UNIVERSITÄT HOHENHEIM

Faculty of Agricultural Sciences

Institute of Animal Production in the Tropics and Subtropics

Animal Breeding and Husbandry

Prof. Dr. Anne Valle Zárate

Participatory risk assessment on game products marketed through formal and informal chains: Hazard identification and risk assessment

Master Thesis

by

Alexander W. Heeb

Stuttgart-Hohenheim, Germany

September 2009

This work was financially supported by the Eiselen Foundation Ulm.

First supervisor: Prof. Dr. Anne Valle Zárate

Second supervisor: Prof. Dr. rer. soc. Volker Hoffmann

Date of defence: 13th October , 2009

TABLE OF CONTENTS

i. List of Tables

ii. List of Figures

iii. List of Abbreviations

AG – Australian Government
AIDS – Aquired immunodeficiency syndrome
BD – Business Dictionary
BMBF – Bundesministerium für Bildung und Forschung *(Federal Ministry of Education and Research)* (Germany)
CAC – Codex Alimentarius Commission
CI – Confidence interval ($\alpha = 0.05$)
CFU – Colony forming units
°C – Degrees celcius
DAC – Department of Arts and Culture (South Africa)
DFD – Dark, firm and dry (meat)
DPLG – Department: Provincial and Local Government (South Africa)
DVS – Directorate: Veterinary Services (South Africa)
€ – Euro (currency of the European Union)
FAO – Food and Agriculture Organization of the United Nations
FSIS – Food Safety and Inspection Service, United States Department of Agriculture (U.S.A.)
GMO – Genetically modified organism
HACCP – Hazard Analysis and Critical Control Point
HIV – Human immunodeficiency virus
ICMR – Indian Council of Medical Research
JEMRA – Joint Expert Meeting on Microbiological Risk Assessment
ILRI – International Livestock Research Institute
KZN AEA – KwaZulu-Natal Agriculture and Environmental Affairs
NAMC – National Agricultural Marketing Council (South Africa)
NDA – National Department of Agriculture (South Africa)
NRF – National Research Foundation (South Africa)
OIE – World Organisation for Animal Health
ORC – Omusati Regional Council (Namibia)
p – p-value
PHASA – Professional Hunter's Association of South Africa
Phi – Phi-coefficient
PRA – Participatory Rural Appraisal
RRA – Rapid Rural Appraisal
SABS – South African Bureau of Standards
SADA – South African Department of Agriculture
SAGR – South African Game Reserves
SARB – South African Reserve Bank
SAS – Statistical Analysis System
SpCC – Spearman's rank correlation coefficient
SPS – Sanitary and phytosanitary measures
SSA – Statistics South Africa
UDM – Umkhanyakude District Municipality
US$ - U. S. Dollar (currency of the United States of America)
WHO – World Health Organization
WTO – World Trade Organization
ZAR – South African Rand (currency of South Africa)

iv. Terminology

Biltong

Traditional South African meat snack made from strips of lean meat that is dried, salted and flavoured. The word "biltong" is derived out of the dutch language, whereby "bil" means "round" or "buttock" and "tong" refers to long strips of meat. Nowadays biltong has become a market-driven delicacy due to modern methodologies of processing and packaging (STRYDOM, 2004).

Biltong hunter

A South African national or permanent resident of South Africa who is conducting bitlong hunting more or less regularly as a hobby, sport, secondary or minor source of income and who is not a professional hunter as his primary occupation. However, the person may be involved into professional hunting from time to time.

Biltong hunting

An activity whereby game animals are hunted with a rifle or any other weapon in order to obtain game meat for the production of different game meat products such as biltong and sausages (VAN DER MERWE and SAAYMAN, 2008). In the context of this study, biltong hunting is marked-off to professional hunting as commercial aspects are not the major driving factor of doing so. Although it may be carried out as a source of income, biltong hunting more refers to a recreational activity, a sport, a hobby, a secondary or minor source of income. Nevertheless, the boundary between biltong hunting and professional hunting sometimes becomes blurred, especially if biltong hunters are involved into commercial hunting activities from time to time or if they claim to derive their primary income from it.

Boerewors

Traditional south African meat sausage. It is traditionally spiced and can be made out of different kinds of meat such as game, beef, lamb, pork or out of a combination of these.

Edible game meat by-products

Parts of the carcass that are not utilized and/or marketed although suitable for human consumption. This includes internal and external offal.

External offal

External carcass parts that are not utilized or utilized to a limited extent and that are not marketed or marketed to a limited extent although suitable for human consumption. In the context of this study, this refers to the head, the feet and other external off-cuts.

Game

In the context of this study ,"game" refers to Southern African ungulates and other animals of the region that are commonly hunted for meat such as zebras. All strictly protected and therefore rarely hunted species are excluded.

Game harvest

The commercial shooting of large numbers of game animals, usually ungulates and some other species such as zebras, during a short time period in the scope of commercial game meat production. This is usually conducted by professional hunters.

Indigenous tribe

Peoples who maintain their traditional lifestyle against modern influences. In the context of this study the term is limited to such peoples within Southern Africa such as the Ovahimba and the San.

Informal meat trader

In the context of the study, an informal meat trader is a person who is trading meat and/or meat products informally, exclusively or together with other products and in a prepared and/or raw state.

Internal offal

Internal carcass parts that are not utilized and/or marketed, although suitable for human consumption. In the context of the study, this refers to the edible fraction of intestines. Ingesta are not inlcuded. Parts difficult to clean and therefore not suitable for consumption and/or marketing such as the hindgut are not included, too.

Meat inspector

In the South African context, a meat inspector for game meat is a person who has an appropriate bio-scientific qualification as approved by the national executive officer and, if required, a certificate for game meat examiners which is approved by the national executive officer and accredited by the South African Qualifications Authority (SAQA). Commercial hunters who have acquired these qualifications of game meat examiners to perform inspections at a harvesting depot can be meat inspectors, too. Persons who wish to do game meat inspection must register with the

provincial executive officer in order to do meat inspection at a specified game abattoir or to be associated with a specific harvesting team. Commercial hunters need to register with the provincial executive officer and provide information on proposed harvesting operations as this may be required by the provincial executive officer (DVS, 2007).

Non-edible game meat by-products

Parts of the carcass that are not edible or not suitable for human consumption. This usually refers to horns, hooves, hides and the non-edible parts of the external and internal offal such as ingesta and certain organs.

Primary meat inspection

Every game animal carcass is examined by a registered meat inspector through observation, palpation, smell and, if necessary, incision. Because the South African legislation subdivides game animals into different categories, the regulations in terms of primary meat inspection slightly differ from one category to the next. However, generally, the following needs to be taken into consideration during primary meat inspection: State of nutrition; colour; odour; symmetry; efficiency of exsanguination; contamination; pathological conditions; parasitic infestation; injection marks; bruising and injuries; any abnormalities of muscles, bones, tendons, joints, or other tissues; species; age; gender. No cutting, deboning or removal of lymph nodes is allowed prior to primary meat inspection. It is not allowed to remove signs of disease and condition prior to primary meat inspection. Heads, feet and offal must be identifiable with the carcass until primary meat inspection is conducted. It is not allowed to sell or dispatch any carcass or parts of it, if it was not inspected and approved by a registered inspector and marked with 'passed' (DVS, 2007).

Professional hunting

The commercial generation of game meat for export and domestic marketing. Differently to biltong hunting, manifold regulations are attached to this activity as the meat produced is destined for the formal market. Usually large quantities of game animals are shot within a short period of time in the scope of commercial game harvests.

Professional hunter

A person who is shooting game animals as a primary occupation and source of income. Professional hunters are usually employed by companies that produce game meat in large quantities for the international and domestic market. They are highly precise marksmen and act according to the orders of their employers. The obtainment of game meat is not the major reason for them to hunt as this is usually the salary paid by the employer.

Secondary meat inspection

Suspect carcasses found during primary meat inspections must be marked "detained". They need to be subjected to secondary meat inspection by a registered meat inspector. The meat inspector carrying out secondary meat inspection needs to be a veterinarian. Information on the following must be ascertained during secondary meat inspection: Species; age; gender; organs or parts of carcass affected; condition or disease; probable cause of condition or disease; finding and motivation therefore if applicable. In dependence on the latter, the carcass, organ or meat may be approved, conditionally approved, subject to treatment, partially approved by removal of condemned parts or totally condemned. Moreover, particular attention must be paid to: Carcass colour; blood content of intercostal veins and the small vessels beneath the serosa of the abdominal wall and in the retroperitonial fat in the walls of the pelvis; all visible lymph nodes after the splitting of the carcass; examination and loosening of a shoulder and opening of an acetabulum from the medial aspect to observe the exposed connective tissue, fat lymph nodes and articular surface; the condition of the musculature and abnormal odours. If considered as necessary by the registered veterinarian, the carcass or meat may be analyzed in a laboratory in order to be able to make a final decision. Results from primary as well as secondary meat inspection must be recorded (DVS, 2007).

Trophy animal

A trophy animal is an animal that is a desired hunting target due to its appearance (e.g. size, length of horns). In many cases, old males fall into this category.

Trophy hunter

A person who is hunting trophy animals as a kind of sport and recreation. A trophy hunter does not necessarily hunt trophy animals only and may be a biltong hunter and/or professional hunter at the same time.

Trophy hunting

A sport and an activity for recreation, whereby trophy animals are hunted. The generation of game meat is usually of secondary importance only. Trophy hunting is conducted by South Africans as well as international tourists.

v. SUMMARY

Game animals are a natural and renewable resource of South Africa that is utilized by the national tourism industry (namely photo-tourism and trophy hunting) and for meat production. However, in terms of the marketing of meat products, problems and constraints related to food safety hamper the further development of the South African game industry. A major reason for this are hazards and risks to food safety, which must be expected to prevail within product flows, production and processing steps, especially in regard to products not destined for export.

