than meat from other red meat species. However, tenderness of game meat has been examined by trained sensory panels as part of the sensory analysis of meat and by instruments as part of the physical analyses of meat (Hoffman, 2000). The Warner-Bratzler shear force value is *inter alia* used for the objective evaluation of meat tenderness. The shear force values (g / cm²) for different game species are as follows; blesbok, 2 323; eland, 3 366; gemsbok, 4 088; hartebeest, 2 907; impala, 2 751; springbok, 1 181 and wildebeest, 1 805. The shear force value for pork is more or less the same as impala. These data dispel the misconception that game meat is tough as high shear force values >6 000 (g / cm²) is considered as tough meat. This was confirmed by Hoffman (2000) who concluded that poor culling techniques were the main reasons for an increase in the toughness of
game meat. For the purpose of this study more emphasis was placed on the microbiological (hygienic) quality of game meat.

2.2 HYGIENE AND SAFETY OF GAME MEAT

In the European Union, Commission Regulation (EC) No 853/2004 defines game as: “1) wild ungulates and lagomorphs, as well as other land mammals that are hunted for human consumption and are considered to be wild under the applicable law in the Member State concerned, including mammals living in enclosed territory under conditions of freedom similar to those of wild game as well as, 2) farmed ratites and farmed land mammals” (Radakovic & Fletcher, 2011).


The Meat Safety Act 40 of 2000 (South Africa, 2000) (hereafter referred to as the MSA) was developed and promulgated to address the meat safety issue of not only animals produced for their meat, but for the five different groups of animals that required to be regulated in terms of slaughter animals for meat production.
The MSA replaced the Abattoir Hygiene Act 121 of 1992 (South Africa, 2000) and was developed using the red meat requirements as a basis. The Red Meat-Poultry- and Ostrich- Regulations were promulgated under the MSA, but the Game- and Crocodile Regulations are still in draft format. The main reason that the draft Game Regulations (hereafter referred to as the DGR), have not yet been promulgated since its inception 10 years ago, is the requirement in the MSA that stipulates that a dead animal may not be brought into an abattoir (game animals are shot in the veld) and that game meat inspections should be performed by an independent game meat inspector (Government is responsible to ensure independence). Neither of these requirements is practical on a game farm.

The Department of Agriculture Forestry and Fisheries (DAFF) is unable to render an independent game meat service due to man-power shortages and logistical issues. The latter issues include the distribution of game farms and distances to be travelled to the estimated 9000 game farms in South Africa (Patterson, 2001). For export purposes of game meat, DAFF developed Veterinary Procedural Notices (hereafter referred to as VPN), based on the requirements for game meat as stipulated by the European Union (a major importer of South African game meat). The DGR that has not been promulgated was intentionally developed to ensure similar safety of game meat to local meat markets, by unrealistically proposing the Red Meat Regulations. This has resulted in the current lack of control and emphasizes the need for an interim guideline or practical game meat scheme to address the possible safety issues concerning the increasing amount of game meat, for human consumption, entering the local market.
2.2.1 The current health and safety status of game meat in South Africa

The current status of game meat in South Africa available on the local market is unknown due to the fact that legislative procedures are not applied that require *inter alia*; from a consumer perspective; meat inspection, the approval and registration of the slaughter facility, traceability of the meat and a hygiene system for the slaughter process.

In Table 2.1, a summary of rural game abattoirs currently supplying meat to the local market in South Africa is given according to the nine Provinces (Bergh, 2005). The daily throughput of a rural abattoir (this abattoir type or size can be registered on game farms producing meat by means of hunting) is limited to 2 units per day (a unit is the equivalence in size of one category B animal for example an eland or six category C animals for example impala). Low throughput abattoirs are restricted to 20 units per day (abattoirs slaughtering for local commercial purposes) and high-throughput abattoirs are not limited, but are allowed to operate according to the facilities available and compliance with VPN. The lack of registered low throughput and rural abattoirs could explain the tons of uncontrolled game meat commercially available during the hunting season.

Furthermore, the duration of the hunting season in the past was only three months (1 May to 31 July) but has gradually been extended to meet the demand for hunting and for game meat. The hunting season now opens in March and extends to as late as August of every year. The export abattoirs can apply for cropping even in hot summer months such as November, December and February (Bergh, 2005). In support of this practice; Paulsen and Winkelmayer (2004), found that the
ambient hunting temperature did not have an influence on the bacterial quality of the game meat.

Studies by Hoffman and Dicks (2011) indicated that game meat is more resistant to microbiological spoilage than mutton, beef and pork due to *inter alia* lower pH values of the meat and ante-mortem stress resulting in DFD meat (dry, firm and dark). They concluded that impala, warthog and zebra showed high resistance to bacteriological deterioration and to a slightly lesser extent this also applied to nyala, ostrich and wildebeest. However, the safety of game meat in terms of the bacteriological quality during the culling process on the game ranch remains unknown and became a prime motivating factor for the conduct of this research.

**Table 2.1**: Numbers of approved low throughput and rural abattoirs in South Africa

<table>
<thead>
<tr>
<th>Province</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mpumalanga</td>
<td>1</td>
</tr>
<tr>
<td>Gauteng</td>
<td>1</td>
</tr>
<tr>
<td>North West</td>
<td>0</td>
</tr>
<tr>
<td>Limpopo</td>
<td>3</td>
</tr>
<tr>
<td>Free-State</td>
<td>0</td>
</tr>
<tr>
<td>Kwazulu-Natal</td>
<td>6</td>
</tr>
<tr>
<td>Western Cape</td>
<td>0</td>
</tr>
<tr>
<td>Eastern Cape</td>
<td>3</td>
</tr>
<tr>
<td>Northern Cape</td>
<td>0</td>
</tr>
</tbody>
</table>

Bergh (2005) stated that the meat inspection records for a high-throughput abattoir showed a low condemnation figure of 0.829% where condemnation was mainly due to bruising and poor slaughter techniques in the harvesting process. He is of the opinion that no condemnations as a result of animal and zoonotic diseases, was recorded but could have been eliminated in the veld with primary meat inspection and not recorded. However, for cattle, sheep and pork the
condemnation percentage is 2.205% due to pathogenic bacterial and other disease-related conditions that render such infected meat unsuitable for human consumption (SAMIC, 2009). In Table 2.2 the annual condemnation figures in percentages for domesticated species are shown.

### Table 2.2: Condemnation percentages of domesticated species

<table>
<thead>
<tr>
<th>Domesticated species</th>
<th>Whole carcass condemned</th>
<th>Condemnation of red offal (heart, kidney, liver and lung)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cattle</td>
<td>1.902 %</td>
<td>31 %</td>
</tr>
<tr>
<td>Pig</td>
<td>0.2016 %</td>
<td>11.7 %</td>
</tr>
<tr>
<td>Sheep</td>
<td>0.1017 %</td>
<td>78 %</td>
</tr>
</tbody>
</table>

#### 2.2.2 The current health and safety status of game meat in the rest of the world

Europeans consume large quantities of venison from fallow deer, red deer and roe deer. Hughes (2008) reported that the main source of wild game meat in Europe is animals shot as trophies with few regulatory requirements on the bacterial quality thereof. In Spain hunting is a major economic activity with an annual turnover of 240 million euros, hunters take 40 000 large game animals and 3 000 000 small game animals every year (Ruiz et al., 2006). Traditionally the hunter is entitled to the trophy (head and hide) and the owner to the meat. He in turn, sells the meat to a meat purveyor who provides it to restaurants and individual consumers. Game meat consumption in Germany amounts to 73.000 tons per year of which half is sold directly to consumers. According to Bandick and Hensel (2011) the following safety strategies were developed as precaution measures: 11% of all large game
hunted in Germany in 2007 was inspected, 114,000 hunters in Germany were trained and certified as “trained persons” and identification marks on each game carcass were made obligatory. They concluded that the increase of this awareness and knowledge has impacted positively on consumer safety. In Italy data from 2004 to 2008 indicated that diseases such as tuberculosis, pasteurellosis and trichinellosis have been detected in wild animals, but only sporadically. Alberto et al. (2011) reported that in 526 wild boars and red deer tested for tuberculosis 13.9% tested positive, but they emphasized that the animals were scattered throughout Central Portugal with an increasing exposure to humans.

Winkelmayer (2009) reported that in Austria the amount of total game carcass weight produced annually is 9 million kg. He furthermore reported that their current inspection system had undergone minor modifications to align with the EU hygiene requirements. This system however, depends on the way of marketing (self-supply, local trade, intra-community trade and export) and the presence of certain carcass abnormalities detected during ante- and post-mortem inspection or the suspicion of possible environmental pollution through the slaughter process. Austria has developed their own checks for hygiene that are applicable in the following scenarios:

- Shared cool rooms for game carcasses.
- Temporary premises for hunters supplying small quantities to the consumer and to local retailers, restaurants etc.
- Permanent premises for hunters supplying small quantities of game meat to the consumer and to local retailers, restaurants etc.
- Trained persons performing tests for disease control.

Namibia is well known for its quality game meat and products and South Africa as well as the European Union (EU) are importers of game meat from Namibia. According to Van Schalkwyk and Hoffman (2010), strict HACCP principles and Commission Regulation (EC) No 852 (based on the South African VPN) prescribe the hygiene control procedures to be followed before export of game meat from Namibia to the EU is approved.

In the United Kingdom venison is growing in popularity, but a difference in microbial hygiene exists between farmed deer (kept in parks) and deer in the wild in terms of the higher incidence of *E. coli* and Enterobacteriaceae. According to Richards *et al.* (2009), the uncontrolled environment of the processes of slaughter and evisceration are responsible for the higher readings in the case of wild deer.

A study conducted by Nagy *et al.* (2009) on factors other than bacteriology in the Slovak republic, indicated that the pH value, amount of lactic acid and ammonia content of muscle tissue post-mortem are negatively influenced by poor shot placements as well as high storage temperatures. According to them, a pH value below 6 indicates healthy animals and predicts better shelf life of the game meat.

According to Paulsen (2005) the observance of “Good Hygiene Practice” (GHP) with regard to different modes of game harvesting and processing, will play a decisive role in determining the microbiological safety of the meat. The shot placement, the time-temperature profile from wounding to evisceration and the technique of evisceration will influence the surface contamination of the carcass.
Furthermore, according to him, despite the multiple wounding and contamination of muscles, the adherences to GHP will allow the production of meat that is safe for human consumption.

2.3 THE ESTIMATED SUPPLY FROM GAME FARMS TO LOCAL MARKETS

It was recorded by the Professional Hunters Association of South Africa (PHASA) and the Department of Nature Conservation that for the 2009 hunting season, 62,843 trophy game animals were hunted in South Africa (Caroll, 2010). The meat from these animals was not suitable for export, but was sold on the local market. It is well known that during the hunting season fresh unapproved game meat is available at butcheries and some of the bigger retailers. Throughout the year game meat from uncontrolled origin is further processed to products such as biltong and ‘dry wors” and is made available at all the major retailers, outlets and biltong shops in South Africa (van der Merwe et al., 2011).

In all the Provinces game meat generated during the hunting season is utilized and consumed locally. This argument was further strengthened by a report by van der Merwe and Saayman (2008) that estimated the total economic impact of biltong and trophy hunting in the Northern Cape at R774 million in 2007. They furthermore reported that an income locally from biltong hunters (own consumption) totaled R3 million per year. Processing of this meat was in the past mainly performed on formal butchery premises, but recently an increasing number of private processors on uncertified premises are entering this niche market. Records obtained by the researcher from several butcheries in the Tshwane
Metropolitan Municipality’s jurisdiction relating to processed game meat, indicated that as much as 43,000 kilograms of game meat was processed for biltong hunters at a single butchery during the 2009 hunting season (unpublished data). It is a known fact that some of the meat is sometimes sold to the butchery owner as partial payment of the processing fee and consequently becomes commercially available. Products manufactured from a combination of red meat and game meat such as: “species wors” has gained popularity for the quality attributes that game meat is adding to the product as well as the improved taste.

2.3.1 The production on game farms

Today there is more wildlife in South Africa than at any time in the past 100 years (Bothma, 2002). Game farmers have contributed significantly to this recovery in numbers, with some 19,576 wild animals being sold live at 58 boma and catalogue auctions combined in 2002, and some 8,900 head of game being hunted in the Eastern Cape Province in 2001 alone (Bothma, 2005b; Flack, 2002b). Moreover, there is a considerable private trade in live animals. Reports by van Dyk (2009) on only four auctions that were held in May 2009 showed a turnover of more than R19 million for 16,170 animals sold live. According to Bothma (2009), the difference between numbers of wildlife in 2003 and the numbers in 2011 shows an increase of almost 40%. The game farmer is mainly responsible for the increase in game animals and consequently for the game meat available on the local market especially during the hunting season. Phase 1 of the farm to fork production line is the responsibility of the game rancher and this acknowledgement
motivated the request to the researcher to develop a practical guideline for game ranchers to render safe game meat to the local market.

2.3.2 The farm workers

The farm workers on a game farm are utilized in all the functions and duties to be performed on the farm. These people are multi-tasked and in the hunting season they assist with tracking of animals, slaughtering and general handling of the carcasses. In the off-season they maintain roads, repair fences and perform other farm labour (Bothma, 2009). However, since meat production in the past was not an objective, the farm workers are seldom trained in basic meat hygiene, personal hygiene or good meat handling practices. According to Sprenger (1999), personal hygiene of food handlers and in particular their hands plays a vital role in the contamination of raw meat. This unhygienic scenario could successfully be addressed on the game farm with courses offered to farm workers in basic meat hygiene training and skills development in terms of good slaughtering practices.

2.3.3 The role of the hunter

Professional hunters and outfitters are mainly interested in trophy hunters and align themselves with the hunter’s choice of weapon which could be heavy or light caliber rifles, bow and arrow or shotguns. The Professional Hunters Organisation of South Africa (PHASA) is the official mouthpiece for the professional hunters and organisers of hunting trips in South Africa and has expressed similar concerns as those of WRSA on the implementation of the Game Regulations that will prohibit trophy carcasses for commercial purposes. Globally, more than 80 % of all trophy
carcasses become the property of the professional hunter and are sold to private processors (Atanassova et al., 2008). In many European countries the function of game meat inspection is performed by the hunter and the meat then rendered to the local market (Winkelmayer, 2009). Marksmen on the other hand are employed for harvesting and culling for export purposes and are registered with State Veterinary services. According to the draft Game Regulations marksmen are allowed to harvest for commercial purposes, whereas the competent hunter (who has undergone training and has qualified as a competent hunter) may hunt for own consumption.

A pre-study conducted by the researcher at a private processing plant over a period of two years (2008-2009) involving a total mass of 22535.7 kg of game meat, showed that poor shot placements such as abdominal shots (hind quarter) resulted in an average meat loss of 16% per carcass (Table 2.3). For carcasses with front quarter shots only 6% meat loss was noted. Head shots (as required by the export market) resulted in no meat loss. The percentage of meat loss was calculated after the damaged and contaminated meat tissue was cut away, weighed and expressed in terms of the total carcass weight. The contamination was due to bone splinters and thoracic or stomach contents caused by the destructive path of the bullet through the carcass. It was found by Von La Chevallerie and Van Zyl (1971) that the effect of shooting can impact negatively on meat in terms of losses, as well as on meat quality.

Harvesting methods according to the draft Game Regulation prescribe rifle caliber (to lessen tissue damage) for boma harvesting, culling from vehicles at night or
during the day and for helicopter culling. The responsibility of ante-mortem inspection is stipulated in not only the Game Regulations and Veterinary Procedural Notices (VPN), but globally in all legislative procedures relating to hunting (Bandick & Hensel, 2011).

Table 2.3: The percentage meat loss due to shot placement for both category B and C animals (unpublished data)

<table>
<thead>
<tr>
<th>Number and species of game carcasses</th>
<th>Category/average weight</th>
<th>Shot placement</th>
<th>Average % meat loss</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Front quarter</td>
<td>Hind quarter</td>
</tr>
<tr>
<td>49 Blesbok</td>
<td>C/36.7kg</td>
<td>40</td>
<td>9</td>
</tr>
<tr>
<td>87 Kudu</td>
<td>B/112kg</td>
<td>60</td>
<td>27</td>
</tr>
<tr>
<td>112 Impala</td>
<td>C/32.6kg</td>
<td>92</td>
<td>20</td>
</tr>
<tr>
<td>12 Red hartebeest</td>
<td>B/85kg</td>
<td>11</td>
<td>1</td>
</tr>
<tr>
<td>42 Oryx</td>
<td>B/105kg</td>
<td>33</td>
<td>9</td>
</tr>
<tr>
<td>23 Springbok</td>
<td>C/29.4kg</td>
<td>18</td>
<td>5</td>
</tr>
<tr>
<td>12 Blue wildebeest</td>
<td>B/103kg</td>
<td>8</td>
<td>4</td>
</tr>
<tr>
<td>Total 337</td>
<td>22535.7kg</td>
<td>262</td>
<td>75</td>
</tr>
</tbody>
</table>

Although poor shot placements often result in the bullet becoming embedded in the carcass or muscle and are only removed from the carcass by the secondary processors, the risk of possible lead poisoning of the meat has proved to be insignificant. According to Haldimann et al. (2002) and Iqbal et al. (2009) there is no risk of lead intake by consumers in hunted animals. For this reason the specification of caliber size serves mainly to minimize the damage to the muscle tissue and possible contamination with thoracic or abdominal contents.

2.4 PROCESSORS AND RETAILERS
An investigation into the section of the supply chain of game meat from the farm to the secondary processors or final consumer was not included in this study. However, a pilot study that was conducted by the researcher indicated unacceptably high levels of microbiological growth with aerobic plate counts in excess of $10^7$ CFU/cm$^2$ on the surface of these uncontrolled game carcasses taken to processors and retailers. This could be ascribed to a variety of factors such as poor shot placements and bleeding practices, poor hygiene during slaughter, unapproved methods of transportation as well as the lack of sufficient cooling procedures (Citterio et al., 2011; Paulsen, 2005, Paulsen & Winkelmayer, 2004). The implementation of a practical game meat guide will address all these issues and will enhance the adherence to hygiene procedures further down the processing line to consumers (van der Merwe et al., 2009). Furthermore, the studies of Hoffman et al. (2003) indicated that the main complaint of local consumers against game meat is based on the activities (the process of hunting) on the farm. The present study focused on the production phase of game meat and the applicable legislation of the Department of Agriculture, Forestry and Fisheries. The secondary processing and retail selling of game meat to the consumer falls outside the scope of DAFF’s control, but within the scope of the Department of Health and specifically under Regulation R962; General hygiene of food premises and transportation of foodstuffs: under the Foodstuffs, Cosmetics and Disinfectant Act 54 of 1972. Officials of these Departments are currently discussing the alignment of game meat issues (Bekker et al., 2011).

2.5 MEAT SAFETY SCHEMES
The provision made in the Meat Safety Act 40 of 2000 for meat schemes stipulates as follows: “The Minister may by notice in the Government Gazette establish a scheme for the improvement of meat safety and safety of animal products. The Minister may establish different schemes in respect of different kinds of animals and different categories of persons. The Minister may make any scheme applicable to the whole of the Republic or to different areas of the Republic, or to a particular province or specified part thereof. A scheme may be established for:

- the enhancement of meat safety practices;
- the conducting of surveys; training in aspects of meat safety and safety of animal products;
- investigations into food-borne diseases;
- the promotion of hygiene practices;
- the determination of the origin of meat and animal products;
- the monitoring of residues on meat and animal products;
- the availability of and access to meat hygiene services;
- hygiene assessment services; or
- any other matter which is necessary or expedient to achieve and promote the objectives of this Act.

Furthermore, a scheme should:

- set out the objectives of the scheme;
- set out the kinds of animals and classes of persons to,
- and the areas in, which the scheme applies;
- determine the tests to which animals and the meat and animal products obtained therefrom must be subjected in order to determine
the extent of compliance with the objectives of the scheme and
describe the manner of interpreting these tests;
- describe the manner in which the animals must be treated, kept and
cared for;
- the manner in which meat and animal products may be disposed of
- determine the circumstances under which the participation lapses or
may be cancelled;
- specify the particulars to be recorded by persons enrolled in a
scheme;
- determine the facilities to be provided by a person participating in a
scheme for the purpose of the performance of the required tests;
- or for any other act necessary to promote the objectives of a
scheme; and
- determine which of the provisions of a scheme bind a person who is
enrolled for participation therein.

The Minister may, after consultation with the MEC of a province, by notice in the
Gazette declare that participation in a particular scheme is compulsory in the
province in question, or in a specified part thereof. A scheme in terms of which any
form of monetary assistance may be rendered to participants by the national
government may only be established with the approval of the Minister of Finance.

The Game Meat Scheme as introduced in this study was a combination of the
procedures as required in the MSA and the DGR. The GMS was developed to
guide the process of harvesting and slaughtering on the farm to assist the game
rancher to render safe game meat and game products to the local meat market.

2.6 THE GAME MEAT SCHEME

2.6.1 Introduction

Traditionally game meat was a dry processed product, secondary to the hunt and not part of the local fresh meat market and consequently not included in any food legislation. However, this scenario has changed in the last decade, partly because of the health attributes of game meat and the global demand for the “African taste experience” (Hoffman, 2003). As a result the fresh game meat market has increased tenfold and has led to the current vast numbers of game meat entrepreneurs in the market. However, they are currently operating in uncontrolled fashion in the market and with unknown health status. This has highlighted the need for a game meat scheme as proposed. Although game meat examiners (to inspect and approve game meat) have been trained through the Tshwane University of Technology over the past six years, this route has always been restrictive due to the high cost of the course and the fact that very few of these examiners have in actual fact entered into the market (Bergh, 2005).

The game industry, for the non-export market, in South Africa has not been subjected to the same level of meat safety legislative control as for instance the Red Meat Industry. Game animals are identified as being included under the jurisdiction of the Meat Safety Act 40 of 2000 and as such have been controlled by Meat Safety legislation only since 2000. In addition it was stated by Bergh (2005)
that the game industry has never been legislated for meat safety before the year 2000 and that the draft Regulations which, due to legislative problems, have not been promulgated yet, were introduced to the industry as such and prompted their leaders to enter into negotiations with DAFF to establish a scheme under the Meat Safety Act. Bergh (2005) also stated that the aim of these negotiations was to facilitate a program of training of the rural and low throughput sectors of the industry toward compliance with legislation and safety standards. For the local market logistical problems are evident in providing meat safety services to a fast expanding farm-based game meat producing industry. This was one of the concerns that prompted the negotiation process. Game meat, especially trophy meat, according to him has for the past few years been “dumped” on the market with little or no safety or quality procedures and taking into account that dangerous zoonotic diseases have sporadically established themselves in game, this is a serious concern for DAFF. Bergh (2005) furthermore emphasized that it will be only with the co-operation of the game meat industry that a proper infrastructure for registered non-export game abattoirs will be achieved.

2.6.2 Development of the scheme

Wildlife Ranching South Africa (WRSA) is a Section 21 company and registered as such. The company came into existence more than 30 years ago and was initially operated as separate provincial offices that amalgamated in 2000 into a national company with a head office in Pretoria. WRSA is regarded by the game industry as the official mouthpiece for game ranchers in South Africa. WRSA’s code of conduct stipulate the following on meat safety and the meat scheme and
emphasizes the intention of the game industry on game meat production: “Given the importance of meat production with specific reference to game meat intended for local commercial purposes the rancher will assertively promote and implement the Memorandum of Understanding (MoU) between WRSA and the Department of Agriculture, Forestry and Fisheries over the next 5 years” (see Addendum B).

The researcher, as a co-opted member of the executive committee, was requested by WRSA to represent the organisation and enter into negotiations with DAFF on the implications of the draft Game Regulations to all game ranchers in South Africa. WRSA was of the opinion that the draft Game Regulations has unaffordable financial and other dysfunctional implications for the game rancher and therefore, objected to the development process of the draft Game Regulations that did not include representatives from WRSA. Small role players and entrepreneurs would furthermore, not be able to comply with the draft Game Regulations and register their operations and could then be forced into illegal operations. In Table 2.4 a comparison is made between the Draft Game Regulations and the envisaged Game Meat Scheme, to highlight the differences in terms of their legal compliance.

Table 2.4: Comparisons of Draft Game Regulations and the Game Meat Scheme

<table>
<thead>
<tr>
<th>DRAFT GAME REGULATIONS</th>
<th>GAME MEAT SCHEME</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not yet published for public comments</td>
<td>Published for public comments</td>
</tr>
<tr>
<td>Not acceptable to *WRSA, *PHASA,</td>
<td>Acceptable to *WRSA, *PHASA</td>
</tr>
<tr>
<td>Abattoir approved as rural, Low/ High throughput, registered</td>
<td>Slaughter facility approved and registered under the Scheme.</td>
</tr>
<tr>
<td>under the Act</td>
<td>Game Meat Examiner 6 months training.</td>
</tr>
<tr>
<td>Game Meat Inspector 3 year training.</td>
<td>Certificate qualification</td>
</tr>
<tr>
<td>Diploma qualification</td>
<td>Units according to facilities (20 units with harvesting team)</td>
</tr>
<tr>
<td>Rural abattoir 2 units, low throughput 20 units</td>
<td>Head shots preferred but thoracic and</td>
</tr>
<tr>
<td>Only head shots approved, thoracic and</td>
<td></td>
</tr>
</tbody>
</table>

abdominal shots detained for secondary inspection
Administration and enforcing done by DAFF
Audits on *HMS by DAFF
Must comply with all requirements before registration.
Game meat approved for the export market according to VPN
No trophy carcasses allowed
Independent game meat inspector
Bleeding within 10 minutes by throat slitting
Evisceration within 2 hours
Carcasses <7°C within 24 hours after chilling commences
Regulation only amended by DAFF.

abdominal approved at - discretion of meat examiner
Administration by WRSA and joint enforcing by WRSA and DAFF
Audits on *HMS by DAFF
Registration with 5 years granted to comply.
Game meat approved for local market under the Scheme
Trophy carcasses allowed – approval
Provincial Executive Officer (*PEO)
Dependent game meat examiner
Time and method of bleeding - pending approval by PEO
Evisceration before bloating (approval by PEO)
Carcasses <7°C within 24 hours after chilling commences
Game Meat Scheme to be revised after 5 years by DAFF.

*WRSA- Wildlife Ranching South Africa. *PHASA- Professional Hunters Association of South Africa. PEO- Provincial Executive Officer at DAFF. *HMS- Hygiene Management System

Consequently a letter drafted by the researcher on behalf of WRSA was send to DAFF requesting a meeting with the Director: Veterinary Public Health. A second letter was sent to the latter official, requesting the establishment of a Meat Safety Scheme (see Addenda B and C).

WRSA offered full participation in the negotiation process to establish sound norms and standards for the game meat industry and also agreed that safe game meat is a priority. All the negotiations and agreements would benefit and assist the game rancher to develop this market without compromising game meat safety. The aim of the Meat Scheme is explained in three phases: firstly, to share ownership and regulation with DAFF on the tons of uncontrolled game meat currently on the local meat market as well as the possible health hazards associated with human consumption. Secondly, to ensure the sustainable supply
chain of safe game meat, all year round and not only in the hunting season, to an increasing local population. Thirdly, to stimulate training and career opportunities for game farm workers by focusing on meat hygiene and good slaughtering practices.

The following proposals were made over a two year negotiation process by WRSA and were accepted by DAFF after extended deliberations and changes (Bergh, 2005):

- With approval of the Minister of Agriculture, Forestry and Fisheries a five year phasing in scheme for compliance to the Regulations.
- Compulsory hygiene training on a basic level for all farm workers that handle the game meat.
- When the hunter/owner/farmer has completed the meat examiner’s training and has obtained the qualification, he may conduct the carcass inspection for approval.
- Rural game abattoirs to be registered although they do not necessarily comply (with the Draft Game Regulations), but follow a program of upgrading under supervision of the Provincial Executive Officer (PEO).
- This Game Meat Scheme will not be applicable for export purposes.
- WRSA will develop and implement a logo and brand name for SA game meat. All members of WRSA will receive a stamp to identify their carcasses after complying with the requirements.
- Further processing i.e. making of biltong does not fall under the jurisdiction of the Department of Agriculture, Forestry and Fisheries,
but the Department of Health and will be negotiated with them by WRSA. It must further be emphasized that the scope for this study includes only the processes on the game ranch from obtaining the carcass to meat inspection and excludes transportation from the ranch and further processing other than quartering of a carcass.

- Training of key personnel and resident hunters to qualify as game meat examiners in order to perform preliminary meat inspection at harvesting on game farms. This concept is also prescribed by FAO, Codex Alimentarius and EU legislation.

- Exemption from the provision of the Act that meat inspection should be independent of the abattoir for the duration of the Scheme in cases of rural game abattoirs on farms where preliminary as well as final meat inspection is done on dressed carcasses.

WRSA consequently requested that the Minister consider above-mentioned suggestions as the basis for establishing a meat safety scheme under section 12 of the Meat Safety Act 40 of 2000, to create a stable and legal structure in which game ranchers could improve standards to comply with legislation over a period of five years. WRSA concluded that the following advantages of a scheme with the above objectives will be (Dry, 2012):

- That Provincial Executive Officers will gain the confidence of role players in the game industry.

- By registering existing structures and then accommodating and assisting game abattoirs to comply, provinces will avoid illegal and uncontrolled operation of these facilities.
• Meat hygiene training of all meat handlers is an empowering step in providing safe meat obtained from a hygienically managed slaughter process.

• Addressing the literacy of farm workers and presenting more career opportunities for them, will be a direct result after the approval of the proposed scheme.

• Young and upcoming game farmers will be offered an opportunity in the local meat market.

The Game Industry proposes to implement a logo to be used by game farmers that participate in the scheme. This will ultimately give consumers the choice of a safer controlled product; improve consumer confidence in South African game meat and boost the marketing of game meat.

2.6.3 Administrative processes followed

Subsequent to the negotiation process, a requirement was entered that rural abattoirs should be compelled to submit, together with their abattoir application form, an environmental health impact study. Therefore, a second letter was sent to the Department of Environmental Affairs and Tourism to request the exemption of only rural game abattoirs from environmental health impact studies as well as rezoning applications. WRSA was of the opinion that the daily units slaughtered at rural game abattoirs do not justify such a study when the game abattoir process is a “dry” process in contrast with “wet” process in the red meat abattoir.

WRSA and DAFF representation in the negotiation process were as follows:
Mr. Coert Steynberg represented Wildlife Ranching S.A.; Ms. M. van der Merwe represented Tshwane Municipality Health Department as well as being an advisor for WRSA and Mr. J. Odendaal representing the Professional Hunters Association of South Africa (PHASA) attended the last meeting. The following provincial veterinary public health representatives from the Western Cape Province attended the first meeting – Dr. H. Nel, Dr. K Kloppers, Mr. Z. Le Roux, while DAFF (Pretoria) representatives were – Dr. S. Meyer, Dr. J. van Wyk, Dr. J. Panne-Reeves, Dr. C. Gilfillan and Mr. J. C. du Preez (Secretary). Meetings were chaired by Dr. T. Bergh (Deputy Director: Veterinary Public Health DAFF).

In conclusion the draft Game Meat Scheme was accepted by DAFF in principle as the proposed measures may curb the current problems with game meat. The decision was made that the proposals will be sent to the Director, Veterinary Services, DAFF National Department of Agriculture, Forestry and Fisheries to the Minister. The measures will first have to be agreed upon by the Minister before it can be published for public comment. DAFF concluded that it will in fact be implemented because the control through the government structures currently is virtually impossible due to a lack of trained and experienced personnel. This statement was confirmed by Bekker et al. (2011).

The Department Legal Services at DAFF was requested to examine the proposals and to prepare the necessary documentation for further submission to the Minister. It was anticipated that the Game Industry could approach the Minister directly in this regard, and it was suggested that the Minister’s office be notified of the
proposal in preparation of such meeting (see Addendum C for the Game Meat Scheme).

2.7 STANDARDS APPLICABLE TO GAME MEAT FOR EXPORT

Veterinary Procedural Notices (VPN) were developed for the export market as previously mentioned and could be described as the most stringent of all the legislation since it is based on European standards and management principles such as Hazard Analyses Critical Control Point (HACCP), ISO 9000 and 14000. The VPN currently in use are inter alia listed as follows: VPN/05/2008-09 Standard for the registration or re-registration of a game farm for export purposes, VPN/08/2008-09 Standard for the registration of hunters for harvesting wild game intended for export of game meat, VPN/09/2008-09 Standard for the ante-mortem meat inspection and hygiene at the point of harvest, VPN/10/2008-09 Standard for post-mortem meat inspection and hygiene control at game meat establishments and VPN/15/2008-09 Standard for the microbiological monitoring of meat. The abovementioned VPN in combination with the draft Game Regulation as the guideline for the export market will be further discussed in Chapter 6.

2.8 GAME MEAT QUALITY AND HYGIENE

2.8.1 Microbiological factors

Game meat does not differ from red meat in terms of possible contamination of the meat during slaughter. Bacteria from the hide, the gut, the processing environment or humans involved in the slaughter process may contaminate the surface of the
meat (Wiklund, 2009). This study aims to provide some insight into the present possible over-regulatory legislation for the local game meat market in South Africa. Therefore, the bacterial and physical quality standards as prescribed by the VPN and required by the export market were used in this study as “control” measures to compare with the existing situation in the local market and to determine what possible risks there might be to human health due to the consumption of meat from unregulated game carcasses. This study will include all game carcasses whether hunted for trophy, biltong or harvesting purposes. It will also include all other game carcasses that are absorbed by the local market, but will exclude carcasses intended for the export market.

The bacterial standards that will be used in this study are prescribed by countries worldwide. The standards specifically apply to South Africa in terms of the requirements of the European Union (EU) countries that import game meat from South Africa. These bacterial standards include requirements for the following analyses namely: Aerobic Plate Count (APC); a count for Escherichia coli (E. coli); Staphylococcus aureus (S. aureus) and Salmonella. Furthermore, according to Bandick and Hensel (2011), zoonotic agents considered in relation to human infections after consumption of game meat are E. coli, Salmonella and S. aureus in the wild game population. The EU also requires that, elements of safety strategies in handling game should include; efficient surveillance of meat hygiene during the process of hunting, education of hunters, relevant hygienic measures and control of zoonotic pathogens, traceability of products by means of documentation and well-equipped facilities. Citterio et al. (2011) reported that training of all the role players in the process of hunting is essential for meat
hygiene. This applies especially to the hunter as the primary person in the process of obtaining a carcass.