Moreover, the utilization of edible by-products such as offal, heads and feet obtained during privately conducted game hunts and commercial game harvests remains deficient. Although usable as food, such products are greatly considered as not being marketable and are mostly not used at all. Their potential as a valuable source of animal protein for poor parts of the South African society seems to be neglected.

The study focused on the formal and informal marketing of game meat products within South Africa. South Africans who hunt game animals on a private basis and for sport and recreation, known locally as " biltong hunters", and commercial game harvesters were included as key stakeholders of the South African game industry. Informal meat traders and indigenous tribes were included as potential stakeholders and end-users of benefits from the game industry in the form of meat or edible by-products of either no or a limited marketability. The role-players in the game meat marketing chain are the State Veterinary Services and officials and inspectors from the Department of Health. Their role in control and monitoring of the domestic game meat marketing chain is currently not legislated.

Conceptually, the study was based on two different marketing chains. For simplification, these will be called "Marketing Chain I" and "Marketing Chain II". One experiment for "Marketing Chain I" and two observational studies ("Observational Study I and II") for "Marketing Chain II" were conducted to complement the two marketing chains of interest.

"Marketing Chain I" describes the informal trade of meat products in informal markets as a potential domestic marketing chain for South African game meat products. Particulary for poor households, the informal trade is an important source of affordable food. A survey was conducted with n = 51 informal meat traders in KwaZulu-Natal using structured interview techniques, combined with observations using a structured observation sheet and photographs. 25 meat samples (seven raw and 18 prepared ones) were collected for microbiological analysis from n = 21 purposively selected respondents. These were interviewed for a second time, using a short structured questionnaire. The information generated for "Marketing Chain I" was used to construct a flow chart. This was done to evaluate whether game meat products could be utilized through this existing informal marketing chain for red meat and poultry.

Once the variables were established the hypothesis was tested in an experiment. Game meat was supplied to informal meat traders in Pretoria to see if they could process it by cooking so that there would be a minimal food safety risk to consumers. Eight raw and n = 8 cooked meat samples were collected for microbiological analysis. A structured observation sheet was applied for the documentation of prerequisites and practices, complemented by a short structured group interview and photographs.

"Marketing Chain II" describes "biltong hunting". It is an established domestic formal marketing chain for game meat products through supermarkets and butcheries. An opinion survey was conducted with a total n = 9 of biltong hunters in different parts of

South Africa, using structured interview techniques to estimate the type of hunting and marketing done. A commercial game harvest for the production of export meat was attended near Kimberley / Northern Cape to investigate and draw a flow chart of both, biltong hunting and commercial game harvesting (Observational Study I). A structured observation sheet was applied. The time differences between fatal shot and throat cut for exsanguination and between throat cut and evisceration were recorded for seven animals shot during the game harvest. The data generated was triangulated by informal interviews with stakeholders (seven professional hunters involved in the game harvesting) and role-players (two senior state veterinarians and a local animal health technician).

A clan of Ovahimba was visited near Ruacana / Namibia and a group interview was conducted using a structured questionnaire, in combination with a structured observation sheet and photographs, to evaluate the possibility of supplying indigenous rural tribes with affordable, edible game meat by-products from commercial game harvests for a more efficient utilization of game resources and to improve food security (Observational Study II).

The identification of hazards and the participatory assessment of risks to food safety and product quality that potentially prevail within and between the two Marketing Chains was the major objective of the study. Thus, prerequisites and hygiene practices during meat product handling were of interest. For each category, potential hazards and risks to food safety and product quality were identified and assessed. In regard to edible by-products, currently non-existent product flows between stakeholders and potential end-users were documented and evaluated in terms of their potentials and limitations. All steps of participatory risk assmessment were conducted excepting exposure assessment, which was not practicable. Participatory methods were used to achieve the duties of a HACCP team. As far as practicable, the principles of a “Participatory Rural Appraisal” (PRA) were followed for the achievement of objectives.

Critical control points to minimize or eliminate hazards and risks to food safety and product quality were identified and documented using a flow chart. Mainly microbiological (microbiological contamination and multiplication) hazards were considered and the risk of occurrence was qualitatively estimated for each hazard at each stage of the marketing chains. Ways to to facilitate improved access to edible by-products from game hunts and harvests for informal meat traders and indigenous tribes of the region were suggested.

The information obtained from the 51 informal meat traders and the results from the microbiological analyses of meat samples were evaluated statistically. The other datasets generated from biltong hunters, the experiment and the two observational studies were too small to do so.

Informally prepared and traded meat products can be assumed to be generally safe for human consumption. According to the microbiological analysis of the n = 18 prepared meat samples obtained from informal meat traders in KwaZulu-Natal and the n = 8 cooked game meat samples obtained during the experiment, only one and no sample contained coliforms respectively.

Nevertheless, numerous potential hazards and risks to food safety and product quality were identified in terms of prerequistes and practices of product handling. Especially the conditions under which informal meat traders are operating appeared to be detrimental in regard to food safety in various aspects. Only n = 5 respondents had access to running water at or close to their places of business, only one had access to electricity and n = 37 did not cool their raw stock during business hours.

Certain inadequate prerequisites and practices of product handling were as well identified for the formal marketing of game meat products and for "biltong hunters" in particular, such as the delivery of game meat over long distances without cooling it. The prerequisites and product handling by the Ovahimba can be assumed to bring along hazards and risks to food safety when considering the absence of both, running water and electricity.

Concerning the informal trade of meat, promising intervention points are provided by the study. In terms of biltong hunting, the domestic South African game meat product trade is currently being reviewed and legislation updated in terms of standards and regulations. The information from this study will probably be used in this legislative process, as one of the key informants, Dr. S Ramrajh, is involved in this process.

Strong linkages and interactions between the formal economy and the informal meat trade were identified within the study area in terms of business supplies. Almost all informal meat traders (96.08%) apparently derived their raw stock out of formal marketing chains. However, in terms of game meat products in particular, virtually no linkages and interactions could be identified between biltong hunters and commercial game harvesters on the one hand and informal meat traders as well as the Ovahimba on the other. The study clearly indicates that edible game meat by-products are greatly underutilized. The legal and cheap access to game meat and edible by-products for informal meat traders and the Ovahimba appears to be greatly limited. Only one informal meat trader (1.96%) apparently traded such products regularly. The Ovahimba were never provided with such products by the stakeholders.

The virtually non-existent access to edible by-products for informal meat traders and the Ovahimba can be assumed to predominantly originate from a substantial lack of supply of these products by biltong hunters and commercial game harvesters. Currently, a general depreciation of the value and marketing potential of these products at the hunters' end of the marketing chain seems to be a major reason for their insufficient utilization. All biltong hunters interviewed regarded the marketing potential of edible by-products as either limited or unimportant and, generally, commercial game harvesters have been of the same opinion. Edible by-products were left behind by commercial game harvesters and doing so was called a common practice. The marketing of edible by-products by the stakeholders seems to be rather uncommon as stated by most biltong hunters (n = 8) and all professional hunters (n =7) involved into the game harvest attended.

Differently, the proposed recipients and end-users of these products appeared to be generally willing to utilize them as long as they could be provided legally and cheaply. This was stated by the Ovahimba clan and by n = 30 out of the 51 informal meat traders. Informal meat traders can be assumed to be risk averse and to suffer from cash shortage. Therefore, it appears logical that they would readily accept and use edible by-products from game harvests and biltong hunting, especially if provided with a price advantage over other formally offered meat products.

However, because potential hazards and risks to food safety and product quality were identified within most actual and potential product flows, their consideration and mitigation will be crucial if, in future, the supply of edible by-products to informal meat traders and poor communities such as the Ovahimba shall be facilitated. In respect of this, commercial game harvests appear to be more suitable for the potential provision of edible by-products, as their current set of standards and regulations is clearly superior to biltong hunting. Moreover, they generate these materials in high quantities during short time periods, what improves their marketability.

vi. ZUSAMMENFASSUNG

Wild ist eine natürliche, erneuerbare Ressource Südafrikas und wird durch die nationale Tourismusindustrie (z.B. Fototourismus und Trophäenjagd) sowie zur Fleischproduktion genutzt. Jedoch wird die Vermarktung von südafrikanischen Wildfleischprodukten durch diverse Probleme und Hindernisse behindert, welche im Zusammenhang mit Lebensmittelsicherheit stehen und welche die Weiterentwicklung der südafrikanischen Wildindustrie bezüglich der Vermarktung von Wildfleisch und Wildfleischprodukten erschweren. Besonders die Tatsache, dass entlang der derzeitigen Wertschöpfungskette Gefahren und Risiken hinsichtlich der Sicherheit der Produkte für Konsumenten angenommen werden müssen, kann als ein wesentlicher Grund hierfür betrachtet werden. Dies gilt vor allem für Produkte, welche innerhalb des Landes vermarktet werden.

Darüber hinaus ist die Verwertung von genießbaren Nebenprodukten wie Innereien, Köpfen und Füßen, die im Zuge privater Jagden und kommerzieller Wildernten anfallen, weiterhin unbefriedigend. Diese Produkte werden meist als nicht vermarktungsfähig betrachtet und werden, obwohl genießbar, meistens in keiner Form genutzt und ihr Potential als wertvolle Proteinquelle tierischen Ursprungs für ärmere Teile der südafrikanischen Gesellschaft scheint vernachlässigt zu werden.

Der Schwerpunkt der Studie war die formelle und informelle Vermarktung von Wildfleischprodukten innerhalb Südafrikas. Südafrikaner, die Wild privat als Sport oder als Freizeitbeschäftigung jagen (in Südafrika als so genannte „Biltong hunters“ bezeichnet) und kommerzielle Wildernter („game harvesters“) wurden als Schlüsselakteure der südafrikanischen Wildindustrie berücksichtigt. Informelle Fleischhändler und indigene Stämme fanden Berücksichtigung als potenzielle Empfänger und Endnutzer von Zuwendungen der Wildindustrie in der Form von Fleisch und genießbaren Nebenprodukten, welche entweder kein oder eine begrenztes Vermarktungspotential haben. Von institutioneller Seite wurden staatliche Veterinäre sowie Offizielle und Inspektoren des südafrikanischen Gesundheitsministeriums berücksichtigt. Deren Rolle in der Kontrolle und Überwachung der Vermarktung von Wildfleischprodukten innerhalb Südafrikas ist bis heute nicht festgelegt.

Grundlegend basierte die Studie auf zwei verschiedenen Wertschöpfungsketten. Zur Vereinfachung werden diese im Folgenden als „Wertschöpfungskette I“ und Wertschöpfungskette II“ bezeichnet. Um diese beiden Vermarktungsketten zu ergänzen, wurden ein Experiment für “Wertschöpfungskette I” und zwei Beobachtungsstudien (“Beobachtungsstudie I und II”) für „Wertschöpfungskette II“ durchgeführt.

Wertschöpfungskette I“ beschreibt den informellen Handel von Fleischprodukten auf informellen Märkten als eine potentielle innersüdafrikanische Wertschöpfungskette für Wildfleischprodukte. Der informelle Handel ist besonders für ärmere Teile der südafrikanischen Gesellschaft eine wichtige Quelle für erschwingliche Nahrungsmittel. In KwaZulu-Natal wurde eine Befragung mit n = 51 informellen Fleischhändlern durchgeführt. Strukturierte Befragungstechniken und ein strukturierter Beobachtungsbogen wurden angewendet und Fotografien wurden gemacht. 25 Fleischproben (sieben rohe und 18 zubereitete) wurden von n = 21 vorsätzlich aus allen Befragten ausgewählten Personen genommen und einer mikrobiologischen Untersuchung unterzogen. Die n = 21 Fleischhändler wurden mit einem kurzen, strukturierten Fragebogen ein zweites Mal befragt..

Basierend auf der Information, welche für “Wertschöpfungskette I” erzeugt werden konnte, wurde ein Ablaufdiagramm konstruiert um abschätzen zu können, in wie weit

Wildfleischprodukte innerhalb dieser existierenden Wertschöpfungskette für rotes Fleisch und Geflügel gehandelt werden könnten. Als die notwendigen Variablen bestimmt waren, wurde diese Hypothese in einem Experiment getestet. Informelle Fleischhändler in Pretoria wurden mit Wildfleisch versorgt um zu sehen, ob diese dazu in der Lage wären, das Wildfleisch so zuzubereiten dass minimale Risiken für den Konsumenten entstehen würden. Insgesamt wurden n = 8 rohe und n = 8 gekochte Fleischproben genommen und einer mikrobiologischen Analyse unterzogen. Ein strukturierter Beobachtungsbogen wurde angewandt um Vorraussetzungen sowie Abläufe der Fleischzubereitung zu dokumentieren. Ein kurzes strukturiertes Gruppeninterview wurde durchgeführt. Auch Fotographien wurden gemacht.
„Wertschöpfungskette II“ beschreibt „Biltong hunting“. Dies ist eine etablierte formelle Wertschöpfungskette für Wildfleischprodukte innerhalb Südafrikas, welche in Supermärkten und Metzgereien des Landes angeboten werden. In verschiedenen Teilen Südafrikas wurde mit insgesamt n = 9 „Biltong hunters“ eine Meinungsumfrage durchgeführt. Strukturierte Befragungstechniken wurden angewandt um die Art und Weise der Jagd und der Produktvermarktung abschätzen zu können, welche beim „Biltong hunting“ stattfindet. Eine kommerzielle Wildernte zur Produktion von Wildfleisch für den Export wurde nahe Kimberley / Northern Cape besucht, um ein Ablaufdiagramm für „Biltong Hunting“ sowie für kommerzielle Wildernten konstruieren zu können (Beobachtungsstudie I). Ein strukturierter Beobachtungsbogen wurde angewandt. Die Zeitspanne zwischen dem tödlichen Schuss und dem Durchschneiden der Kehle zur Ausblutung sowie zwischen dem Durchschneiden der Kehle und dem Ausweiden wurde für sieben geschossene Tiere ermittelt. Die erzeugte Information wurde mit informellen Befragungen von Schlüsselakteuren (sieben professionelle Wildernter) und instutionellen Vertretern (zwei staatliche Veterinäre in führenden Positionen und ein Facharbeiter) trianguliert.
Eine Ovahimbasippe wurde nahe Ruacana / Namibia besucht. Mit einem strukturierten Fragebogen wurde ein Gruppeninterviewsdurchgeführt. Ein strukturierter Beobachtungsbogen wurde angewandt und Fotographien wurden gemacht. Die Möglichkeit, indigene Stämme mit erschwinglichen und genießbaren Nebenprodukten von kommerziellen Wildernten zu versorgen um dadurch eine effizientere Nutzung der Wildressourcen zu erreichen und die Lebensmittelsicherheit zu verbessern, wurde so ausgewertet (Beobachtungsstudie II).
Das Hauptziel der Studie war die Identifizierung von Gefahren und, unter Mitwirkung aller berücksichtigten Gruppen, die Abschätzung von Risiken für die Sicherheit und Qualität von Produkten, welche möglicherweise innerhalb der zwei Wertschöpfungsketten gegeben sind. Vorraussetzungen und Abläufe der Handhabung von Fleischprodukten waren von besonderem Interesse. Für alle in der Studie berücksichtigten Gruppen wurden potentielle Gefahren und Risiken für die Sicherheit und Qualität von Fleischprodukten identifiziert und abgeschätzt. Hinsichtlich genießbarer Nebenprodukte wurden die zur Zeit nicht vorhandenen Produktbewegungen zwischen Schlüsselakteuren und potentiellen Endnutzern bezüglich ihrer Möglichkeiten und Begrenzungen dokumentiert und abgeschätzt.
Bis auf die nicht praktikable Expositionsabschätzung, wurden alle Schritte einer Risikoabschätzung betrieben. Um den Pflichten eines HACCP-Teams nachkommen zu können, wurden partizipative Methoden angewandt. Die Prinzipien eines „Participatory Rural Appraisal“ (PRA) wurden so weit wie möglich befolgt um auf diesem Wege die Ziele der Studie zu erreichen.
Kritische Kontrollpunkte für die Minimierung oder Ausschaltung potentieller Gefahren und Risiken für die Sicherheit und Qualität von Fleischprodukten wurden

gefunden und anhand eines Ablaufdiagramms dokumentiert. Vor allem mikrobiologische Gefahren (mikrobiologische Verseuchung und Vermehrung) wurden berücksichtigt und das Risiko ihres Auftretens wurde an jedem Punkt der Wertschöpfungsketten und für jede potentielle Gefahr qualitativ abgeschätzt. Wege zur Förderung des verbesserten Zugangs für informelle Fleischhändler und indigene Stämme der Region zu verzehrbaren Nebenprodukten privater Jagden und kommerzieller Wildernten wurden angedeutet.
Die Information, welche von den 51 informellen Fleischhändlern erzeugt wurde, sowie die Ergebnisse der mikrobiologischen Analysen von Fleischproben wurden statistisch ausgewertet. Die anderen Datensätze, welche im Zuge der Befragung der" Biltong hunter", dem Experiment und der zwei Beobachtungsstudien erzeugt wurden, waren zu klein um dies zuzulassen.
Die Zubereitung von Wildfleisch unter informellen Bedingungen scheint grundsätzlich keine Risiken für Konsumenten mit sich zu bringen. Nur in einer beziehungsweise keiner Fleischprobe der n = 18 Proben zubereiteten Fleisches von informellen Fleischhändlern in KwaZulu-Natal und der n = 8 Proben gekochten Wildfleisches aus dem Experiment konnten Colibakterien nachgewiesen werden. Trotzdem wurden, bezüglich der Vorraussetzungen der Produktion, Verarbeitung und des Handels von Fleischprodukten und deren Handhabung, zahlreiche potentielle Gefahren und Risiken aufgedeckt, welche mit der Sicherheit und Qualität von Fleischprodukten im Zusammenhang stehen. Besonders die Bedingungen unter denen informelle Fleischhändler arbeiten schienen in vielerlei Hinsicht negative Auswirkungen auf die Sicherheit der gehandelten Produkte zu haben. Nur n = 5 der Befragten hatten Zugang zu fließendem Wasser an oder nahe ihres Arbeitsplatzes und nur ein informeller Fleischhändler hatte Zugang zu elektrischem Strom. 37 der Befragten kühlten ihre Rohprodukte während der gesamten Arbeitszeit nicht.
Bestimmte unbefriedigende Vorraussetzungen und Produkthandhabungen wurden auch innerhalb formeller Vermarktungswege identifiziert, wobei dies besonders für „Biltong hunter" der Fall war. Zum Beispiel transportieren diese in manchen Fällen Wildfleisch über längere Entfernungen ohne dieses zu kühlen.
Hinsichtlich des informellen Fleischhandels wurden vielversprechende Ansätze zur Verbesserung der gegenwärtigen Situation aufgezeigt. Im Hinblick auf „Biltong hunting" wird die Vermarktung von Wildfleischprodukten innerhalb Südafrikas gegenwärtig überprüft und die Gesetzgebung wird hinsichtlich Standards und Bestimmungen aktualisiert. Die Erkenntnisse dieser Studie werden aller Voraussicht nach zu diesem Prozess mit beitragen, da Dr. S. Ramrajh, eine Schlüsselinformantin dieser Studie, darin involviert ist. Auch bezüglich der Handhabung von Fleischprodukten durch die Ovahimba und den Bedingungen unter welchen diese stattfinden müssen Gefahren und Risiken für die Sicherheit und Qualität von Fleischprodukte angenommen werden, da fließendes Wasser und elektrischer Strom nicht vorhanden sind.
Innerhalb des Forschungsgebietes bestehen offenbar starke Verbindungen und Wechselbeziehungen zwischen der formellen Wirtschaft und dem informellen Fleischhandel dezüglich dessen Versorgung mit Rohprodukten. Nahezu alle informellen Fleischhändler beziehen (96.08%) ihre Rohprodukte offensichtlich aus formellen Wertschöpfungsketten. Für Wildfleischprodukte im speziellen konnten jedoch praktisch keine derartigen Verbindungen und Wechselbeziehungen festgestellt werden. Genießbare Wildfleischnebenprodukte werden größtenteils nur sehr unzureichend verwertet. Der legale und kostengünstige Zugang zu Wildfleisch und genießbaren Nebenprodukten für informelle Fleischhändler und die Ovahimba scheint