According to Paulsen (2005), there is a variety of ways by which game is harvested from industrial to domestic scale. This applies even to the small scale traditional hunting techniques in Central Europe, where the mode of production is not well standardised and the quality of the final product is sometimes not really predictable. This wide variety in hunting techniques can obviously influence the composition and magnitude of microbial contamination:

2.8.1.1 Aerobic Plate Count (APC)

The Aerobic Plate Count (APC) is used globally and in all meat related industries as an indicator of the level of contamination and when high counts are obtained, it acts as a pre-warning of the potential presence of pathogens (Timmreck, 1994; Todar, 2008; Todd, 2004). The APC is furthermore used as a quality control mechanism by the game export market as it provides information with regard to the hygienic status of the slaughter process and the hygienic quality of the meat (Bergh, 2005).

In South Africa no registered bacteriological standards for raw meat (including all species defined in the Meat Safety Act) are available. The only available guideline for the bacterial and pathogenic count on raw beef, lamb and pork meat is a standard developed by the retailer Pick and Pay. This guideline has since been adopted and used by laboratories as well as quality auditing authorities in the meat
industry in SA (Andrin, 2008). Although their proposed APC standard for fresh meat from domesticated animals was $<10^5$ CFU/g they have decided after continuous non-adherence to rather use $<10^6$ CFU/g as a standard for fresh meat. However, the VPN standard for export purposes is much less lenient at $\leq10^4$ CFU/g (South Africa, 2010d). Low counts of APC reflect good slaughtering techniques and high standards of general hygiene. This includes the slaughtering facility and the personal hygiene of the workers, a prolonged meat shelf life and ultimately the safety of the meat for human consumption in terms of bacterial contamination (Sprenger, 1999; Thornton & Gracey, 1974; Todd, 2004).

2.8.1.2 *Escherichia coli*

The WHO (2005) warned that *Escherichia coli* (*E. coli*) is an organism that is commonly found in the gut of humans and animals but that certain strains can cause severe food borne diseases. These strains can be transmitted to humans primarily through the consumption of contaminated foods, such as raw and undercooked meat. High counts of *E. coli* therefore, are indicative of faecal contamination and when faecal contamination is visually present on game carcasses it needs to be trimmed off (Bergh, 2007). *E. coli* is an important member of the Enterobacteriaceae family. These organisms are facultative anaerobic Gram-negative rods that often reside in the intestinal tracts of humans and animals and many of the members of this family are either outright pathogens or can be opportunistic pathogens (Frazier & Westhoff, 1988). The infective dose for pathogenic *E. coli* strains (depending on the strain) is $>10^5$ and the organisms are killed by temperatures above 60 °C and inhibited by temperatures below 7 °C.
(Dunn et al., 2004). Although the South African standard for fresh red meat for *E. coli* is $<10^3$ CFU/g, a much more stringent standard is required by the export market and is stipulated in the VPN to be $\leq 10^2$ CFU/g. This standard is currently in revision and in the process of being changed to the South African standard. *E. coli* tests are an EU requirement for the export market and were supported by Bartels and Bülte (2009) as a requirement for game meat. More than 700 serotypes of *E. coli* have been identified and it is important to know that most strains of *E. coli* do not cause disease in humans, being commensals in the gastro-intestinal tract of humans and other mammals (Membre et al., 2011; Newton, 1997). For the purpose of this study the *E. coli* serotypes that are responsible for the numerous reports of contaminated foods are (among others) those that produce Shiga toxin (Stx) (so called because the toxin is almost identical to that produced by *Shigella dysenteriae* type 1 that also causes bloody diarrhoea and the hemolytic uremic syndrome) were focused on.

These bacteria can survive for several weeks on dry surfaces and in a moist environment for up to a year. (Sargeant et al., 1999; Weiser et al., 1970). Brock and Brock (1973) furthermore warned that less than 50 bacterial cells are needed to cause infection when present in food. According to Sargeant et al. (1999), the *E. coli* serotype 0157:H7 is the most well-known of all the virulent strains and responsible for the majority of food borne infections. It is of interest to note that the Washington State Department of Health (WHO, 2005) recommended that to prevent infection with *E. coli*, beef should be cooked to 71 °C, but venison to 74 °C. Common belief is that game meat could host *E. coli* based on the possibility
of faecal contamination usually when the rumen and intestines are ruptured during slaughtering but sometimes as a result of an abdominal shot.

2.8.1.3  *Salmonella*

*Salmonella* is a Gram negative rod-shaped non-sporeforming member of the Enterobacteriaceae. It is a facultative anaerobe that is closely related to *E. coli* and is found in the intestinal tract of warm and cold blooded animals, humans and birds. *Salmonella* is used by the export market to determine the bacterial contamination of the game meat by specific pathogens (Bergh, 2007).

It is however, important to note that *Salmonella* in the literature is more often associated with poultry and swine (Doyle, 2002; Nagy *et al*., 2011) and in 2001 the United States proposed an end to the testing for *Salmonella* due to the lack of positive results in the beef industry. Strengthening this argument was a study conducted by Fegan *et al.* (2004), in which beef cattle did not appear to be a source of entry of *Salmonella* into the human food chain. However, Citterio *et al.* (2009) studied wildlife diseases in Italy and during the study *Salmonella* was isolated from wild boars, occasionally from roe deer, red deer, fox and from birds. A similar study by these authors, reported no *Salmonella* isolated from the 90 muscle samples they tested from wild ungulate species. To conclude with the EU’s sentiment on testing for *Salmonella*, this study honoured their status as the decision makers for the export market (by accepting their requirements as the presiding standard).
Salmonella is usually transmitted to humans by eating meat contaminated with animal faecal discharge. It can be associated with raw meat, but meat and other products (also cooked meat) may become infected via the hands of food handlers who do not wash their hands with soap after using the bathroom (Thornton & Gracey, 1974). According to Ryan and Ray (2004), Salmonella is resistant to drying (they have been found in dried excrement for up to two and a half years) and is not destroyed by freezing, but can be eliminated by heat treatment at 75°C for 10 minutes. The infective dose for Salmonella is 15-20 CFU/g. The most widely used standard for Salmonella is absent in 25 g and the same standard is used by the export market for meat from South Africa (South Africa, 2010d).

2.8.1.4 Staphylococcus aureus

Staphylococcus aureus is a Gram-positive spherical organism (coccus). Staphylococci exist in air, dust, and sewage, food, on food equipment, and on humans and animals (Weiser et al., 1970). Staphylococci are present in the nasal passages and throats and on the hair and skin of 50% or more of healthy individuals. This incidence is even higher for those who associate with or who come into contact with sick humans or animals (Mossel, 1978; Shapton & Shapton, 1993). Although food handlers are usually the main source of food contamination, equipment and surfaces can also be sources of contamination with S. aureus (Sprenger, 1999). Cell numbers in the food needed for producing sufficient enterotoxin to result in staphylococcal food poisoning is in excess of $10^5$ CFU/g. Foods that are usually incriminated in staphylococcal food poisoning include meat and meat products and human intoxication is caused by ingesting
enterotoxins produced by *S. aureus* usually because the meat has not been kept cold enough (<7.2 °C) or hot enough (>60 °C) (Thornton, 1981). *S. aureus* produces a highly heat-stable protein toxin that causes illness in humans (Vorster *et al.*, 1991). Hoffman and Dicks (2009) reported that game meat is resistant to *S. aureus* and that game meat possesses an inherent antimicrobial activity toward the growth of this organism. The Pick and Pay (PnP) standard for *S. aureus* in fresh red meat of <10^3 CFU/g is in contrast with the more stringent standard prescribed by the export market (VPN) namely < 10^2 CFU/g.

### 2.8.2 Physical factors

Physical factors that will have an influence on the bacteriological and physical quality of the game meat are stipulated in the MSA and will be used in the study as benchmarks to determine their importance in evaluating the bacterial differences between the carcasses for export and carcasses intended for the local market. These include *inter alia*, factors such as refrigeration, structural requirements of the slaughtering facility and periods of time allowed for slaughtering procedures (South Africa, 2000).

The maintenance of the cold chain (WHO, 2006), the environment (veld type) and the time periods between slaughtering procedures (for example between the shot and bleeding procedure or between bleeding and the evisceration procedure) according to the MSA and VPN will play a role in the acceptability of the game meat in the commercial local market (Smulders, 2009). It was stated by Richards *et al.* (2009) that the slaughter and evisceration of game within a specialised
environment enables a level of control to be exerted on factors that influence product hygiene. The carcass physical quality for this study was determined inter alia by measuring the carcass temperature, the hydrogen-ion concentration in the meat, the shot placement, the ambient temperature during the hunt, the veld type (bushy or open), the transportation of the carcass after the hunt, the bleeding of the carcass, the place of evisceration (veld or slaughter facility), the evisceration position (hung or flat), the time period from bleeding to evisceration and the position when skinned (hung or flat). These factors will be further discussed in Chapters 4, 5 and 6.

2.8.3 Carcass temperatures

It was stated by Richards et al. (2009), that maintaining and preventing delays in the cold chain are the major factors in producing venison of good microbiological quality and with a low risk of bacterial pathogens. Winkelmayer (2009) commented that self-control and own-checks of hygiene are crucial and should be implemented at all the steps of the hunting process. He highlighted three areas of importance namely; temporary premises for hunters supplying to the local market, permanent premises for hunters supplying to the local market and the cooling facilities needed for game carcasses. Buchanan et al. (1992) concluded that the aerobic plate count determined after storage of game carcasses at temperatures of 7-14 °C was much higher than when the carcasses were stored at the correct storage temperature of 0-4 °C in cold rooms.
The VPN requires the ultimate carcass temperature \((T_u)\) to be below 7 °C within 12 hours. No requirement can be set for the initial carcass temperature \((T_1)\) (± 38 °C) since factors such as wind chilling and evaporation will decrease this temperature reading. However, for the purpose of this study the \(T_1\) was taken during this research study to provide the same starting point for both the export and the “local” carcasses.

2.8.4 **Carcass hydrogen-ion concentration (pH)**

After death, anaerobic glycolysis takes place in non-stressed muscle tissues and stored glycogen is converted to pyruvate, which is then reduced to lactic acid resulting in a fall in pH, ultimately to a value of 5.6 - 5.7 (Wiklund et al., 1996). Wariss (2000), has calculated that a decline in pH from 7.0 to 5.5 (ultimate pH) requires the formation of 60 to 80 mg of lactic acid per kg muscle tissue depending on the muscle tissue and the animal species. This has an important impact on the survival of the foot and mouth disease virus (FMDV) because the virus is inactivated by acid conditions (Fletcher, 2004). Therefore pH has an extremely important influence on food safety (van der Merwe, 2005).

Furthermore, the accompanying depletion of ATP is responsible for rigor mortis (stiffening of the muscle) which normally takes 6 – 12 hours for beef muscle. Glycogen can be depleted by several pre-slaughter stress conditions including: stringent activity, fasting, hot and cold temperatures and fear (Wiklund et al., 2001), resulting in reduced muscle tissue acidification and improved survival conditions for FMDV. Good transportation conditions and proper handling and
animal welfare practices are crucial to obtain an ultimate pH value of 5.8 or lower after ageing or maturation of the carcass (O’Halloran et al., 1997). The glycogen content of muscle tissue is approximately 1% and this will generate the production of 1.0 to 1.1% lactic acid. For each 1% lactic acid formed, the pH will be lowered by approximately 1.8 pH units (Barlow et al., 1994). Nevertheless, according to Wiklund et al. (1995) both the rate of pH fall and the ultimate pH achieved are influenced by factors such as:

- species;
- type of muscle in an animal;
- genetic variability between animals;
- administration of drugs which affect metabolism;
- environment prior to slaughter (feeding, stress, etc);
- post-mortem temperature (increased temperature increases rate of pH decline); and
- electrical stimulation of excised muscle increases rate of pH decline.

The flavour and toughness as well as the shelf-life of meat are determined by its lactic acid content (pH) (Nagy et al., 2011). According to Smulders (2009) the ideal pH for game meat is 5.4 to 5.8. In addition, Wiklund (2009) found that meat pH is related to shelf-life, tenderness, colour and water holding properties, and is therefore a good indicator of meat quality. According to him pH values of 5.5 – 5.7 are within the normal range, while values exceeding 5.8 will result in reduced shelf-life and tough meat. If the glycogen stores in the muscle are low, meat pH will be elevated. Low muscle glycogen stores might result from poor physical condition, intense physical activity or stress during pre-slaughter handling (Wiklund
et al., 1996). The difference between the meat pH 1 hour and 72 hours post-mortem is directly correlated with the levels of glycogen (available muscle energy) at the time of slaughter. However, it has been established by Lana et al. (1998) that the pH of a carcass measured 24-72 hour post-mortem will be the lowest and will be a stabilized reading. The pH is used as a quality standard at the 72 hour post-mortem time frame at the export abattoir and was used in this study to determine the stress level of the animals as well as predicting the shelf-life and meat quality.

In conclusion, this literature review has attempted to demonstrate that there is a need for a practical game meat guide for the game farm owner/management. Furthermore, the examples in section 2.3 of this review of the vast amounts of unapproved game meat available on the South African meat market highlight the much needed practical control measures to ensure safe game meat in the local market.

The next four research chapters will focus on the development of bacteriological and physical parameters that were used in comparative studies to determine the hygiene and safety levels of local game meat and will be analysed by comparative statistical analyses. In Chapters 5 and 6; the implementation of game meat hygiene knowledge on a game farm, was applied in the development of a practical guide for game farmers in South Africa to ensure the provision of safe game meat to the local market.
CHAPTER 3

A RESEARCH NOTE ON THE TWO SAMPLING TECHNIQUES USED FOR BACTERIOLOGICAL SAMPLING OF GAME MEAT

3.1 INTRODUCTION

The Meat Safety Act 40 of 2000 stipulates that: “No person may export any meat from the Republic unless the essential National Standards in respect of the slaughtering of animals and the handling of meat, and such additional requirements as may be determined by the National Executive Officer have been complied with” (South Africa, 2000). The VPN are those essential standards in respect of exportation of meat from South Africa. The VPN/15/-2010-01 is the standard for the microbiological monitoring of meat with which exported meat must comply with. This VPN makes provision for the microbiological status of meat to be used as an indicator of the adequacy of process interventions and process hygiene. According to the VPN (South Africa, 2010d), the results of microbiological testing must be plotted on graphs on an annual basis. These results must be compared with the results of microbiological tests of the water supply and the equipment in the abattoir. An overall picture of the microbiological status of the establishment and its products must always be available. The VPN furthermore states that these monitoring programs are only as valid as the competency and reliability of the laboratory performing the analyses (South Africa, 2010d). A Laboratory Approval Programme was designed to provide a credible, independent system to ensure that laboratories are competent to carry out tests

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required to verify production hygiene (Andrin, 2008). All laboratories performing microbiological analyses for establishments approved to export fresh meat from the Republic of South Africa must take part in the Laboratory Approval Programme. The Laboratory Approval Programme is managed by the Agricultural Research Council (ARC)-Onderstepoort Veterinary Institute, on behalf of the Directorate Veterinary Services. The management of the establishment approved to export must coordinate with the management of the laboratory performing their microbiological testing and arrange for regular inspections, as well as training in relation to this standard. The strategy encompasses all aspects of a microbiological monitoring programme, including the development of standardised sampling plans, sampling and transportation procedures and analytical methods and the verification of laboratory proficiency. The present investigation has focused on determining the equivalence of two approved microbiological sampling techniques, one of which is used for carcasses intended for the export market (measuring CFU/g of excision samples) and a second technique (measuring CFU/cm² of standardised swab samples) to be used for the evaluation of the microbiological quality of game carcasses intended for the local market. The objectives of the investigation were:

- To determine how equivalent the two sampling techniques are in terms of the bacterial counts obtained;
- To establish a comparable unit standard; and
- To ensure that the data obtained with the two techniques would not erroneously be regarded as equivalent when used for comparative purposes.
3.2 MATERIALS AND METHODS

3.2.1 Comparative study of the two sampling techniques on game meat carcasses

A comparative study was conducted to verify the results of the excision-versus the swabbing technique for the sampling of game carcasses. A total of 13 category B carcasses were sampled using the two methods on each carcass and the samples were submitted to the same laboratories for analysis. The excision and swabbing sampling methods were done in adherence to the VPN that prescribes *inter alia* the following: good quality insulated cooler containers (polystyrene or similar) must be used and samples must reach the laboratory prior to possible temperature rises above 2 °C. Stomacher sample bags (80 ml or 400 ml) or other sterile plastic bags must be used. After the plastic bags with the samples are properly marked and folded several times to seal them properly, they must be further secured in a tightly folded position using elastic bands. The following data of the samples were recorded: the exact time (hour of the day and minute) of sampling; the date of sampling; the farm of origin; and the temperature at the time of sampling and the nature of the product sampled. Environmental conditions (i.e. any condition that could have had an impact on the result of the sample) were also recorded. The collection of the samples was done with all the necessary aseptic precautions and the samples were kept on ice until delivery to the laboratory. The temperature of the sample on arrival and the time of arrival were recorded. The samples were transported to the laboratory at temperatures less than 7 °C, but not at less than 0°C (Zweifel *et al*., 2005).
The sample mass was noted in order to report the microbial count as the number of colony forming units (CFU) per gram. Most of the bacteria on or in the product are actively bonded to the tissues and therefore maceration in a Stomacher (a total destruction technique) was used to separate the bacterial cells from the meat tissue. Serial decimal dilutions were made up to a $10^{-4}$ dilution in buffered peptone water (BPW) plated out on the respective media and incubated before counting the colonies and computing the bacterial counts.

For the purpose of this study the exact same protocol as with the export carcasses was followed and applied to the randomly selected game carcasses. All samples were then transported to the SANAS accredited laboratory in Polokwane (Limpopo Province) for testing. The two methods are explained in more detail as follows:

3.2.1.1 The excision sampling technique

The excision apparatus (cork borer) had an inner diameter of 25 mm and a surface area of 5 cm$^2$. This qualified the apparatus as a standardised sampling tool. Furthermore, a jar with a wide mouth containing 70% ethanol in which the excision “heads” (or plug borer tips) were immersed was available during sampling. A scalpel with disposable blades were used to separate disks of meat excised by the cork borer and the blade was sterilized between different sets of samples by immersing in 70 % ethanol (South Africa, 2010d). Samples from carcasses hunted for the local market were collected by means of the excision method within 30 minutes after skinning in the slaughter facility on the farm. For the aerobic plate count and counts of the indicator organisms (S. aureus and E.
coli respectively), samples of 25 g per carcass were excised from primal cuts on
the outer surface of the hind leg of the 13 randomly selected carcasses. The
sample was added to 250 ml of 0.1 % sterile peptone water Oxoid (CM0009) (1:10
dilution) and macerated in a Stomacher.

3.2.1.2 The cattle and swine Bio-trace swabbing technique

The surface sampling for the carcasses intended for the local market n=13
(inclusive of trophy and biltong carcasses) was done in accordance with the
method as prescribed by the United States Food and Drug Agency using the Bio-
trace cattle/swine sampling equipment (Food and Agriculture Organization of the
United Nations and World Health Organization, 1997). Sampling was conducted
on a surface area of 200 cm², on the external surface of the carcass prior to
cooling. The surface swabbing of the carcasses was done in the slaughter facility
or abattoir on the farm after the carcass was eviscerated and dressed. The
Enviro-biotrace cattle and swine test kit consists of sterilized templates, gloves;
resealable sachets with a 1.5 x 3 cm² biocide free, dry sponge and glass bottles
containing 25 ml buffered peptone solution. The sponges were hydrated by adding
10 ml of buffered peptone water to the pouch. For convenience the sponge was
moved to the top of the sample pouch by shaking the pouch in a downward
motion. By squeezing the bag behind the sponge, the sponge was then pushed up
until it just protruded through the opening in the pouch. The sponges are durable,
withstand scrubbing, are biocide free to maintain organism viability, have a long
shelf-life and are gamma-irradiated to guarantee sterility. The sponges were, after
swabbing, placed into the 532 ml leak free plastic pouch and the remaining 15 ml
of the buffer was added. The top of the pouch was folded down and the wire tabs were used to secure the pouch before placing in the cooler. The sample was identified using a waterproof marker pen to write on the allocated space on the pouch. For the purpose of this report the same 13 carcasses, that had been subjected to the excision method, were sampled with this technique and the samples were transported to the laboratory in Polokwane (see further laboratory details in Chapter 4). In Figure 3.1 the sterilized pouch with the sponge, the template to standardize the sampling surface on each of the 4 quadrants of the carcass, the buffered peptone water diluent (0.1 % according to ISO 6887) (SANS, 1999b) and the sterilized gloves for aseptic sampling are shown.

![Image of sampling equipment](image.png)

Figure 3.1: The sampling equipment for the Bio-trace cattle and swine test
The sterile glove was then aseptically removed from its holder and put on with care. Using the sterile gloved hand, the sponge was removed from the pouch. The inside of the bag was not touched to prevent contamination. The sponge was aseptically soaked in the peptone solution and using the template (10 x 20 cm = 200 cm² area), on each of the areas on the 4 quadrants of the carcass (the shoulders and the outside surface of the hind legs) was firmly swabbed. The repetitive and abrasive swabbing technique ensured that most if not all bacteria on the surface was removed onto the sponge. The collection of the swab samples was done using all the necessary aseptic precautions and samples were kept on ice until delivered to the laboratory. The analyses of the samples were carried out within 12 hours of the samples being taken to ensure that the pathogens would not die off before testing. In the laboratory report the microbial count was indicated as the number of colony forming units per 1 cm². In Figure 3.2 the swabbing of the carcass surface is demonstrated.

Figure 3.2: The Bio-trace swabbing method demonstrated
According to Brodsky (1995) and Brown et al. (2000) the surface sampling technique is generally preferred to the excision method because the sampling surface is statistically more realistic and target organisms are more effectively recovered. This investigation focused on the aerobic plate count and counts of *E. coli*, *S. aureus* and *Salmonella* spp. as index and indicator organisms and the analytical methods used for samples from both the excision and swabbing sampling technique are discussed below.

**i) Aerobic Plate Count (APC)**

This method was performed according to the International Standard ISO 4833: 1991 (SANS, 2007). This technique is meant to be applied to blood and carcass swab samples. Blood samples are directly plated (undiluted) and surface swabs are diluted to provide a liquid matrix. Samples were plated onto a non-selective medium Plate Count Agar (PCA) medium, incubated in an aerobic atmosphere at 30°C for 72 hours (to select for the mesophytic target group). Calculation of colonies was done after counting the colonies on the Petri-plates at dilutions containing between 30 and 300 colonies. The number \( N \) of colony forming units (CFU) per gram or per cm² (Andrin, 2008; Vanderzant & Splittstoeser, 1992) was calculated using the following equation:

\[
N = \frac{\Sigma C}{n1(d)}
\]

Where:

- \( \Sigma C \) is the sum of colonies counted on all the dishes retained in the countable dilution;
- \( n1 \) is the number of dishes retained in the countable dilution; and
• $d$ is the dilution factor corresponding with the counted dilution.

ii) *Escherichia coli (E. coli) Type 1*

This method was performed according to Oxoid (2006). Samples were plated on a chromogenic *E. coli*/*coli*iform selective medium and incubation was at 37 °C for 24 hours. The number ($n$) of CFU per gram or per cm$^2$ (Andrin, 2008; Vanderzant & Splittstoeser, 1992) was calculated using the same equation as for APC. The principle of the method is based on the direct counting of viable organisms within the coliform group where differentiation between general coliforms and *E. coli* is based on the enzymes glucuronidase and galactosidase produced by the latter organism. A chromogen was incorporated in the medium to enable differentiation between general coliforms and *E. coli* (Andrin, 2008).

iii) *Staphylococcus aureus (S. aureus)*

*S. aureus* counts were performed according to the procedure of SANS 6888 (SANS, 1999a). The principle of the method is based on the primary selection of *S. aureus* organisms on Baird Parker Egg Yolk Tellurite Agar and the demonstration of coagulase positive *S. aureus* colonies (Baird-Parker, 1972). Incubation temperature was at 35 °C for 24 to 48 hours. Presumptive colonies were confirmed as coagulase positive *S. aureus* by the Staphylase agglutination procedure (Andrin, 2008). The Staphylase test demonstrates the ability of *S. aureus* to produce coagulase or clumping factor. The number ($N$) or CFU of *S.
*aureus* per milliliter or per gram of product, depending on the case, was calculated using the following equation:

\[
N = \frac{\sum C}{n_1 \times v \times d}
\]

- \(\sum C\) is the sum of colonies counted on all the dishes retained in the countable dilution, giving positive Staphylase reactions;
- \(n_1\) is the number of dishes retained in the countable dilution;
- \(d\) is the dilution factor corresponding to the counted dilution; and
- \(v\) is the diluent volume spread over the surface of the agar plate.

The result was taken as being the number of CFU’s (colony forming units) per milliliter or per gram or per cm² of the product sampled.

**iv) Salmonella**

*Salmonella* may be present in small numbers and are often accompanied by considerably larger numbers of other Enterobacteriaceae or bacteria from other taxonomic entities. Furthermore, pre-enrichment is necessary to permit the detection of low numbers of *Salmonella* or injured *Salmonella*. The method for the determination of *Salmonella* was according to SANS 6579 (SANS, 2003). The principle of the method is based on the recovery and multiplication of *Salmonella* (that were present in the sample), in buffered peptone water as a primary enrichment mechanism. Secondary enrichment occurred by culturing an inoculum from the primary enrichment step in Muller-Kauffmann tetrathionate/novobiocin (MKN) medium and Rappaport-Vassiliadis medium with soya (RVS), followed by plating on *Salmonella/Shigella* (SS agar) and Xylose Lysine Deoxycholate (XLD
agar) media for detection of typical *Salmonella* colonies. Incubation was at 37°C for 24 hours. Identification of the isolated colonies was conducted using various carbohydrate and biochemical tests including oxidase and catalase reactions, Gram stain, growth on Simmons citrate (scit) agar, lysine and ornithine dehydrogenase tests, the Voges Proskauer reaction, aesculin hydrolysis and the utilization of lactose and xylose.

### 3.2.2 A pilot study to correlate two measuring units

During the execution of the study into comparing the two sampling techniques, the question on the two different measuring units used for the two methods stimulated the need for a pilot study (in addition to the sampling of the game carcasses as described above) to confirm whether units in grams (excision technique) and units in cm² (swabbing technique) are comparable. The pilot study was conducted on spiked beef tissue to address this question. In accordance with the method of Milan (2008), brisket tissue were collected from each of 12 beef carcasses from a certified butchery and spiked with a purified *E. coli* strain. *E. coli* is a known aerobic mesophilic bacterium and according to SANS/ISO 4833 may be used as a quality control organism (SANS, 2007). A bacterial suspension in Nutrient Broth was incubated at 37°C overnight and centrifuged to obtain a bacterial pellet. The pellet was then rinsed in sterile saline, homogenised in peptone water and streaked onto the surface of the brisket cut with a sterile throat swab (long handled swab) using a template of $2.5 \times 10 \text{ cm}^2 = 25 \text{ cm}^2$. Using a fresh sterile swab, the spiked surface was then swabbed, within the confines of the latter template, and the swab was subsequently broken off into 10 ml of 0.1 % sterile peptone water
(1:10 dilution). An adjacent surface of the same brisket cut was again spiked as described above. On this surface and cutting inside the same template, an excision sample of 25 g was then taken. The sterile cork borer with a diameter of 25.2 mm and a surface area of 5 cm$^2$ was used to obtain the 25 g excised tissue mass which was added to 250 ml of 0.1 % sterile peptone water (CM0009) (1:10 dilution) in a Stomacher bag. The procedure of spiking, swabbing and excision was repeated as described on each of the 12 brisket cuts. The 1:10 dilution of the swab and excision samples from each of the 12 brisket tissues was subjected to a further range of decimal dilutions and each dilution was plated onto the surface of Brilliance Chromogenic E. coli selective agar plates and incubated for 72 hours at 30 °C (Oxoid, 2006). Plates containing 30 to 300 colonies were then counted to compute the E. coli count. The pilot study was conducted in the controlled sterile environment of the SANAS accredited laboratory in Polokwane.

### 3.3 Statistical Procedures

The statistical analyses were performed using SAS statistical software version 9.2 (SAS, 1979). The Shapiro-Wilk’s test was performed on the standardised residuals to test for deviation from normality (Shapiro & Wilk, 1965). Data were analysed using the paired T-test for both methods on the same carcasses ($n = 13$) for the comparative test between the Bio-trace swabbing method and the excision method. The data from the pilot spiking (unit correlation) study ($n = 12$) were analysed using the paired T-test for both units. Generally, a correlation coefficient ($r$) of about ± 0.7 or more is regarded as indicating a fairly strong correlation, and in the region of ± 0.9 it indicates a very strong correlation. In the region of ± 0.5 the
correlation is moderate, and in the range –0.3 to + 0.3 it is a weak correlation (Rayner, 1969).

3.4 RESULTS AND DISCUSSION

The excision sampling technique is motivated by the hypothesis of bacteria migrating deeper into the tissues to more favourable conditions when the exposed, drying meat surface restricts bacterial growth. However, this theorem was researched and refuted by Capita et al. (2004), Hutchison et al. (2005) and Pepperell (2005). The argument in terms of game meat possessing a dryer surface than meat from domesticated animals (Hoffman & Dicks, 2011) motivated the utilization of the EU approved method (Zweifel et al., 2005) of swabbing in this study. Furthermore, a more representative result is obtained by swabbing and no damage (such as cutting) is done to the carcass. The results in this report (see Table 3.1) clearly show a better bacterial recovery rate using the swabbing method in comparison with the excision technique. It was confirmed by Ransom et al. (2002) that multiple-site sponge swabbing was the most feasible and effective sampling method for the recovery of E. coli on carcasses. In this study the ratio for APC was 5.4 times better, for E. coli it was 108 times better and for S. aureus it was 3.4 times better than the results obtained by the excision technique. The swabbing technique has the added advantage that it could be even more effective than the excision method in terms of recovery rate. This can be explained by the bigger more representative sampling area, but also by the method of swabbing several times across the sample surface. It can be argued that the swabbing technique can have an unfair advantage in terms of the recovery rate of micro-
organisms and that the game carcasses intended for the local market may present with higher bacterial counts than the game carcasses intended for the export market which were sampled with the excision technique. In Table 3.1 the statistical values for the bacterial counts of both the excision and swab methods are shown.

The normality test on standardised residuals indicated no deviation from normality (see Shapiro Wilk results in Table 3.1). No significant differences \( (P < 0.05) \) were found when comparing the excision and swabbing techniques. This confirmed the possibility of applying the Bio-trace cattle- and swine test as an alternative and comparable sampling technique in this study.

The spiked beef samples used in the pilot study confirmed that a very good correlation existed between the results of the two techniques in spite of the different measuring units. \( E. \ coli \) counts were selected and used for the correlation test since this was one of the main bacterial quality parameters used in the study as well as the fact that the recovery rate on spiked samples for \( E. \ coli \) (indicator organisms) was effective and viable (Ransom et al., 2002).

In Table 3.2 the raw data from the pilot spiking project conducted can be seen. In Figure 3.3 the results from the pilot spiking project conducted for \( E. \ coli \) with different measuring units showed a statistically significant \( (p < 0.01) \) correlation \( (r = 0.9) \) between CFU / gram versus CFU / \( \text{cm}^2 \). The different sampling techniques for the export and local market that measure in CFU / gram and CFU / \( \text{cm}^2 \) respectively could therefore be regarded as equivalent in terms of the bacterial counts of the carcasses tested. It should be noted that the template used for the
swabbing technique was 25 cm² and was compared to the 25 g mass (as specified by VPN 15) used for the excision technique (South Africa, 2010d).

Table 3.1: Mean bacterial counts obtained with the Excision and Swab methods applied on the game carcasses

<table>
<thead>
<tr>
<th>Method</th>
<th>APC</th>
<th>E. coli</th>
<th>S. aureus</th>
</tr>
</thead>
<tbody>
<tr>
<td>Excision method</td>
<td>a0.50</td>
<td>1.64</td>
<td>167261.4</td>
</tr>
<tr>
<td>Swab method</td>
<td>b27.71</td>
<td>173.64</td>
<td>638850.1</td>
</tr>
<tr>
<td>Probability (P)</td>
<td>0.0015</td>
<td>0.0044</td>
<td>0.0037</td>
</tr>
<tr>
<td>Shapiro Wilk</td>
<td>0.5810</td>
<td>0.7127</td>
<td>0.0449</td>
</tr>
</tbody>
</table>

*the measuring unit for the excision sampling method: CFU/ gram (g)

*the measuring unit in the biotrace cattle and swine test: CFU/ square centimeter (cm²)

*P<0.05 indicates significant differences at the 5% level within columns.

*Shapiro Wilk’s (P<W) probability test the H₀ hypothesis for normality, thus for a probability > 0.01 there is not enough evidence of non-normality.

Table 3.2: E. coli raw data results obtained from the spiked brisket cuts using different measuring units (CFU / g and CFU / cm²)

<table>
<thead>
<tr>
<th>Carcass nr</th>
<th>E. coli excision (/g)</th>
<th>E. coli swab (/cm²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>83500</td>
<td>50000</td>
</tr>
<tr>
<td>2</td>
<td>60000</td>
<td>165000</td>
</tr>
<tr>
<td>3</td>
<td>124500</td>
<td>850000</td>
</tr>
<tr>
<td>4</td>
<td>100000</td>
<td>500000</td>
</tr>
<tr>
<td>5</td>
<td>150000</td>
<td>500000</td>
</tr>
<tr>
<td>6</td>
<td>124500</td>
<td>500000</td>
</tr>
<tr>
<td>7</td>
<td>165000</td>
<td>835000</td>
</tr>
<tr>
<td>8</td>
<td>166500</td>
<td>650000</td>
</tr>
<tr>
<td>9</td>
<td>500000</td>
<td>1250000</td>
</tr>
<tr>
<td>10</td>
<td>166000</td>
<td>600000</td>
</tr>
<tr>
<td>11</td>
<td>125000</td>
<td>500000</td>
</tr>
<tr>
<td>12</td>
<td>118000</td>
<td>680000</td>
</tr>
</tbody>
</table>

Mean value 201917 713750
Although there is a good correlation between the test results the counts cannot be regarded as equivalent. The swab technique is 3.35 times higher on average than the excision technique and is also in line with the results obtained on game carcasses in the next chapter. The swab method demonstrates a higher measure of bacteriological hygiene and using the latter technique would be preferable to the excision technique for this reason.

Figure 3.3: Correlation and scatter plot between *E. coli* obtained with the two sampling techniques on the spiked brisket cuts using different measuring units (CFU / g vs CFU / cm²)

*Salmonella, S. aureus* and *E. coli* reside within the APC group and a good recovery of *E. coli* will indicate the same for these indicator and index organisms (Oxoid, 2006). However, according to Milan (2008) and Ransom *et al.* (2002) the recovery of *Salmonella* and *S. aureus* from spiked meat tissue is low and was therefore not included in the pilot study. It should be noted that meat is always contaminated and although an initial bacterial count was not conducted for the
pilot study, the intention of the study was to determine the magnitude of the correlation between the measuring units \( r = 0.91 \). The coefficient of determination \( (r^2 = 83 \%) \) indicates a strong relation between the two measuring units (Snedecor & Cochran, 1967). The actual bacterial counts were therefore deemed irrelevant.