sehr begrenzt zu sein, da nur ein informeller Fleischhändler (1.96%) solche Produkte regelmäßig anbot. Die Ovahimba wurden nie mit solchen Produkten versorgt. Dem scheint vor allem ein weitgehend unzureichendes Angebot dieser Produkte durch „Biltong hunters“ und kommerzielle Wildernten zugrunde zu liegen. Eine generelle Geringschätzung des Wertes und des Vermarktungspotentials dieser Produkte durch „biltong hunter“ und kommerzielle Wildernter scheint ein weiterer wichtiger Grund hierfür zu sein. Fast alle (n = 9) “Biltong hunter” betrachteten die Vermarktungsmöglichkeiten für genießbare Nebenprodukte entweder als eingeschränkt oder als praktisch nicht vorhanden. Die kommerziellen Wildernter waren der gleichen Meinung. Im Zuge der kommerziellen Wildernte wurden diese Produkte im Feld zurückgelassen und dies wurde als gängige Praxis bezeichnet. Darüber hinaus, scheint die Vermarktung verzehrbarer Nebenprodukte eher keine gängige Praxis unter diesen Schlüsselakteuren zu sein, da fast alle „Biltong hunter“ (n = 8) und alle professionellen Jäger (n = 7) der Wildernte dieser Meinung waren.
Die potentiellen Empfänger und Endnutzer dieser Produkte würden diese jedoch generell nutzen, sofern sie legal und kostengünstig zu ihrer Verfügung ständen. Die Ovahimbasippe sowie n = 30 der 51 informellen Fleischhändler äußerten sich dementsprechend. Informelle Fleischhändler scheinen generell risikoscheu zu sein unter Geldknappheit zu leiden. Deshalb kann angenommen werden, dass sie genießbare Nebenprodukte von Wildernten und privaten Jagden nutzten würden, vor allem wenn solche Produkte zu günstigeren Preisen als andere formell angebotene Fleischprodukte gehandelt werden würden.
Allerdings wurden potentielle Gefahren und Risiken für die Sicherheit und Qualität von Fleischprodukten innerhalb der meisten existierenden und möglichen Produktbewegungen aufgedeckt. Wenn der Zugang zu diesen genießbaren Nebenprodukten für informelle Fleischhändler und arme Gemeinschaften wie die Ovahimba künftig gefördert werden soll, dann ist die Berücksichtigung und Minderung dieser Gefahren und Risiken von essentieller Bedeutung.
Kommerzielle Wildernten erscheinen tauglicher für solch ein Vorhaben zu sein, da die gegenwärtige Gesamtheit von Standards und Bestimmungen für kommerzielle Wildernten der von „Biltong hunting“ klar überlegen ist. Außerdem werden im Zuge kommerzieller Wildernten genießbare Nebenprodukte in großen Mengen innerhalb kurzer Zeitspannen erzeugt, was deren Vermarktungsfähigkeit verbessert.

vii. Author's Declaration

I, Alexander W. Heeb, hereby declare that this Master Thesis is my own original work. If not indicated otherwise, all findings were derived from my own research work. Neither in its' entity nor in parts, I did previously submit this Master Thesis anywhere for the obtainment of any degree or for any other purpose whatsoever.

Hohenheim, September 30th, 2009

_____

Alexander W. Heeb

viii. Acknowledgements

The author would like to express his special thanks to the Eiselen Foundation Ulm for the generous financial support of this Master Thesis. Without their support, this Master Thesis would not have been possible.

For their supervision, advice and support, the author would like to thank Prof. Dr. Anne Valle Zárate, Prof. Dr. rer. soc. Volker Hoffmann and Dr. Marianna Siegmund-Schultze at the University of Hohenheim.

At the Veterinary Campus of the University of Pretoria in Onderstepoort / South Africa, the author would like to thank Prof. Cheryl ME McCrindle, Dr. Erika Van Zyl and Dr. Nenene Qekwana for their supervision, advice and support. Furthermore, the author would like to thank Segomotso Lebogo for here consistent assistance and care. The author would as well like to thank Dr. Shashi Ramrajh in Richards Bay for her commitment and support of the study.

Furthermore, the author would like to thank the following persons:
Angelika Heeb; Bini Heeb with Linnah Mukenu Mumbela and Bbasari; Julia Heeb with Sasa Stankovic and David; Johannes Klaus; Anna Lendel; Stergios and Elli Pilichos; Olivia Namutenya Shitaleni with Hanganeni, Tujoleni and Mingona; Vaino Nashilongo; Abet Nashilongo; Mwaala Vaino Shivute; Katazo Sampofu; Kazeziruka, Vandulula and Waendavi Kaunohoni; Trisha Nangula Gabriel; Amdonia; Bertha Magkwadi; Tumi, Caroline and Ronald; Jenna Buley; Zama Mbatha; Dr. Pera Herold; Bianca Haussner; Dr. Regina Rössler; Burcin Demir; Stanimira Penkova; Loveline Tikum; Flavien Kasse Ndongo; Sékou Traore; Dr. Andreas Büchse; Victor, Nana and Leah; Christian und Tanja Briest; Franziska Ehrmann; Liya Siltan-Grüner; Peter Schekorr; Sunil Nepal; Adrian Kowollik; Jorgo Prassas; Andreas Schön; Lisa-Ann Lehrer; Jeanette Nasser; Alexander Fromm; Linda Gorim; Marco Sosa; Stefan Burkart; Sebastian Gyre; Ulrike Semmler-Busch; Robert Weisbier; Marcus Häußler.

1 INTRODUCTION

South Africa is characterized by an extreme cultural diversity as well as by strong disparities between the rich and the poor, between the formal and the informal sector and between developed and developing areas (AERNI, 2002). However, compared to other African countries, in South Africa, there are substantial wildlife resources outside protected areas, due to the dominance of privately owned farms and ranches in the underlying pattern of land distribution (BIGALKE, 2000).

Already in 1974, ASIBEY pointed out the great potential of African game animal species as a protein source in human nutrition. The South African agricultural sector experienced an obvious movement away from conventional livestock production towards game meat production. Over the past decades, the South African game industry has become a multi million Euro business (VAN DER WAAL and DEKKER, 2000) and today South Africa is one of the worlds' leading game meat exporters (FIELD, 2004).

Besides export, South African game meat products are marketed domestically and there are different domestic marketing chains for these products. Game meat is domestically consumed by different demographic groups of the population (HOFFMAN and WIKLUND, 2006) and it is the domestic market in particular, where South African game meat products can be assumed to have a promising potential as a valuable source of animal protein, especially for the rural and urban poor. This is particularly the case for edible but currently greatly unused by-products that are obtained during game hunts and harvests such as offal, heads and feet. The extent to which such products are accessible to poorer parts of the South African society was not evaluated and quantified. Currently, the identification of potential ways for a more efficient utilization of edible game meat by-products has not been investigated.

However, as food safety has become a fundamental public health issue all over the world (FAO & WHO, 2005a), concerns were raised in regard to the safety of game meat products, too (FIELD, 2004). Indeed, projects targeting game meat production were regularly obstructed by public health concerns and their costs (FÉRON *et al*., 1998). In this context, hazards to food safety and product quality can currently be expected within the domestic marketing chains of South African game meat products, particularly due to partly insufficient standards and regulations (HOFFMAN *et al.*, 2004, FIELD, 2004, HOFFMAN *et al.*, 2005a). Therefore, these potential hazards to food safety and product quality that may be present within different product flows as well as production and processing steps need to be identified for the sake of consumers and for the viability of the South African game meat production in terms of its' current contribution to domestic food production and its' future potentials.

A participatory risk assessment (GRACE *et al.*, 2008a) was conducted to identify potential hazards of food safety relevance within domestic marketing chains for South African game meat products to assess the risks of their occurrence, to facilitate their mitigation and to point out intervention points for doing so. Moreover, a more efficient utilization of edible by-products should be facilitated this way in favour of the rural and urban poor. Different stakeholders, end-users and role-players were considered and participated in the achievement of objectives.

This study was conducted in the scope of the multi-national BMZ-ILRI – "Safe Food, Fair Food-Project" and the bilateral research project "Participatory risk analysis for safe food of animal origin in informal markets" of the BMBF and the NRF.

2 LITERATURE REVIEW

2.1 Definitions

2.1.1 "Game", "wildlife", "game farming" and "game ranching"

The term "game" in some cases appears to be reserved for animals that are hunted for amusement, while the term "wildlife" comprises all indigenous animals of a region. Problems arise when trying to distinguish "game" and "wildlife" in the South African context: There is no such distinction made in both, the English and the Afrikaans language. The term "wild", which is pronounced "vilt" in Afrikaans, refers to game animals and other wild animals to the same extent. Nevertheless, in the South African game industry, the term "game" appears to be applied for ungulates in particular (CARRUTHERS, 2008). LEOPOLD (1986) defined "game management" as "the art of making land produce sustained annual crops of wild game for recreational use".

The terms "game farming" and "game ranching" appear to be used synonymously in many cases (TWISS *et al*., 1996), although they refer to different production systems. "Game farming" is referring to a production system in which "wild animal species are maintained in a domesticated or semi-domesticated manner by being enclosed in relatively small areas and provided with regular supplementary feeding in order to harvest by-products such as meat or skins". Differently, "Game ranching" refers to a system in which "selected species of ungulates are maintained on large tracts of land in a semi-wild state that does not involve regular feeding and water provision (although this may be provided in drought years) at a level that can be harvested regularly for meat". Reviewing this, "game ranching" can be called an extensive game meat production system whilst "game farming" is an intensive one (CARRUTHERS, 2008). However, Intermediate cases between the two categories may occur (MOSSMAN, 1975). POLLOCK (1969) additionally connected "game farming" to "the domestication of one or more wild animal species". According to MOSSMAN (1975), "game ranching" is "the organized and scientifically based utilization of free living wild animals for human needs, where commercial or other cultural incentives are involved". Differently, "game farming" involves confined wild animals (MOSSMAN, 1975).