### 3.5 CONCLUSION

It can be concluded then that for this investigation, the specific method of sampling of game carcasses by either the excision or the swabbing technique may be used for determining the bacterial quality of export and local carcasses and that the data so obtained would statistically be correlated. The bacterial counts using the swab technique are to be preferred because it is consistently a more stringent measurement tool in determining the microbiological hygiene status of game carcasses than the excision required in the VPN. It is also non-destructive and does not damage the carcass. For this reason this technique was preferred in the present study.

The following chapter will deal with research conducted in two populations namely; game carcasses harvested for the export market and game carcasses hunted for trophy and other purposes.
CHAPTER 4

APPLICATION OF EUROPEAN STANDARDS FOR HEALTH AND QUALITY CONTROL OF GAME MEAT ON GAME RANCHES IN SOUTH AFRICA

4.1 INTRODUCTION

The current health status of game meat available on the local South African market is unknown due to the fact that legislative procedures that require meat inspection or approved game slaughter facilities are not applied. This has raised concern and speculation as to the health status of this meat (van der Merwe, 2005). Any incident of a reported zoonotic disease or a case of food poisoning that may be traced to game meat will have a negative effect on the expanding local game meat market in South Africa. The Meat Safety Act 40 of 2000 (MSA) that regulates the meat industry in South Africa makes provision for five different regulations i.e. red meat and the meat from poultry, ostrich, game and crocodile (South Africa, 2000). However, the Regulation applicable to game meat has been in draft form since 2004 (to be promulgated in the near future under the MSA). This delay is due to the need to address the hunting process that delivers dead game animals to the abattoir and not live animals as required by the MSA. This contradiction between act (MSA) and regulation (the draft Game Regulation) is in the process of being addressed and is responsible for the delay in promulgation of the Game Regulation since 2004 (Bergh, 2005). The Game Regulation originated from the Red Meat Regulation that is applicable to domesticated animals and did

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64
not consider practical and important differences that apply specifically to the game meat industry. Further concerns from game ranchers are that such regulations will be impractical and too costly to implement on a game ranch (Bekker et al., 2011; van der Merwe, 2005). Cropping and export of game meat from South Africa is done in strict accordance with the guidelines of the Veterinary Procedural Notices (VPN) that, as previously mentioned, are issued and annually amended by the Department of Agriculture Forestry and Fisheries (DAFF) in conjunction with the European Union (countries of import). In contrast, the game carcasses hunted for the local market are uncontrolled and no regulations or guidelines currently apply to such carcasses.

The hygiene and quality of export and locally hunted game carcasses will be investigated in this study to determine how effectively these issues are addressed by the MSA and the mentioned VPN. Less than ideal culling and slaughtering techniques are usually associated with meat from locally hunted animals, e.g. trophy animals, as opposed to the “ideal” or benchmark techniques of the export game carcasses. Unfortunately, the standards of slaughter and cooling facilities available for carcasses intended for the local market are usually not on a par with the EU requirements (VPN) for carcasses intended for export purposes. The latter are transported refrigerated and unskinned (transportation time ≤ 72 hours) from the ranch, where initial (partial) primary carcass inspection was concluded, to the export abattoir for skinning of the carcasses and for secondary or final meat inspection to be conducted (South Africa, 2007). This scenario of initial and final primary inspection is unique to game meat and secondary inspection can be performed both on the ranch and at the abattoir pending at which stage (initial or
final) of primary inspection the carcass was detained. According to DAFF, such ranches must be registered for export harvesting (South Africa, 2010a). On the other hand, carcasses for the local market are usually skinned or caped (this involves the removal of the head and neck skin of a game animal so that it can be mounted for trophy purposes) directly after the hunt and transported unrefrigerated, without primary or secondary meat inspection, to the consumer or processor. The transportation time from the ranch to the processor or consumer may exceed 2 hours, but seldom 24 hours.

Winkelmayer (2009) stated that hygiene and safety has been an issue in game meat for export/import for a long time and optimising the primary production level is the key to improving safety and shelf-life of wild game meat. He conducted that legislative sectors continue to present questions and challenges in terms of the hygiene and safety of the meat. This study therefore envisaged comparing two systems namely a high intensity commercial cropping system typical of the export market and a low intensity hunting system typical of the local market.

It is speculated that in South Africa, especially during the hunting season, game meat contributes more than 20% towards red meat consumption (SAMIC, 2009). It is expected that this phenomenon will increase even more as a result of the fact that the South African hunting season has been extended from three to almost six months (from the beginning of March to the end of August), coupled with the increase in the number of game farms as more and more cattle farms are changing to more profitable game farming (Bothma, 2002).
The question may be posed from a public health perspective as to whether the current local game meat supply systems can provide safe game meat to the consumer? The envisaged study will target safety and hygiene procedures that are applied following the hunting phase on the ranch and will not include any processing activities away from the ranch. The study will consequently determine the hygienic quality of the meat before the onset of the final phase of processing for human consumption. This latter processing phase is usually implemented outside the premises of the ranch (Deutz et al., 2006; Smulders, 2009; Thornton & Gracey, 1974) and is regulated in South Africa by Regulation R962 published under the Foodstuffs, Cosmetics and Disinfectant Act 54 of 1972 (South Africa, 1972).

This study will compare the bacteriological status of the carcasses intended for export with those intended for the local markets during the hunting phase on the ranch and based on this information, conclusions will be drawn. The aim was not to focus on specific micro-organisms, but rather to compare the general bacteriological quality of meat obtained from local and export hunting and cropping procedures.

Index or indicator micro-organisms have been used to monitor the hygienic quality of water over the past hundred years and this principle has been extended to a variety of raw and processed foods (Nortjé & Naude, 1981). Index organisms are used as a measure of the possible presence of pathogens and provide a predictive function, whereas indicator organisms are used to assess process integrity and are regarded as general hygiene markers of good manufacturing practices (GMP).
(Brodsky, 1995). For the purpose of the study, *Escherichia coli*, *Staphylococcus aureus* and *Salmonella* spp. were regarded as “index” organisms while the Aerobic Plate Count was regarded as a measure of “indicator” organisms (Siliker, 1963).

### 4.2 MATERIALS AND METHODS

The procedures, readings and samples analysed did not concentrate on specific game species, but included the whole range of animals that were hunted on the farms during the study period. A breakdown of the categories of game species that were available during the study for both the export and local market respectively is shown in Table 4.1.

#### 4.2.1 Sampling of heart blood

Heart blood was sampled <3 hours post-mortem (initial time) from game carcasses (trophy carcasses) by making a longitudinal incision into the heart to expose the ventricles. The game carcasses culled for export purposes were effectively sampled within 1 hour post-mortem. Blood was collected while adhering to aseptic sampling principles. In the process sterile, vacuum heparin blood tubes were used. The filled tubes were then transported in an insulated container at less than 7 °C to a South African National Accreditation System (SANAS), accredited laboratory (Capricorn Veterinary Laboratories, 82 Hans Van Rensburg Street, Rondebosch Suite 4, Polokwane, South Africa) within 12 hours.
The blood samples were subjected to the Aerobic Plate Count (ISO 4833; 1991 (E) MI-Meth-003), by pipetting decimal dilutions in dilution fluid according to ISO 6887 (2003) onto Standard Plate Count Agar. A total of 515 heart blood samples from hearts undamaged (not contaminated) by shot placements, out of a total of 625 carcasses, were taken during the period 2006 to 2009. Small buck such as impala (*Aepyceros melampus*; a category C animal) and medium sized buck such as kudu (*Tragelaphus stepsicero*; a category B animal) were selected from carcasses hunted and cropped for the local and export markets. The game animals were in categories according to the MSA which further prescribes a category A which *inter alia* includes big animals such as giraffe (*Giraffa camelopardalis*) and elephant (*Loxodonta africana*). The bacterial counts however, did not attempt to portray specific game species, but represented the bacteriological hygiene of the meat across the whole range of game animals tested.

Table 4.1: Breakdown of the available categories of game species harvested and hunted for export and local markets respectively in all the provinces of South Africa

<table>
<thead>
<tr>
<th>Common name</th>
<th>Scientific name</th>
<th>Category</th>
<th>Export</th>
<th>Local</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blue wildebeest</td>
<td><em>Connochaetes taurinus</em></td>
<td>B</td>
<td>19</td>
<td>30</td>
</tr>
<tr>
<td>Bushbuck</td>
<td><em>Tragelaphus scriptus</em></td>
<td>B</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>Bush pig</td>
<td><em>(Potamochoerus larvatus)</em></td>
<td>C</td>
<td>24</td>
<td></td>
</tr>
<tr>
<td>Eland</td>
<td><em>Taurotragus oryx</em></td>
<td>B</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>Giraffe</td>
<td><em>Giraffa camelopardalis</em></td>
<td>A</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Impala</td>
<td><em>Aepyceros melampus</em></td>
<td>C</td>
<td>9</td>
<td>46</td>
</tr>
<tr>
<td>Kudu</td>
<td><em>Tragelaphus stepsiceros</em></td>
<td>B</td>
<td>55</td>
<td>41</td>
</tr>
<tr>
<td>Nyala</td>
<td><em>Tragelaphus angasii</em></td>
<td>B</td>
<td>15</td>
<td></td>
</tr>
<tr>
<td>Oryx</td>
<td><em>Oryx gazella</em></td>
<td>B</td>
<td>2</td>
<td>21</td>
</tr>
<tr>
<td>Tsessebe</td>
<td><em>Damaliscus lunatus</em></td>
<td>B</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>Waterbuck</td>
<td><em>Kobus ellipsiprymnus</em></td>
<td>B</td>
<td>14</td>
<td></td>
</tr>
<tr>
<td>Burchell’s zebra</td>
<td><em>Equus burchelli</em></td>
<td>B</td>
<td>29</td>
<td>11</td>
</tr>
<tr>
<td>Common name</td>
<td>Scientific name</td>
<td>Category</td>
<td>Export</td>
<td>Local</td>
</tr>
<tr>
<td>-------------------</td>
<td>-----------------------------</td>
<td>----------</td>
<td>--------</td>
<td>-------</td>
</tr>
<tr>
<td>Black wildebeest</td>
<td><em>Connochaetes gnou</em></td>
<td>B</td>
<td>7</td>
<td>11</td>
</tr>
<tr>
<td>Blesbok</td>
<td><em>Damaliscus dorcas philipsi</em></td>
<td>C</td>
<td>35</td>
<td>8</td>
</tr>
<tr>
<td>Red Hartebeest</td>
<td><em>Alcelaphus caama</em></td>
<td>B</td>
<td>7</td>
<td>17</td>
</tr>
<tr>
<td>Springbok</td>
<td><em>Antidorcas marsupialis</em></td>
<td>C</td>
<td>122</td>
<td>32</td>
</tr>
<tr>
<td>Roan</td>
<td><em>Hippotragus equinus</em></td>
<td>B</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>Sable</td>
<td><em>Hippotragus niger</em></td>
<td>B</td>
<td>14</td>
<td></td>
</tr>
<tr>
<td>Warthog</td>
<td><em>Phacochoerus africanus</em></td>
<td>C</td>
<td>14</td>
<td></td>
</tr>
<tr>
<td>Ostrich</td>
<td><em>Struthio camelus</em></td>
<td>B</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td></td>
<td>295</td>
<td>330</td>
</tr>
</tbody>
</table>

### 4.2.2 Temperature and pH measurements

Temperature readings and pH measurements were taken at 3 hours (initial) and 72 hours (ultimate), post-mortem to establish possible correlations with meat quality. All the measurements were taken using a portable, calibrated Testo 205 pH and temperature meter (Unitemp, Johannesburg, South Africa). Measurements were taken and recorded directly after evisceration. The Testo meter was calibrated between readings and measurements were taken by inserting the probe into the middle of both longissimus dorsi muscles. A total of 2500 measurements from a total of 625 carcasses (n= 295 each for export and n= 330 for local) were taken for both temperature and pH at initial time (T₁ and pH₁ respectively) and at ultimate time (Tᵤ and pHᵤ respectively).

### 4.2.3 Aerobic Plate Count (APC)

APC determinations were done on the carcass surfaces of the local group, (n=330) using the Enviro-biotrace swabbing technique described in the FAO/WHO (1979) prescriptions, the FSIS/USDA Meat and Poultry Regulations (1996) and the
Scottish Meat HACCP Regulations (Number 234 of 2002) (Capita et al., 2004; Zweifel et al., 2005). One sponge swab was used to swipe each carcass (targeting four anatomical sites namely one on each hindquarter and one on each forequarter) to get a sample representative of the surface bacteria on all the sampled carcasses). Category A and B animals were sampled on the rump and neck area and category C animals on the perineal area from the base of the tail to the hock and the neck area (South Africa 2010d). This was done by dividing the sponge into 4 quadrants and applying each quadrant to an anatomical site. The 4 sponge quadrant swabs taken from each carcass were combined and the laboratory results gave an average bacteriological profile for each of the 330 local carcasses for $T_1$ and then again for $T_u$. The total number of individual carcass results for the local group was $n= 660$.

The Enviro-biotrace Cattle and Swine Test kit (see Chapter 3) consists of sterilized templates, gloves, resealable sachets with 29 cm$^2$ dry sponges and glass bottles containing 10ml sterile peptone solution (Analytical & Diagnostic Products CCPO Box 6378, Weltevreden Park, 1715, South Africa). The dry sponges were soaked aseptically in the peptone solution and the templates were used to swab the 4 quadrants (front and hind quarters) of the carcass. Ten horizontal and ten vertical swabbing movements for each of the quadrants within the confines of the USDA sterile and flexible plastic template (10 x 10 cm$^2$) ensured that the recommended carcass surface (100 cm$^2$) was covered. Dividing the sponge into 4 sections and swiping with a clean part of the sponge surface for every quadrant of the carcass and then combining the 4 quadrants, gave a representative indication of the bacteriological status of the overall carcass surface. Excision sampling, on the
other hand, is based on the mooted theory of bacteria migrating deeper to more favourable conditions than the exposed, dry meat surface. This theory has however been tested and refuted by Hutchison et al. (2007), Miraglia et al. (2005) and Pepperell et al. (2005). The export carcasses (n= 295) could only be sampled at \( T_u \) (after skinning) by excision sampling which forms part of the export sampling programme and this sampling was performed on site by qualified laboratory technicians. A total of 955 (samples taken during the period 2006 to 2009 from both local (n=330, taken at both \( T_1 \) and \( T_u \) and resulting in a total of 660 samples) and export carcasses (n= 295, sampled only at \( T_u \)) were subjected to the Aerobic Plate Count.

### 4.2.4 Salmonella spp, Escherichia coli and Staphylococcus aureus

Analyses of the abovementioned samples (APC) included simultaneous analyses for *Salmonella* spp. (*Salmonella*), *Escherichia coli* (*E. coli*) and *Staphylococcus aureus* (*S. aureus*). The approved International Standards (ISO) and South African National Standards (SANS) used as the analytical methods for the determination of APC, *Salmonella, E. coli and S. aureus* were listed and discussed in chapter 3. During the period 2006 to 2009, a total of 625 samples (295 export and 330 local) (ultimate time = \( T_u \)) were taken and analysed for the three types of pathogen (index) types respectively.
4.3 STATISTICAL PROCEDURES

The total overall data (n = 4275 readings) were used to compute the final results. Statistical analyses were done using Sigma Stat and the T-test (Shapiro-Wilk) for normality. The Whitney Mann rank sum test was used when normality failed. Differences in median values between the two groups (export-cropping and local-hunting) were expressed with P < 0.05 (indicating significance). The Sigma Plot 2 programme was used to graphically produce the figures presented in this study.

4.4 RESULTS AND DISCUSSION

The results of the comparison between APC Colony Forming Unit (CFU/ml) for heart blood sampled initially from both the groups for the years 2006 to 2009 respectively, are illustrated in Figure 4.1.
Test groups

<table>
<thead>
<tr>
<th></th>
<th>Ex06</th>
<th>Ex07</th>
<th>Ex08</th>
<th>Ex09</th>
<th>Loc06</th>
<th>Loc07</th>
<th>Loc08</th>
<th>Loc09</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ex/(cfu)Heart blood</td>
<td>ND</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Loc/(cfu)Heart blood</td>
<td>ND</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
</tr>
</tbody>
</table>

Figure 4.1: Median results of APC (CFU / g) for heart blood sampled at T1 post-mortem for the Ex = export and Loc = local groups for the period 2006 to 2009

The lower control line (QL) in grey proposes a maximum level for the bacterial count of the blood (Andrin, 2007). The t-lines indicate 5% data outside of the normal range (box plot) and the bullets show outliers. The QL shows the highest acceptable level of bacteria that may be present in the heart blood. This control line indicates that a contamination level of < 1 x 10^3 CFU / g is acceptable for the purposes of this study in terms of the sampling method used (Andrin, 2007). Significant differences were not found in terms of the bacterial quality of the heart blood sampled from the two cropping/hunting groups. The results of the Aerobic Plate Count performed on the heart blood from the two groups were similar, in other words there were no significant differences (P = 0.693) between the groups. The blood samples should have been taken intravenously to adhere to prescribed aseptic sampling methods, but experience during the study showed that all
arteries of the animal collapsed immediately post-mortem and no blood could be accessed intravenously. Consequently an incision was made into the heart to expose the ventricles for blood collection. Despite the anti-coagulant (heparin) used in the sterilised tubes, some of the blood samples were already coagulated inside the ventricles and explained the measuring unit of the results as received from the laboratory (not per ml, but per g). See Chapter 3 for the discussion on measuring units. In the process, bacteria on the exposed surface of the heart or bacteria from the environment could have been introduced into the blood sample. However, for the purpose of this study, a standardized sampling method was used with both groups and a similar T1 bacteriological status for the two groups was established. The results do not support the principle of an ideal harvesting or hunting method, but they do indicate a similar initial post-mortem bacteriological status. Game animals hunted with the heart as target were not included to exclude possible high bacterial counts as a result of cross contamination.

The results of the comparison between the temperature (T1 and Tω) values of the local and export carcasses are illustrated in Figure 4.2. Horizontal lines in this figure are quality lines and not specification lines as they do not indicate legal standards. The recommended temperature range is indicated by the red and green lines and the ideal pH range by the blue lines. The t-lines indicate 5 % data outside of the normal range (box plot) and the bullets show outliers.
Figure 4.2: Median temperatures (T₁ and T_u) and pH values (pH₁ and pH_u) measured over time from the export and the local groups from 2006 to 2009.

The temperature (varying from -1 °C to 7 °C), is recommended to be not less than minus 1 °C (to prevent freezing of the meat). Furthermore, according to Paton et al. (2009) the carcass temperature should be kept above 2 °C for 24 hours maturation and to reduce the risk of foot-and-mouth disease (FMD). Temperature readings noted for the two groups at T₁ and T_u differed significantly (P < 0.001).

The ideal pH range (< 6.0) will together with the reduced temperature minimise the risk of FMD. There is a downward pH curve from the time of the successful shot placement to the stabilizing pH_u. pH values noted for the two groups at pH₁ and pH_u differed significantly (P < 0.001). The t-lines indicate 5% data outside of the normal range (box plot) and the bullets show outliers.

The measurement of pH is currently used in the export market for quality and shelf life purposes (Gill et al., 2000a; Gill, 2007). The former author further noted that
high pH values are indicative of high ante-mortem stress levels, disease or inflammation in the carcass and are therefore recorded and noted at the export abattoir prior to processing. The higher pH values of the export group at pH\textsubscript{1} and pH\textsubscript{u} could be explained by the intensity of the cropping process resulting in increased stress of the animals and therefore raised pH levels. The pH readings were not associated with the bacterial numbers taken by the swab technique although it is well known that lower pH values of game meat are a deterrent to bacterial growth (Wiklund et al., 1995; Wiklund et al., 2001).

The mean results of APC, \textit{E. coli} and \textit{S. aureus} at ultimate time for the export and the local groups are shown in Fig.4.3. The t-lines indicate 5 % data outside of the normal range (box plot) and the bullets show outliers. The means of the data for the respective organisms are indicated in yellow. The legal maximum allowed for \textit{E. coli} is $10^2$ CFU/ml and that for \textit{S. aureus}, $10^2$ CFU/ml as indicated by the red and blue specification lines (South Africa, 2010d). All 625 carcasses from both groups tested negative for \textit{Salmonella} spp. (and are therefore not indicated in Figure. 4.3). This is in agreement with the findings of Deutz, \textit{et al.} (2006) and Atanassova, \textit{et al.} (2008). The green line indicates the upper control line for APC. The higher reading for the local group in comparison with the export group can be explained by the early introduction of the cold chain to the export group, but also to the transportation of the export group to the abattoir in dressed status in contrast with the local group that are dressed immediately prior to transportation.
Figure 4.3: Mean results of APC (CFU/cm²), *E. coli* and *S. aureus* at ultimate time for the export (n = 1180) and the local (n = 1320) groups for the years 2006 to 2009.

In addition it was shown by Gill (2007) that when initial bacterial counts are sufficiently low, carcass tissues are typically sterile when tested at ultimate time. This phenomenon can be ascribed to the lag phase of bacterial growth (Zweifel *et al.*, 2005). The similarity in the *E. coli*, *Salmonella* and *S. aureus* counts when comparing the local and export groups can serve to question the necessity of stricter requirements as specified in the VPN. All bacterial differences at ultimate time can be ascribed to the maintenance of the cold chain and dressing in the case of the export group where the risk of bacterial multiplication/contamination is decreased (Ayres *et al.*, 1980). It was noted by Argos, *et al.* (1979) that refrigeration had a suppressive effect on the numbers of bacterial types such as *E. coli* and *Salmonella*. The export market requires that the prescribed refrigeration
be applied \( \leq 4 \) hours post-mortem. This is in contrast to the refrigeration period applied voluntarily to the local group (any period up to 24 hours post-mortem). The export group readings were lower, most probably due to the continuous maintenance of the cold chain. It is the normal procedure to load the carcasses in the field, after evisceration and meat inspection, into cold trucks set at 5 °C with the carcasses being maintained at this temperature until arrival at the abattoir. Here the data-logger of the cold truck is inspected and if it complies with the requirements the carcasses are off-loaded into a cold room from where they are removed for skinning and further processing (Bergh, 2007).

The total absence of *Salmonella* and low numbers of *S. aureus* weighed against the financial costs of such analyses and support the argument that index/indicator organisms in the process of harvesting game carcasses should not be a regulatory requirement as intended by VPN. Such analyses could however be used to evaluate Good Hygiene Practices (GHP), Good Manufacturing Practices (GMP) and the Hygiene Management System (HMS) when further processing for the local market is envisaged. Leaving the skin on could be considered as a method of control for bacterial contamination during long periods of transportation (Nortjé *et al.* 1979). This can clearly be seen in the overall lower bacterial counts (Figure 4.3). In addition, game carcasses possess less visual surface fat and marbling than domesticated animals and if these carcasses were to be skinned and left in efficient cold rooms for long periods (> 24 hrs.), drying out of the surface area could occur (Nortjé *et al.*, 1979). This will result in an unattractive appearance as well as larger yield losses during further processing. Dressing or skinning of game
carcasses should therefore ideally be conducted after the transportation of the carcasses to the abattoir and prior to processing.

Brown, et al. (2000) noted that it is of little value to predict the safety of meat based on the levels of APC and/or *E. coli* found on the carcass. The fact that *E. coli* is found commonly as a contaminant of raw meats, even when produced under hygienic conditions, casts doubt on the specified South African legal level requirements for this organism (Cox et al., 1988).

According to Paulsen and Winkelmayer (2004), the observance of “Good Hygiene Practice” (GHP) in the different forms of game harvesting and processing will play a decisive role in determining the microbiological status of the meat. The shot placement, the time-temperature profile from shooting to evisceration and the technique of evisceration, will influence the surface contamination of the carcass. Furthermore, according to Paulsen and Winkelmayer (2004) despite the multiple wounding and contamination of muscles, the adherences to GHP will allow the production of meat that is safe for human consumption. Game meat and meat products must comply with microbiological requirements similar to meat from domesticated animals i.e. cattle and sheep (Brown et al., 2000). However, according to Bergh (2005) export abattoir records show that condemnation of carcasses is usually due to bruising and slaughter techniques in the harvesting process. This condemnation figure is low (0.829 %). To place this in perspective, a corresponding condemnation figure for the controlled red meat market (cattle, sheep and pork) in South Africa is 2.205 %. These rejections are often due to
disease related conditions that render such infected meat unsuitable for human consumption (SAMIC, 2009)

The mean results of APC for the export group at ultimate time only and the local group at both initial and ultimate time are presented in Figure 4.4. The overall bacterial results (CFU/cm²) at initial time, for the local group had similar values to the results at ultimate time for the export group and there were no significant differences between the counts of the two groups (P= 0.291).

Figure 4.4: Mean results of APC (CFU /cm²), for the export group (Ex) at ultimate time only (n=295) and the local group (Loc) at both initial and ultimate time (n=660), all tested in the period 2006 to 2009
However, the results at ultimate time for the local group compared with ultimate time for the export group showed significantly higher levels ($P = 0.006$) of APC tested. The red dashed line indicates the upper specification of $10^5$ APC (CFU/cm²) (South Africa, 2010d). A total of 955 samples were used to calculate the values in the box plots. The t-lines indicate 5 % data outside of the normal range (box plot) and the bullets show outliers.

The bacteriological samples collected from both high and low intensity carcasses were compliant with the legal standards for high intensity carcasses as prescribed in the VPN (South Africa, 2010d). As reported by the Food and Agricultural Organization of the United Nations and World Health Organization (1997), the prescribed standard for APC is $\leq 10^5$ CFU/ml, but levels as high as $10^6$ CFU/ml are acceptable in the global red meat market (Brown et al., 2000).

4.5 CONCLUSIONS AND RECOMMENDATIONS

From this comparison it can be concluded that game meat is currently relatively free of bacterial contamination. However, in farmed game animals, as in New Zealand, ailments such as zoonoses (animal diseases that infect humans) and other conditions that require condemnation could be more evident (Bothma, 2002). In South Africa game are currently indigenous wild animals and roam freely, but this could change if the focus from hunting shifts and meat production becomes more intensified.
Consequently, from the results of this study, it can be proposed that the differences in bacterial quality between meat/carcasses from the local and export groups could be ascribed to the fact that GHP’s and GMP’s have been compromised in the case of local carcasses. The differences however are not dramatic enough to justify the application of the export regulations (VPN) to the local market. For this reason the following recommendations are made: practical and affordable guidelines that emphasize the importance of meat hygiene and the integrity of the cold chain should be followed in the process of obtaining a game carcass on a game farm intended for the local market. In addition, keeping the skin intact could be considered as a method of bacterial control during extended periods of transportation and to ameliorate the negative effects of moisture loss and subsequent darker meat. Legally prescribed bacteriological testing will always have a cost implication for those who produce for the local market and its application in terms of hygiene and quality of the meat can be questioned.

The next chapter deals with a report on three systems of hunting in South Africa, comparing animal class and health compliance.
CHAPTER 5
THE HYGIENIC PRACTICES APPLIED IN THREE SYSTEMS OF GAME MEAT PRODUCTION IN TERMS OF ANIMAL CLASS AND HEALTH COMPLIANCE

5.1 INTRODUCTION

5.1.1 Game meat hygiene in South Africa

It is well known that during the hunting season, fresh unapproved game meat (not inspected and approved with an abattoir stamp) is available at butcheries and some of the bigger retail outlets (Carruthers, 2008). Throughout the year game meat from uncontrolled and unregistered facilities is further processed into dry products such as biltong and dry sausage which is made available at all major retailers, outlets and biltong shops in South Africa (van der Merwe, 2005). A recent annual report on trophy hunting in South Africa (Caroll, 2010), stated an income of R5.5 billion accruing to biltong hunters. In the past processing of this meat was mainly performed on formal butchery premises, but recently an increasing number of private processors on uncertified and unapproved premises have been exploring this niche market (Reilly et al., 2003; van der Merwe et al., 2009). For the purposes of this study the focus has been on the microbiological and quality standards of game meat from biltong and trophy hunting.

Hoffman and Dicks (2011) found that game meat is more resistant to microbiological spoilage than domesticated meat sources such as mutton, beef

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3 Parts of this Chapter have been published as: van der Merwe, M., Hoffman, L.C., Jooste, P J. & Calitz, F.J. 2012. The hygiene practices of three systems of game meat production in terms of animal class and health compliance. Meat Science, In press.
and pork, but further scientific information to corroborate these findings is not currently available. The safety of game meat in terms of the bacteriological quality during the culling process on the game ranch is unknown and will be discussed. In South Africa, the Meat Safety Act 40 of 2000 (hereafter the MSA) was developed and promulgated to address the meat safety issue of not only animals farmed for their meat, but for five different groups of animals that are required to be regulated in terms of slaughter animals for meat production.

The MSA replaced the Abattoir Hygiene Act 121 of 1992 (South Africa, 1992), and was developed and based on legal requirements applicable to the red meat industry. The Red Meat-, Poultry- and Ostrich- Regulations have been promulgated, but the Game- and Crocodile Regulations are still in draft format. The requirement in the MSA that game meat inspections should be performed by an independent game meat inspector, led to the postponement of the promulgation of the Game Regulations. The problem is that this service is usually provided by Government to ensure independence. The Department of Agriculture, Forestry and Fisheries (DAFF), however, cannot render an independent game meat service due to logistical issues such as the distribution of farms and distances to be travelled to the estimated 10 000 game farms in South Africa (Dry, 2012).

Veterinary Procedural Notices (VPN) based on the export requirements for game meat as required by the European Union (EU) (a major importer of South African game meat) were developed and implemented by DAFF. For this reason, the Draft Game Regulations were intentionally developed to ensure safe game meat
specifically to the local meat market. This was, however, met with resistance from the game farmers due to the costs involved and the impracticalities in the Regulation. This situation emphasized the need for an interim guideline or more practical game meat scheme to address the current activities involving game meat in the local market (van der Merwe et al., 2011 [refer Chapter 4]).

While meat inspection data is available for the game export market, the current status of game meat (in terms of safety for human consumption) intended for the local market is unknown. This is due to the total lack of recorded meat inspection data. Such information can become part of a database if a similar system to that used currently for the red meat- and export game market is developed and implemented.

According to Gill and Penney (1979), Gill (2005a) and Paulsen (2005) the observance of Good Hygiene Practice (GHP) applying to the different modes of game harvesting and processing, will play a decisive role in determining the microbiological safety of the meat. The shot placement, the time-temperature profile from wounding to evisceration and the technique of evisceration will influence the surface contamination of the carcass. Paulsen and Winkelmayer (2004) stated that, despite the multiple wounding and contamination of game meat tissue the adherence to GHP will nevertheless allow for the production of meat that is safe for human consumption. The present study, therefore, has focused on the safe and hygienic production of game meat and the applicable legislation from DAFF. The secondary processing and retail of game meat to the end-consumer falls outside the scope of this study, but also outside the legislative jurisdiction of
DAFF. Secondary game meat processing is controlled by the Department of Health through Regulation R962 (General hygiene of food premises and transportation of foodstuffs) under the Foodstuffs, Cosmetics and Disinfectant Act 54 of 1972 (South Africa, 1972).

The final consideration is that game meat and meat products for both export and local use, should comply with the same microbiological requirements as for meat from domesticated animals i.e. cattle and sheep (Gill, 1979, 2005b). Further scientific information is needed to address the current lack of practical safety and hygiene criteria for game meat.

5.1.2 Game meat hygiene in Europe and Africa

Bandick and Hensel (2011) stated that game meat consumption in Germany amounts to 73,000 tons per year of which half is sold directly to consumers. However, human cases of infection relating to game meat have been found to occur and elements of the safety strategies that were developed, included 11% of all shot large game in 2007 being inspected. In addition 114,000 hunters in Germany have been trained and certified as “trained persons” and the obligatory identification marks (for traceability purposes) have been attached to each game carcass. They concluded that the increase of awareness and knowledge in this regard has impacted positively on consumer safety.

Winkelmayer (2011) reported that in Austria the total game carcass weight produced annually is 9,000 tons. He furthermore reported that their current inspection system has undergone modifications to align with the EU hygiene
requirements. This system includes the mode of marketing (i.e. self-supply, local trade, intra-community trade and export trade) and the detection of listed or specified abnormalities during ante-and post-mortem inspection (Gill & Durão, 1990).

Namibia is well known for its quality game meat and products and South Africa as well as the European Union are importers of game meat from Namibia. Van Schalkwyk and Hoffman (2010) noted that HACCP principles and Commission Regulation (EC) No 852 prescribe the hygiene control procedures to be followed before the export of game meat from Namibia to other countries is approved. However, according to them, trophy and hunted game meat are utilized commercially in the local Namibian market without any adherence to these hygiene requirements.

In the United Kingdom venison is growing in popularity, but differences in the microbiological quality between farmed deer (kept in parks) and wild deer are noted in terms of the higher incidence of *E. coli* in wild deer. According to Richards *et al.* (2011) the uncontrolled environment of the processes of slaughter and evisceration is the main reason for the less favourable bacterial results.

Nagy *et al.* (2011) in the Slovak Republic indicated that the pH value, amount of lactic acid and ammonia content of muscle tissue post-mortem are negatively influenced by poor shot placements as well as by high storage temperatures. According to them, pH measurement is used to indicate healthy animals and to predict the shelf-life of game meat.
In order to evaluate the health status of game meat in South Africa, this study will focus on comparing the effect of three different systems of game meat production on the hygiene and safety of game meat. The systems to be compared will include game carcasses for export purposes (to be called System 1); game carcasses intended for the local market, but subjected to specific hygiene and safety guidelines (System 2) and game carcasses intended for the local market, but not subjected to health and safety guidelines (System 3).

The carcasses in the three systems will be tested for, and compared on the basis of a range of parameters, namely carcass pH, carcass temperature, aerobic plate count (APC) of the heart blood, shelf-life in terms of the bacterial count, and counts of *E. coli*, *S. aureus* and *Salmonella* in two classes of animal in each of the three systems. The present study, therefore, has focused on the safe and hygienic production of game meat and evaluates the applicability of legislation from DAFF.

### 5.2 MATERIALS AND METHODS

#### 5.2.1 Experimental design

In Table 5.1 the dependant variables that were used in this chapter and that are currently recommended and enforceable for System 1 (Sys1) are shown. The procedures, readings and samples analysed were not concerned with the different game species, but rather with the range of animals that were available during the study period (van der Merwe *et al.*, 2011). Currently System 2 (Sys2) and System 3 (Sys3) do not adhere to any legislation or standards however, the
measurements and results were compared to the export standard as specified in
the VPN i.e. in effect the carcasses sampled in Sys1. In this chapter (Table 5.1)
dependent variables based on EU standards (VPN) were used to compare
differences between the three processes of obtaining carcasses in terms of safety
and quality.

Table 5.1: Summary of the dependant variables used for the three systems

<table>
<thead>
<tr>
<th>Category</th>
<th>Criteria</th>
<th>Indicator</th>
<th>Sys1</th>
<th>Sys2 and Sys3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Species</td>
<td>Class of animal</td>
<td>B-size animal e.g. Kudu</td>
<td>B-C</td>
<td>B-C</td>
</tr>
<tr>
<td></td>
<td></td>
<td>C-size animal e.g. Impala</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Product Safety and Quality</td>
<td>Quality indicators</td>
<td>pH$_1$ ≤3hr</td>
<td>≤6.8</td>
<td>≤6.8</td>
</tr>
<tr>
<td></td>
<td></td>
<td>pH$_{u}$ ≤72hr</td>
<td>&lt;5.8</td>
<td>&lt;5.8</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Temp$_1$ ≤3hr</td>
<td>&lt;38°C</td>
<td>&lt;38°C</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Temp$_{u}$ ≤72hr</td>
<td>2-7°C</td>
<td>2-7°C</td>
</tr>
<tr>
<td>Bacterial indicators</td>
<td>APC$_u$ carcass</td>
<td>≤100 000 / cm$^2$</td>
<td>≤100 000/cm$^2$</td>
<td></td>
</tr>
<tr>
<td></td>
<td>APC$_1$ blood</td>
<td>≤2 000/ g</td>
<td>≤2 000/ g</td>
<td></td>
</tr>
<tr>
<td></td>
<td>$E. coli_{u}$</td>
<td>≤100/ g</td>
<td>≤100/ cm$^2$</td>
<td></td>
</tr>
<tr>
<td></td>
<td>$S. aureus_{u}$</td>
<td>≤100/ g</td>
<td>≤100/ cm$^2$</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Salmonella$_{u}$</td>
<td>Absent/ g</td>
<td>Absent/ cm$^2$</td>
<td></td>
</tr>
</tbody>
</table>

These variables included the index and indicator organisms as used in Chapter 4
namely: APC (carcass and heart blood), $E. coli$, $Salmonella$ and $S. aureus$.
Furthermore, carcass temperature and pH measurements were used to compare
possible quality differences in the three systems. In Table 5.2 the numbers (n)
used for the final statistical analyses of the 3 x 2 factorial structure (three systems with two classes of animal) using SAS statistical software are shown. There is an equal distribution of animals between the three systems and the two classes.

Table 5.2: Summary of animals within the 3x2 (Systems x Class) factorial structure

<table>
<thead>
<tr>
<th>Compliance</th>
<th>Class B n=331</th>
<th>Class C n=281</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sys1</td>
<td>125</td>
<td>170</td>
<td>295</td>
</tr>
<tr>
<td>Sys2</td>
<td>121</td>
<td>44</td>
<td>165</td>
</tr>
<tr>
<td>Sys3</td>
<td>85</td>
<td>67</td>
<td>152</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>331</strong></td>
<td><strong>281</strong></td>
<td><strong>612</strong></td>
</tr>
</tbody>
</table>

5.2.2 Experimental procedures

5.2.2.1 Three systems of game meat production in South Africa

System 1 (Sys1) comprises of the game animals intended for the export market (n = 295). Sys1 is a high intensity cropping system and two digit numbers of animals are targeted to make the cropping project financial viable. It should be noted that cropping and export of game meat from South Africa is done in strict accordance with the guidelines of the VPN (South Africa, 2007; South Africa 2010a, South Africa 2010b, South Africa 2010c, South Africa 2010d) which are issued and amended annually by DAFF in conjunction with the EU (ICMSF, 1996). Under these provisos, Sys1 carcasses were transported unskinned and refrigerated (transportation time < 72 hours) from the ranch where the animals had been shot, and where primary carcass inspection was done (South Africa 2010c)
to the export abattoir where the carcasses were skinned. The secondary and final inspection was done at these export abattoirs (South Africa, 2010e). According to DAFF, such ranches have to be registered for export harvesting (see also Chapter 6) (South Africa, 2010a). Samples and measurements were made on carcasses obtained from registered and planned cropping activities for the export market and from the specific export abattoirs. System 2 (Sys2) comprises of game carcasses intended for the local market, but subjected to specific hygiene and safety guidelines \((n = 165)\). Approved training modules (SAQA accredited service provider for Wildlife Ranching South Arica-WRSA) for game meat hygiene and carcass inspection were implemented on a selected game ranch that mainly produces trophy carcasses for the local market. The main difference between Sys2 and System 3 (Sys3) is that ranch workers and management on the ranch for implementing the Sys2 system were subjected to modules of basic training in meat hygiene, good hygiene practices and good slaughtering techniques (Bergh, 2007). The management team completed training as game meat examiners, to conduct initial and final game meat inspection on all hunted and trophy carcasses intended for the local consumer market. Sys3 game carcasses are intended for the local market, but are not provided with health and safety guidelines or training \((n = 152)\). In this system less than ideal culling and slaughtering techniques that is usually associated with meat from locally hunted animals as opposed to the “ideal” techniques used for export carcasses, were used. The standards of slaughter and cooling facilities available for carcasses intended for the local market are usually not on a par with the EU requirements. These carcasses are usually transported skinned, unrefrigerated and without primary or final meat inspection, directly to the consumer or the processor. An additional APC test conducted over 7 days was
conducted on samples from Sys3 to determine a shelf-life period for this system which is regarded as uncontrolled in terms of legislative procedures.

Class B and C animals (the class refers to the size of the animal e.g. kudu [class B] and impala [class C]) from the three systems were sampled and although different species were not portrayed, these included *inter alia* blue wildebeest (*Connochaetes taurinus*), Eland (*Taurotragus oryx*), Kudu (*Tragelaphus stepsiceros*), nyala (*Tragelaphus angasii*), Blesbok (*Damaliscus dorcas philipsi*) and Springbok (*Antidorcas marsupialis*).

5.2.2.2 Blood sampling and bacteriological analysis

Samples of heart blood (see Chapter 4) were taken from all three groups to standardize the sampling method and to establish a similar initial time ($T_1$) bacteriological status for the three groups. The sampling did not support the principle of an ideal harvesting or hunting method, but were conducted to indicate a similar initial post-mortem bacteriological status. A total of 515 heart blood samples from hearts undamaged (not contaminated) by shot placements, out of a total of 612 carcasses, were taken during the period 2006 to 2009. Small buck such as Impala (*Aepyceros melampus*; a category C animal) and medium sized buck such as Kudu (*Tragelaphus stepsicero*; a category B animal) were selected from carcasses hunted and cropped in the case of each of Sys1, Sys2 and Sys3. The bacterial counts however, did not attempt to portray the meat quality of specific game species, but represented the bacteriological hygiene of the meat across the whole range of game animals tested. Heart blood was sampled at
initial time from Sys1, Sys2 and Sys3 game carcasses and subjected to the aerobic plate count (APC) bacteriological analysis.

APC determinations were done on the carcass surfaces for systems 2 and 3 at ultimate time which is approximately 72 hours post-mortem \((T_u)\) using the Enviro-biotrace swabbing technique (Van der Merwe et al., 2011). Carcasses from Sys1 could only be sampled at the abattoir after skinning through excision sampling which forms part of the export sampling program and was performed by on-site qualified laboratory technicians. In Chapter 3 the swab and excision techniques using different measuring units i.e. / g and / cm\(^2\) were motivated for comparative purposes between the techniques. In this chapter the results from Sys1 were compared with results from Sys2 and Sys3. The swabs and excision samples of all three systems were, simultaneously with the APC determinations, analysed for the index organisms: E. coli, Salmonella, and S. aureus. High counts of these organisms were indicative of poor slaughtering techniques and poor hygienic practices (Gill et al., 2000b; Smith et al., 1974).

5.2.2.3 Shelf-life study

An aerobic plate count was performed on the samples taken with the incision method (discussed in chapter 3) from Sys3 carcasses \((n = 13)\) at ultimate time. The samples were incubated in the laboratory which was a South African National Accreditation System (SANAS), accredited laboratory (Capricorn Veterinary Laboratories, 82 Hans Van Rensburg Street, Polokwane) over a 7 day period at an average temperature of 3.85 °C. Samples were taken from muscle tissue obtained
from: blue wildebeest, class B (n = 8) and kudu (n = 3 with a pH\textsubscript{u} of 5.3 and samples from impala, C class (n = 2) with a pH of 5.7

5.2.2.4 pH and temperature measurement

Temperature readings and pH measurements were taken at <3 hours (T\textsubscript{1}-initial time) and <72 hours (T\textsubscript{u}-ultimate time), post-mortem to establish possible correlations between the three systems with meat quality. For temperature and pH, 2460 measurements from a total of 615 carcasses were taken (Sys1, n = 295; Sys2, n = 165; and Sys3, n = 152). Measurements were taken at initial time (T\textsubscript{1} and pH\textsubscript{1} respectively) and at ultimate time which is 72 hours post-mortem (T\textsubscript{u} and pH\textsubscript{u} respectively) for each carcass.

5.2.3 Methods

5.2.3.1 Blood sampling

Heart blood was sampled using the method of van der Merwe et al. (2011). Heart blood was sampled at initial time (T\textsubscript{1}) from game carcasses from all three systems by making a longitudinal incision into the heart to expose the ventricles. Blood was collected while adhering to aseptic sampling principles. In the process sterile, vacuum heparin blood tubes were used. The filled tubes were then transported in an insulated container at less than 7 °C to a South African National Accreditation System (SANAS), accredited laboratory (Capricorn Veterinary Laboratories, 82 Hans Van Rensburg Street Rondebosch Suite 4, Polokwane, South Africa) within
12 hours. The blood samples were subjected to the Aerobic Plate Count (ISO 4833) (SANS, 2009) test, by pipetting decimal dilutions in dilution fluid according to ISO 6887 (SANS, 1999b) onto Standard Plate Count Agar.

5.2.3.2 pH and temperature measurement

All the measurements were made using a portable, calibrated, Testo 205 pH and temperature meter (Unitemp, Johannesburg, South Africa) (van der Merwe et al., 2011). Measurements were taken and recorded directly after evisceration at $T_1$ and again at $T_u$. The Testo meter was calibrated between readings and measurements were taken by inserting the probe into the middle of Longissimus dorsi (LD) muscle in carcasses from all three systems. The pH measurements were taken simultaneously with the temperatures at initial time (pH$_1$) and ultimate time (pH$_u$). The Unitemp temperature meter was verified with an additional hand thermometer to ensure consistent and correct temperature readings.

5.2.3.3 Bacterial counts

Bacterial counts were performed as follows:

- The Aerobic Plate Count (APC) was done according to APHA (1992). The swabs were diluted to provide a liquid matrix and plated on Standard Plate Count Agar. Incubation temperature was at 37°C for 72 hours
- *E. coli* counts were done according to Oxoid (2006). The method is based on the direct counting of viable organisms within the coliform group plated on
chromogenic E. coli/coliform selective medium. Incubation temperature was at 37°C for 24 hours

- **S. aureus** counts were done according to Baird-Parker (1972). The principle of the method is based on the primary selection of **S. aureus** organisms on Baird Parker egg yolk tellurite agar and the demonstration of coagulase positive **S. aureus** strains. Incubation temperature was at 35°C for 24 hours

- **Salmonella** detection was done according to De Smedt (1986) in buffered peptone water as a primary enrichment mechanism. Secondary enrichment occurred by culturing the primary medium in Muller-Kauffmann tetrathionate/novobiocin (MKN) medium and Rappaport-Vassiliadis medium with soya (RVS) followed by further selection of colonies on **Salmonella/Shigella** (SS agar) and Xylose Lysine Deoxycholate (XLD agar) media. Incubation temperature was at 37°C for 24 hours

- **Lactobacillus** counts were done according to the procedure of Sahoo & Anjaneyulu (1997). Dilutions were plated on **Lactobacillus** MRS agar and incubated for 48 hours at 30°C under anaerobic conditions.

### 5.2.3.4 Shelf-life study

Excision samples were taken of muscle tissue of 13 Sys3 carcasses according to the method prescribed in VPN 15 (South Africa, 2010d). The samples were incubated in the laboratory (sterile environment) for 7 days at 3.85°C. APC determination was done on a daily basis for the 7 days. The exponential growth observed on the 5th, 6th and 7th day were plated on **Lactobacillus** MRS agar and...
incubated for 48 hours at 30°C under anaerobic conditions (Sahoo & Anjaneyulu, 1997).

5.2.4 Statistical procedures

A total of 625 carcasses were sampled of which 612 were used for the final data analysis. There were 10 dependant variables (pH1,u, Carcass Temperature1,u, Aerobic Plate Count1,u E. coli1,u and S. aureus1,u). Results from all the bacterial analyses were transformed into log values for statistical analysis. R x C contingency tables was set up and Chi square tests were performed for independent frequency patterns (Snedecor & Cochran, 1967). The dependant variables were subjected to a 3 x 2 factorial analysis of variance with factors 3 Compliance (Sys1, Sys2 and Sys3) and 2 Classes (B and C) in a complete randomised design. Of the dependent variables Heart Blood, APC, E. coli and S. aureus data were subjected to a log10 (X +1) transformation before analysis. Shapiro-Wilk’s test was performed on the standardised residuals to test for deviation from normality (Shapiro & Wilk, 1965). Outliers were identified and excluded until the standardised residuals were normal or symmetrically distributed for the final analysis of variance ANOVA (Table 5.3). The Compliance x Class interaction means were presented in Figures 5.1 to 5.9 (SAS, 1979). The Student’s t-LSD (least significant difference) was calculated at the 5 % level of significance to compare means of significant effects (Table 5.4). In Table 5.4 means with the same letter or letters do not differ significantly at the 5 % significance level e.g. a, b, c, d, e or ab, bc and cd. The LSD indicated only heart blood with no significance for both class and system. Student’s t-Least Significant
Difference determinations and all the above statistics were done using SAS statistical software version 9.2 (SAS, 1979).

5.3 RESULTS

In Table 5.3 the final analysis of variance (ANOVA) shows the probability of compliance, class and compliance by class. pH$_1$ shows significant differences for compliance and compliance by class but no significance for class interaction. pH$_u$ differed in terms of compliance only. Temperature at both initial and ultimate time had significant differences in compliance, class and compliance by class. However, in Temp$_1$ the class showed no significant differences. The APC and E. coli counts had significant differences for compliance, class and compliance by class. S. aureus only differed significantly in compliance. In heart blood significant differences were only observed for the class of animal difference (P<0.01). In Table 5.4 the interaction of compliance by class are illustrated. As previously explained the means with same letter or letters do not differ significantly. To illustrate: in the analysis of S. aureus in Sys1 class B and C were the same (both c) but they differed from Sys2 class B and C in that both have the same letter (both b). However in Sys3 there were similarities between class B and C (marked a and ab) but class C had similarities with the classes in Sys2 (marked ab). In the same manner all the variables used for the three systems are marked according to their interaction means.
Table 5.3: Factorial Analysis of Variance (ANOVA) in a complete randomized design for the listed measured variables with compliance and class as main effects on harvested game carcasses

| Source         | DF^1 | MS^2 | P^3   | MS | P   | MS | P   | MS | P   | MS | P   | MS | P   | MS | P   | MS | P   | MS | P   | MS | P   | MS | P   | DF | MS | P   |
|----------------|------|------|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| Compliance     | 2    | 24.9 | <0.01 | 18.2| <0.01| 74.2| <0.01| 78.9| <0.01| 48.8| <0.01| 17.4| <0.01| 5.81| <0.01| 5.81| <0.01| 17.4| <0.01| 5.81| <0.01| 2  | 0.09| 0.86|
| Class          | 1    | 0.06 | 0.51  | 0.05| 0.53 | 0.06| 0.94 | 95.3| <0.01| 78.1| <0.01| 26.9| <0.01| 0.04| 0.57 | 0.04| 0.57 | 26.9| <0.01| 0.04| 0.57 | 1  | 8.28| <0.01|
| Comp. x Class  | 2    | 1.05 | <0.01 | 0.35| 0.09 | 65.3| <0.01| 10.6| <0.01| 15.7| <0.01| 10.4| <0.01| 0.15| 0.37 | 0.15| 0.37 | 10.4| <0.01| 0.15| 0.37 | 2  | 2.56| 0.02|
| Error          | 606  | 0.16 | 0.15  | 13.2| 1.78 | 1.78| 1.08 | 0.42| 0.15 | 0.42| 0.15 | 0.42| 0.15 | 502 | 0.67 | 502 | 0.67 | 502 | 0.67 | 502 | 0.67 | 502 | 0.67 | 502 | 0.67 | 502 | 0.67 | 502 | 0.67 | 502 | 0.67 | 502 | 0.67 | 502 | 0.67 | 502 | 0.67 | 502 | 0.67 | 502 | 0.67 | 502 | 0.67 | 502 | 0.67 | 502 | 0.67 | 502 | 0.67 | 502 | 0.67 | 502 | 0.67 |

^1 = Degrees of freedom, ^2 = Mean square, ^3 = Probability (a probability P<0.05 is considered as significant)
Table 5.4: Mean values of the compliance by class interaction are illustrated

<table>
<thead>
<tr>
<th>Compliance</th>
<th>Class</th>
<th>pH$_1$</th>
<th>pH$_u$</th>
<th>T$_1$</th>
<th>T$_u$</th>
<th>Log APC</th>
<th>Heart blood</th>
<th>Log E. coli</th>
<th>Log S. aureus</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sys1</td>
<td>B</td>
<td>6.43$^a$</td>
<td>5.88$^a$</td>
<td>34.4$^a$</td>
<td>3.78$^a$</td>
<td>2.93$^a$</td>
<td>86.2$^a$</td>
<td>1.20$^a$</td>
<td>0.01$^c$</td>
</tr>
<tr>
<td>Sys1</td>
<td>C</td>
<td>6.33$^a$</td>
<td>5.81$^a$</td>
<td>34.2$^{ab}$</td>
<td>2.59$^b$</td>
<td>1.74$^c$</td>
<td>77.8$^a$</td>
<td>0.41$^{cd}$</td>
<td>0.00$^c$</td>
</tr>
<tr>
<td>Sys2</td>
<td>B</td>
<td>5.74$^{cd}$</td>
<td>5.31$^{cd}$</td>
<td>34.3$^{ab}$</td>
<td>2.31$^{bc}$</td>
<td>1.50$^{cd}$</td>
<td>60.4$^a$</td>
<td>0.15$^e$</td>
<td>0.17$^b$</td>
</tr>
<tr>
<td>Sys2</td>
<td>C</td>
<td>5.66$^d$</td>
<td>5.25$^d$</td>
<td>33.1$^c$</td>
<td>1.96$^{cd}$</td>
<td>1.38$^d$</td>
<td>72.1$^a$</td>
<td>0.26$^{de}$</td>
<td>0.22$^b$</td>
</tr>
<tr>
<td>Sys3</td>
<td>B</td>
<td>5.85$^c$</td>
<td>5.39$^{bc}$</td>
<td>31.8$^d$</td>
<td>2.18$^c$</td>
<td>2.69$^a$</td>
<td>95.2$^a$</td>
<td>0.71$^b$</td>
<td>0.37$^a$</td>
</tr>
<tr>
<td>Sys3</td>
<td>C</td>
<td>6.03$^b$</td>
<td>5.49$^b$</td>
<td>33.3$^{bc}$</td>
<td>1.68$^d$</td>
<td>2.28$^b$</td>
<td>69.9$^a$</td>
<td>0.50$^c$</td>
<td>0.28$^{ab}$</td>
</tr>
<tr>
<td>t-LSD(P=0.05)</td>
<td></td>
<td>0.122</td>
<td>0.117</td>
<td>1.101</td>
<td>0.405</td>
<td>0.315</td>
<td>ns</td>
<td>0.197</td>
<td>0.119</td>
</tr>
</tbody>
</table>

* = Means with the same superscript letter or letters do not differ significantly at the 5% significance level
LSD = Student’s t-Least Significant Difference
5.3.1 APC heart blood

Figure 5.1 shows the APC as found in the heart blood taken from Sys1, Sys2 and Sys3, in the two different animal classes. There was not enough evidence for significant interaction ($P = 0.79$) resulting in acceptance of the counts as being statistically similar in the three systems. Furthermore, compliance with the accepted bacteriological standard for this sampling method ($\leq 2\,000\, \text{CFU/g}$) (Andrin, 2008; Van der Merwe et al., 2011) was noted for both classes of animal in the three systems.

![Aerobic Plate count of heart blood of class B and C game animals tested in the three systems](image)

Figure 5.1: Aerobic Plate count of heart blood of class B and C game animals tested in the three systems

5.3.2 pH measurements

In Figure 5.2 similar and statistically significant interaction patterns were noted for the class B and C game animals. However, all measurements were within the
quality standard set (pH ≤ 6.8). The class B game meat had a slightly higher pH₁ value than the meat from the smaller class C game carcasses. The meat tested in Sys1 had significantly higher pH₁ values than Sys2 and Sys3 (see section 5.4). The Student’s t-LSD (0.122) was calculated at the 5% level of significance to compare means of significant effects. This indicates that the LSD was only calculated when the source effect in the ANOVA is less than or = 0.05). The error bar in the figure is the actual distance of the LSD and can be used to evaluate if differences between means are significant or not. (means further apart than the distance of LSD are significant).

![Figure 5.2: The pH₁ values measured in the meat tissue of class B and C game animals in the three systems](image)

In Figure 5.3 the pH_u values were taken in the same manner as pH₁, but at ultimate time (pH_u). A similar pattern was found in the class B and C game meat.
and all readings were within the set quality standards of pH ≤ 5.8. The two classes of animal showed the same trend as in pH₁. Although there was not enough evidence for a significant interaction pattern (P=0.09) between the two classes in the three systems. Sys1 had significantly higher pH values than Sys2 and Sys3.

![Figure 5.3: The pHᵤ values measured in the meat tissue of class B and C game carcasses in the three systems](image)

5.3.3 Temperature measurements

In Figure 5.4 the carcass temperature measurements taken at (T₁), post-mortem showed significant (P < 0.01) interaction patterns between the three compliances as well as between the two classes. The T₁ for Sys1 and Sys2 were the same for class B, at 34.4 °C, but the T₁ for Sys3 was slightly lower but significantly so (P < 0.01) for the interaction patterns between the classes. A similar pattern was followed for the class B and C game meat, as the class C was the same in Sys1
and Sys2 but lower in Sys3. All measurements were below the <38 °C set standard.

![Graph showing carcass temperatures (T₁) of class B and C game carcasses measured in the three systems.](image)

**Figure 5.4:** The carcass temperatures (T₁) of class B and C game carcasses measured in the three systems.

In Figure 5.5 the carcass temperatures measured (Tᵤ), also showed significant (P < 0.01) interaction patterns between the three compliances and two classes. The Tᵤ for Sys1 was significantly higher than the Tᵤ for Sys2 and Sys3. A similar pattern was followed for the class B and C game meat. All readings were within the 2-7 °C set standard.
Figure 5.5: The carcass temperatures ($T_u$) of class B and C game carcasses measured in the three systems

5.3.4 Time period to chilling

In Figure 5.6 the time to chill in hours for the B and C carcasses in Sys1, Sys2 and Sys3 are illustrated. The compliant time (VPN ≤4 hours) was only adhered to in Sys1. Sys2 and Sys3 carcasses were only refrigerated after 12-13 hours. Although a similar time pattern was followed for the class B and C game meat, class differences were significant ($P < 0.01$).
Aerobic Plate Count (APC)

APC determinations were conducted on the carcass surfaces for all three systems at ultimate time (72 hours post-mortem). Sys1 using the excision technique and Sys2 and Sys3; the Enviro-biotrace swabbing technique (see section 5.2.2.2). In Figure 5.7 the results for the APC are illustrated; significant (P < 0.01) interaction patterns between the three compliances and two classes were noted. The interaction is due to the significant difference between class B and C for Sys1 and Sys3 while for Sys2 there was no significant differences. The results for all three systems fell within the upper specification of \(10^5\) APC CFU/cm²) (South Africa, 2010d). A similar pattern was observed for class B and C, with class C showing a slightly lower bacterial load than class B. Overall Sys2 had a significantly lower bacterial contamination than Sys1 and Sys3.
Figure 5.7: The Aerobic Plate Counts (APC) determined on class B and C game carcasses for the three systems.

5.3.6 *Escherichia coli* (*E. coli*)

In Figure 5.8 the mean results of *E. coli* at ultimate time for the significant (P<0.01) interactions between compliance (Sys1, Sys2 and Sys3) and classes (B and C) are indicated. The pattern for the class B carcasses was more curved due to the lower results for Sys2. The results for class B carcasses for Sys1 were higher than those observed for Sys2 and Sys3. There was a significant difference between the class B and C game within Sys1. In general, class C showed a slightly lower bacterial load than class B. Class B and C game carcasses from Sys2 had lower bacterial counts than Sys1 and Sys3. The counts for class B and C for Sys2 were overall lower than that of the other two classes. The results for all the systems...
were below the upper specification of ≤ 100 CFU/cm² (ICMSF, 1996; South Africa, 2010d).

Figure 5.8: *E. coli* determined on class B and C game carcasses for the three systems

![Graph showing E. coli results for different classes and systems](image)

5.3.7 *Staphylococcus aureus (S. aureus)*

In Figure 5.9 the transformed interaction results of the mean *S. aureus* counts at ultimate time for compliances and classes are shown. The results for Sys1 were lower than that observed for Sys2 which in turn was lower than Sys3. There was no significant difference between classes B and C for *S. aureus* within Sys1 or Sys2. In Sys3 only slight differences between the classes were observed. The *S. aureus* results for all the systems complied with the upper specification ≤ 100/1 cm² (CFU/cm²) (ICMSF, 1996; South Africa, 2010d).
Figure 5.9: *S. aureus*, determined on class B and C game carcasses for the three systems

5.3.8 *Salmonella*

None of the samples (n = 612) analysed for *Salmonella* for the three systems showed any positive results and were consequently with null data significance.

5.3.9 Shelf life of game meat in Sys3

In Figure 5.10 the regression coefficient of the shelf life test results are shown. A similar pattern was observed for samples of all the species tested: blue wildebeest n = 8 (class B), kudu n = 3 (class B) and impala n = 2 (class C). The initial APC count on all the samples decreased towards the third day after which the initially undetectable *Lactobacillus* or spoilage bacteria increased towards the sixth day. Lactobacilli present in the sample are part of the APC count, but are not
quantifiable in low numbers (Gill et al., 2000b; Siliker, 1963). Class C samples showed a shorter period (2.6 days) in comparison with the class B animals (3.4 days) before the upward curve in the increased *Lactobacillus* count was observed.

![Figure 5.10: Shelf-life 2nd order polynomial regressions fitted to each of the game species samples tested in System 3](image)

### 5.4 DISCUSSION

It is reported that in South Africa, especially during the hunting season, uncontrolled game meat contributes to more than 20% of the total fresh red meat consumption (SAMIC, 2009). It is expected that the phenomenon will increase even more as a result of the fact that the South African hunting season has been extended from three to almost six months (from the beginning of March to the end of August), coupled with the on-going increase in the number of game farms. In
addition Bothma (2005b) and Reilly et al. (2003) reported that more and more cattle farms are changing to the more profitable farming of game animals. In this scenario, the increasing production of game animals for meat production can create a need for hygiene guidelines.

From the results of the bacterial counts performed on the heart blood from the three groups it could be interpreted that \textit{E. coli}, \textit{S. aureus} and \textit{APC} \textsubscript{u} were not initially present, but were added to the carcasses during the slaughter process (Dunn et al., 2004; Fegan et al., 2005; Gill et al., 2000a; Ryan & Ray, 2004; Sargeant et al., 1999; Smith et al., 1974; Vaarala & Korkeala, 1994). The least student difference t-test (LSD t-test=0.05) supported this theory with no differences in the interaction means for the three systems.

The pH\textsubscript{1} results (Figure 5.2) indicated a low level of lactic acid resulting in a higher pH in carcasses of animals in Sys1 due to lower activity stress in these animals before cropping. In a typical situation, high intensity cropping is conducted on a ranch registered for export where professional marksmen use highly sophisticated methods to ensure swift and efficient killing methods (Hoffman & Laubscher, 2009, 2010, 2011). The pH results for Sys2 and Sys3 carcasses were lower and typical of when individual animals are tracked and hunted as trophies in a low intensity hunting system (Hoffman, 2000; Hoffman & Ferreira, 2000; Hoffman & Laubscher, 2009, Kritzinger, Hoffman & Ferreira, 2003). Muscle activation (running animals) and stress can deplete the glycogen levels and induce higher pH levels that will negatively influence the shelf life of the meat (Wiklund, 2011; Wiklund \textit{et al.}, 1996). However, according to Hoffman and Dicks (2011) game meat normally has a lower
pH than meat from domesticated animals and this will not enhance rapid bacterial
growth. In relating the pH to the size of the animal it was found that Class B
(larger) animals presented with a slightly higher pH than the class C animals.

Temperature measured for the three groups (Figure 5.4) presented with
significant differences only between the classes. As expected, the initial post-
mortem carcass temperatures were close to normal body temperature and
decreased towards $T_u$, the rate depending on the effectiveness of the cold chain.
The $T_1$ and $T_u$ were higher for the class B animals (Figures 5.4 and 5.5), a
phenomenon most probably indicative of the slower cooling rate of the larger
carcasses. The explanation of the class difference in Sys3 (class C took longer
than class B) was due to refrigeration not being prioritised as the hunter and his
trophy are photographed and consequently the carcasses were cooled down more
slowly due to delayed refrigeration of the specific carcasses. Class B carcasses
could however be halved to enhance the cooling process and to prevent deep
bone taint (that was not tested for). However, Wariss (2000) notes that the
temperature of carcasses should not fall below 10 °C during early post-mortem
since lower temperatures would inhibit the natural meat tenderizing enzymes,
resulting in less tender meat.

Although significant differences were observed between classes B and C the APC
determined for Sys2 (Figure 5.7) was lower than Sys1 and Sys3 and this indicated
that low intensity hunting adhering to meat hygiene principles resulted in game
carcasses with lower bacterial counts. Gill et al. (2000b), Paulsen (2005) and
Vaarala and Korkeala (1994) noted that if GHP are adhered to, low APC counts
will be expected. In Sys1 (high intensity cropping), a greater number of animals are cropped for meat (export) an activity usually conducted during night time in comparison with trophy hunting where hunting occurs during the day and fewer animals are involved. This night harvesting could have a negative influence on conforming to hygiene principles due to poor visibility on the slaughter line as well as in the field where evisceration frequently occurs. Furthermore, the slaughtering procedures and handling of larger game carcasses in comparison to smaller carcasses generally poses greater difficulties in terms of hygiene and results in higher bacterial contamination levels (Gill et al., 2000b; Smith et al., 1974).

The same argument as with the APC could be used for E. coli in terms of the classes as well as the three systems (Figure 5.8). In terms of health compliance, the larger animals presented with higher numbers of E. coli and the results would seem to indicate that the hygiene knowledge and correct slaughtering methods as implemented made a difference in terms of safe meat as observed in the low intensity hunting in Sys2 carcasses. This finding was similar to observations of other workers where training and GHP are adhered to (Fegan et al., 2005; Li et al., 2004; Stephens, 2006).

The compliance with the standard for S. aureus in the three systems showed no significant differences Figure 5.9) and the interaction of classes B and C similarly also showed no differences. The counts for Sys2 were lower than with the other two systems and indicated that S. aureus could be minimized when addressing the “human factor” (Casoli et al., 2005; Coburn et al., 2005;). General and personal
hygiene are crucial in the slaughter process to eliminate pathogens such as E. coli and S. aureus (Sprenger, 1999).

The shelf life tests conducted (Figure 5.10) indicated that maintenance of the cold chain (samples incubated at 4°C) will within the first 3 days inhibit most of the bacteria (including pathogens) present. Similar results were noted by Buys et al, (1997). Lactobacilli did however, increase in numbers after day five – most probably due to anaerobic bacterial growth and consequently the lower pH (O’ Halloran et al., 1997). A metabolite of lactobacilli is lactic acid and the more their numbers increase the more acidic the environment becomes and the more favourable the growth medium becomes for lactobacilli. This will inhibit pathogens and other spoilage organisms (Lambert et al., 1991; Smith et al., 1974; Todd, 2004). High carcass pH values will ultimately result in a less desirable shelf life due to the growth of spoilage organisms (Smith et al., 1974). However, Sahoo and Anjaneyulu (1997) concluded that better palatability and increased flavour are characteristic of meat when there is an increase in the numbers of lactobacilli. Too many lactobacilli can however result in a cheesy off-flavour.

5.5 CONCLUSIONS

It was clear that the carcasses from Sys2 (that is uncontrolled and do not comply with VPN) is on par with the carcasses from Sys1 (that complies with the strict requirements of VPN). Furthermore, both systems adhere to basic training in personal and meat hygiene and conducting the prescribed procedure of game meat inspection. It could be concluded that accredited, industry driven training modules in basic meat hygiene as well as training of game meat examiners to
conduct game meat inspection on game farms, could play a vital role in the insurance of safe game meat production for the commercial local market.

In this study low intensity hunting (adhering to hygiene principles) for the local market in comparison with high intensity cropping for the export market proved to render meat of a comparable bacteriological and quality standard.

The farm workers on a game farm are utilized in all the functions and duties to be performed on the farm. These people are multi-skilled and during the hunting season they assist with tracking of animals, slaughtering and general handling of the carcasses. In the off-season they maintain roads, repair fences and do general farm work (Shack, 2008). However, since meat production has in the past not been regarded as a source of income, the farm workers are seldom trained in basic meat hygiene, personal hygiene or good meat handling practices. According to Frazier and Westhoff (1988), Smulders and Woolthuis (1983), and Sprenger (1999), personal hygiene of food handlers and in particular their hands plays a vital role in the contamination of raw meat. In addition, potable and warm water according to South Africa (2004) should be available during meat handling for the washing of hands to control contamination (Sprenger, 1999).

The primary slaughter facility in Sys1 during high intensity cropping is a temporary structure and a formal abattoir as required by the MSA is only required for the secondary slaughter processes. For this reason, the primary slaughter facilities for low intensity hunting on the ranch could be approved according to the same standard. It is then in conclusion recommended that the concept of mobile abattoirs (currently used by the export market in the cropping of game carcasses)
could be the most practical, affordable and hygiene compliant solution to both the export and local markets.