Different to other important game meat producing countries such as Australia, New Zealand and the European Union, where game animals are increasingly replaced by domesticated and farmed animals, South African game meat production is predominantly based on wild, free-roaming animals (HOFFMAN and WIKLUND, 2006). Therefore, the term "game ranching" seems to be more appropriate for South African conditions than "game farming", which seems to be more suitable for other countries such as New Zealand in particular. However, in South Africa, both terms are applied by different authors. Nevertheless, in the following, exclusively the terms "game ranch" and "game ranching" will be used in terms of the South African game industry.

2.1.2 "Consumptive" and "non-consumptive" utilization of game

The non-consumptive utilization of game is the provision of services to tourists. These are activities such as game viewing, bird watching and wildlife photography. The consumptive utilisation comprises game meat production, trophy hunting, recreational hunting as well as live capture and sales (MOSTERT and HOFFMAN, 2007). Not only the non-consumptive but also the consumptive utilization of game animals is regarded as an appropriate way to sustainably utilize wildlife by different conservationalists (ASHLEY and JONES, 2001).
Due to a favourable exchange rate (2002), South Africa can be regarded as an affordable destination for many international tourists. Particularly hunters and eco-tourists are visiting the country and it is estimated that about 80% of the total income from tourism is comes directly from either hunting or eco-tourism (LUCK, 2005). Compared to trophy hunting, for example, the non-consumptive utilization of wildlife such as photographic eco-tourism generates greater gross revenues in Africa, as comparatively large numbers of tourists are involved (LINDSEY *et al.*, 2007). This study will exclusively focus on the consumptive utilization of game animals.

2.2 The consumptive utilization of game animals in South Africa

2.2.1 Current status

In South Africa, the commercial utilization of game animals has shown a strong growth during the past 20 to 25 years (MOSTERT and HOFFMAN, 2007). Besides domestic retail and consumption, South African game meat products are traded on the world market. In 2005, there were three companies that exported South African game meat (PATTERSON and KHOSA, 2005). The meat of game animals is consistently gaining popularity in European markets (LA NEVE *et al.*, 2008). Especially the demand for meat derived from species such as springbok and kudu in European countries fuels the export of game meat products (MOSTERT and HOFFMAN, 2007). However, currently, the meat of African game animals is greatly regarded as exotic in overseas markets and is almost exclusively supplied to upmarket hotels, delicatessens and restaurants (PATTERSON and KHOSA, 2005). Also the international marketing of biltong, a traditional South African meat snack made from lean meat strips which are dried, salted and flavoured with spices, is being increasingly marketed as a branded delicacy (STRYDOM, 2004).
It is estimated that, in 2005, South Africa exported the deboned meat of 160,000 game animal carcasses, whereby springbok accounted for more than 80% of this amount (HOFFMAN and WIKLUND, 2006). The Camdeboo Meat Processers Limited traded the meat of about 65,000 game animals in 2001, what contributed about 80% to the total amount of exported game meat during this year (DAMM, 2005). South Africa produced 18,000 tonnes of game meat in 2007(FAOSTAT, 2009).
When looking at different annual statistics provided by FAOSTAT, the rapid increase of the country's game meat production is becoming apparent. While, in 1969, 500 tonnes of game meat were produced in South Africa, this number increased tenfold by 1977. Then, until 1987, it doubled again to 10,000 tonnes. In 1997, 13,000 tonnes of game meat were produced. Therefore, between 1997 and 2007, the production of South African game meat was increased by more than 38% (FAOSTAT, 2009). However, some researchers are of the opinion that the South African game industry has actually become greatly saturated in terms of a further expansion (PATTERSON and KHOSA, 2005, DAMM, 2005).

Nevertheless, others are of the opinion that a great potential potential remains for the expansion of target markets for South African game meat products (MOSTERT and HOFFMAN, 2007).

The production, as well as the consumption, of game meat within South Africa remains inadequately documented (HOFFMAN, 2000a). It was almost impossible to generate reliable data about the current domestic retail marketing of game meat (HOFFMAN *et al.*, 2004). The perceptions of South Africans towards game meat were evaluated to a very limited extent, too (HOFFMAN *et al.*, 2005a). Nevertheless, game meat can be called a relative popular component of human nutrition (HOFFMAN *et al.*, 2007). Also, the consumption of game meat within the South African hotel and restaurant sector is increasing (MOSTERT and HOFFMAN, 2007).
A study conducted by HOFFMAN *et al.* (2005a) indicated that, domestically, game meat may be most frequently consumed by white South Africans followed by coloureds and that it may be of the least importance in the diet of blacks. The study indicated that South Africans in general tend to perceive game meat as an exotic and seasonal product in contrast to domestic livestock meats such as beef, lamb and chicken, although the game animals hunted and harvested for meat are indigenous in the country (HOFFMAN *et al.*, 2005a). This widespread perception of game meat as an exotic item, and therefore the unfamiliarity of consumers with it, can be regarded as a major obstacle for an expansion of marketing (RADDER, 2003). Moreover, in many cases, game meat is considered as being 'dry and gamey' by South Africans (PATTERSON and KHOSA, 2005).
South Africa may be the most popular country for trophy hunting in the world. Especially because in South Africa there are more than 60 mammalian species available for hunting, which is the highest number in the world, the country is a very popular hunting destination. Up to US$ 130 million (€ 104.66 million (OANDA, 2009)) is generated anually by international hunters visiting the country. In 2004, about 7,000 foreigners visited South Africa in order to hunt and it may be expected that each one of them added a revenue of about US$ 18,500 (€ 14,894 (OANDA, 2009)) to the national economy (DAMM, 2005). Similarly, PATTERSON and KHOSA (2005) counted between 5,000 and 6,000 visitors for the 2003/04 hunting season. In the 2003/04 hunting season, foreigners hunted a total of 55,000 animals (DAMM, 2005). When looking at the numbers of operators, visiting hunters and animals shot as well as in terms of revenues generated, South Africa has the largest hunting industry in sub-saharan Africa (LINDSEY *et al.*, 2007). Besides 5,000 to 6,000 jobs that are created directly by the hunting industry, another estimated 63,000 jobs are provided by secondary industries such as tourism (PATTERSON and KHOSA, 2005).
However, almost no data could be found to quantify the hunting conducted by South Africans with the exclusion of international tourists. Nevertheless, it can be assumed that hunting is conducted by about 200,000 South Africans on a more or less regular basis (DAMM, 2005, PATTERSON and KHOSA, 2005). In 2007, a total of 7,973 game animals were shot by 676 "biltong hunters"(South Africans who hunt game animals on a private basis and for sport and recreation), according to an extensive survey conducted on South African biltong hunters. Most of them were either springbok (25%) or impala (18%) (VAN DER MERWE and SAAYMAN, 2008). If this is assumed to be representative for the total number of 200,000 biltong hunters as mentioned by DAMM (2005) and PATTERSON and KHOSA (2005), a total number of approximately 2.3 million game animals is shot annually by South Africans only. In 2000, more than half (52.8%) of the overall gross income of the South African game industry was generated by biltong hunters (PATTERSON and KHOSA, 2005).

2.2.2 "Game ranching" in South Africa

Different reasons such as a declining profitability of cattle farming, an increase in stock theft and the re-emergence of South Africa into the world community have led to the growing attractiveness of game ranching in South Africa (COUSINS *et al.*, 2008). BOND *et al.* (2004) were of the opinion that the possibility to link recreational services such as trophy hunting to game ranching has become the major driving factor for the fast growth of the South African game industry, after the right to use wildlife was transferred to the commercial sector.
Differently, CARRUTHERS (2008) identified biltong production. More generally, ASIBEY (1974) suggested the possibility to generate direct economic returns from game animals by utilizing them for meat, as a driving factor of this development. Amongst other aspects, LUCK (2005) regarded the agricultural deregulation in post-apartheid South Africa as a stimulator for game ranching. The growing concern amongst consumers to protect the environment and the growing demand for organic and naturally produced products may also facilitate this development (HOFFMAN *et al.*, 2004), as there is an increasing awareness of consumers in regard of health issues and an increase of the demand for lean meat (HOFFMAN *et al.*, 2005a).

Meat production is increasingly gaining importance as a source of income for game ranches. In terms of return per kilogram of biomass, the production of meat is probably the most rentable strategy for game ranches when compared to the sale of live animals, or trophy and recreational hunting. (HOFFMAN *et al.*, 2005b). SKINNER (1970) made clear that marginal areas and therefore the hot and arid environments of southern Africa, are particularly suitable for protein production with wild ungulates, as these areas cannot be used for intensive production. Their grazing radius, their disease resistance (e.g. trypano- and heat tolerance (CHILD, 1991)) as well as their tolerance for water shortage is high. The costs of entering game ranching as well as its' operating costs are potentially lower than those connected to cattle husbandry, which includes expenditures for fencing, inoculation and dipping (POLLOCK, 1969). Moreover, herbage can be utilized more efficiently if several herbivore species are maintained on the same land (COOK, 1977).
HOFFMAN *et al.* (2005b) pointed out that several studies conducted on African ungulate species have contributed to the current wide acceptance of the meat production potential of different game animal species. In this context, HOFFMAN (2000a) evaluated the the carcass yield as well as the chemical composition of the 9^{th}-10^{th}-11^{th} rib cut of impala, whereby the dressing percentage of carcasses turned out to range around 58%.
A similar study was carried out by VAN ZYL and FERREIRA (2004) to evaluate a possible correlation between the chemical composition of the carcass to that of the 9^{th}–10^{th}–11^{th} rib cut in springbok, blesbok and impala. They concluded that, when compared to domestic livestock, game animals have a higher meat production potential in regard to dressing percentage and lean meat production. The dressing percentage of springbok was calculated to range between 56.2% and 57.6%, that of blesbok ranged between 49.5% and 50.8% and impala had a dressing percentage between 54.7% and 58.2% (VAN ZYL and FERREIRA, 2004). Compared to this, cattle and sheep have a dressing percentage between 40 and 60% and of about 42% respectively (SKINNER, 1970). The three game animal species also showed much higher proportions of carcass protein when compared to domestic livestock. The investigated species apparently have a very high total production (84.8%) of usable products (VAN ZYL and FERREIRA, 2004).