The next chapter will deal with a further comparison of environmental and other independent variables for the three systems of game meat production in South Africa.
CHAPTER 6

THE HYGIENIC PRACTICES INVOLVED IN THREE GAME MEAT PRODUCTION SYSTEMS IN SOUTH AFRICA BASED ON ENVIRONMENTAL AND OTHER INDEPENDENT VARIABLES

6.1 INTRODUCTION

The Game Industry in South Africa can be divided into two systems: on the one hand, the strict regulatory system for game meat intended for export purposes and on the other, an uncontrolled system applicable to game meat on the local market (van der Merwe et al., 2009). In Chapters 4 and 5 of this thesis the biological and food safety requirements of the European Union were discussed and researched in terms of different game meat production systems in South Africa. In this chapter independent variables based on EU standards will be used to further compare environmental and other differences between these systems, (systems described in Chapter 5) in terms of safety and quality. System 1 (Sys1) supplied game animals intended for the export market ($n = 295$) and cropping projects were conducted on ($n = 12$) game farms with similar facilities, System 2 (Sys2) supplied game carcasses intended for the local market, but was subjected to the application of specific hygiene and safety guidelines ($n = 165$) on a specific game farm ($n = 1$) and System 3 (Sys3) game carcasses ($n = 152$) were intended for the local market, but were not subjected to the application of any health and safety guidelines and were conducted on ($n = 12$) game farms with similar facilities. In Chapter 5 dependent variables, *inter alia*; carcass temperature and pH, shelf-life as well as index and indicator bacterial counts for the three systems were discussed. In the present chapter it has been deemed important to further report
on the independent variables that were studied for the three systems. These variables are situational and are based on procedural, environmental and other parameters as specified in the Veterinary Procedural Notices (VPN). These include *inter alia*: compulsory farm registration for harvesting for the export market, requirements for the hunter, the required shot placement and bleeding method, carcass transportation on the farm, requirements for the slaughter facility, a hygiene management system (HMS), and traceability compliance of the game meat. Furthermore, the training of farm staff in basic meat hygiene as well as the training of a game meat examiner to conduct meat inspection on the game carcasses is discussed.

The VPN could be described as the most stringent part of the game meat hygiene legislation as it is based on EU standards that further require management principles such as HACCP, ISO 9000 and ISO 14000. The VPN that were used for the independent variables described in the previous paragraph include: VPN/05/2008-09 i.e. the Standard for the registration or re-registration of a game farm for export purposes (South Africa, 2010b), VPN/08/2008-09 i.e. the Standard for the registration of hunters for harvesting wild game intended for export of game meat (South Africa, 2010a), VPN/09/2008-09 i.e. the Standard for the ante- and post-mortem meat inspection and hygiene at the point of harvest and hygiene control at point of game harvest and finally VPN/10/2008-09 i.e. the Standard for post-mortem meat inspection and hygiene control at game meat establishments (South Africa, 2010c). Although a standard operating procedure (VPN/19/2009-01 i.e. the Standard relating to the National export residue control programme) is used by the export market as an assessment to determine which veterinary drugs
and environmental chemicals or agricultural compounds must be singled out for surveillance in animal products, it is currently not compulsory for the local market and this has been documented in the abovementioned VPN nr.19 as such. The main aim of this chapter was to strengthen the discussion in the previous three chapters that safe game meat is ensured by good hygiene practices and knowledge through meat hygiene training. Therefore, the identification of independent variables (based on the standard as prescribed in the VPN) that can influence meat safety and quality within the three systems were conducted.

6.2 MATERIALS AND METHODS

6.2.1 A situational analysis of environmental and other independent variables relevant to the quality of game meat in three South African game meat production systems.

The following independent variables were addressed: farm registration, the hunter, veld type, shot placement and bleeding method, carcass transportation on the farm and the slaughter facility. Further aspects investigated relate to a hygiene management system, traceability compliance and training of farm staff involved in the process of obtaining game carcasses. The variables discussed play an important role in ensuring high quality safe game meat for export purposes, but were also used to compare the three systems and to highlight areas of concern in the uncontrolled supply of game meat to the local market. The analysis was done through documented observations of the three systems measured against the EU criteria of the abovementioned VPN. The observations included the swab-techniques and other measurements reported on in chapter 5. The three systems
(defined in Chapter 5) used in this study differed as follows in the hunting procedures that were followed:

- **System 1**
  Animals were shot from a vehicle, hoisted onto a frame or a ramp on the recovery vehicle and exsanguinated within 10 minutes by cutting the throat. Evisceration (removal of the “viscera” this is the fore stomachs {rumen, reticulum, omasum, abomasum and intestines}) and primary meat inspection follows at the temporary slaughter frame in the veld, which is equipped with slaughter frames, inspection hooks and washing facilities for sterilization. The undressed (unskinned) carcasses are loaded within 4 hours onto a refrigerated vehicle and transported to the abattoir.

- **System 2 and System 3**
  Animals are shot both from a vehicle and on foot, depending on the hunt and the hunter’s preference. Trophy carcasses are not exsanguinated to prevent damage to the trophy but bleeds internally when damaged by thoracic shot or when the chest stick method is used to promote internal bleeding. Evisceration usually takes place in the veld and the eviscerated material is left for scavengers and vultures. Carcasses are transported to a slaughter facility on the farm after photos and other traditional procedures are completed. Carcasses are caped (for trophy purposes) or skinned and hung to dry before refrigeration (usually for 10-12 hours). Meat hygiene and inspection were applied to Sys2 carcasses.
6.2.2 Specific techniques or methods employed

The criteria used for all independent variables were based on the VPN requirements as previously specified (South Africa, 2010a; South Africa, 2010b; South Africa, 2010c). The dependent variables included the following:

- **Veld type** only two criteria were considered in terms of accessibility to carcasses for transportation to the slaughter facility namely: open or bushy terrain. Dense areas with trees and hills were classified as “bushy” and open savannah areas with mainly grass and smaller shrubs were classified as “open”. A refined definition of the above criteria was used for each carcass.

- **Shot placement** quantified by observation of the part of the body in which the shot was placed namely in the head, in the front quarter (including the neck) or in the hind quarter (including the backbone and gut).

- **Bleeding methodology** data was obtained by observation and recording of the time to bleed from shooting as well as the method used (if any) compared against criteria from the VPN.

- **Taking and testing of water samples** sampling results were obtained on Sys1, Sys2 and Sys3 farms.

- **Level of training** proof of qualifications (see Addenda G and H) and meat hygiene training were requested to determine the level of training of staff on the specific farm (Sys2).

- **Compliance in % of meat inspection** Based on observations recorded during harvesting and hunting projects out of the total number of carcasses monitored in each system.
6.2.3 Statistical procedures

A total of 625 carcasses were observed and measurements taken, of which 612 were used for the final data analysis. R x C contingency tables were constructed (a two way table with measurements and percentages) and the Chi-square test was performed to test for independence and similar patterns between the different rows. This was done using SAS statistical software version 9.2 (SAS, 1999).

6.3 RESULTS AND DISCUSSION

6.3.1.1 Veld Types

The VPN do not require description or specification of the veld type and consequently game farms registered for export, can be situated in various regions or environments including the following: semi-desert areas in the Northern Cape, savannah veld in the Free State, mountainous terrain in the eastern Cape and the very dense bush in the Provinces of Limpopo and North West. The veld type for Sys1 was mainly open veld as harvesting for export purposes is conducted mainly on springbok that prefer open savannah regions (Ebedes & Meyer, 2008). Sys1 preferred two and three digit numbers of game units to be harvested at a time, to increase the profit margin as transportation and the costs for harvesting teams and equipment are high (Bothma, 2002, Kruger, 2004). For this reason, open areas were preferred to accommodate big harvesting teams with their equipment as well as to facilitate the harvesting process (Ebedes & Meyer, 2008). Sys2 and Sys3 conduct trophy as well as biltong hunting and therefore vast regions, regardless of
the topography, are covered to hunt game on these types of ranches (van der Merwe & Saayman, 2008). It is however recommended that an open hunting area could facilitate shorter time periods for carcass recovery and less transportation time to the slaughter facility and the further cooling process of the carcass (see comments on the findings in terms of the relevant Figure in the Results section). The predominant veld type in Sys1 was open areas in Sys2 bushy veld and Sys3 an equal combination of the two. However, for each carcass a more refined definition was used in terms of the specific area on the farm where the animal was hunted. Low velocity calibre rifles should be used in bushy areas to minimize the damage to the carcass (shooting distances less than 120 m). According to Shack (2008) in desert areas long distances could be applicable and fast heavy premium spritzer bullets should be used. He noted that; when hunting bigger animals in open plains, heavy bullets with good ballistic co-efficiency should be used whereas heavy bullets will destroy smaller animals. Hunters have to use different calibres that suit the area as well as the animal being hunted. Difficult terrain will have a negative influence on the shot placement (damage to the carcass) bleeding time, evisceration time and the time to chilling. All such factors will determine the safety and quality of the meat.

The veld type will also influence the recovery time of the hunted carcass (in terms of accessibility and carcass transportation) which could consequently, have an effect on the hygiene and quality of the meat. All three systems are compelled to hunt or harvest in different veld types to obtain the preferred trophy (Sys2 and 3) or an economically viable number of animals for cropping (Sys1). In Figure 6.1 the results are shown for the veld type in the three systems. Differentiation has only
been made in this section between open and bushy, but veld types could also differ from steep hills to sandy and rocky. For the purpose of this study and to determine the accessibility, only the open and bushy criteria were used. On the Sys1 ranches, harvest was mainly conducted in open veld to prevent time delays in obtaining game carcasses and because it was the habitat of springbok that is the preferred export carcass. The ranch that represented Sys2 was situated in the North West Province and the veld type was predominantly bushy. On the Sys3 ranches an equal combination of open and bushy veld types occurred.

Figure 6.1: Veld types on which harvesting and hunting occurred in the three systems
6.3.1.2 Carcass transportation on the farm

i) System 1

Vehicles used in Sys1 to transport harvested game carcasses from the point of kill to a game depot, game abattoir or establishment must be constructed according to the category of game handled. Vehicles used for harvesting category C or small game must for example have a hanging frame to bleed carcasses in a hanging position and vehicles used for harvesting category B or medium game must in addition have a hoist and a suitably manufactured ramp for hanging and bleeding this category of animals. The method of transport that is used to take carcasses to the slaughter facility will determine the time, and to a lesser extent, the contamination of the carcasses.

The relevant VPN (South Africa, 2010c), furthermore requires sterilizers, hand washing facilities and artificial light of at least 220 Lux (where culling takes place at night), available on these vehicles. Game carcasses must be transported to the slaughter facility within 2 hours. Other requirements for vehicles in Sys1 include sterilizers and potable water (South Africa, 2004) for the washing of hands.

ii) Systems 2 and 3

The vehicles used in the veld during the hunt in these two systems, are normally also the vehicles that will transport the carcasses and no hanging frames or sloped facilities are available on these vehicles. Usually, 4x4 vehicles are the preferred method of transport due to the numbers or the size of the carcasses and the manoeuvrability of the vehicles. Most of these vehicles also have elevated seating
for the hunters and thus the space for carcasses is limited. The distance and terrain will determine the period of transport time to the slaughter facility (abattoir) and will have an influence on the time to bleeding and evisceration. Carcasses are eviscerated in the veld when a carcass is in danger of bloating (Veary, 1991). The distance to travel will ultimately be decisive in the time to chilling or refrigeration of the carcass. The hunters, trackers and sometimes dogs (frequently used to help follow the spore of wounded animals) are transported with the hunted carcass on these vehicles back to the slaughter facility on the farm. However, some carcasses are bled and/or eviscerated in the veld, but most carcasses remain unopened during transportation to the slaughter facility on the farm.

6.3.1.3 Shot placement

Shot placements are regarded by the export market as the starting point of a safe carcass for human consumption. According to Hoffman and Bigalke (1999) poor shot placements will result in poor carcass yield. Marksmen in Sys1 are punished in terms of their remuneration when failing the required head shots. In Sys1, carcasses with front and hind quarter shots are condemned (South Africa, 2002, South Africa, 2010c).

In Sys2 and Sys3 the shot placement and the meat is not prioritized, the hunt itself being granted top priority (van der Merwe et al., 2009). Therefore, less than ideal shot placements as can be seen in Figure 6.2 to be the norm. In support of Sys2 and Sys3, the application of an ideal shot placement was refuted by Urquhart and
Mckendrick (2006) and they recommended that factors such as animal welfare should rather be considered.

The bleeding method and time is specified for Sys1 and no other bleeding methods are approved for export. However, successful bleeding has been observed with immediate post-mortem evisceration of carcasses as well as that due to internal bleeding with thoracic shots (when vital organs are damaged). Recorded, scientific proof of throat slitting as preferred method of bleeding is not available, but is an international norm suggested by the OIE, FAO and Codex Alimentaruis Commission based on the slaughtering process of domesticated animals when the animal is not killed but stunned and the pumping action of the heart ensures complete bleeding through the severed throat (Herenda et al., 2000; South Africa, 2000). Sys2 and Sys3, as mentioned, make use of several other methods of bleeding and not always within the required 10 minutes (Shack, 2008; van der Merwe & Saayman, 2008

i) System 1
In this ranching system the harvesting of game for export purposes may only be done by a registered hunter and must furthermore be done in such a way that it is reliably expected to cause immediate death; and is in accordance with animal welfare. Head shots are used and game killed with thoracic shots is subject to secondary meat inspection so that a decision can be made on condemnation (veterinary approval). Abdominal shots must be condemned for export purposes and cannot be transported to establishments together with approved carcasses. The VPN (South Africa, 2010a) and draft Game Regulations (to be promulgated
under the Meat Safety Act, Act 40 of 2000) stipulate that only head shots are approved for commercial purposes and that any wounded animals requiring a second shot be condemned if a time period of more than 10 minutes is exceeded after the first shot. The desirability to cause instant death with minimum injury or pain to the animal and the ideal to prevent high levels of stress and low levels of muscle glycogen are all motivational issues in this requirement.

i) Systems 2 and 3
The hunters in ranching systems Sys2 and 3 are not registered, but are competent hunters (National Conventional Arms Control Act 41 of 2002 a(South Africa, 2002) and shot placement is relevant to the trophy required (caped or full mount) and the veld type (accessibility to the game). In this scenario; a thoracic shot is regarded as a safe shot in terms of animal welfare (Shack, 2008). Abdominal shots may take place when trophy hunting and when hunting in dense bushes with poor visibility. Urquhart and Mc Kendrick (2006) concluded that head shooting could result in wounded animals and more consideration should be given to animal welfare rather than marksmanship. However, for trophy purposes shot placements are sometimes intentionally gut and hind quarter to facilitate cape or full mount trophies. Although this is not desirable in meat production, the possible conditional utilization of trophy carcasses in the commercial market was recommended by Hoffman and Laubscher (2009). Trophy hunting, when conducted in difficult hunting terrain or with poor visibility for a clear shot usually require thoracic and even hind-quarter (gut) shots. These shot placements are considered by the export market to result in high pH readings and poor bleeding reports.
In Figure 6.2 the different shot placements used in the three systems are shown. On the Sys1 ranch, head shots were compulsory and marksmen in the export trade are paid according to their compliance percentage (Bergh, 2005). Game shot on Sys2 and Sys3 ranches showed a high incidence of shot placement in the thorax as well as in the gut.

![Shot placement graph]

Figure 6.2: Shot placements in hunted game on the ranches representing the three systems

6.3.1.4 Bleeding (exsanguination)

i) System 1

Game hunted on Sys1 ranches must according to the VPN be bled within 10 minutes of being shot. Sufficient literature is not available on bleeding volumes for every species, neither is literature available with regard to the time needed for “good bleeding”. Category B animals (blue wildebeest and eland) are compared to
domesticated bovine animals to determine the bleeding volumes (Bergh, 2005). Domesticated pigs or sheep are similarly used in comparison with category C animals such as impala and springbok for their blood volumes. Visually noted observations, during the study, of the dressed carcasses at export harvesting operations as well as planned trophy hunts, indicated that game animals are bled as effectively as their counterparts in red meat abattoirs. Bleeding is done by means of severing the jugular vein and carotid artery on either side of the neck (throat slitting). Bleeding must be done whilst the carcass is in the same position as during transportation (South Africa, 2010c). The bleeding knife used must be cleaned and sterilised with water at 82 ºC or via a chemical method of sterilisation, approved by the Veterinary Authority, may be used (South Africa, 2002).

ii) Systems 2 and 3

On Sys2 and 3 ranches, hunted animals are not always bled within 10 minutes of shooting or with the required method of throat slitting. It can however be argued that bleeding is equally effective when, for example, the carcass is immediately eviscerated in the field and the femoralis artery is severed. Also, bleeding of trophy carcasses (throats not being slit for cape and trophy purposes) usually occurs internally when the vital organs are damaged by the shot (especially when a thoracic shot is used) and such cases have been shown to bleed effectively as blood accumulates in the thoracic cavity and is released during the slaughtering process (Bergh, 2005). In Figure 6.3 the bleeding method used by the hunters in the three systems are shown as a percentage of the animals shot. Game bled on the Sys1 ranch complied fully and the method of bleeding was by severing the jugular vein in the neck, but bleeding on the Sys2 and Sys3 ranches was usually
internal (thoracic shot), since neck bleeding is undesirable with trophy hunting in the latter two systems.

![Bleeding method chart]

Figure 6.3: The different bleeding methods used by the three systems respectively

6.3.1.5 Water sampling

VPN 10 (South Africa, 2010e) requires proof of potable water according to SANS 241 (South Africa, 2004). For the purpose of this study the focus was on the bacteriological compliance of the water. Sys1 and Sys2 complied with VPN10, but 29% of the farms in Sys3 did not comply (Figure 6.4). Taking into consideration the dry process when game animals are slaughtered, a statement can be made that potable water is not as applicable in a game slaughter facility as in a red meat abattoir with big volumes of effluent and where water is used to wash carcasses, surfaces and floors. However, potable water is very relevant for the washing of
hands, surfaces and sterilization of equipment and should therefore be adhered to on game farms (Sprenger, 1995).

i) System 1

According to the VPN Standard for post-mortem meat inspection and hygiene control at game meat establishments (South Africa, 2007), the ranch owner is responsible to provide proof of potable water available on the ranch registered for export harvesting. Furthermore, the abattoir owner must ensure that water used in the slaughter facility/abattoir is potable, as stipulated by the South African National Standards (SANS) 241 (South Africa, 2004). In the abattoir, records of microbiological and chemical water test results must be available. Such results were recorded in this study for Sys1. For the process of obtaining the carcasses on the farm, potable water and facilities must be provided for the sterilisation of the knives and equipment at 82 °C or any other means of sterilization approved by the Veterinary Authority. The washing of hands and equipment with hot running water at 40º C or using an acceptable SABS Food Grade approved disinfectant added to the water is required (Sprenger, 1999).

ii) Systems 2 and 3

Although the slaughter process of game animals is inherently a very dry process and the amount of water used in the slaughter facility/abattoir is minimal, water tests were conducted on all the ranches in Sys2 and Sys3 to test compliance with the SANS 241 standard for potable or drinking water (bacteriologically compliant) and to rule out possible contamination from water sources (SANS, 2005). The SANS standard for potable water is: *E. coli* count per 100ml = 0 and coliform count
per 100ml ≤ 10. Water samples were taken aseptically from taps in the slaughter facility in sterilized 250ml glass bottles provided by the laboratory, placed in coolers and submitted to the laboratory together with the surface swabs taken from carcasses on the ranch.

In Figure 6.4 the results of the water samples taken are shown for the three systems. As required by the VPN the farms that were registered for export harvesting in Sys1 complied. With regard to Sys2 all carcasses were from one farm and the results were also in accordance. However, game farms make use of boreholes and river water and this could result in possible water contamination when such uncontrolled water sources are utilized.

Figure 6.4: The compliance of potable water (SANS, 2005) tested on ranches representing the three systems

In Figure 6.5 the traceability of carcasses in the three systems are given in percentage of the animals hunted. According to the VPN this is required for Sys1,
but according to the new regulations is also required for any carcass in the local commercial market. Sys3 ranches however, do not have any recording systems available. In Sys2, 1% of the carcasses were recorded but were not traceable due to trophy carcasses that could not be utilized for their meat. In Sys3 1% of the carcasses were traceable when records were kept on request from the professional hunters or outfitters. The documented recording system is discussed in more detail under section 6.3.1.9 under the heading “Registration of a game farm for meat export”. Traceability is required by the EU and Sys 1 is consequently compelled to ensure traceability of all meat (South Africa, 1972). Traceability in terms of animal disease control is very important and required for all foodstuffs on the commercial market (Bekker et al., 2011). Traceability requires a recorded system of documentation from the production farm through to the consumer (South Africa, 1972). The Sys2 ranch had a recording system on the farm, but the documentation was sometimes not completed by the processors or end-buyers since the legal requirement is not compulsory yet for the local market (Bekker et al., 2011). Sys3 did not comply with traceability (see Figure 6.5) as no records are kept on the farm or by the buyers of the meat. Priority again is with the thrill of the hunt and not with records (van der Merwe et al., 2011). VPN 09 (South Africa, 2010c) stipulates that meat inspection must be performed by a qualified meat inspector (qualified to SAQA level 4) for the purpose of export. However, the physical inspection is conducted on the slaughter floor by a meat examiner (qualified to SAQA level 3) (see Addendum G). The meat examiner conducts his inspection under the supervision of a meat inspector or a veterinarian to assist with secondary inspections and final decisions on detained carcasses (South Africa, 2010c). The function performed in Sys2 by the meat examiner is then in
compliance with a supervision deficit of a game meat inspector or a veterinarian (South Africa, 2010c). However, carcasses can be detained until a secondary inspection has been conducted by a game meat inspector or a veterinarian and a decision made to condemn or approve the carcass. In Sys3 no meat inspection is conducted as there is no legislation applicable except for export game meat (Sys1) that requires inspection. Inspection will not be required if a few animals are culled for own consumption, yet large numbers of animals sold through super markets may have to adhere to standards as prescribed in the Meat Safety Act, 40 of 2000.

![Traceability compliance chart](chart.png)

Figure 6.5: Traceability of game carcasses from ranches in the three systems

6.3.1.6 The Harvester/hunter

i) System 1

The hunter, after the owner, is the second role player in the harvesting team that will assist the game rancher in removing certain pre-planned parts of the game
population, by culling those animals intended- and fit for human consumption (South Africa, 2010a). The hunter/harvester in system 1 is expected to: provide a professional team of people consisting of well trained and experienced marksmen as well as trained and accredited veld abattoir personnel. The hunter must provide the right equipment to execute the task swiftly and professionally, such as suitable rifles, spotlights, specially equipped vehicles, a mobile field abattoir constructed according to state veterinary specifications, scales, sterilizers, generators, etc. In addition he must follow the correct prescribed veterinary procedures and ensure the highest levels of hygiene during the whole process. Correctly dressed and inspected carcasses are then transported within prescribed time schedules by refrigerated trucks to the abattoir. This is the stage when the crucial cold chain during meat transport and processing starts (Shack, 2008).

ii) System 2
Although the hunter in Sys2 is not registered (as in Sys1), he has successfully completed training in modules, as specified in Chapter 5, that include procedures or techniques in meat hygiene during and after the process of hunting as well as proficiency in meat inspection. These components are needed to ensure a carcass that is safe for human consumption (Bergh, 2005, Bergh, 2007, South Africa, 2010c).

iii) System 3
In Sys3 the hunter’s intention is to obtain a trophy for his collection. Shot placements and correct slaughtering or dressing methods are not a priority (van der Merwe et al., 2009).
6.3.1.7 Meat inspection at a game depot or abattoir

i) System 1
The registered inspector at the depot or abattoir must inspect each game carcass and matching viscera, head and feet, noting any abnormalities and in the case of a depot, an inspection report must be made to the registered inspector at the game abattoir. The inspection procedure is specified in the VPN and MSA (South Africa, 2010c; South Africa, 2000).

ii) System 2
On Sys2 ranches game meat inspection was conducted on all carcasses by hunters qualified as game meat examiners. However, the inspection was done according to the MSA and VPN as specified in Sys1, not by a “game meat inspector” but by a trained “game meat examiner” (see Addendum H for the qualification specifications according to SAQA). The relevance of the training level is motivated by the Game Meat Scheme as well as the proposed Game Meat Guide in Chapter 7 where a game meat examiner performs the same function as a game meat inspector but on a lower level of training according to SAQA. This lower qualification level is more affordable and viable on game farms producing meat for the local market. This finding was furthermore confirmed by Bekker et al. (2011).
iii) System 3

Meat inspection was not performed on any of the carcasses on Sys3 ranches for approval and no qualified persons were appointed at the facility for meat inspection.

In Figure 6.6 the different levels of training are shown for the three systems. Sys1 is compelled to have meat inspection by a qualified meat inspector, Sys2 conducted meat inspection by a game meat examiner and in Sys3 no inspection was conducted on any of the carcasses.

![Figure 6.6: The level of training for meat inspection on ranches in the three systems](image-url)
6.3.1.8 Registration of a game farm for meat export

i) System 1

In a ranching set-up such as System 1 (Sys1), the VPNs require the owner of the farm to apply in writing for a registration certificate issued by the Provincial Executive Officer (PEO) if he/she wishes to register or re-register a farm with the intent to harvest wild game animals for abattoirs approved to export wild game meat (South Africa, 2010b). The application must be submitted to the State Veterinarian (SV) at least 14 days prior to intended harvest (Shack, 2008). The State Veterinarian (SV) must explain in person to the owner what the implications are regarding the commitments and obligations the owner undertakes to honour the application. The farm must be located in a foot-and-mouth disease free zone (without vaccination) of South Africa as recognized by the Office International des Epizooties (OIE), or otherwise outside any foot-and-mouth disease restricted area (see Figure 6.1) as communicated from time to time by the National Department of Agriculture, Forestry and Fisheries (DAFF) or as specified in the latest European Union Directives in the case of export to the European Union (EU).

Game animals may not be harvested in a hunting area where during the last 60 days there has been Animal Health restrictions due to an outbreak of a disease to which game animals are susceptible. The farm owner is compelled to not administer or provide access to production enhancers/growth stimulants, as specified, to any animal in the flock/herd or allow such agents to be administered, or provided. The owner must then comply with the control measures imposed by the SV if an outbreak of a controlled animal disease should occur on the farm and
provide a register of all treatments administered (following the controlled animal disease outbreak) for a minimum of 3 months. The Annual Livestock Report for all game animals on the farm must be kept up to date on a monthly basis and must provide the following details: Registration number of farm, farm name, year, month, stock – beginning total, plus: estimated natural population growth, plus: species of game including dates of arrival and origin of game brought in, minus mortalities, minus the following: stock sold, game harvested and finally the stock end-total (Shack, 2008).

A Post-Mortem Record file is required for all livestock and game on the farm and must provide the following details: registration number of farm, farm name, date of death, type of animal, reason for death/diagnosis, official verification (including copies of post-mortem reports where applicable), and be checked by the Directorate Veterinary Services, Department of Agriculture, Forestry and Fisheries (South Africa, 2009).

Finally, an auditable and documented Animal Health and Management Programme [also known as Good Farming Practices (GFP’s)] must be drawn up and implemented (Shack, 2008). This should include (where applicable) vaccinations administered, anthelmintic treatments, external parasite treatments, mineral-, vitamin- and nutritional supplementations and other on-farm procedures, as well as any other records that may relate to the quality of the game presented for slaughter. A file with official inspection reports must be kept. Records of harvesting must be kept. All records must be available on request by the SV. The registration of a farm is not transferable to new management or between different
farms under control of one management (Shack, 2008; South Africa, 2010b). The approval of a farm for export purposes is subject to the maintenance of prescribed standards. The Provincial Executive Officer may at any time cancel approval if the farm does not conform to export requirements.

ii) System 2

In Sys2, registration of the farm or other responsibilities by the owner as referred to in System 1, are not required. However, adherence to the restricted animal disease areas where African swine fever and Foot-and-Mouth disease occurs is necessary (South Africa, 1984). In Figure 6.7 a map of the controlled areas for African swine fever is shown. Legislation such as regulations pertaining to the Animal Diseases Act, 1984 (Act 35 of 1984) and the Animal Protection Act, 1962 (Act 71 of 1962) are applicable to all game carcasses hunted or harvested, regardless of their intended use (South Africa, 1962, South Africa, 1984).
iii) System 3

The same criteria applicable to Sys2 apply to Sys3, but sometimes cases of carcasses being harvested from zoned areas for disease control are reported to be available on the market. Although movement permits are required, it is not always possible to implement as state veterinary services cannot easily monitor a few animal carcasses being moved around. However, criminal liability means that there could be consequences for hunting outfitters, their clients and game farms in terms of the Animal Diseases Act 1984 and the Animal Health Act 2000 (South Africa, 1984; South Africa, 2002).
6.3.1.9 Abattoir

i) System 1

The abattoir is a specialized plant where animals of the different game categories A, B and C are skinned and prepared for the processing plant. Abattoirs from which animals are exported are built to certain specifications and undergo stringent testing and scrutiny before being certified by State Veterinary and European Union authorities as being fit for exportation purposes. Figure 6.8 shows a typical low throughput game abattoir as specified by the MSA. The game abattoir is mentioned only briefly as it falls outside the scope of the study. Nevertheless, the draft Game Regulations stipulate that a registered game abattoir must be available on the game farm if the intended use is commercial. In Figure 6.8 the layout of a low throughput game abattoir (allowed to slaughter 20 units i.e. 1-B class or 6 times-C class animals per day) is shown to illustrate the advanced technology and consequent high capital expenditure accruing to the game farmer when producing commercially for the local or export market.
Figure 6.8: Layout for a low throughput abattoir (Bergh, 2007)

ii) Systems 2 and 3

In Chapter 2, a list of all the registered abattoirs for export and local purposes has been provided and clearly shows the deficit in terms of sufficient facilities for the demand. Basic and practical cost-effective slaughter facilities are available on most hunting farms, but such facilities are sometimes not on par with the abattoir shown in Figure 6.8. In Figure 6.9 a comparison is made between the three systems illustrating compliance in terms of game meat inspection (yes or no), the
training of the slaughter staff in basic meat hygiene (yes or no) and the registration of the slaughter facility with DAFF (yes or no). Sys1 and Sys2 presented with full compliance (100 % Yes) with all mentioned criteria. Sys3 presented with (100 % No) for non-compliance.

6.3.1.10 Time of the Year for Harvesting

i) System 1
In terms of hunting on Sys1 ranches, the VPN restrict harvesting when the ambient temperature is more than 15 ºC. Export harvesting is usually conducted over a period of less than 4 hours from shot placement to the commencement of chilling. It is recommended that harvesting of game takes place during the following times of the year: With regard to daytime harvesting, it should take place during the period April through August. Night-time harvesting should take place from March through September.
ii) Systems 2 and 3

Traditionally hunting only takes place during the colder winter months from May to July, but the hunting season in South Africa has now been extended from March to August (van der Merwe et al. 2009). Furthermore game farms that are exempted can hunt from January to December. Finally, a study conducted by Deutz et al. (2011) refuted the belief that high ambient temperatures could influence diseases in game animals. Furthermore, Veary (1991) found that the effect of delayed evisceration on the microbial quality of the meat was insignificant.
6.4 CONCLUSIONS

The observations and tests conducted in this study clearly show there is a considerable difference in the independent variables tested for the three systems in this study. In most cases Sys2 and Sys3 had similar results due to the same uncontrolled hunting process. The facility registration was only honoured by Sys1 and the facilities in Sys2 and 3 were not registered or audited by DAFF officials for compliance with the Meat Safety Act. Although formal building structures are required to enhance the process of hygiene and cleaning as well as the safe disposal of offal (Sprenger, 1995), basic slaughter facilities can render carcasses safe for human consumption.

It is then concluded that the only difference between Sys1 and Sys2 was the training component and that the independent variables compared with these two systems clearly show that strict legal requirements and costly formal registered abattoirs do not ensure the safe production of game meat.

It is recommended that game farm workers and personnel on farms producing game meat for the local market, should be trained in basic meat hygiene and meat examination to pro-actively ensure a good standard of meat hygiene and to prevent unsafe game carcasses becoming commercially available.

The next chapter will deal with a final general discussion and the recommendations made to DAFF, game farmers as well as other role-players in the game industry.
CHAPTER 7

GENERAL DISCUSSION AND RECOMMENDATIONS

7.1 INTRODUCTION

Wildlife Ranching South Africa (WRSA), representing game farmers in South Africa is committed to the responsibility of commercially safe game meat in collaboration with the Department of Agriculture, Forestry and Fisheries (DAFF). This action could result in self-control of game meat hygiene by WRSA through the promulgation of a meat scheme which could be the answer to the much debated hygiene and safety concerns of game meat currently available in the local market.

The proposed Game Scheme as negotiated between WRSA and DAFF, (authorizing WRSA as administrator of the scheme) is published for public comment and could guide the legal provision of game meat to the local market for the next five years (see Addendum C). The advantage for participating game farm owners is that they may use facilities not yet compliant with the Meat Safety Act, 2000 40 of 2000 affording them a chance to upgrade before the five year period has lapsed. Furthermore, participants must enroll in the stipulated training program to achieve compliance in terms of meat inspection and basic meat hygiene.

To further illustrate the intention of the Game Meat Scheme, the following quote is from a letter of the chairperson, Dr Bergh, in the negotiation process to WRSA:

“*To enable you to enter into an agreement with the Minister to a “Meat Scheme” you have agreed to train not only one person on each farm, where meat for the*
local market is produced, but also to train the personnel who are going to slaughter and handle this meat. Over and above this your team has also agreed to ensure the upgrading of the facilities to such an extent that they will comply with the regulations when they are signed by the minister. This, in fact, will make the training compulsory to all game farmers, intending to sell game meat on the local market. We, as the negotiators for the Department, have agreed that the measures, as proposed to us, will in effect curb the current problems with game meat and will send the proposals through the Director, Veterinary Services, NDA, (Public Health DAFF) to the minister. As can be appreciated, these measures will first have to be agreed upon by the minister before it can be implemented. We are positive that it will in fact happen because the control through the government structures currently is near impossible due to a lack of personnel and infrastructure. Help from the industry is appreciated and will show your willingness to ensure the safety and quality of your product. The concept of training of key personnel and resident hunters to qualify as game meat examiners in order to perform preliminary meat inspection at harvesting on game farms is also prescribed by FAO, Codex Allimentarius and EU legislation. Exemption from the provision of the Act that requires meat inspection to be independent of the abattoir for the duration of the scheme for preliminary as well as final meat inspection. The advantages of a scheme with the above objectives will be:

- Provincial Executive Officers will gain the confidence of role players in the game industry.

- By registering existing structures and then accommodating and assisting game abattoirs to comply, provinces will avoid illegal and uncontrolled operation of these facilities.
• *Meat hygiene training of all meat handlers is a very positive and uplifting step in providing safe meat obtained from a hygienically managed slaughter process.*

DAFF acknowledged the fact that Government can only with the cooperation of the game industry control and ensure safe game meat to the consumers in South Africa and more importantly, that the role of meat hygiene training is crucial in producing safe meat. Furthermore, industry standards are the international way of ensuring that the standards are higher than government regulations making government “control’ just about obsolete.

However, the results obtained during this study indicated that although Sys 1 is in compliance with the strict VPN and aspire to the EU standards for game meat; Sys 2 is on par with the same bacteriological and quality standards. Sys 2 as indicated in chapters 5 and 6 was subjected to approved training modules, (similar to Sys 1) in game meat examining and game meat hygiene (see Addenda G and H). Sys 3 on the other hand was not subjected to any training and the study results clearly showed that game meat produced on such ranches was not on the same standard as that from ranches operating according to the principles of Sys 1 and Sys 2.

### 7.2 PROPOSING A TESTED GAME MEAT GUIDE FOR THE LOCAL MARKET IN SOUTH AFRICA

The proposed Game Meat Scheme between WRSA and DAFF may still be over-regulating and only gives the game farmer a 5 year grace period to comply with all requirements of the soon to be published Game Regulations. In effect the Game
Meat Scheme only exempts game farmers from independent meat inspection and secondly full compliance of the slaughter facility for registration with DAFF will only be applicable for the said grace period.

For this reason, a Game Meat Guide is proposed (see Addendum D). The difference between the Game Meat Scheme and the Game Meat Guide is that the latter does not grant a grace period but in a simplified manner requires the following:

- A basic permanent or temporary slaughter facility to facilitate meat hygiene.
- Meat inspection conducted by the hunter or farm owner.
- Basic meat hygiene training of farm workers engaged in the process of obtaining a carcass.
- Recording (documentation) of the hygiene and traceability checklists.

In Table 7.1 the differences in the parameters for the VPN, the Draft Game Regulations, the Game Meat Scheme (GMS) and the Game Meat Guide (GMG) are illustrated to motivate the proposed Game Meat Guide as an alternative and possible legal document.
Table 7.1: Comparison of the dependent and independent variables used in the study for the Veterinary Public Notices (export requirements), the Draft Game Regulations (local requirements), the Game Meat Scheme (as negotiated and approved) and the proposed Game Meat Guide

<table>
<thead>
<tr>
<th>CATEGORY</th>
<th>CRITERIA</th>
<th>INDICATOR</th>
<th>VPN</th>
<th>Draft Regulation</th>
<th>GMS</th>
<th>GMG</th>
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<td>Conditionally</td>
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<td>C=Hung and B @ 20°</td>
<td>C=Hung and B @ 20°</td>
<td>According to GMG</td>
<td></td>
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<td>≤ 2 hours</td>
<td>≥ 2 hours</td>
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<td>E-partially condemn</td>
<td>C-totally condemn</td>
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<td>Hung</td>
<td>Hung</td>
<td>Hung /bed</td>
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<td>HAS</td>
<td>Basic hygiene checklist</td>
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<td>C-totally condemn</td>
<td>I-MI-Approved</td>
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<td>12hr (4hr if &gt;15°C)</td>
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<td>GMS</td>
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7.3 TRAINING MODULES RECOMMENDED

According to Winkelmayer (2009) minor changes were made in Austria to their current hunting system to align with EU hygiene requirements applicable to their local trade. Temporary and permanent premises for this purpose were put in place, but greater emphasis was placed on a training component to ensure practical knowledge of meat hygiene. Bandice and Hensel (2011) reported that the training of hunters in meat hygiene impacted in a positive way to ensure consumer safety.

In support of the above measures, Richards et al. (2009) concluded that the high incidence of *E. coli* and *Enterobacteriaceae* in the game meat in the United Kingdom can be explained by the lack of knowledge of the processes of slaughter and evisceration and not by the structural compliance of the slaughter facility. Cox *et al* (1988) furthermore, questioned the quantitative use of index and indicator bacteria in meat hygiene.

According to Hughes (2008) the main source of game meat in Europe is from trophy animals and few regulatory requirements exist for the bacterial quality thereof. Taking into consideration a report from Hoffman and Dicks (2011) on game meat being more resistant to microbiological spoilage than mutton, beef and pork, the question could rightfully be asked: Why do we strive to overregulate this lucrative industry?

Paulsen (2005), Robberts (1980) and Winkelmayer *et al.* (2011) concluded that the adherence to good hygiene practices (GHP) is the only criterion to ensure safe game
meat for human consumption. Citterio et al. (2011) offered a solution in terms of meat hygiene in the training of the hunter and suggested that it will ensure safe game meat. The solution offered was based on the meat hygiene results recorded after hunters were trained in meat hygiene. Bekker et al. (2011) confirmed that a lack of knowledge should be addressed with relevant training modules.

The approved training modules used in the present study and currently used by the export and local commercial markets are attached as Addenda G and H (Bergh, 2007; SAMIC, 2009). The training modules are recommended for the meat examiner conducting meat inspection and for the staff on the farm engaged in the slaughter processes. Firstly, the training aims to ensure that slaughter staff on game farms adhere to GHP’s and understand meat hygiene. Secondly, it aims to identify possible zoonotic and other animal diseases on the farm during meat inspection and to deal with it according to the Meat Safety Act (Herenda et al., 2000, South Africa, 2000; South Africa, 1984).

7.4 THE GAME MEAT GUIDE: HYGIENE AND TRACEABILITY CHECKLISTS

The researcher has, in collaboration with representatives from DAFF and the Independent Meat Quality Assurance Systems (IMQAS), developed a short but practical checklist for hygiene and a record for traceability on game farms (see Addenda E and F). These documents are proposed as part of the Game Meat Guide to assist the game farmer when supplying game meat to the commercial market to
comply with legal requirements concerning the place of product origin (South Africa, 1972).

7.5 GENERAL RECOMMENDATIONS

Hutchison et al. (2007) concluded that the implementation in a red meat abattoir of management programmes such as the Hazard Analysis of Critical Control Points (HACCP) can have a positive effect in decreasing the indicator bacterial numbers on carcasses. However, this administrative intensive management programme will be impractical and costly on a game farm but could be simplified to serve such a purpose.

Eden et al. (2008) reported on the distrust of consumers in such food assurance schemes and the fact that results can be “fixed”. This study therefore proposes the legal implementation of a practical and affordable “clean game policy” in compliance with the Meat Safety Act 40 of 2000. The training of role players in the process of hunting will not only have a positive influence on literacy and career opportunities, but will ensure safe game meat to all consumers in South Africa. Lastly, young and upcoming game farmers will have the opportunity to access the local meat market and consequently help to alleviate the challenge of protein food deficit in Africa. Furthermore, the health attributes of game meat, being inter alia, low in cholesterol and fat, high in protein and minerals as promotion of game meat in the diet should be highlighted in future marketing material (Drew & Seman, 1987; Jansen van Rensburg, 2002; Van Heerden et al., 2001).
The game meat industry should engage in further scientific research on issues such as bleeding times and methods, evisceration times and basic slaughter facilities to motivate changes in current legislation and to propose new legislation with regard to the production/supply of commercial game meat. The concept of mobile abattoirs are recommended for both the export and local game meat markets to ensure cost effective, practical and hygiene compliant production of game carcasses. Recorded data during meat inspection should become a priority not only for the game farmer and professional hunter/outfitter, but for all Veterinary Public Health and Environmental Health officials in both Provincial and National authorities. Such information can be used to prevent zoonotic disease outbreaks and highlight future trends in the game industry in terms of intensive breeding or meat production on smaller game farms.

Concluding with the words of Dr Hans Wyss: Director Swiss Veterinary Services: “If the application of the Meat Safety Act is within reach of the young and upcoming game farmers and local communities owning land with wildlife, the result will be improved nutrition and the adoption of game meat for commercial purposes. Taking into consideration that the total ban on hunting of elephants and rhino because of alarming levels of poaching did more harm than good, this mistake should not be repeated with game meat” (Wyss, 2010).

In support of the opinion of Hans Wyss; it was stated by Rolf Uys: the manager AIB International and an specialist in food audits such as HACCP that: “the secret to ensuring safe game meat is not to do thousands of microbial tests nor is it to have
HACCP programme that looks acceptable on paper, but to implement a practical system that really works” (Dry, 2012).
CHAPTER 8
REFERENCES

ACTS, see SOUTH AFRICA.


ANDRIN, M.  2008.  Personal communication; Director: Capricorn Veterinary laboratories. In Polokwane, South Africa (Notes in possession of author).


DU BUISSON, P.M. 2006. Improving the meat quality of blesbok (*Damaliscus dorcas phillipsi*) and springbok (*Antidorcas marsupialis*) through enhancement with inorganic salts. Masters of Science in Animal Science (Meat Science), University of Stellenbosch, South Africa.


HUGHES, K.H.  2009.  Comparison of multidrug-resistant and drug-susceptible *Salmonella* in ground beef and freshly harvested beef brisket exposed to commonly used industry antimicrobial interventions. PhD thesis, Texas Tech University, USA.


KRUGER, A. 2006. Personal communication; Veterinarian: Mosstrich game abattoir, Port Elizabeth, South Africa (Notes in possession of author).


SOUTH AFRICA NATIONAL STANDARDS (SANS). 1999b. SANS 6887-1/ISO 6887-1, Microbiology of food and animal feeding stuffs — Preparation of test samples, initial suspension and decimal dilutions for microbiological examination — Part 1: General rules for the preparation of the initial suspension and decimal dilutions. Pretoria, South Africa: SABS


SOUTH AFRICA NATIONAL STANDARDS (SANS). 2007. SANS 4833/ISO 4833, Microbiology of food and animal feeding stuffs — Horizontal method for the numeration of microorganisms — Colony-count technique at 30 °C. Pretoria, South Africa: SABS


STEPHENS, T. 2006. Improvements, challenges and validation of enumeration of *Escherichia coli* 0157 and sampling methods for *Escherichia coli* and *Salmonella* in feedlot cattle. PhD thesis, Texas Tech University, USA.


TODAR, K. 2008. Todar`s online textbook of bacteriology. Online: [http://textbookofbacteriology.net/e.coli.html](http://textbookofbacteriology.net/e.coli.html) [Accessed 8 January 2010].


Faculty of Science
Department of Environmental Health

Project Information for informed consent

Project leader: Professor Paul Jagals (Environmental Health) - Tshwane University of Technology
Team leader: Maretha van der Merwe

We are researchers from the Tshwane University of Technology. We are doing a research project on the development of a game meat scheme for game intended for the local consumer market that has the intention to thoroughly investigate the current legislation and its implications on the game industry in South Africa and to develop practical health and hygiene guidelines to assist the game rancher to render game carcasses and meat intended for the consumer market on a safe and acceptable standard.

The project has been approved by the Ethics Committee of the Tshwane University of Technology. We will now explain the project and will then request your participation.

The project

The project name is: A game meat scheme for game ranchers to supply safe game meat to local markets in South Africa

- The development of health and hygiene guidelines when obtaining game carcasses intended for the local consumer market
- The purpose of the study will be to develop and apply a practical game meat scheme to control / validate the health-related quality of game meat during the processes of hunting, dressing and transporting on the game ranch.

What is expected of you?

- Between one and three interviews or visits will be conducted here on your farm/premises over the next two years.
- These interviews or visits will include collection of samples, such as: post-mortem carcass inspections, aseptic blood samples from the heart, microbiological analyses of surface swabs from dressed carcasses, temperature and pH measurements directly post-mortem as well as 72 hours post-mortem (accepted as the stabilizing time).
- We request that you allow observations of the following to be done: ante-mortem appraisal of the animal to be hunted, slaughter facilities on the farm and the method or activities when handling the carcass post-mortem.
- Accommodation and refreshments (meals) when prior arranged and agreed with you will be paid by the researchers when for practical reasons are necessary to stay overnight.
I understand that there will be no harm to me or my business;
I was given adequate time to think about the issue before I consent;
I was and still am provided the opportunity to ask questions;
I have not been pressurised to participate in any way;
I understand that participation in this research project is completely voluntary;
I understand that I will not receive any monetary compensation for my participation and that participation will not cost me anything;
I understand that I may withdraw from the study at any time without supplying reasons and without prejudice;
I confirm that I may speak on behalf of my business/partners or management;
I consent to supply personal details of me and my business. The condition is that while the details will be involved in the analysis of the results, it will not be used in any way to breach confidentiality;
I understand that this research project has been approved by the relevant ethics committee of the Tshwane University of Technology;
I am fully aware that the results of these projects will be used for scientific purposes and may be published. I agree to this, provided my privacy is guaranteed.

I hereby consent to participate in this project and can sign for this consent.

[Signature]

Name of respondent

[Signature]  [Signature]

Place  Date

Statement by Interviewer

I have provided the respondent with verbal information regarding this Research Project. The respondent indicated that the content and activities of this form is understood. I have left a signed copy of this form, translated into [Language], with the respondent.

[Signature]

Name of interviewer

[Signature]  [Signature]

Place  Date
WILDLIFE RANCHING SOUTH AFRICA

CODE OF CONDUCT FOR WILDLIFE RANCHING

1. PRE-AMBLE

As a member of Wildlife Ranching South Africa, I will act as an ambassador for the wildlife ranching industry, and hereby agree to support the principles and abide by its Code of Conduct.

2. THE RANCHER’S COMMITMENT

2.1 Comply with all applicable laws, jurisprudence, codes, rules and regulatory requirements in general, and specifically those relating to wildlife ranching and the environmental, social, market behaviour and the wellbeing of stakeholders.

2.2 Provide and maintain fit-for-purpose ranching facilities, related to one or more of the following:

   (i) sustainable game production and utilization factoring in the ecology, economy and socio-cultural aspects that would facilitate meat production, hunting and fishing;
   (ii) preserving and fostering the condition of game for hunting;
   (iii) eco-tourism and/or;
   (iv) environmental conservation.

2.3 Apply humane live game capturing, slaughtering and culling practices of game during meat production processes.

2.4 Assertively prevent any cross-breeding of species and destroy any animal which may result from unintended cross-breeding.

2.5 Be an activist for the principle of sustainable utilization of all natural resources on the ranch.

2.6 Apply all practical and economic measures to mitigate against the degradation of the ecology and natural environment.

2.7 Participate in programs aimed at the conservation and protection of endangered animal and plant species in the surrounding environments.

2.8 Nominate a compliance officer for the ranch in respect of hunting, meat production, eco-tourism, conservation and to prevent the degradation of land resources.
3.  HUNTING

3.1  With regard to all types of hunting, the rancher will assertively promote and ensure:

3.1.1  the development and maintenance of an economically sound hunting strategy for time- and area & branch-specific hunting and continuous monitoring of the effects of hunting;

3.1.2  adhere to all written and unwritten hunting codes, regulation and practices, including the prescribed procedures applicable to the specific ranch;

3.1.3  hunting with compassion and discretion;

3.1.4  employment of humane hunting practices at all times;

3.1.5  hunting is orientated to the well-being of the game; and is practiced with as little pain for the animal as possible;

3.1.6  prevention of socially unacceptable hunting practices such as hunting by using snares or poison;

3.1.7  no sport or trophy hunting of any caged animals, i.e. animals that live in zoo-like enclosures, that are in contact with humans on a daily basis, received food on a daily basis and cannot for more than one day survive in a natural habitat.

4.  MEAT SAFETY

4.1  Given the importance of meat production with specific reference to Game meat intended for local commercial purposes the rancher will assertively promote and implement the Memorandum of Understanding (MoU) between WRSA and the Department of Agriculture over the next 2 years.

5.  ECO-TOURISM

5.1  With regard to all types of eco-tourism activities, the rancher will assertively promote:

5.1.1  Preserving and fostering the condition of the environment, factoring in influences of other anthropogenic forms of use (agriculture, forestry, hunting, transport infrastructure, etc.);

5.1.2  visitors not taking anything from nature to which he/she is not entitled;

5.1.3  not causing or effecting anything to the environment that is harmful to health or well-being of present and future generations;

5.1.4  integrity of marketing and advertising.
MEMORANDUM OF UNDERSTANDING

between

DEPARTMENT OF AGRICULTURE (DoA)

and

WILDLIFE RANCHING SOUTH AFRICA (WRSA)

1 ORIENTATION

1.1 At a meeting on 14 March 2007 between DoA and WRSA it was agreed that implementation of sub-sets of the Meat Safety Act related to Game meat production and marketing should be done in stages to ensure continued progress:

Training of hunters, farmers or selected persons in harvesting teams to perform preliminary–meat inspection of shot and partially dressed carcasses to determine the viability for human consumption. They must be trained to spot diseases in carcasses, gross contamination and any other condition that necessitates the removal of such carcasses from the process. This is in line with the Codex Allimentarius requirements. These persons must register with the Provincial Executive Officer as game meat examiners.

- Training of farm workers, involved with harvesting and partial dressing of carcasses, in basic hygiene practices. Courses are available at various institutions.

- Upgrading of harvesting facilities to conform to the standards required by the draft regulations i.e. depots. These facilities are those used for intensive harvesting for short periods.

- Upgrading of unregistered structures on farms used as “slaughter rooms” or places where game carcasses are dressed. These facilities are those used over longer time periods or on a permanent basis also to handle game carcasses dressing in addition to trophy hunting. These structures must be upgraded to the level of at least registered Rural Game Abattoirs.

- Game carcasses that are transported, to collecting facilities, or to regional game abattoirs, must be in chilled vehicles complying to the provisions of the draft regulations.

- All collection and processing facilities must be upgraded and be registered as game abattoirs. Facilities that are used for further processing must be registered with Department of Health and have a Certificate of Acceptance issued by that
1. Department. Game abattoirs must procure the services of independent game meat inspectors.

2. It is also planned to provide pamphlets to inform game ranchers of the new requirements. The marketing of game meat under a special brand or logo is envisioned in order to make consumers aware of the fact that inspected game meat is safer than the product bought from un-controlled sources.

1.2 Animals hunted for own use

The matter of private persons hunting small numbers of animals for own use and having it processed at specially equipped butcher shops in Gauteng was discussed. This is a matter presently being looked at by Municipal authorities in Gauteng. Included will be specially trained Environmental Health officers from the municipalities offering this service, to inspect the game carcasses at those selected butcher shops. The question was raised that technically these butcher shops should then be registered as game abattoirs under the Meat Safety Act. It seems though that this matter is provided for in the Health Act under R918. Control of the situation seems to be a crucial matter and if health does this successfully, much is to be gained.

2 IMPLEMENTATION AND SELF REGULATION

2.1 The following agreements are proposed and with concurrence with the DoA, will be implemented over a period of two years:

Game meat intended for local commercial purposes will be subjected to the following requirements:

1. All hunters hunting on a game farm will be in possession of a meat examiner’s certificate.
2. The bleeding and evisceration process will be under the supervision of the hunter and the first inspection of the head, feet, eviscerated material and red offal will be carried out by him.
3. Deviations will be on a written report to the meat inspector at the abattoir or processing unit (butchery).
4. The slaughter facility, whether stationary or mobile, shall comply to the requirements as set out in Addendum A.
5. All farm staff working in the slaughter facility shall be in possession of a certificate of basic hygiene training.
6. A traceability system will be in place, to ensure that non compliant meat do not reach the market.
REQUIREMENTS FOR STATIONARY AND MOBILE SLAUGHTER FACILITIES

Mobile slaughter facilities must comply with the following –

(a) A hanging frame of sufficient height to prevent heads and necks of category B and C carcasses making contact with the ground;

(b) A separate table for the inspection of the red and rough offal;

(c) A tarpaulin that can be cleaned on a continuous basis or moving the frame to a clean area;

(d) Sufficient closable containers that comply with regulatory requirements to accommodate –
   i. Red offal;
   ii. Other material to be detained for further inspection or transported with the carcass.

(e) Portable water and facilities for washing of hands and equipment;

(f) Chemical sterilizing for knives;

(g) Artificial light where game is slaughtered at night.

Stationary slaughter facilities must comply with the requirements for mobile facilities, but in addition –

(a) The frame must be fixed on a curbed and drained concrete base;

(b) Roads and walkways should be treated to minimize dust;

(c) Have an underground effluent disposal system;

(d) Toilets and hand wash facilities must be provided.
I, Tina Joemat-Pettersson, Minister of Agriculture, in terms of section 12 of the Meat Safety Act, 2000 (Act No. 40 of 2000), hereby establish a scheme for implementing the provisions of the Meat Safety Act in the Game industry and in particular limited throughput game slaughter facilities and harvesting processes, over a period of five years, in order to facilitate the safety of game meat in the Republic, to the extent set out in the Schedule.

T. Joemat-Pettersson,
Minister of Agriculture, Forestry and Fisheries.
SCHEDULE

DEFINITIONS

1. In this Schedule

“the Act” means the Meat Safety Act, 2000 (Act No. 40 of 2000);

“eviscerate” means the removal of the contents of the thoracic and abdominal cavities;

“game industry” means Wildlife Ranching South Africa (WRSA) as facilitator and accredited service provider, with associated institutions co-operating in this Scheme;

“HMP” means Hygiene Management Program;

“limited harvesting” means not exceeding the throughput limit set by the PEO;

“NEO” where used, means the National Executive Officer under the Meat Safety Act, 2000 (Act No. 40 of 2000).

“Partially dressed” means a game carcass of which the skin has not been removed although eviscerated, and of which the head and feet may have been removed.

“PEO” where used, means the Provincial Executive Officer under the Meat Safety Act, 2000 (Act No. 40 of 2000)

“private use” means for own consumption and must not be sold for commercial purposes and must not be considered under this Scheme;

“Scheme” means a Scheme established in terms of section 12 of the Act;

“unit” – means a quantity standard for determining throughput of game carcasses in a game slaughter facility, registered under the Scheme, where one unit equals one category B or medium size game animal, for example buffalo, kudu, eland or zebra or one unit is equal to six category C or small size game animals for example springbuck, impala or blesbuck, with the understanding that larger animals, category A, for example giraffe, elephant and hippopotamus do not apply under the Scheme.

“WRSA” means Wildlife Ranching South Africa.
NAME OF SCHEME

2. The Scheme is known as the Game Meat Scheme

APPLICATION OF SCHEME

3. The Scheme is applicable throughout the Republic of South Africa.

OBJECTIVES OF SCHEME

4. (1) To establish a sound infrastructure for producing safe game meat for the country by enabling WRSA to conduct limited harvesting utilizing slaughter facilities on game farms, registered under the Scheme, while such facilities are being upgraded to standards set by the Act within time limits determined by the PEO, within the five year duration of the Scheme,

(2) To Promote hygiene practices during harvesting of game and hygienic handling of game meat during slaughtering as set out in sections 6 to 16 of the Scheme;

(3) To train meat examiners, by an approved service provider, to perform duties harvesting and in game slaughter facilities registered under the Scheme. During the implementation of the Scheme, such persons may be employed by the owner;

(4) To train personnel working under this Scheme, in the correct harvesting and slaughter procedures as set out in the Scheme; and

(5) To establish systems within the harvesting and slaughter processes to determine traceability of game meat.
CATEGORIES OF ANIMALS TO WHICH THE SCHEME IS APPLICABLE

5. This Scheme applies to all –

(a) game animals declared as such by the Minister by notice in the Gazette for the purposes of the Act and for purposes of the Scheme are categorized as follows:

(i) Category A or large game for example giraffe, elephant and hippopotamus;

(ii) Category B or medium size game for example buffalo, kudu, eland or zebra where one animal is equal to one unit; and

(iii) Category C or small size game for example springbuck, impala or blesbuck where six animals are equal to one unit.

(b) Category A game do not apply to slaughter facilities registered under the Scheme except in special cases under a protocol approved by the PEO.

PROCEDURAL ROUTES FOR HARVESTING AND SLAUGHTER

6. The Scheme makes provision for the following routes for harvesting and slaughter:

(1) Game animals harvested and then dressed directly in slaughter facilities registered under the Scheme;

(2) Game trophy animals hunted in accordance to hygienic procedures and dressed in slaughter facilities registered under the Scheme; and

(3) Game animals harvested then partially dressed and eviscerated using depots, chilled transport thereby providing partially dressed game carcasses to slaughter facilities registered under the Scheme. This route is relevant in cases where harvesting occurs at a greater pace or volume per time than can be accommodated directly by such slaughter facility.
HARVESTING OF GAME

7. (1) Game must be harvested by hunters whose competency was assessed and approved by WRSA.

(2) The NEO or PEO may require additional special precautions to ensure safety and good hygiene of the product pertaining to a specific farm or area where trophy animals are harvested.

SHOOTING

8. (1) Shooting must be done so that it is reliably expected to cause immediate death.

(2) Thoracic and abdominal shots must be avoided and carcasses with such wounds must be marked for attention of the registered inspector.

BLEEDING

9. (1) Game must be bled within 10 minutes of being shot.

(2) Bleeding is done by means of severing the jugular vein and carotid artery on either side of the neck (throat slitting) with a clean sterilized knife.

(3) The different categories must be bled in the following ways:

(a) Category C or small animals – hanging position;
(b) Category B or medium animals – on a ramp at an angle of 20° to 30°.
TRANSPORT OF HARVESTED GAME FROM POINT OF SHOOTING TO SLAUGHTER FACILITY OR DEPOT

10. (1) Game must be transported to a game depot or slaughter facilities registered under the Scheme within 2 hours after being bled.

(2) Care must be taken not to contaminate the neck slit area when transporting the carcass to the game depot or slaughter facility.

PRELIMINARY MEAT INSPECTION

11. Preliminary meat inspection, during harvesting, must be performed by a trained person, as described in section 17 to 36 as applicable, who verifies proper bleeding times and hygienic harvesting and transport procedures.

EVISCERATION

12. All harvested game must be eviscerated at a slaughter facility registered under the Scheme or depot within two hours of bleeding provided that if a danger of bloating exists evisceration may take place in the field requiring intestines to be taken to the slaughter facility or depot for inspection.

HARVESTED GAME RECEIVED AT SLAUGHTER FACILITIES DIRECTLY FROM HARVESTING

13. (1) The Procedures for dressing and evisceration of game directly after harvesting that occurs at slaughter facilities, registered under the Scheme, shall be as follows:

(a) Carcasses must be transferred from the harvesting vehicle to clean slaughter frames in a slaughter facility in such a manner as to avoid contamination or soiling.

(b) Whereas carcasses are eviscerated with the skin on at depots, harvested carcasses taken directly to a slaughter facility must be
evisceration after full skin removal in such slaughter facility.

(c) Opening incision lines on a hide or skin must be made with a clean sterilized knife from the inside to the outside only (spear cuts).

(d) All flaying equipment making contact with meat must be sterilized after use on each carcass.

(e) Lactating udders, which are regarded as being condemned, must be removed with the skin on, in such a way to prevent milk contamination, leaving the lymph nodes: inguinalis superficialis on either side intact on the carcass.

(f) Reproductive organs and any part not utilized commercially must be handled as condemned material and placed in appropriate containers.

(g) Contact of the exposed meat with platforms, slaughter frames, floor, outer surface of the skin or hide and soiled equipment must be avoided at all times.

(h) Heads, feet, rough and red offal must at all times be identifiable with the carcass of origin till meat inspection is complete.

(i) Final meat inspection of carcasses after removal of the skin or hide, must be performed at the slaughter facilities with the understanding that all organs i.e. head, feet and intestines must be available for this inspection.

(j) Soiling on dressed carcasses must not be washed off but cut off.

(k) Carcasses may not be cleaned, wiped or dried with a brush or cloth.

(l) A carcass may be washed with running water under moderate pressure to remove bone chips from the split sternum and vertebrae and to wash off blood after completion of meat inspection.

(m) A person may not apply to any carcass, meat or animal product any insecticide, antibiotic substance, or any substance which is intended to prevent spoilage by inhibiting the activities of insects, or by preventing the development of bacteria or moulds, or for any purpose whatsoever, but this does not apply to a substance which complies with the requirements of the Foodstuffs, Cosmetics and
Disinfectants Act, 1972 (Act No. 54 of 1972), at levels not harmful or injurious to health and is approved per protocol by the PEO. Dressed carcasses must be chilled and a core temperature of 7°C must be accomplished within 24 hours after chilling commences.

**HARVESTED GAME HANDLED VIA A DEPOT ROUTE**

14. (1) The Procedures for partially dressing and evisceration of game that occurs at a depot directly after harvesting shall be as follows:

(a) Carcasses must be transferred from the harvesting vehicle to clean slaughter frames at a depot in such a manner as to avoid contamination or soiling.

(b) Complete flaying or skin removal may not be performed at depots. In this regard, evisceration must be performed with the skin on in such a manner that the internal surfaces of eviscerated carcasses are not contaminated in any way.

(c) Opening incision lines on a hide or skin must be made with a clean sterilized knife from the inside to the outside only (spear cuts).

(d) Lactating udders, which are regarded as being condemned, must be removed with the skin on, in such a way to prevent milk contamination, leaving the Lymph nodes: inguinalis superficialis on either side intact on the carcass.

(e) Reproductive organs and any part not utilized commercially must be handled as condemned material and placed in appropriate containers.

(f) Contact of the exposed meat with platforms, slaughter frames, ground, outer surface of the skin or hide and soiled equipment must be avoided at all times.

(g) Heads, feet, rough and red offal must at all times be identifiable with the carcass of origin till preliminary meat inspection is complete.

(h) Inspection of heads, feet and intestines must be performed if these parts are removed before transportation to a slaughter facility i.e.
during use of a depot, any deviations or abnormalities found during such inspections necessitates a report to the meat inspector at the registered slaughter facility.

(i) Partially dressed carcasses may not be washed, wiped or dried with a brush or cloth; accidental soiling must be cut off from exposed meat areas.

(j) Partially dressed carcasses and offal must be chilled within 12 hours of killing but when the ambient temperature is more than 15°C, it must be chilled within 4 hours of being killed.

(k) A core temperature of 7°C must be accomplished within 24 hours after chilling commences.

TRANSPORT OF PARTIALLY DRESSED GAME CARCASSES FROM DEPOT TO SLAUGHTER FACILITIES REGISTERED UNDER THE SCHEME FOR FINAL DRESSING

15. A vehicle used for the transport of partially dressed carcasses must comply with the standards for a meat transport truck according to requirements stipulated in the Health Act, 1977 (Act No.63 of 1977), but with the understanding that –

(a) if partially dressed carcasses and associated offal need to be held in a chiller truck for periods exceeding eight hours, the chiller unit must have the potential to chill such carcass to a temperature of less than 7°C within 24 hours of having been loaded;

(b) partially dressed carcasses must be hung away from the floor in such a way as to ensure optimal airflow within the chiller space;

(c) partially dressed game carcasses must be handled and hung in such a manner as to avoid contact between skin surfaces and exposed meat or body cavities;

(d) where edible rough offal and red offal is transported in the same load space as partially dressed game carcasses, it must be packed in separate closable leak proof containers;

(e) dressed carcasses or meat must not be transported in the same cargo compartment with partially dressed game carcasses; and
(f) no live animal or person may be transported in the same cargo compartment with a game carcass.

**RECEIVING OF PARTIALLY DRESSED GAME CARCASSES AT SLAUGHTER FACILITIES REGISTERED UNDER THE SCHEME**

16. (1) All partially dressed game carcasses received at a game slaughter facility must be accompanied by an inspection report from the registered inspector at the harvesting depot.

(2) (a) Partially dressed game carcasses received at a game slaughter facility must be offloaded and moved to holding chillers for partially dressed game carcasses without delay.

(b) If a chiller truck connected to the receiving area of the slaughter facility by a docking seal is used to hold partially dressed game carcasses before dressing, the doors of the truck must be kept closed when not offloading.

**INSPECTION OF ANIMALS AND MEAT**

17. The NEO or a PEO may require any additional provisions or tests for ante-mortem and post mortem inspection of animals, carcasses and meat to the requirements set out below.

A. ANTE-MORTEM INSPECTION

*Persons harvesting for commercial purposes*

18. The person harvesting game must –

(a) ensure that animals are not harvested for commercial purposes if there is a sign of existing injury or disease;

(b) ensure that all carcasses which exhibit abnormalities during the preliminary meat inspection at harvesting, including those that have been wounded, are identified and clearly marked and that relevant information is provided to the
registered inspector who may refer such carcass for secondary inspection by a registered inspector, who is a veterinarian, at the game slaughter facility registered under the Scheme;

(c) ensure that additional information, including observations made during harvesting is communicated to the registered inspector who may refer such information to the registered inspector at the game slaughter facility;

(d) acquaint himself or herself with all further guidelines issued by the NEO regarding ante-mortem inspections on game.

Owners of animals being harvested

19. The owner of the game animals to be harvested for commercial purposes must–

(a) provide the registered inspector with –

(i) information regarding controlled disease outbreaks within a radius of 10 km of the place of origin of the animals to be killed; and

(ii) any other relevant information that may indicate that the harvested game is unsafe for human consumption;

(b) ensure that an animal in respect of which there is a reasonable suspicion that it has been injected with antibiotics, immobilising drugs, tranquillisers or any other substance is not harvested;

(c) ensure that a carcass or part thereof that has been condemned is not brought into any part of a depot or a slaughter facility containing edible products, but the registered inspector may authorize the salvage of the hide or skin or any part of such animal for the sole purpose of producing trophies or curios, providing that such condemned animal may only be handled in the slaughter facility after the normal processing for the day has been completed; and

(d) acquaint himself or her-self with all further guidelines issued by the NEO regarding ante-mortem inspections.
B. PRIMARY MEAT INSPECTION

Provisions for meat inspection personnel

20. The PEO may determine the number of meat inspectors or meat examiners required at a depot or in a slaughter facility registered under the Scheme after having considered the design, number of inspection stations, processing speed, structural and managerial aspects.

General provisions regarding meat inspection

21. (1) A carcass, part thereof, rough or red offal may not be sold or dispatched from a slaughter facility registered under the Scheme unless inspected and approved by a registered inspector and marked with the “PASSED” mark, as contemplated in section 71.

(2) All relevant information, including ante mortem and health records must be taken into consideration when inspecting meat.

(3) No person may remove, cut or debone any carcass or meat prior to inspection.

(4) No person may remove any sign or evidence of any disease, condition, contamination or soiling by washing, trimming or any other manner prior to meat inspection, unless this is done under supervision of a registered inspector.

(5) Lymph nodes may not be removed prior to meat inspection.

(6) Heads, feet, rough and red offal must be identifiable with the carcass of origin until inspection is done.
A registered inspector must acquaint himself or herself with all further guidelines issued by the NEO regarding primary meat inspections.

**Specific inspections**

**Specific inspection of the category C game carcass and organs, excluding warthogs and bush-pigs**

22. **(1)** The Registered inspector must examine a carcass by means of observation, palpation, smell and, where necessary, incision and take the following into consideration –

(a) its state of nutrition;
(b) colour;
(c) odour;
(d) symmetry;
(e) efficiency of bleeding;
(f) contamination;
(g) pathological conditions;
(h) parasitic infestation;
(i) injection marks;
(j) bruising and injuries;
(k) any abnormalities of muscles, bones, tendons, joints, or other tissues; and
(l) the species, age, and sex of the animal from which it derives.