Nevertheless, game ranching may be associated with the possibility that game animals are forming a reservoir for livestock relevant diseases such as rinderpest or Food-and-mouth disease (POLLOCK, 1969). LUCK (2005) connected the ongoing retrenchment and eviction of South African agricultural labour to the growing popularity of game ranching. When a farm is converted into a game ranch or reserve, farm labour tends to be considered dispensable. One the one hand, former farm workers who reside on a newly established game ranch or reserve tend to be regarded as a security threat to land owners and animals in terms of poaching activities. On the other hand, they are considered to be at risk due to dangerous animals kept on the land (LUCK, 2005). Figure 1 displays the increase of game ranching in relation to conventional livestock production in South Africa from 1964 to 2007.

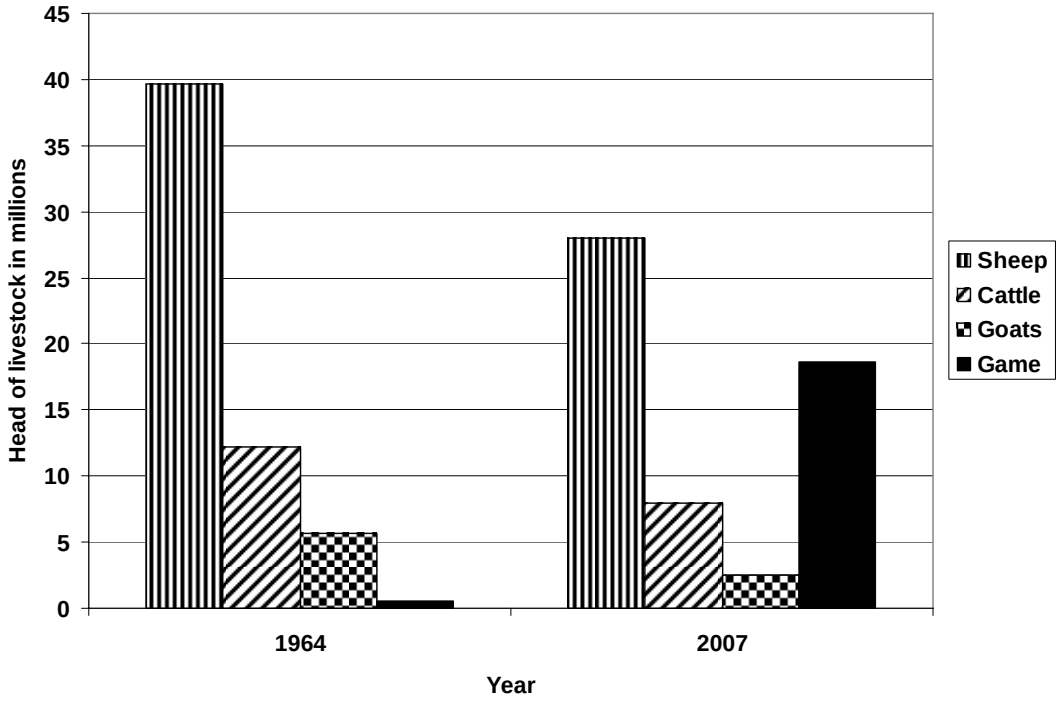

Figure 1: The relative importance of game ranching compared to different species of conventional South African livestock production in 1964 and 2007

Adopted from CARRUTHERS (2008, based on DU TOIT, 2007).

Although being a relatively new type of agricultural land use, game ranching is currently well established in South Africa (HOFFMAN *et al.*, 2005b). The onset of this process was about 40 years ago (VAN ZYL and FERREIRA, 2004). In 1964, already 4,000 ranches in the Transvaal alone, were commercially involved in game meat production (ASIBEY, 1974). In 1985, between 7,000 and 10,000 South African farmers derived some kind of income from the utilization of game animals (LUXMOORE, 1985, Abstract). In 2000, the South African game industry was worth ZAR 843 million (€ 132.18 million (OANDA, 2009)) (ELOFF, 2002, as cited by HOFFMAN *et al.*, 2005b).

There are currently between 5,000 and 6,000 game ranches and an additional 4000 mixed livestock/game ranches in South Africa (BOND *et al.*, 2004, DAMM, 2005), which comprise a total game animal population of more than 1.7 million individuals (BOND *et al.*, 2004).

Privately owned South African game ranches covered an area of approximately 20.5 million ha in 2006. This area equals about 16.8% of the country's total land area (NAMC, 2006, as cited by COUSINS *et al.*, 2008). Annually, this area is increasing by 5.6% (ELOFF, 2002, as cited by VAN ZYL and FERREIRA, 2004).
In terms of species, the springbok is both, the most frequently hunted game animal species and the species from which most of the game meat destined for export is coming from (HOFFMAN, 2008). The rapid reproduction rate of the springbok allows the establishment of a game population in a relatively short period of time (HOFFMAN *et al.*, 2005b). Nevertheless, the impala is another important species to the South African game industry (KOHN *et al.*, 2005).

2.2.3 The commercial harvesting of game animals in South Africa

"Game harvesting" can be defined as "the killing of animals for meat production purposes" (HOFFMAN and WIKLUND, 2006). Most methods of harvesting game animals are rather labour intensive, so that they offer employment to people who would otherwise be unemployed (ASIBEY, 1974). Due to the variation of farms in terms of size and area, in South Africa, there are different methods of game harvest applied than in game meat producing countries in other parts of the world. Another reason is the long distance between production centers and markets (KRITZINGER *et al.*, 2003).
In South Africa, the great majority of game animals hunted for meat are killed in the field (GILL, 2007). Currently, all South African game animals that are harvested for export come from large privately owned enclosures or from state owned reserves (HOFFMAN and WIKLUND, 2006). Traditionally, commercial game harvests are taking place during the South African winter months when low ambient temperatures prevent a spoilage of carcasses prior to dressing and cooling. Nevertheless, "game harvesting" can also be conducted during hotter times of the year if cooling facilities are available close to the hunting location and if the dressing of carcasses is carried out immediately (HOFFMAN *et al.*, 2004). However, no game harvest should take place during the hotter months of the year if chilling facilities are not readily available at the spot (SKINNER, 1970, FIELD, 2004).
When commercially harvested, South African game is either shot at night or during daylight. The latter is usually done from a helicopter or hide (HOFFMAN and FERREIRA, 2000). However, game harvests are mostly carried out after dark by well-trained marksmen (registered professional hunters), whereby the animals are blinded by a spotlight. As soon as a blinded animal has been selected it is shot. The marksmen usually have a killing success of more than 90% and misses or inadequate shots are very rare (HOFFMAN and WIKLUND, 2006). Night harvest is assumed to minimize the stress of the animals during the process (KRITZINGER *et al.*, 2003) and to cause the least damage and wastage of carcasses. Moreover, it is assumed to cause the least stress for individuals which survive the process (HOFFMAN and FERREIRA, 2000). Several studies suggest that night harvest in particular does not have negative effects on the quality of the meat obtained (see Chapter 2.2.6). However, certain adverse effects may occur during game harvests, although there is only little scientific information available concerning the effect of the harvesting and shooting procedures on game meat quality (ONYANGO *et al.*, 1998).
When shot in the head or neck, an individual game animal usually drops instantly. If shot into the shoulder or the ribs, the animal may still run quite far until it finally collapses and this may result in reduced meat quality (HOFFMAN and FERREIRA, 2000). A shot through the neck also

results in wastage of about 3% only. Also, in the meat trade, the neck is regarded as a cut of less value than, for example, the shoulder HOFFMAN (2000b). Nevertheless, shooting the animals in the head is the most commonly practiced method to bring them down. In South Africa, 95% of commercially harvested game is killed this way (HOFFMAN and WIKLUND, 2006, GILL, 2007).

All South African ranches that produce game meat for export are required to register with the controlling authority. Every ranch that fulfills the requirements is issued with an annually renewable registration number. This registration number can be linked to all game meat obtained from a particular ranch, thus ensuring the traceability of meat back to the ranch of origin and it provides a profound knowledge about the health status of animals utilized. Harvesting teams and game depots require a registration number, too. Game depots are constructed for the holding of game animal carcasses only. In most cases, such facilities are chiller trucks that are used for the transport of game animal carcasses within South Africa. They are required to be in accordance with certain standards and regulations set and approved by the controlling authority in terms of field container types and equipment (HOFFMAN and WIKLUND, 2006).

Before the start of a game harvest, vehicles and equipment need to be inspected according to the regulations. If shooting is carried out from vehicles, they are usually driven by the marksmen who also carry out all shooting in order to avoid misunderstandings between hunter and driver. A well-trained spotlight operator accompanies each collecting vehicle. Every collecting vehicle needs to be accompanied by a field meat inspector for the exsanguination and loading of carcasses (HOFFMAN and WIKLUND, 2006).

After an animal was shot, it is exsanguinated in the field. A sterile knife is used and each animal is given an identification number. Animals are then hung by the hind legs onto the side of the collecting vehicle. Usually, the marksmen keep on harvesting game until sufficient numbers are achieved or until the time limit for the collecting vehicles to deliver carcasses to the game depot for further processing is almost reached (HOFFMAN and WIKLUND, 2006).