**(2)** When examining the hindquarter, the registered inspector must examine bilaterally –

(a) the parietal peritoneum by observation;
(b) the Lymph nodes: iliaci mediales et laterales by observation;
(c) the Lymph nodes: inguinalis superficialis, Lymph nodes: subiliacus, Lymph nodes: popliteus, Lymph nodes: analis by
(d) palpation; kidneys by exposure, observation and palpation and the Lymph nodes: renalis by palpation; and
(e) the muscular part of the diaphragm by visual inspection.

(3) When examining the forequarter, the registered inspector must examine bilaterally –

(a) the parietal pleura and thoracic cavity; and
(b) Lymph nodes: cervicalis superficialis by palpation.

(4) When examining the head, the registered inspector must –

(a) visually examine the head; and
(b) if required, examine the throat, mouth, tongue and retropharyngeal and parotid lymph nodes.

(5) The feet must be examined by observation.

(6) When examining the red offal, the registered inspector must examine –

(a) the surface of the visceral pleura by observation;
(b) the liver by palpation and incisions into the gastric surface and the base of the caudate lobe to open the bile ducts;
(c) the hepatic lymph nodes by multiple incisions into the Lymph nodes: hepaticus;
(d) the lungs, oesophagus and trachea by observation and palpation; the bronchial and mediastinal lymph nodes by observation;
(e) the pericardium and the heart by an incision made lengthwise to open the ventricles;
(f) the spleen by observation and if necessary palpation;
(g) both sides of the diaphragm by observation; and
(h) the testes and ovaries by observation.
When examining the rough offal, the registered inspector must examine –

(a) the visceral peritoneum and omentum by observation;
(b) if necessary, the inner surfaces of the stomach and intestines but this examination will only take place in the rough offal room or detention area with separate equipment; and
(c) the gastric and mesenteric lymph nodes (Lymph nodes. gastrici, mesenterici, cranialis and caudalis) by observation.

Specific inspection of warthog and bush-pig carcass and organs

23. (1) The registered inspector must examine a carcass by means of observation, palpation, smell and, where necessary incision and take the following into consideration –

(a) its state of nutrition;
(b) colour;
(c) odour;
(d) symmetry;
(e) efficiency of bleeding;
(f) contamination;
(g) pathological conditions;
(h) parasitic infestation;
(i) injection marks;
(j) bruising and injuries;
(k) any abnormalities of muscles, bones, tendons, joints, or other tissues; and
(l) the species, age, and sex of the animal from which it derives.

(2) When examining the hindquarter, the registered inspector must examine bilaterally –

(a) the parietal peritoneum by observation;
(b) the *Lymph nodes: iliaca mediales et laterals* by multiple incisions;
(c) the *Lymph nodes: inguinalis superficialis* by multiple incisions;
(d) the muscular part of the diaphragm by making two incisions approximately 25 mm apart and removing the peritoneal layer to expose the muscle; and
(e) kidneys by exposure or incisions if necessary and the *Lymph nodes: renalis* by incisions if necessary.

(3) When examining the forequarter, the registered inspector must examine bilaterally –

(a) the parietal pleura; and
(b) *M. triceps brachii* by making one deep transverse incision through the distal part of the muscle.

(4) Where the carcass has been split, the sternum, ribs, vertebrae and spinal cord must be examined.

(5) When examining the head the registered inspector must examine bilaterally –

(a) the *Lymph nodes: mandibulares* and *Lymph nodes: parotidei* by multiple incisions;
(b) the external masseters (*M. masseter*) by making two deep linear incisions parallel to the mandible and the internal masseters (*M. pterygoideus medialis*) by making a single deep linear incision; and
(c) observe the tongue, skin, lips, gums, hard and soft palate, eyes and nostrils.

(6) When examining the red offal, the registered inspector must examine –

(a) the surface of the visceral pleura by observation;
(b) the liver by palpation and incisions into the gastric surface and the base of the caudate lobe to open the bile ducts;
the hepatic lymph nodes by multiple incisions into the Lymph nodes: hepaticus;

the trachea by a lengthwise incision and the oesophagus by observation;

the lungs by palpatation and an incision in their posterior thirds perpendicular to their main axes to open the main branches of the bronchi;

Lymph nodes: mediastinales by multiple incisions;

Lymph nodes: bronchiales bilaterally by multiple incisions;

the pericardium and the heart by an incision made lengthwise to cut through the interventricular septum and open the ventricles and two additional vertical cuts into the split septum;

the spleen by visual examination and if necessary incision; and

both sides of the diaphragm by observation; and

the testes and ovaries by observation.

(7) When examining the rough offal, the registered inspector must examine –

(a) the visceral peritoneum and omentum by observation;

(b) if necessary, the inner surfaces of the stomach and intestines but this examination will only take place in the rough offal room or detention area with separate equipment; and

(c) the gastric and mesenteric lymph nodes (Lymph nodes: gastrici, mesenterici, cranialis and caudalis) by observation.

Additional tests

24. Additional tests must be carried out to determine the presence of Trichinella where the PEO has reasonable grounds to require this.
Specific inspection of category B game carcass and organs, excluding zebras

25.  

(1) The registered inspector must examine a carcass by means of observation, palpation, smell and, where necessary incision and take the following into consideration –

(a) its state of nutrition;
(b) colour;
(c) odour;
(d) symmetry;
(e) efficiency of bleeding;
(f) contamination;
(g) pathological conditions;
(h) parasitic infestation;
(i) injection marks;
(j) bruising and injuries;
(k) abnormalities of muscles, bones, tendons, joints, or other tissues;
(l) and

the species, age, and sex of the animal from which it was derived.

(2) When examining the hindquarter, the registered inspector must examine bilaterally –

(a) the parietal peritoneum by observation;
(b) the \textit{Lymph nodes: iliaca mediales et laterales} and the \textit{Lymph nodes: subiliacus} by multiple incisions;
(c) the \textit{Lymph nodes: inguinalis superficialis} by multiple incisions;
(d) the muscular part of the diaphragm by making two incisions approximately 25 mm apart and removing the peritoneal layer to expose the muscle; and
(e) the kidneys by exposure or incisions if necessary and the \textit{Lymph nodes: renalis} by incisions if necessary.

(3) When examining the forequarter, the registered inspector must examine
bilaterally –

(a) the parietal pleura;
(b) *cervicalis superficialis* by palpation; and
(c) *M. triceps brachii* by making one deep transverse incision through the distal part of the muscle.

(4) Carcasses must be split and the sternum, ribs, vertebrae and spinal cord must be inspected.

(5) When examining the head the registered inspector must examine bilaterally –

(a) the *Lymph nodes: mandibulares, Lymph nodes: parotidei*, and the
(b) *Lymph nodes: retropharyngiales* by multiple incisions;
(c) the external masseters (*M. masseter*) by making two deep linear incisions parallel to the mandible and the internal masseters (*M. pterigoideus medialis*) by making a single deep linear incision.
(d) the registered inspector must observe the skin (or external surface of de-masked heads), lips, gums, hard and soft palate, eyes and nostrils; and
(e) the tonsils must be removed under supervision after inspection as part of the slaughtering process and condemned.

(6) The feet must be examined by observation.

(7) When examining the red offal, the registered inspector must examine –

(a) the surface of the visceral pleura by observation;
(b) the liver by palpation and incisions into the gastric surface and the base of the caudate lobe to open the bile ducts;
(c) the hepatic lymph nodes by multiple incisions into the *Lymph nodes: hepaticus*;
(d) the trachea by a lengthwise incision and the oesophagus by
observation;

(e) the lungs by palpation and an incision in their posterior thirds perpendicular to their main axes to open the main branches of the bronchi;

(f) *Lymph nodes: mediastinales* by multiple incisions;

(g) *Lymph nodes: bronchiales* bilaterally by multiple incisions;

(h) the pericardium and the heart by an incision made lengthwise to cut through the interventricular septum and open the ventricles and two additional vertical cuts into the split septum;

(i) the spleen by visual examination and if necessary incision;

(j) the tail by observation;

(k) the thyroid gland by observation;

(l) both sides of the diaphragm by observation; and

(m) the testes and ovaries by observation.

(8) When examining the rough offal, the registered inspector must examine –

(a) the visceral peritoneum and omentum by observation;

(b) if necessary, the inner surfaces of the stomach and intestines but this examination will only take place in the rough offal room or detention area with separate equipment; and

(c) the gastric and mesenteric lymph nodes (*Lymph nodes: gastrici, mesenterici, cranialis* and *caudalis*) by observation and, if necessary by multiple incisions.

**Specific inspection of zebra carcass and organs**

26. (1) The registered inspector must inspect a carcass by means of observation, palpation, smell and, where necessary incision, and must take into consideration –

(a) its state of nutrition;

(b) colour;
(c) odour;
(d) symmetry;
(e) efficiency of bleeding;
(f) contamination;
(g) pathological conditions;
(h) parasitic infestation;
(i) injection marks;
(j) bruising and injuries;
(k) any abnormalities of muscles, bones, tendons, joints, or other tissues; and
(l) the age, and sex of the animal from which it was derived.

(2) When inspecting the hindquarter, the registered inspector must inspect bilaterally –

(a) the parietal peritoneum, by observation;
(b) the Lymph nodes: iliaki mediales et laterales, and the Lymph nodes: subiliacus by multiple incisions; and
(c) the kidneys, by exposure or incisions if necessary and the Lymph nodes: renalis by incisions if necessary.

(3) When inspecting the forequarter, the registered inspector must inspect bilaterally –

(a) the parietal pleura, by observation; and
(b) the Lymph nodes: cervicalis superficialis, by palpation;

(4) Carcasses must be split after which the sternum, ribs, vertebrae and spinal cord must be inspected.

(5) To inspect the head the registered inspector must –
(a) examine the head by observation;
(b) palpate the tongue; and
(c) observe the skin, lips, gums, hard and soft palate, eyes and nostrils.

(6) The feet must be inspected by observation.

(7) When inspecting the red offal, the registered inspector must inspect –

(a) the surface of the visceral pleura, by observation;
(b) the liver, by palpation and incisions to open the bile ducts;
(c) the hepatic lymph nodes, by multiple incisions into the lymph nodes: hepaticus;
(d) the lungs, oesophagus and trachea by observation and palpation and an incision into the trachea;
(e) the pericardium and the heart, by an incision made lengthwise to cut through the interventricular septum;
(f) the spleen, by visual inspection and if necessary by palpation;
(g) the tail, by observation;
(h) both sides of the diaphragm, by observation; and
(i) the testes, by observation.

(8) When inspecting the rough offal, the registered inspector must inspect –

(a) the visceral peritoneum and omentum by observation;
(b) if necessary, the inner surfaces of the stomach and intestines but this examination will only take place in the rough offal room or detention area with separate equipment; and
(c) the gastric and mesenteric lymph nodes (Lymph nodes: gastrici, mesenterici, cranialis and caudalis) by observation.
PARASITIC INTERMEDIATE STAGES – ADDITIONAL INCISIONS AND TREATMENT

Parasitic intermediate stages and treatment

27. (1) A carcass, head and red offal found to be infested with one or more parasitic intermediate stages, which may be alive or calcified, must be detained and in category B animals and wild pigs, two additional incisions must be made into each *M. triceps brachii*, parallel and proximal to the original incisions.

(2) If one or more parasitic intermediate stages are found on the majority of incision surfaces the carcass must be condemned.

(3) Where the infestation is not excessive the carcass and organs may be passed on condition that it undergoes treatment as described under subsection (6).

(4) A conditionally passed carcass must be identified by roller marking in red ink along its entire side with the letter “M”, being a minimum of 2 cm in height.

(5) All parts belonging to the carcass to be treated, must be identified by “M” tags.

Carcasses and organs must be treated by freezing using one of the following methods –

(a) split carcasses in a freezer with air temperature at least minus 18 °C for 72 hours;
(b) split carcasses in a freezer at air temperature of at least minus 10 °C for 10 days;
(c) to reach a deep bone or core temperature of at least minus 6 °C, confirmed by the registered inspector and in accordance with the protocol approved for the specific slaughter facility registered
under the Scheme by the PEO;

(d) after deboning, in accordance with a protocol approved by the PEO and –

(i) the container or carton in which deboned meat is packed must be marked with the letter “M” and the date of introduction into the freezer must be indicated;

(ii) the core temperature of meat inside the container must be colder than minus 6 °C before it can be released by the registered inspector.

(e) in portions in a chest type freezer according to a protocol approved by the PEO.

(7) Visible parasitic intermediate stages must be removed from the meat of a carcass that is conditionally passed and treated as described.

(8) Records of core temperatures, freezer temperatures and batches of containers, carcasses and organs introduced for freezing must be kept by the owner for at least six months, and must be available for inspection purposes.

C. SECONDARY MEAT INSPECTIONS

General provisions regarding secondary meat inspection

28. (1) Suspect carcasses found during primary meat inspections, must be marked “detained” and must be subjected to secondary meat inspection by a registered inspector who is a veterinarian.

(2) During secondary inspection, information regarding carcasses must be ascertained on the –
(a) species, age and sex;
(b) organ or part of the carcass affected;
(c) condition or disease;
(d) probable cause of the condition or disease; and
(e) finding or judgement and the motivation thereof where applicable.

(3) Depending on the said finding, the carcass, organ or meat may be –

(a) approved;
(b) conditionally approved, subject to treatment;
(c) partially approved by removing the condemned part; or
(d) totally condemned.

(4) When a carcass has not been passed, the owner may request a written condemnation certificate.

Additional examination for suspect game carcasses

29. (1) The meat of animals which were referred to a registered inspector who is a veterinarian during harvesting inspection and primary meat inspection, as contemplated in sections 18 and 19, must be examined by the veterinarian who must pay particular attention to –

(a) the carcass colour, blood content of intercostal veins and the small vessels beneath the serosa of the abdominal wall and in the retroperitoneal fat in the walls of the pelvis;
(b) all exposed connective tissue, fat, lymph nodes and articular surfaces; and where required by the inspector, the carcass must be split and the surfaces so exposed examined;
(c) the condition of the musculature and abnormal odours and colour;

(2) If regarded as necessary by the registered veterinarian, the carcass or meat must be submitted for laboratory examination in order to make a final
Records of meat inspection

30. The results of the ante-mortem examination, primary meat inspection and secondary meat inspection must be recorded and where zoonotic and controlled diseases, contemplated in the Animal Diseases Act, 1984 (Act No. 35 of 1984), are diagnosed the local state veterinarian must be notified on the day such diagnosis is made.

Guidelines

31. A registered inspector who is a veterinarian must acquaint himself or herself with all further guidelines issued by the NEO regarding secondary meat inspections.

Condemnations

32. Carcasses or parts of carcasses that are condemned by the registered inspector either at harvesting, a depot or a slaughter facility must be handled according to section 33, provided that in cases where this is not practicable, the PEO must approve another method for each particular situation.

Handling of condemned material

33. (1) Carcasses, portions thereof or any edible products, in a game depot and slaughter facilities registered under the Scheme, which cannot be passed for human or animal consumption, must be –

(a) portioned and placed in a theft proof container which has been clearly marked “CONDEMNED”, in letters not less than 10 cm high, or conspicuously marked with a stamp bearing the word “CONDEMNED”, using green ink;

(b) kept in a holding area or a room or dedicated chiller provided for
that purpose, except if removed on a continuous basis; and
(c) removed from the slaughter facility at the end of the working day or be secured in a dedicated chiller or freezer at an air temperature of not more than minus 2 °C.

(2) A person may not remove a carcass, part thereof or any edible product which has been detained or condemned from a slaughter facility, except with the written permission of a registered inspector who is a veterinarian and subject to such conditions as he or she may impose.

(3) The slaughter facility owner must comply with the legal requirements or conditions relating to the safeguarding and disposal of any carcass, part thereof or any edible product which cannot be passed for human or animal consumption.

Disposal of condemned material

34. Condemned material must be disposed of in a manner consistent with National Legislation as well as ordinances and provisions made locally by environmental and other authorities.

D. GENERAL REQUIREMENTS FOR PERSONS INSPECTING GAME MEAT

Required qualifications for persons inspecting meat at harvesting and game meat facilities under the Scheme

35. The following persons are qualified to perform meat inspection services under the Scheme –

(a) a veterinarian, meat inspector, meat examiner, an animal health technician;
(b) a person who has an appropriate bio-scientific qualification approved by the NEO; and
(c) if required by the NEO, a person who has a certificate for game meat inspection which is approved by the NEO and accredited by South African Qualifications Authority (SAQA);

Registration of persons inspecting meat at harvesting and game meat facilities under the Scheme with PEO

36. (1) A person contemplated in section 35 of the Scheme who wishes to inspect game meat–

   (a) must register with the PEO in order to do meat inspection at a specified game slaughter facility or be associated with a specific harvesting team; and
   (b) may be suspended or deregistered by the PEO in the event of non-conformance to these requirements or if found incompetent to perform the functions required of registered inspection personnel.

(2) A list of registered game meat inspection personnel must be maintained by WRSA and provided to the relevant PEO on a quarterly basis.

Requirements for participation in Scheme

37. The following persons are qualified to perform meat inspection services under the Scheme –

   A person participating in the Scheme must –

   (a) be a person who utilizes a game slaughter facility or who plans to handle and prepare game meat commercially; and
   (b) (i) be a game harvester or plans to harvest game commercially; or
       (ii) receive game carcasses from harvesters who adhere to the provisions of the Scheme; and
(c) agrees in writing to adhere to the provisions of this Scheme, in order to establish a workable infrastructure for producing safe game meat commercially.

**Application for admission and information to be furnished by applicant**

38. (1) An applicant may register for participation in the Scheme by completing an application form obtainable at the offices of WRSA and stating:

(a) current involvement in game harvesting for commercial use;
(b) places where harvesting is done or planned to be done;
(c) address of game slaughter facility which is being utilized or is planned to be utilized for commercial game production; and
(d) all relevant contact information as well as relevant contact persons during absence of applicant.

(2) An applicant or a designated representative of an applicant who is a legal entity must sign a declaration of intent to comply with the requirements of the Scheme and promote the aims of the Scheme.

(3) The facilities and procedures, including harvesting, followed by an applicant must be subjected to a preliminary inspection by trained personnel from WRSA before his or her application is forwarded to the relevant provincial veterinarian offices for final approval and registration under the Scheme by the PEO.

**Circumstances under which application may be refused**

39. (1) The PEO may, after inspecting the operation of an applying game slaughter facility, refuse the application on the grounds that production from such operation or facility presents danger to consumers. The PEO may determine that an applicant should first make significant improvements to facilities or procedures to ensure a basic level of safety in his or her harvesting or slaughter process, before being allowed to participate in the
A person whose application has been refused by the PEO may appeal against the decision of the PEO in accordance with the provisions of section 42.

**Manner in which a person may participate in Scheme**

40. (1) A person may utilize an existing game slaughter facility for producing game meat for a commercial purpose provided that –

(a) (i) the PEO has inspected the slaughter facility and operations and is of the opinion that slaughtering is performed in such a manner so as to pose no threat to human safety and the meat is inspected; or

(ii) the PEO may determine that certain facilities and procedures must be improved before production may commence with safety; and

(b) if the PEO grants permission for commercial production of game meat before full compliance with the requirements of the Act, the PEO must determine a time schedule within which the game facility must conform with all the requirements of the Act, at which time such facility may be registered as a game abattoir by the PEO.; provided that

(i) the PEO has inspected the harvesting procedures and facilities relevant to the slaughter facility and is of the opinion that harvesting is performed in such a manner as to pose no threat to human safety, and that capable trained personnel perform preliminary meat inspection; or

(ii) the PEO may determine that certain facilities and procedures must be improved before harvesting may commence safely; and
(c) the owner or operator of the slaughter facility remains responsible for assuring that all carcasses received at the slaughter facility are harvested according to the provisions of the Scheme.

(2) An owner of a game slaughter facility must take part in a training programme provided for under section 4 of the Scheme, in order to train all personnel, including harvesters, in good meat hygiene practices and also to provide trained personnel at the point of harvesting to identify and exclude diseased carcasses from production.

_Circumstances under which participation lapses or may be cancelled_

41. (1) Participation in the Scheme may lapse under the following circumstances:

(a) If, after an inspection, the PEO or WRSA is of opinion that, in spite of the provisions of the scheme, the operation or facilities of a game slaughter facility or the state of harvested game received, has regressed to the extent that it poses a danger to consumers; or

(b) If a training programme for persons involved in harvesting or slaughtering in a slaughter facility is not being followed as required by the PEO or WRSA;

(2) The PEO will notify an owner of a slaughter facility in writing through WRSA that his or her facility ceases to be registered under the Scheme, provided that participation may be reinstated if he or she implements the requirements of the PEO.

_APPEALS_

42 (1) An owner whose slaughter facility has been refused registration under the
Scheme or has been deregistered from the Scheme may apply for reconsideration with the PEO to be heard by a committee consisting of the PEO and representatives of WRSA.

(2) Should such owner not be satisfied with the outcome of the reconsideration, an appeal may be lodged with the NEO, the outcome of which will be binding on all parties.

(3) An appeal made to the NEO must be in writing including:

(a) A copy of the original application and complete relevant history;
(b) The reason why the application has been refused or the registration has been withdrawn;
(c) Full reasons why the appellant is of the opinion that he/she should be registered or not be deregistered;
(d) The NEO may appoint an officer or persons including a person suggested by the appellant, to investigate the case in order to arrive at a conclusion; and
(e) The Appellant must be notified in writing concerning the outcome of the appeal.
(f) No costs incurred by an appeal may be claimed from the PEO, NEO or WRSA.

**RECORDS SYSTEMS AND HYGIENE PROGRAMS REQUIRED**

43. Owners of slaughter facilities, registered under the Scheme, and harvesting operations must undergo training, provided by WRSA under guidance of the PEO, to establish record systems and hygiene programs that are relevant to each particular slaughter facility and harvesting operation to include as applicable:

(1) Record Management systems.

(2) Schematic plans of slaughter facility and harvesting depots.
(3) Flow diagrams of harvesting and dressing at depots and slaughter facility.

(4) Identification of hazards

(5) Prevention and management of hazards

(6) Hygiene management programmes

**RECORD MANAGEMENT SYSTEM**

44. A record system for slaughter facilities registered under the Scheme must provide for –

(a) the accessibility of documents relating to an identified harvest batch;
(b) the recording of each harvest batch containing information regarding date of harvesting, species harvested, mass, quantities, identification and destination for carcasses as well as cut meat; and
(c) a documented product recall procedure approved by the PEO.

**SCHEMATIC PLAN OF SLAUGHTER FACILITY REGISTERED UNDER THE SCHEME AND HARVESTING DEPOTS**

45. The owner must provide an updated schematic plan which must include details of as applicable –

(a) all the different areas;
(b) all the different rooms in each area identified, indicating the process or operation including the capacities or rates of operation that take place in such rooms;
(c) the flow of the product;
(d) ancillary structures on the premises;
(e) the required temperature as well as the capacity of each room where temperature is controlled;
(g) all entrances to rooms, areas and building; and boundaries, indicating entrances and exits to and from premises.

**FLOW DIAGRAM OF HARVESTING AND DRESSING PROCESSES**

46. The owner must provide a flow diagram of the harvesting as well as the dressing process which includes –

(a) all steps involved in the process, including delays during or between steps, from harvesting, receiving of the carcasses to placing of the end product on the market; and

(b) details and technical data including equipment layout and characteristics, sequence of all steps, technical parameters of operations, flow of products, segregation of clean and dirty areas, hygienic environment of the slaughter facility and harvest depots, personnel routes and hygienic practices, product storage and distribution procedures.

**POTENTIAL HAZARDS**

47. The owner must prepare a list of all potential biological, chemical or physical hazards that may occur at each step of the process, including –

(a) unacceptable contamination of a biological, chemical or physical nature;

(b) unacceptable survival or multiplication of pathogenic micro-organisms; and unacceptable production or persistence of toxins or other undesirable products of microbial metabolism.

**PREVENTION OF HAZARDS**

48. The owner must prepare written hygiene management programmes (HMP) for approval by the PEO, to prevent, eliminate or reduce hazards mentioned in section 47 to acceptable levels and must –

(a) ensure that management programmes for each hazard is implemented;
(b) establish critical limits for control points;
(c) establish a monitoring or checking system for each control point, which may include bacteriological monitoring where required by the PEO; and
(d) prepare written corrective actions that must be taken without hesitation when a deviation is observed and such corrective action must specify –

(i) the persons responsible to implement the corrective action;
(ii) the means and action required for each hazard;
(iii) the action to be taken with regard to the meat having been processed during the period when the process was out of control;
(iv) and
that written record of measures taken must be kept.

**HYGIENE MANAGEMENT PROGRAMMES**

49. (1) Hygiene management programs (HMP) must be compiled to provide written descriptions of all functions during harvesting and in a slaughter facility including duties of all workers required to make such harvesting and slaughter facility operate successfully.

(2) The PEO must advise slaughter facility owners how to develop such programs which are relevant to their particular circumstances.

(3) The owner of a slaughter facility registered under the Scheme must maintain –

(a) a HMP for ante-mortem inspection during harvesting (section 18), including measures to –

(i) identify animals with diseases and conditions of which symptoms may not be visible during post-mortem meat inspections;
(ii) identify animals with contagious diseases or diseases
controlled under the Animal Diseases Act 1984 (Act No. 35 of 1984);

(iii) identify animals that pose a contamination risk;

(iv) prevent the harvesting of such animals as identified above; and

(v) ensure that all harvested carcasses which for some reason or other cannot be processed into safe meat are identified as being condemned (section 32) and handled in accordance with section 33;

(b) a HMP for harvesting and dressing, including –

(i) measures to ensure that no contamination of meat and edible products occur from –

(aa) the external surface of the harvested animal;

(bb) wind and dust;

(cc) the contents of hollow organs;

(dd) persons working with edible products; or

(ee) contact with unclean objects;

(ii) harvesting and dressing procedures which must limit any contamination to the absolute minimum;

(iii) training of all workers in correct harvesting and dressing techniques including principles of hygiene practices which must be monitored; and

(iv) a programme for the daily checking of carcasses, after dressing, for soiling to provide for regular checking of a representative sample of carcasses throughout the production period on a random basis and to determine the levels of contamination of carcasses;
(c) a HMP for meat inspection, at harvesting and at the slaughter facility, in terms of which the supervisory registered inspector must monitor meat inspection by means of implementation of written measures to ensure –

(i) that meat inspection is done according to the provisions of this Scheme;
(ii) the competency of the meat inspection personnel;
(iii) the personal hygiene of the meat inspection personnel;
(iv) that heads, red and rough offal are correlated with the carcasses of origin;
(v) the security of detained carcasses and organs;
(vi) the security of provisionally passed carcasses and organs;
(vii) the security of the stamp of approval;
(viii) the security of condemned material; and
(ix) the implementation of standard operational procedures (SOP’s) to ensure the production of safe meat;

(d) a HMP for the personal hygiene of workers in terms of which –

(i) a general code of conduct, approved by a registered inspector, for personnel and in particular for workers who come into direct contact with meat and edible products, must be available;
(ii) a training programme, as well as registers of attendance, for all personnel to apply the principles of the code of conduct referred to in subparagraph (i) must be available; and
(iii) records of surveillance and supervision including records of disciplinary action in cases of repetitive misconduct or non-compliance must be available;

(e) a HMP for medical fitness of workers in terms of which –
records of initial medical certification that workers are fit to work with meat and edible products, prior to employment, must be available; and

records of daily fitness checks, including corrective actions applied in cases of illness and injury, must be available;

(f) a HMP for sterilizer equipment and maintenance thereof in terms of which –

(i) measures to ensure the continuous availability and accessibility of sterilizers in good working order at water temperatures of 82 °C;

(ii) registers for daily checks indicating frequency of checks as well as corrective action procedures in cases of non-compliance, must be available. In cases where chemical sterilizers are used on harvesting vehicles and depots, these must be maintained as required and a register kept;

(g) a HMP for the availability of liquid soap and soap dispensers, toilet paper, and disposable towels, in terms of which measures to ensure the continuous availability and accessibility of liquid soap and soap dispensers for hand-washing purposes, toilet paper and disposable towels at pre-identified points, must be available;

(h) a HMP for sanitation and continuous cleaning including a cleaning schedule which provides for –

(i) a list of all the areas to be cleaned;

(ii) a list of all the rooms that have to be cleaned within every area;

(iii) the name of the person responsible for the cleaning of each area, section or room;

(iv) each room within a particular area, a detailed description of
the cleaning of each structure, including –

(aa) the frequency of cleaning;
(bb) step by step methods of cleaning;
(cc) data of the chemicals which are used, such as registration data, safeness, dilutions, application prescriptions;
(dd) the correct application of the detergents such as dilution, temperatures and contact times;
(ee) the rinsing off of applied chemicals; and
(ff) the results to be obtained as an objective of the cleaning programme;

(v) an addendum for each room in which the cleaning of each structure must be described in detail including aspects such as method, frequency and target results;
(vi) the training of cleaning teams in the execution of these programmes;
(vii) control over the storage of detergents to prevent contamination of edible products;
(viii) a detailed description for continuous cleaning in the processing areas during processing, which must include –

(aa) a list of all the actions in this programme including the cleaning of moving equipment and crates; and
(bb) a step by step description of each action;

(ix) these programmes to be approved by a registered inspector; and
(x) laboratory checks as a control of effectiveness of the cleaning programmes to be instituted and documented;

(i) a HMP for availability and quality of water in terms of which –
the owner of the slaughter facility or depots must account for the source of water supply and the status of such water; the owner must be able to demonstrate the water distribution system within the slaughter facility or depots and provide an updated schematic plan of the water distribution on the premises; a sampling programme must be followed to ensure that all outlets, including water hoses are checked on continuous basis within allotted periods of time, and the sampling procedure must be described; and the owner must ensure that water used in the slaughter facility or depots is potable and that records of microbiological and chemical water test results are available;

(j) a HMP for vermin control in terms of which the owner of the slaughter facility or permanent depots must provide a written control programme for each vermin type for approval by the PEO, and such programme must include –

(i) schematic drawings indicating the position of bait stations;
(ii) a poison register, including specifications for the use of different poisons;
(iii) training programmes for persons working with poisons; and
(iv) routine checking of bait stations;

(k) a HMP for waste disposal, including condemned material, in terms of which –

(i) the owner of the slaughter facility or depot must provide a written control programme for the removal of each different category of waste material including general refuse removal for approval by the PEO; and security arrangements to prevent condemned material from
(ii) entering the food chain must be described;

(i) a HMP for in contact wrapping and packing materials in terms of which –

(i) the owner of the slaughter facility or depot must provide a written control programme addressing the suitability as well as the storage and handling of all in contact wrapping and packing material;

(ii) measures to prevent contamination in store rooms must be provided; and

(iii) measures to prevent contamination of wrapping materials must be provided;

(m) a HMP for maintenance, providing for the owner of the slaughter facility or depot to provide a document addressing the routine maintenance of all equipment and structures; and

(n) a HMP for thermo control in terms of which –

(i) a plan must be provided that indicates the layout of all the chillers, freezers and processing rooms where temperature control of the rooms is required or applicable to the particular installation including –

(aa) each temperature controlled room or area;

(bb) the number of the room or area;

(cc) the temperature requirement of each room; and

(dd) the throughput of each room;

(ii) each chilled room and where a chilled truck is used to transport carcasses from the harvesting area, must be equipped with a recording thermograph, or an equivalent means of monitoring and recording, that indicates the
temperature measurements in the room or chilled truck on a continuous basis taking into account that:

(aa) actual time, temperature and correct date must be appear on graphs or recorded data;

(bb) annual calibration certification must be available for meters;

(cc) records of regular testing of digital thermographs and meters against a certified fluid in glass thermometer, done by the owner, must be available;

(dd) if a centralized computer system is used, relevant readings must be recorded ongoing, at least at 30 minutes intervals;

(ee) the temperature status of every room must be checked at least every 12 hours by the owner to ensure maintenance of temperatures and that all deviations are accounted for;

(ff) checks by the owner must be recorded on the temperature control records;

(gg) any deviations from the required temperature must receive immediate corrective attention;

(hh) records must be available for inspection by the NEO or PEO; and

(ii) the hygiene manager must indicate daily control checks by way of signature on the records.

FACILITIES REQUIRED BY PERSONS PARTICIPATING IN THE SCHEME

50. (1) Subject to section 37, a person who wishes to participate in the Scheme must have the basic structures and equipment which have been recommended by WRSA and accepted by the PEO as being sufficient to provide a safe product.
A participant must co-operate with the objectives of the Scheme as set out in section 4 in order to upgrade the structures over the time period agreed upon with the PEO for each slaughter facility to achieve the standards set out below.

The PEO must, in consultation with the owner, determine the actual throughput requirements and set appropriate goals towards which upgrading can be done to achieve either a rural or a low throughput grade game slaughter facility as provided for in this Scheme.

**REQUIREMENTS FOR RURAL THROUGHPUT GAME SLAUGHTER FACILITY**

51. Considering the structural requirements set out in section 53, for a slaughter facility to be graded as a rural throughput game slaughter facility it must comply with the following:

(a) the throughput may not exceed 2 units per day, provided that the PEO may determine a lower maximum throughput for a slaughter facility on grounds of the hourly throughput potential relative to available equipment and facilities including hung space, chiller capacity;

(b) the premises must be fenced and provided with a gate to control access of people and animals;

(c) the slaughter facility must consist of a room equipped with hung facilities where harvested game carcasses or partially dressed game carcasses are dressed and such room must have an air temperature of not more than 12°C when chilled carcasses are handled, provided that if chilled carcasses are handled so that its temperature does not rise more than 2°C during dressing, subject to the approval of the PEO, the temperature of the room need not be maintained at 12°C or less;

if windows are not glazed, fly screens must be provided;

(d) curbed and drained areas, must be provided adjacent to the slaughter facility for –

(i) handling, washing and keeping rough offal; and
to hold containers with inedible products prior to removal.

(f) doors must be provided –

(i) where harvested game carcasses or partially dressed game carcasses are received into the slaughter facility;
(ii) where dressed or partially dressed carcasses and red offal are dispatched but, dispatching may be done via the carcass receiving door mentioned in subparagraph (f)(i) if these functions are done at different times; and
(iii) between the dressing room and the adjacent area referred to in paragraph (e)

(g) hand washing facilities must be provided in the slaughter facility;
(h) a sterilizer adjacent to a hand wash basin must be provided;
(i) toilet and hand wash facilities must be provided;
(j) facilities to store items needed in the daily process must be provided;
(k) the design must allow for future upgrading of the facility;
(l) separate chillers must be provided for –

(i) partially dressed game carcasses;
(ii) dressed carcasses and red offal;
(iii) rough offal.