However, carcass may as well be eviscerated at or very close to the spot after an animal has been killed in the field. If doing so, before any further dressing, carcasses are then most commonly hung by the hind legs with the body cavity propped open to enhance the drying of internal surfaces which were exposed during evisceration (GILL, 2007). The body cavity should be cleaned with cold water or with a clean cloth in the case of water unavailability (FIELD, 2004). However, commercial harvesters usually tranport uneviscerated carcasses to the game depot (KRITZINGER *et al.*, 2003, HOFFMAN and WIKLUND, 2006, GILL, 2007). Carcasses obtained during commercial game harvests must reach the game depot within two hours after the fatal shot (HOFFMAN and WIKLUND, 2006).

At the game depot, the carcasses are unloaded from the collection vehicles to be places on the slaughter frame. It is taken care that these do not touch the ground when doing so. The slaughter staff needs to be subdivided into two groups. The first group are the so-called “dirty workers”. They exclusively carry out work that brings along the potential contamination of hands, clothes and equipment. The second group only deals with clean carcasses. For example, they remove intestines, thoragic organs, the liver and the “pluck”, which comprises of trachea, lungs and spleen. This second group is also responsible for the weighing of carcasses and the loading of carcasses into the chiller truck (HOFFMAN and WIKLUND, 2006).

Prior to their loading into the chiller truck, all carcasses and plucks need to be inspected by an accredited health official. Each carcass and its’ pluck need to be marked with identity tags.

These tags have a serial number so that the name of the ranch, the harvesting date as well as the name and number of the harvesting team and game depot can be traced back for each carcass. As soon as the internal surfaces have dried after evisceration, carcasses need to be loaded into a chiller truck. If the ambient temperature exceeds 15°C, they need to be stored inside the pre-chilled chiller truck at 7°C within two hours subsequently to evisceration. Subsequently to the loading of carcasses into the chiller truck it is sealed and carcasses are transported to the processing plant, which mostly is an export abattoir approved by the European Union (HOFFMAN and WIKLUND, 2006).
Before the carcasses can be offloaded, the controlling authority checks the integrity of these seals (HOFFMAN and WIKLUND, 2006). The carcasses must reach the export abattoir within 72 hours (KZN AEA, 2005, RAMRAJH, 2009, personal communication). Within the processing facilities, further stringent regulations for the export of South African game meat need to be met and followed. The South African standards for the export of game meat comprise an intensive residue monitoring programme and complete health and hygiene requirements. These standards also make provision for an inspection carried out by the importing countries (HOFFMAN and WIKLUND, 2006).

2.2.4 Trophy hunting

The opinion of conservationists in regard to trophy hunting ranges from an absolute opposition, to the recognition of trophy hunting as a practical way of generating incentives for conservation. Compared to the consumptive utilization of wildlife, the sustainabililty of non-consumptive utilization is rarely questioned. Many conservationists are of the opinion that the non-consumptive utilization of wildlife must be the preferred option in terms of sustainability. However, the income generated from consumptive ways of utilization such as trophy hunting should not be neglected as an important mean to realize the sustainable conservation of biodiversity and habitats (HUTTON and LEADER-WILLIAMS, 2003).
The idea to use hunting as a mean for the sustainable conservation of wildlife and habitats was prevailing amongst conservationists for a rather long time. In the 1980s, the possibility to achieve conservational aims with money raised through hunting has become a central point of interest (ADAMS, 2004). CARO *et al.* (2009) concluded that the hunting of wild animals as a sport and in an organized manner can be substantially beneficial in regard to their conservation. Trophy hunting can be regarded as sustainable when it is taken into consideration that it brings along the prerequisite that landowners maintain habitats as well as biodiversity (BOND *et al.*, 2004). A low off-take is needed to guarantee high trophy quality as well as to maintain the future-marketability of the hunting area (LINDSEY *et al.*, 2007).
If off-take rates are kept low, high prices are charged and both, the size of populations as well as their sex ratios are taken as a basis of quota settings, trophy hunting can play a key role in the provision of incentives for wildlife conservation (LEADER-WILLIAMS *et al.*, 2005). Moreover, the fact that land areas are set aside for hunting protects these habitats from being taken into agricultural production (PATTERSON and KHOSA, 2005).
In South Africa, all of the so-called “Big Five” and even the “Classic Big Five” with the inclusion of the black rhinoceros can be hunted. This contributes to the importance of South Africa as a popular destination for trophy hunters (DAMM, 2005). The “Big Five” comprise of the African lion, the leopard, the rhino (the black or the white one), the African elephant and the African buffalo, which is often called “cape buffalo” (SAGR, 2009).

In terms of the total hunting income generated, the kudu (13.2%), the gemsbok (8.7%) and the lion (8.2%) are the economically most important trophy animals of the South African game industry (PATTERSON and KHOSA, 2005). However, a survey conducted amongst trophy hunters indicated that the buffalo is perceived as the most popular trophy animal, followed by the leopard, the kudu and the lion (LINDSEY *et al.*, 2006b).

In South Africa game hunting is allowed on private game ranches as well as in controlled hunting areas within certain provincial game reserves (PHASA, 2009). All foreign hunters must be supervised by a professional hunter under all circumstances (PATTERSON and KHOSA, 2005). Operators market and sell hunts to clients (LINDSEY *et al.*, 2007). Mostly, "hunting safaris" are organized by specialized companies called "outfitters". This are hunting packages which are tailored to the desires of the client. Most or even all logistical issues are organized including the acquisition of necessary permits. It is also ensured that a professional hunter will accompany the tourist (BAKER, 1997). "Outfitters" lease or own both, hunting areas and safari camps. They employ different types of staff such as professional hunters, trackers, drivers, skinners and camp staff (LINDSEY *et al.*, 2007). In South Africa, there are about 1,000 registered hunting outfitters and approximately 2,000 professional hunters (PATTERSON and KHOSA, 2005).

The majority of countries have made efforts to regulate hunting by passing different laws. Such measures may be the restriction of the off-take of adults or adult males, the restriction of hunting in general to certain times of the year or the restriction of the total number of animals one individual hunter may shoot within a given period of time (CARO *et al.*, 2009). However, there are still different ethical, social, and biological problems connected to trophy hunting which obstruct its' conservation role (LINDSEY *et al.* (2006a). Major problems connected to trophy hunting are the unequal distribution of hunting revenues and the inadequate involvement of communities as well as corruption (LEWIS and JACKSON, 2005, MAYAKA *et al.*, 2005). Moreover, due to the greatly inadequate availability of reliable population data, the setting of suitable quotas that would ensure the sustainability of trophy hunting remains a difficult task (CARO *et al.*, 1998).

However, especially the inability of governments and hunting operators to supply adequate benefits from trophy hunting to local communities may be regarded as the greatest threat to the sustainability of this sport in the long run. Under such conditions, there are only limited incentives for these communities to conserve wildlife (LINDSEY *et al.*, 2006a). Regarding this, so-called community-based conservation efforts which include local communities into conservation efforts and projects instead of excluding them from benefits derived from the use of wildlife may be a promising solution (BORGERHOFF-MULDER and COPPOLILLO, 2005).

In South Africa, the value of trophy animals has obviously inhibited the removal of fences between neighbouring ranches so that the division of the rangeland in predominantly small blocks has generally remained unchanged (BOTHMA, 2002, as cited by LINDSEY *et al.*, 2006a). Concerning this, game ranches are usually fenced in by special stock proof game fences (NUDING, 2002, SIMS-CASTLEY *et al*., 2005).

Furthermore, although game ranch owners may contribute to wildlife conservation by habitat protection and the reintroduction of wild ungulates, they are rarely tolerant of predators roaming their land and, in many cases, negatively affect the environment by overstocking their properties as well as by altering the thicket on their lands for false savanna impressions (LINDSEY *et al.*, 2006a, 2006b, SIMS-CASTLEY *et al.*, 2005).

Additionally, exotic species are regularly introduced for a higher diversity of obtainable trophies and genetics are sometimes deliberately manipulated in order to produce aberrant varieties such as "white blesbok" or "black blesbok" for trophy hunters (LINDSEY *et al.*, 2006a, 2006b).

2.2.5 Illegal utilization of game resources in South Africa

When exclusively focusing on national hunters, hunting in South Africa is basically conducted by two groups. The urban rich, who normally do it as a sport and for commercial purposes, and the rural poor, who hunt in order to utilize game animals as a source of sustenance (KEPE, 1997). Subsistence hunting usually refers to the harvesting of smaller animals for food. It is of significance for rural people (CHILD, 1991). Subsistence hunting is conducted for the obtainment of meat, whereby a wide variety of methods are applied. Generally, the necessary provincial permits and permissions from land owners are absent. Therefore, subsistence hunting is usually not conducted within any legal framework and is generally called poaching and punished as a criminal offence, even if just for home consumption as it threatens the survival of endangered species (CHILD, 1991, PATTERSON and KHOSA, 2005).

Poaching is a major problem faced by authorities responsible for African wildlife management (CHILD, 1991) as conventional wildlife policies exclude rural residents from most legal forms of wildlife utilization. The legal access to hunting is regulated by national legislation and, for individuals, it is influenced by their personal financial situation so that this way of wildlife utilization is a limited option for the rural poor (KEPE, 1997). Wildlife-related legislations in Africa do not adequately support subsistence hunting but, instead, classify it as illegal (CHILD, 1991).

Although rural communities receive few legal benefits from wildlife, these people are in many cases paying the costs of wildlife conservation in different ways, such as crop damage or even lives. Therefore, these exclusionary wildlife policies do not provide sufficient incentives for a sustainable use of game animals and the option of killing wild animals by ignoring the law is taken frequently (GIBSON and MARKS, 1995).

For example, close to the Lubombo Transfrontier Conservation Area ("Peace Park") in South Africa, a very vital trade of poached game meat can be observed and many markets in the region supply poached game meat at a regular basis. According to conservation officials, poaching remains a serious problem in the area and locals are thought to account for about 70% of poaching incidences. The frequent inability of the people in the area to purchase live cattle or its' meat may partly explain this (JONES, 2005). In many cases, poached game meat is available at a lower price to customers than meat from livestock, even if it needs to be purchased and the demand is therefore mostly driven by affordability (TRAFFIC, 1997). In areas characterized by extreme poverty, the cash savings on meat products play an important role in household economics, although this may have negative effects on wildlife populations (JONES, 2005).