The proximity of these chillers to the slaughter facility must be such as not to compromise hygiene standards and be acceptable to the PEO;

(m) a chiller for partially dressed game carcasses may be substituted with a chiller truck connected to the receiving area by docking seals;
(n) a chiller for rough offal may be omitted if rough offal is removed from the slaughter facility on a continuous basis but within four hours after evisceration or receiving; and
(o) where freezing facilities are not provided for treatment of conditionally passed carcasses affected by parasitic intermediate stages (measles) at
the slaughter facility, such facilities may be arranged elsewhere with the approval of the PEO.

**REQUIREMENTS FOR LOW-THROUGHPUT GAME SLAUGHTER FACILITIES**

52. Considering the structural requirements set out in section 53, for a slaughter facility to be graded as a low throughput game slaughter facility it must comply with the following:

(a) a maximum throughput of 20 units per day may not be exceeded, but the PEO may determine a lower maximum throughput for a slaughter facility on grounds of the capacity of the receiving area, hourly throughput potential relative to available equipment and facilities including hanging space, chiller capacity;

(b) the premises must be fenced and provided with a gate to control access of people and animals;

(c) a door equipped with docking seals for offloading harvested game or partially dressed game carcasses and red offal must be provided;

(d) a facility where transport trucks must be sanitized after offloading must be provided;

(e) a receiving area with hanging facilities to accommodate at least 20% of throughput of game carcasses of different categories and red offal must be provided and such area must have an air temperature of not more than 12°C when chilled carcasses are handled provided that if chilled carcasses are handled so that its temperature does not rise more than 2°C during dressing, subject to the approval of the PEO, the temperature of this room need not be maintained at 12°C or less;

(f) a hoist for the hanging of category B game must be provided;

(g) holding chillers must be provided to accommodate partially dressed carcasses received prior to dressing;

(h) the chillers referred to in paragraph (g) may be substituted with a chiller truck connected to the receiving area by docking seals;

(i) a room equipped with a dressing rail must be provided where harvested game carcasses or partially dressed game carcasses are dressed and such
room must have an air temperature of not more than 12°C when chilled carcasses are handled;

a side rail or hooks for carcasses and containers for offal, must be provided for condemned or detained carcasses and organs requiring secondary meat inspection;

(k) a room must be provided where hides, skins, hair, heads, feet and inedible material are kept prior to removal, unless these parts are removed on a continuous basis;

(l) a room must be provided where paunches and intestines are emptied, washed and kept;

(m) the rooms mentioned in paragraphs (k) and (l) must –

(i) be separate and adjacent to the dressing room and interconnected by means of a hatch, door or walkway; and

(ii) have exterior doors for the removal of inedible materials and in the case of paunches and intestines from animals that were eviscerated in the field, paunches and intestines must be received for inspection purposes through the external door;

(n) if paunches and intestines are not intended for human consumption, the room mentioned in paragraph (l) may be omitted provided that all paunches and intestines are removed, immediately after evisceration or receiving and inspection, from the dressing room to a suitable receptacle via a self closing hatch;

(o) separate chillers must be provided for the daily throughput of –

(i) carcasses and red offal, provided that the red offal may be removed from the slaughter facility to alternative chilling facilities, on a continuous basis but within four hours after an animal has been eviscerated, if separate dispatch facilities have been provided for such red offal; and

washed rough offal, unless washed rough offal is removed from the
(ii) slaughter facility within four hours after evisceration or receiving;

(p) where freezing facilities are not provided for treatment of conditionally passed carcasses affected by parasitic intermediate stages (measles) at the slaughter facility, such facilities must be arranged elsewhere with the approval of the PEO;

(q) a dispatch area equipped to quarter, sort and mark carcasses and red offal as well as a door for dispatch must be provided;

(r) a personnel entrance to the clean areas of the slaughter facility must be provided and must be designed as an ante-chamber for cleaning purposes and must be provided with hand wash-basins, soap dispensers, hand drying facilities, a boot wash, facility to wash aprons, hooks for aprons and a refuse container and at the discretion of the PEO, personnel entrances to other areas of the slaughter facility need not be provided with an ante-chamber but must be provided with conveniently placed boot wash and hand wash facilities at the entrance to such areas;

(s) change room, shower, toilet as well as hand wash facilities must be provided on the premises for persons working at the slaughter facility;

(t) dining facilities must be provided with tables chairs or benches and must be situated so that personnel do not sit or lie on the ground or soil their protective clothing during rest periods;

(u) a storage facility for items needed in the daily process must be provided;

(v) rooms or facilities must be provided for –

(i) storage of cleaning equipment and materials; and

(ii) cleaning and sterilization of movable equipment;

(w) if required, a separate room must be provided as an office.

STRUCTURAL REQUIREMENTS FOR GAME SLAUGHTER FACILITIES

53. (1) WRSA and the PEO must evaluate each game harvesting and slaughtering operation as submitted for participation in the scheme according to its
procedural suitability to produce safe game meat, as well as structural conformity or potential to upgrade and reach conformance to the satisfaction of the PEO.

(2) The PEO must—

(a) guide the facility owner according to the requirements relating to his or her particular structure; and

(b) determine a programme for upgrading the facility over a specific time period.

(3) A programme for upgrading a facility must include immediate upgrading to ensure safe production with further upgrading coupled to possible increased production.

GENERAL

54. Premises must be of such design, construction, condition and finish and must be so equipped and so located that they can be used at all times for the purpose for which they were designed, constructed and equipped—

(a) without creating a health hazard; and

(b) in such a manner that meat—

(i) can be handled hygienically on the premises or with equipment on the premises; and

(ii) can be protected by the best available method against contamination or spoilage by poisons, offensive gasses, vapours, odours, smoke, soot deposits, dust, moisture, insects or other vectors or by other physical, chemical or biological contamination or pollution.
**PREMISES**

55. (1) All areas on the premises must be rendered dust and mud free.
(2) Provision must be made for storm water drainage.
(3) The slaughter facility must be equipped with an enclosed drainage system for the disposal of effluent and sewerage.
(4) Truck loading and off loading areas for dispatching and receiving of meat must be curbed, paved, drained and roofed.

**CROSS FLOW**

56. The premises and buildings must be designed to ensure that –

(a) no cross flow between clean and dirty areas and functions, occurs;
(b) inedible or condemned material can easily be removed on a continuous basis from areas where edible material is handled; and
(c) detained meat can be kept and examined without contaminating passed meat.

**REQUIREMENTS FOR INTERIOR OF BUILDING AND ROOMS**

57. In a facility where meat and animal products are handled and in toilets, change rooms and dining facilities –

(a) all rooms must be of such size as not to compromise hygiene;
(b) floors and stairways must be –

(i) smooth, impervious, resistant to wear and corrosion and not slippery; and
(ii) free of cracks and open joints;

(c) floor drainage design and construction –
must ensure that floors are sloped at a gradient of not less than 1:60 towards drainage points or channels;

must ensure that channels drain from clean to dirty areas;

must be such that drainage channels are smooth, impervious, washable and provided with grates or covers; and

must provide all drain inlets with solid traps as well as mechanisms to prevent access of vermin and obnoxious odours into the slaughter facility;

(d) interior wall surfaces, partitions and pillars must be –

(i) smooth, impervious, washable and light coloured;

(ii) rounded at floor to wall, as well as wall to wall, junctions with a minimum radius of 50mm; and

(iii) rounded on top in case of walls and partitions which are not ceiling height;

(e) interior roof structures or ceilings, must be smooth, impervious, light coloured and washable;

(f) doors and doorframes must be smooth, impervious, vermin proof, light coloured and corrosion resistant;

(g) personnel entrances must have self-closing doors and be provided with hand wash-basins, boot wash and apron wash facilities and apron hooks;

(h) hatches, where provided, must have an inclined bottom edge sloping towards the dirtier side, and self closing flaps must be provided when applicable;

(i) chutes must –

(i) be smooth, light coloured and corrosion resistant;

(ii) open at least 300 mm above the floor;

(iii) be sanitizable along its entire length; and

(iv) be separate for meat, inedible material and condemned material, respectively;
(j) windows –

(i) must have light coloured, corrosion resistant frames and must be glazed;
(ii) must be fitted with fly screens when used for ventilation;
(iii) must have window sills that slope at $45^\circ$; and
(iv) may not be opened if they interconnect clean and dirty areas;

(k) all working areas must –

(i) be well ventilated; and
(ii) have artificial or natural lighting at an intensity of at least –
   (aa) 540 lux where meat is inspected; and
   (bb) 220 lux in work areas;

(l) all light fittings must be equipped with covers or splinter protectors;
(m) all electrical fittings must be waterproof; and
(n) all wall mounted equipment, structures and fittings must have a clearance of at least 50 mm from the wall.

**REQUIREMENTS FOR EQUIPMENT**

58. (1) Equipment –

(a) must be corrosion resistant and non-toxic and may not taint or stain meat;
(b) must have surfaces which are smooth, impervious and free of holes, cracks and sharp corners, and must be sterilizable; and
(c) may not contaminate meat with lubricants.

(2) Containers used to hold meat must comply with subsection (1) and if the sides and bottoms are constructed with openings they must be designed so that meat cannot protrude through the openings or make contact with the
59. (1) Toilets and urinals must be situated in a separate room and may not be an integral part of a change room.

(2) All toilets must be provided with toilet paper holders and toilet paper, hand wash-basins, soap dispensers with germicidal liquid soap and hand drying facilities.

(3) Change rooms and toilets may not have direct access into an area or room where meat is handled.

(4) Workers must be provided with clothing lockers in which to store private clothes separately from protective clothing, ensuring that private clothes and clean protective work clothes do not make contact.

(5) Workers must be provided with separate fly proof facilities in which to keep food.

60. (1) Sterilizers must be readily accessible and must –

(a) be placed on dressing platforms and within three meters of workstations, adjacent to hand wash-basins in rooms and areas where –

(i) carcasses are dressed;
(ii) carcasses, meat and offal are detained;
(iii) condemned material is handled; or
(iv) meat is otherwise handled;
be corrosion resistant and capable of sterilizing hand utensils and equipment, such as cutters and saws, at a minimum water temperature of 82°C during slaughter; and

have an inlet, overflow and outlet and must drain through a down pipe directly into a closed drainage system or into an open channel, but such drainage water may not flow over the floor across areas where traffic occurs;

(2) Any other method of sterilization must be approved by the PEO.

HAND WASH-BASINS

61. Hand wash-basins must be readily accessible and be –

(a) placed on dressing platforms and within three meters of workstations in rooms and areas where –

(i) carcasses are dressed;
(ii) carcasses, meat and offal are detained;
(iii) condemned material is handled; or
(iv) meat is otherwise handled;

(b) corrosion resistant;
(c) provided with taps that are not hand or elbow operated;
(d) supplied with warm running water at not less than 40 °C;
(e) provided with an inlet, overflow and outlet and must drain through a down pipe directly into a enclosed drainage system or into an open channel, but such drainage water may not flow over the floor across areas where traffic occurs; and

(f) fitted with a dispenser for liquid germicidal soap as well as hand drying facilities, unless the drying of hands is not necessary in the area where the basin is situated.
**WATER SUPPLY**

62.  (1) Water must be under pressure, and must conform to at least Class II according to the SANS 241 standard for drinking water.

(2) Water points must be provided with –

(a) cold water;
(b) warm water at not less than 40°C and equipped with hose pipes for sanitizing all areas of the slaughter facility; and
(c) hose reels to store hoses away from the floor unless vertical drop hoses are provided.

**CONTAINERS FOR INEDIBLE, CONDEMNED AND REFUSE MATERIAL**

63.  (1) Sufficient theft and leak proof containers with tight fitting lids, complying with section 58 (1)(b), must be provided to keep and transport condemned material and they must be clearly marked “CONDEMNED”.

(2) Containers must be provided to collect and hold inedible material until disposal.

(3) Facilities to collect and hold blood prior to disposal must be provided.

(4) Refuse containers must be provided for the collection of general refuse at various points on the premises.

(5) Areas where waste or refuse containers are kept prior to removal must be impervious, curbed and drained and the containers must be enclosed or fitted with tight fitting lids.
VEHICLES USED FOR HARVESTING GAME AND TRANSPORTING CARCASSES DIRECTLY TO A SLAUGHTER FACILITY OR DEPOT REGISTERED UNDER THE SCHEME

64.  (1) Vehicles used for harvesting Category C or small game must –

(a) have a hanging frame to bleed carcasses in a hanging position which must be –

(i) corrosion resistant and free from holes and cracks;
(ii) durable, non-toxic, smooth surfaced, impervious and resistant to impact;
(iii) easy to clean;

(b) be equipped with facilities for cleaning and sterilising of bleeding knives with water at 82°C or chemical sterilization as approved by the PEO;

(c) have a hand wash facility, with potable running water and soap, for the workers bleeding the harvested game;

(d) not keep equipment or loose objects, other than is required for the harvesting and bleeding of game on the processing area of the vehicle;

(e) have artificial light of at least 220 lux where culling takes place at night.

(2) Vehicles used for harvesting Category B or medium game must –

(a) comply with the requirements for category C game in paragraph (b),(c),(d) and (e) of subsection (1);

(b) have a hoist and a ramp at an angle of 20° to 30° for hanging and bleeding of the animals.
TRANSFERABLE DEPOTS

65. Transferable depots must be provided with –

(a) a hanging frame of sufficient height to prevent heads and necks of carcasses making contact with the ground;

(b) a separate table for the inspection of the rough offal;

(c) adequate hooks for the inspection of heads and feet if removed as well as for red offal;

(d) an approved protocol regarding the accumulation of blood and waste products on the ground below the frame during dressing. This may include a tarpaulin that can be cleaned on a continuous basis or moving the frame to a clean area;

(e) sufficient closable containers that comply with requirements set in section 58(2) to accommodate –

(i) red offal;

(ii) rough offal;

(iii) inedible material; and

(iv) condemned material;

(f) potable water and facilities for –

(i) sterilizing knives and equipment at 82 °C;

(ii) washing of hands and equipment;

(g) bactericidal liquid soap;

(h) artificial light where game is slaughtered at night –

(i) with a minimum light intensity of 220 Lux for dressing; and

(ii) 540 Lux at the inspection point;

(i) toilet facilities provided per protocol.
PERMANENT DEPOTS

66. Permanent depots must comply with the requirements for transferable depots, but in addition –

(a) the frame must be fixed on a curbed and drained concrete base;
(b) roadways and walkways must be dust and mud free and cleanable;
(c) have an underground effluent disposal system;
(d) toilets and hand wash facilities must be provided.

DRESSING AND EVISCERATION FACILITIES IN GAME SLAUGHTER FACILITIES REGISTERED UNDER THE SCHEME

67. (1) The minimum clearance for rails and equipment in dressing areas from rail to floor is –

(a) for category B game dressing, 3.4 m; and
(b) for category C game dressing, 2.2m.

(2) The clearance between equipment and dressing rails must in all cases be such that carcasses do not touch equipment and is at least 1000mm from walls.

(3) Rails with hooks fixed to a wall must be 400 mm from the wall, and meat hanging from such hooks may not touch the floor or wall.

(4) Rails must be at least 700 mm from columns, pillars or the side of a doorway through which carcasses must pass.

MEAT INSPECTION FACILITIES

68. (1) Containers, racks and platforms and any other equipment required for meat inspection must be provided in a slaughter facility.
Marked, leak proof and lockable containers or other means to handle and hold condemned and inedible material prior to removal, must be provided.

**CHILLERS**

69. (1) Chillers must be provided to hold at least the daily throughput.

(2) The minimum clearance for rails in chillers and freezers –

(a) for category B or category C carcasses on cradles with extension rods, is 1000 mm from the wall and 900 mm between overhead carcass rails; and

(b) for category C carcasses, if hung separately, is 330 mm from the wall and between overhead carcass rails.

(3) Spacing of units on the line should be such as to ensure airflow between carcasses or sides with a minimum of 660 mm length of rail per unit.

**DISPATCH AREAS**

70. Dispatch areas must be equipped for –

(a) quartering, marshalling and loading of carcasses;

(b) collection and transport, avoiding cross or contra flow, of used roller-hooks to the sanitation facility; and

(c) sterilization of saws and other cutting utensils.

**MARKING OF GAME MEAT AS PRODUCED UNDER SCHEME**

71. (1) Game carcasses that have been passed by a registered inspector at a registered game, under the Scheme, must be marked on all four quarters using the “PASSED” identification stamp.
(2) (a) A PEO must issue each slaughter facility in his or her province, operating under the Scheme, with a special reference number relating to the Scheme, to be incorporated in the “PASSED” identification stamp used at such slaughter facilities.

(b) The special reference number must consist of a numerical component designating the province, facility number, the letter “G” and the letter “P”. For example 2/01GP, where “2” indicates the province, “01” facility number, “G” refers to Game and “P” signifies “provisional” under the Scheme.

(3) The stamp used to make the mark must comply with the health and hygiene standards as follows:

(a) All stamps or roller marks used to mark any carcass or meat must be constructed of a non-toxic, non corrosive material and must be so constructed as to be readily cleanable.

(b) The stamps must contain –

(i) the slaughter facility registration number; and
(ii) the wording shown in section 71(1), which must be in at least two official languages, one of which must be English.
(c) The minimum sizes of stamps are 60 mm per side.

(d) The letters on the stamps must be readable and may not be less than 8 mm high.

(e) Marks printed on wrapping material may be smaller than the sizes stated in subsection (c) and (d), to suit particular circumstances provided they are approved by the PEO.

(f) A purple coloured ink is required where stamps are applied to carcasses or meat and must be manufactured of harmless, edible ingredients approved for use on foodstuffs as described in the Foodstuffs, Cosmetics and Disinfectants Act, 1972 (Act No. 54 of 1972).

The marks must be placed–

(i) on each quarter of the carcass; and

(ii) on the heads of game in cases where the skins are removed.

A PEO must issue each slaughter facility in his or her province, operating under the Scheme, with a special reference number relating to the Scheme, to be incorporated in the “PASSED” identification stamp used at such slaughter facilities.

The special reference number must consist of a numerical component designating the province, facility number, the letter “G” and the letter “P”. For example 2/01GP, where “2” indicates the province, “01” facility number, “G” refers to Game and “P” signifies “provisional” under the Scheme.

(h) The stamp of approval must be kept and used under control of a registered inspector;

(i) When not in use the stamp must be secured by a registered inspector and kept in safe custody;
A stamp of approval must never be used at a slaughter facility where the slaughter facility number differs from the number on the stamp;

Stamps and roller marking equipment must be cleaned and sterilized regularly, during use;

All marking equipment must be kept hygienically, away from the floor and dirty surfaces;

Marks must be applied in such a manner that it is clearly legible on the carcass or meat;

A person may not place a stamp of approval on, or remove such mark from, any carcass, part thereof, meat or a wrapping, packing or container, except under the supervision of a registered inspector;

A registered inspector may at any time re-inspect a carcass or meat in a slaughter facility despite that the carcass or meat may already have been passed for consumption and, if upon re-inspection the inspector is of the opinion that the carcass or meat is no longer fit for human or animal consumption, the inspector must remove the stamp of approval by trimming, and such meat must be condemned.

CIRCUMSTANCES UNDER WHICH PERSON MAY PARTICIPATE IN SCHEME

72. (1) A person may participate in the Scheme, if his/her facilities are not registered with the PEO at the time and by registering under the Scheme and complying with hygiene and structural standards prescribed by the PEO for such facilities and processes in order to provide adequate safety margins for consumers.

(2) An applicant must provide full details of his or her current operations and sign a declaration of intent to comply with the requirements of the Scheme and promote the aims of the Scheme;

(3) A participant in the Scheme must improve his or her facilities and
operations so as to comply with the requirements of the Act and the regulations under the Act that may be relevant at the time of closing of the Scheme.

(4) A participant who does not comply with the provisions of the Scheme must be notified in writing that his or her participation in the Scheme has lapsed as provided for in section 41 of the Scheme.

DATE OF IMPLEMENTATION OF SCHEME

73. The Scheme comes into operation on the date of publication in the Government Gazette and lapses five years after such date or on a date determined by the Minister.
GAME MEAT GUIDE

SCHEDULE

1. Definition

(a) In this Schedule “the Act” means the Meat safety Act, 2000 (Act No. 40 of 2000) as published in the Government Gazette Notice R 1106 of 1 November 2000;

(b) “Private use” means for own consumption and not for commercial purposes and is exempted under this scheme.

(c) Limited harvesting means not exceeding the units as per registration of the abattoir per day as per definition in the Meat Safety Act, 2000 (Act 40 of 2000) and shall overall not exceed 20 units per day.

(e) In this schedule “game abattoirs” mean the slaughter facility on the game ranch

(f) WRSA mean Wildlife Ranching South Africa as the official mouthpiece for game ranchers in South Africa and administrators of the Guide.

2. Name of the Scheme

The Scheme shall be known as the Game Meat Guide

3. Application of the Guide

The Guide will be applicable throughout the Republic of South Africa to game abattoirs that participate in limited harvesting for commercial purposes.

4. Objectives of the Scheme

The Guide is established to enable the game industry to take ownership and to establish a workable infrastructure for producing safe game meat commercially. This
will be done in consultation and with the assistance of WRSA and the Provincial Executive Officers. The infrastructure shall ensure the following: The game industry shall be responsible to administer and perform supervisory duties from within the Industry. The guide will only be applicable to game abattoirs which are in effect the slaughter facility available on a game farm. The objectives of the scheme are:

(a) Promotion of hygiene practices during harvesting of game and the hygienic handling of game meat in game abattoirs;

(b) Training, by the Industry, of specific personnel who harvest game and or work in game abattoirs, to identify diseases in harvested game and perform meat inspection;

(c) Training, by the industry, of personnel who harvest game as well as those working in rural game abattoirs in correct harvesting and hygienic slaughter procedures;

(d) Practical and affordable Improvement or replacement of present game slaughter facilities or establishment of new game slaughter facilities, in consultation with WRSA and Provincial Executive Officers,

(e) Implementing a basic hygiene system with records

(f) Establishing systems to determine traceability of game meat.

5. **Classes of animals and persons involved in the Guide**

(a) Game animals declared as such by the Minister by notice in the *Gazette* for the purposes of the Act

(b) Game harvesting activities for non-export commercial purposes. Partially dressed and dressed carcasses may be provided for commercial purposes

6. **Harvesting of game**

Harvesting of game must take place in accordance with the requirements set out below:
7. **Shooting**

(a) Shooting must be done as humanely as possible so that it is reliably expected to cause immediate death.

(b) Abdominal shots must be avoided and carcasses with such wounds must be marked for attention of the registered examiner.

8. **Bleeding**

(a) Game must be bled preferably within 10 minutes of being shot. Any carcass that has not bled properly will not be utilized or sold commercially for fresh cuts

(b) Bleeding is done by means of

   (i) severing the jugular vein and carotid artery on either side of the neck (throat slitting) with a clean sterilized knife

   (ii) evisceration and severing the lumbar aorta with a clean sterilized knife.

   (iii) internally by sticking (trophy carcasses) with a clean sterilized knife

9. **Transport of limited harvested game to depot or abattoir**

Care must be taken not to contaminate the neck or eviscerated slit area with a minimum of soiling as possible when transporting the carcass to the game depot or abattoir.

10. **Evisceration**

(1) All limited harvested game must be eviscerated within four hours of bleeding provided that if a danger of bloating exists evisceration may take place in the field and intestines must be taken to the depot or abattoir for inspection.

(2) Carcasses must be transferred from the harvesting vehicle to a clean slaughter frame in such a manner as to avoid contamination or soiling.
(3) Opening incision lines on a hide or skin must be made with a clean sterilized knife from the inside to the outside only (spear cuts).

11. Meat inspection

(1) For the purpose of the WRSA meat scheme a person performing preliminary meat inspection during limited harvesting must be in possession of a certificate as a game meat examiner which is approved by the national executive officer and accredited by South African Qualifications Authority (SAQA). A person doing such inspections at harvesting or a game abattoir and has the mentioned qualification, must be registered with the PEO as a registered examiner.

(2) The meat examiner at the abattoir must inspect each game carcass and matching viscera, head and feet noting any abnormalities and condemning partially, conditionally or in other such cases the whole carcass.

(3) Lockable fly-proof containers for the collection of condemned material must be used during the process and the contents must be disposed of in a method approved by WRSA and the provincial executive officer.

(4) Identification and data collection for animal disease surveillance must be in a format agreed on with WRSA and the provincial executive officer.

12. Chilling of game carcasses

(1) Partially and complete dressed carcasses and offal must be chilled within 12 hours of killing but when the ambient temperature is more than 15 °C, it must be kept in a well-ventilated screened room that will be capable of lowering the carcass temperature with 5 °C

(2) A core temperature of 7°C must be accomplished within 24 hours after chilling commences.
13. **The owner**

The responsibilities of the owner of the game animals to be harvested for commercial purposes are that

(a) The owner must provide the registered examiner with any information regarding controlled disease outbreaks within a radius of 10km of the place of origin of the animals to be killed; and any other relevant information that may indicate that the harvested game is unsafe for human consumption;

(b) No animal for which there is reasonable suspicion to have been administered with antibiotics, immobilising drugs, tranquilisers or any other substance are harvested;

(c) No carcass or part thereof that has been condemned are brought into any part of a depot or an abattoir containing edible products, but the registered examiner may authorize the salvage of the hide or skin, or any part of such animal for the sole purpose of producing trophies or curios, providing that such condemned animal may only be handled in the abattoir after the normal processing for the day has been completed.

14. **Records**

The results of the ante-mortem examination, primary meat inspection and secondary meat inspection must be recorded, and where zoonotic and controlled diseases, contemplated in the Animal Diseases Act 1984 (Act No. 35 of 1984), are diagnosed, the local state veterinarian must be notified on the day such diagnosis are made.

15. **Registration as registered examiner with provincial executive officer**

Persons wishing to do game meat inspection:

(a) Must register with WRSA and the provincial executive officer in order to do meat inspection at a specified game abattoir or be associated with a specific harvesting team; and
(b) May be suspended or deregistered by the provincial executive officer in the event of non-conformance to these requirements or if found incompetent to perform the functions required of a registered inspector.

16. **Transportation from the ranch**

Vehicle used for the transport of partially dressed and dressed carcasses for commercial purposes must comply with the standards for a meat transport truck according to section 13 of the Regulations governing general Hygiene Requirements for Food Premises and the Transport of Food (R918).

17. **Requirements for participation in the Scheme**

(a) A person who is a game harvester or plans to harvest game for commercial purposes;

(b) A person currently utilizing a game slaughter facility or plans to do so with the intention to handle and prepare game meat commercially;

(c) Agree in writing to adhere to the provisions of this Scheme, in order to establish a workable infrastructure for producing safe game meat commercially.

18. **Records required**

The following particulars must be recorded by the Guide participants:

(a) The owner of an abattoir or harvesting depot must keep a documented monthly record of all the game animals’ slaughtered (species, sex). The record must furthermore show any condemnation or deviation. Approved carcasses should be numbered and stamped to ensure traceability to an identified harvest batch.

(b) Records and documentation must be kept of all the training of personnel

(c) A cleaning schedule for the abattoir must be available on the premises
A checklist for all the abattoir personnel for their health, personal hygiene and protective clothing must be kept on a daily basis.

19. **Schematic plan of abattoir and harvesting depots**

The owner must provide an updated schematic plan of the abattoir and harvesting depots, which must include details of:

(a) All the different rooms in each area identified, indicating the process or operation including the capacities or rates of operation that take place in such rooms;
(b) The flow of the product;
(c) The required temperature as well as the capacity of each room where temperature is controlled;
(d) The ablution facilities for workers
(g) All entrances to rooms, areas and building; and
(h) Boundaries, indicating entrances and exits to and from premises.

20. **Facilities required by persons participating in the Scheme**

Subject to section 11 the following are requirements for a game abattoir for participation in the scheme:

(a) The throughput may not exceed the number of animals registered for
(b) Control of people and animals to the area must be ensured
(c) The area must consist of a room equipped with hanging facilities where harvested game carcasses or partially dressed game carcasses are dressed and such room should be ventilated to achieve an ideal room temperature of 15°C
(e) Doors must be provided where harvested game are offloaded into the abattoir
(f) Hand wash facilities must be provided
(g) Chemical or hot water sterilizer must be provided

(h) Ablution facilities must be available

(i) Cool facilities must be available to ensure that the carcass temperature is at 7°C within 24 hours.

21. Marking of game meat as produced under the Guide

Game carcasses must be marked using the “Passed stamp” as contemplated in the Act. Game meat will be differentiated from meat from domesticated species based on the triangular mark (domesticated species are marked with a circle) as below:

![Game Meat Marking Diagram]

22. Date of implementation of the Guide

The Guide will come into operation on the date of publication in the Government Gazette. Future amendments to the scheme could be proposed for promulgation after such date based on new and emerging facts from further scientific based research studies. This new information could be taken up in legislation or could be used to amend current legislation.
Addendum E  
Checklist for hygiene

Name of ranch: ___________________________ Date of hunt: ___________
Name of Game Meat Examiner: ___________________________
Signature of Game Meat Examiner: ___________________________

<table>
<thead>
<tr>
<th>GENERAL</th>
<th>Compliance</th>
<th>Non-compliance</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>GME qualification</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Record of slaughter and hygiene training</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hunter competency</td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>OPERATIONAL</th>
<th>Compliance</th>
<th>Non-compliance</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Only healthy game animals are harvested</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shot placement to ensure immediate death</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Animals should be bled immediately</td>
<td></td>
<td></td>
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<tr>
<td>If evisceration takes place in the veld control intestinal contamination</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Transportation if eviscerated in hanging position, if un eviscerated before bloating</td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>SLAUGHTER FACILITY</th>
<th>Compliance</th>
<th>Non-compliance</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clean and hygienic protective clothing</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wash hands regularly</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Warm water must be available</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sufficient light 250 lux</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Effective cross ventilation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ensure knives are sterilized</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Control insects during slaughter</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Containers available for condemned, inedible material heads/ feet and rough offal</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Game Meat Examiner - meat inspection</td>
<td></td>
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</tbody>
</table>

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<thead>
<tr>
<th>SLAUGHTER PROCESS</th>
<th>Compliance</th>
<th>Non-compliance</th>
<th>Remarks</th>
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</thead>
<tbody>
<tr>
<td>Slaughter bed for effective slaughter</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Remove head and feet</td>
<td></td>
<td></td>
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<tr>
<td>Spear cut when opening carcass</td>
<td></td>
<td></td>
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<tr>
<td>Skinning to be done to control hair contamination</td>
<td></td>
<td></td>
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<tr>
<td>Avoid contamination from equipment</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>If eviscerate prevent intestinal contamination</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prevent floor contact of all edible offal</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pre-chilled/chilled hung space to prevent carcass contact</td>
<td></td>
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</tbody>
</table>
Addendum F

(Logo of Ranch Owner) Record for traceability

(This form must be completed for each days hunting)

A. PARTICULARS OF FARM AND OWNER

Registered Scheme number of farm: __________________________
Name of farm: _____________________________________________
Name of owner / manager: ___________________________________

B. PARTICULARS OF HUNTED CARCASSES

<table>
<thead>
<tr>
<th>Carcass Number</th>
<th>Inspection status</th>
<th>A-approved, E-partially condemned, C-totally condemned</th>
<th>Comments relating to ante- and post-mortem inspection</th>
</tr>
</thead>
<tbody>
<tr>
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</tbody>
</table>

C. DECLARATION BY AUTHORISED PERSON

I, ________________________________________________ hereby declare that:

(name of GME)

The abovementioned game carcasses have been hunted and recorded correctly.

Signed at ___________________________ , (date)
(place) ________________

Signature

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CERTIFICATE: GAME MEAT EXAMINERS (NQF LEVEL 3)

PURPOSE

After completion the candidate should have the skills to act as a Game Meat Examiner in order to ensure a good hygiene standard during the hunting and slaughter processes and to ultimately ensure safe game meat and edible offal to the local market.

REQUIREMENTS FOR ENROLMENT

Candidate must have obtained at least grade 8 with good writing and spelling skills.

PRESENTATION (SAQA accredited unit standards)

| US No: 48655 | National Certificate: General Abattoir Processes |
| US No: 48651 | Further Education and Training Certificate: Meat Classification |
| US No: 48649 | Further Education and Training Certificate: Meat Examination |

Theory and practical theory: Self-study principles will be explained during contact sessions.
Two contact sessions with mentor will be arranged to address problem areas.
Co-operative training / in-service training: Facilitators will assist to obtain a mentor that will assist with practical training.

SYLLABUS

| Abattoir outlay and construction | Slaughter process |
| Personal hygiene | Basic hygiene requirements |
| Disposal of condemned/inedible material | Sanitation |
| Anatomy of game species | Pathology |
| Diseases and conditions | Primary meat inspection |
| Secondary meat inspection | Legislation |
| Microbiology | Laboratory technique |
| Important documentation |

EXAMINATION

Theory: 1 x 3 hour paper
Practical: 1 x practical evaluation
CERTIFICATE: BASIC GAME MEAT HYGIENE (NQF LEVEL 1)

PURPOSE
After completion the candidate should have the skills to perform good hygiene practices during the hunting and slaughtering processes and to have a basic knowledge on workplace hygiene and safety, personal hygiene and meat hygiene to assist in the process of rendering safe game carcasses to the local market.

REQUIREMENTS FOR ENROLMENT
The candidate can be illiterate but must have good background on the game hunting and slaughter processes.

PRESENTATION (SAQA accredited unit standards)

| US No: 120404 Maintain personal hygiene, health and presentation in a food handling environment |
| US No: 123370 Demonstrate knowledge of hygiene awareness in food production |
| US No: 120410 Clean and sanitize food manufacturing equipment and surfaces |

Theory and practical theory: Self-study principles are explained during contact sessions.

SYLLABUS

- Good personal hygiene practices
- Environmental hygiene
- Meat hygiene
- Workplace hygiene and safety

EXAMINATION

Theory: Oral examination
Practical: 1 x practical evaluation
Research Ethics Committee

May 27th, 2009

M van der Merwe
C/o Prof P Jagals
Department of Environmental Health
Faculty of Science

Dear Ms Van der Merwe,

TITLE : "A game meat scheme to supply safe game to local markets in South Africa",
INVESTIGATORS : VAN DER MERWE M
PROGRAMME : D Tech: Environmental Health

Thank you for attending the meeting to clarify specific aspects of the study.

In reviewing the proposal, the following comments/notas, emanating from the meeting, are tabled for your consideration/attention:

- The researcher’s professional status and official privileges as environmental health officer should not interfere with the research status of the project. As such, the research participants need to be clearly informed about the research focus of the project.

The Research Ethics Committee of Tshwane University of Technology reviewed the proposal at the meeting held on May 18th, 2009 and approval for the proposal is hereby granted. It is recommended that the aforementioned comment be taken into account.

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The Committee wishes you well with your research endeavours.

Yours sincerely,

[Signature]

WA MÜLLER (Ur)
Chairperson: Research Ethics Committee
(Ref #2009-05-002:Van Der MerweM)

cc: Chairperson: FODC (Science)
    Faculty Officer: Mr S Smit

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