People living in wildlife areas are of major importance for the survival of wildlife populations in the long run and it can be assumed to be counterproductive to antagonize them in terms of conservation efforts. Their sympathy and cooperation should be achieved by promoting the acceptance of wildlife management as a viable way of land use. Incentives in the form of tangible benefits from wildlife should be provided for these people (CHILD, 1991). The improved access to edible by-products from hunts and harvests could be such an incentive.

2.2.6 Quality attributes of game meat

In 1970, SKINNER concluded that game meat may never be able to directly compete with meat from domestic livestock traded on the markets. Although the South African game meat industry is growing, information on quality aspects of game meat is limited (HOFFMAN *et al.*, 2005b, MOSTERT and HOFFMAN, 2007). However, this is necessary in order to promote its' competitiveness with other types of meat on the market (KOHN *et al.*, 2005).

In terms of meat characteristics, it is difficult to distinguish different game animal species from each other as they are often closely related (LA NEVE *et al.*, 2008). Quality attributes such as caloric content, protein and fat show little variation from one species to the next. Indeed, the variation is often greater within than between species, as these quality attributes are strongly influenced by age, nutrient availability and both, lactation and rutting activities. There is also a very little variation between different game animal species in terms of vitamins, minerals and amino acids contained in the meat (FIELD, 2004).

Already decades ago, it was stated that the chasing of game animals prior to the fatal shot would reduce the quality of meat (BEHR and GREUEL, 1977). Indeed, according to some researches conducted, it can be well assumed that anti-mortem stress does negatively affect the quality of the meat in terms of colour and water-binding capacity (HOFFMAN and FERREIRA, 2000). However, when HOFFMAN (2000b) examined the effects of night harvest on pH, colour, cooking loss, drip loss and tenderness for impala meat under the consideration of gender, the results of this study suggested that the present methods applied when commercially harvesting game animals do not negatively affect these meat quality parameters (HOFFMAN, 2000b).

When comparing night harvest and day harvest of impala in view of meat quality aspects, a study conducted by KRITZINGER *et al*. (2003) indicated that night harvest resulted in a higher product quality. The influence of the harvesting method on the muscle pH 45 minutes after the animals' death as well as on the ultimate pH after 24 hours was the major focus of this study. In regard to pH, drip loss and shear force, impala meat obtained at night was of higher quality. It showed a slower pH-decline over 24 hours as well as a higher water binding capacity and a lower drip loss (KRITZINGER *et al.*, 2003).

Similarly, a study conducted by HOFFMAN and FERREIRA (2000) indicated advantages of night harvest over day harvest in terms of product quality. In this study, ten male Grey Duiker were harvested at night on a commercial sheep farm in the Eastern Cape Province of South Africa. None of the animals was wounded and all of them were shot in the head and were immediately strung up by the hind legs and exsanguinated. The pH of the meat was recorded 45 minutes after death as well as at two, four, six, eight, twelve, 18 and 24 hours after the animals had been shot. Results showed that nine out of the ten carcasses did not exceed the expected decrease in pH of -0.2281 over 24 hours (HOFFMAN and FERREIRA, 2000).

KOHN *et al.* (2005) determined citrate synthase, phosphofructokinase activities and myosin heavy chain isoform contents in four muscle groups of impala meat. They concluded that the body weight and age of individuals may effect meat quality to a certain extent in terms of texture, toughness and susceptibility to "DFD" (KOHN *et al.*, 2005). "DFD" refers to "dark, firm and dry". If an aminal is stressed prior to death, a glycogen defiency occurs in the muscles. The meat obtained then has a high ultimate pH of more than 6. Spoilage occurs more rapidly as the comparatively high pH facilitates the growth of spoilage organisms (NEWTON and GILL, 1980).

Such “DFD meat” is mostly “sticky”, dark in colour and appears dry, as the water holding capacity is increased due to the comparatively high pH. Therefore it is usually not desired by consumers (NEWTON and GILL, 1980).
In general, game animals have very low levels of sub-cutaneous and intramuscular fat when compared to domestic species (HOFFMAN, 2000a, HOFFMAN and WIKLUND, 2006). The fat percentage of game meat can be as low as between 0.07% and 1%. As a result of such low fat contents, the protein content of game meat turns out to be high (KIM *et al.*, 2009).
Modern consumers tend to prefer healthier foods and the fact that game meat generally has a lower fat content than meats from domestic livestock brings along a huge potential of these products to be destined for health conscious consumers (HOFFMAN, 2000a). Moreover, the fat of game animals greatly consists of structural lipid components (phospholipid and cholesterol) and therefore contains high amounts of polyunsaturated fatty acids (HOFFMAN and WIKLUND, 2006).
Because South African game animals are usually extensively ranched under natural conditions, the marketing of game meat as a natural and organic product has potential (HOFFMAN *et al.*, 2005b). South African game meat is, besides being largely free of human intervention, independent from the use of steroids, pesticides and hormones (RADDER and LE ROUX, 2005).
Besides these aspects, its’ special texture and flavour may be another reason for its’ growing popularity (LA NEVE *et al.*, 2008). Sensory variables such as colour, taste, texture and smell can be regarded as very influental on the perception and acceptance of food stuffs by consumers (RADDER and LE ROUX, 2005). However, game meat is rapidly losing colour stability when displayed in air, although it is storable for extended time periods. This may substantially limit its’ suitability as a retail sales item (SEMAN *et al*., 1988).

2.2.7 The potential utilization of offal, heads and feet obtained as by-products of game meat production

Game offal, heads and feet are obtained as a by-product of commercial game harvesting, trophy hunting and biltong hunting. In many cases, these materials are not or only partially utilized (e.g. liver) but left behind in the field. However, these materials are a valuable source of animal protein that could be supplied to both, soup kitchens and school kitchens in South Africa, or that could be made available to informal meat traders, who are patronised by the rural and urban poor. Moreover, poor indigenous tribes of southern Africa could be supplied with these materials (MCCRINDLE and RAMRAJH (2009), personal communication).
In 1970, SKINNER made clear that edible by-products should be utilized efficiently whenever game is harvested. Similarly, FÉRON *et al*. (1998) criticized that edible by-products obtained during game harvests would not be completely utilized for human consumption. Although not focusing on offal in particular, DAMM (2005) pointed out that game meat obtained during trophy hunts would be a cheap as well as healthy source of animal protein for communities in need. Nevertheless, currently, this is obviously not the case.
No research was carried out on the potential utilization of heads and feet obtained during game hunts and harvests. In regard to game offal, there is also almost no scientific literature available concerning its’ quality and utilization. One exception is a study carried out by VAN ZYL and FERREIRA (2004). It indicated that the proportional percentage protein in the internal offal of springbok, blesbok and impala (17.0–21.9%) is very similar to that of sheep (16.5–23.5%).

In general, most studies on offal are from the 1990s and 1980s. This indicates that, in recent years, only little research was dedicated to this matter. Furthermore, these studies generally deal with edible internal offal and neglect edible external offal such as heads and feet. Moreover, exclusively the offal of domestic livestock seems to be considered. Nevertheless, depending on the animal species, meat by-products make up 50-60% of the total slaughter yield. Such by-products can be divided into edible and non-edible ones (SUBBA, 2002).

The edible by-products contain many essential nutrients of which some are utilized pharmaceutically due to certain contents such as amino acids, hormones, minerals, vitamins and fatty acids. Some meat by-products (e.g. lung, kidney, brains, spleen, and tripe) show a higher level of moisture compared to meat. Moreover, certain organs such as liver and kidney have higher content of carbohydrate than other meat materials. Organs are usually richer in vitamins than lean meat (LIU, 2002).

In developed countries, the meat industry is predominantly focusing on the qualitative and quantitative characteristics of carcasses and tends to neglect edible offal items such as heart, liver, kidney, spleen and brain. However, in many parts of the world, offal items are a very popular kind of food that is of central economic interest for such countries' meat producers, whilst qualitative aspects of the carcass receive limited attention (RILEY *et al.*, 1989).

However, for the acceptance of edible meat by-products such as offal by consumers, their sensory quality is of great importance (SUBBA, 2002). The visual quality and final microbiological load of these products is determined by the processing method applied. This also determines the eventual shelf life, the consumer acceptability and the consumer risk connected to the final product (BENSINK *et al.*, 2002). Concerning this, SHERIDAN and LYNCH (1988) carried out a study on the Irish beef and sheep offal market and pointed out that the general assumption, edible offal would be of poor quality and of a short shelf-life is a major obstacle for its' valuation amongst consumers. Indeed, offal reportedly has a shelf-life of only one or two days even if kept at chiller temperatures (PATTERSON and GIBBS, 1979) and a substantial fraction of offal destined for human consumption can be expected to be of poor microbiological quality.

It can be concluded that the poor storage quality of chilled offal may chiefly arise from an inadequate collection as there is a limited understanding of appropriate practices for the hygienic collection and the cooling of offal (GILL and JONES,1992) Inadequate temperature control may play a role, too (SHERIDAN and LYNCH, 1988). However, the major constraint seems to be the great variety of different collection methods as well as cooling processes applied. Although offal comprises a range of different products (for example, "red offal" comprises the lungs, liver, spleen and kidneys, whilst other offal includes stomach and intestines as well as sometimes other discarded organs such as testes, udders and uterus), they are handled rather similarly. Therefore, certain practices applied may not be suitable for some (GILL and JONES, 1992).

The provision of some objective and practical means in regard to the different processes and offal fractions would allow the identification and minimization of hygienic inadequacies (GILL and JONES, 1992). This will also be of crucial importance if a more efficient utilization of game meat by-products shall be realized.

2.3 Informality in South Africa

2.3.1 Current status

The formal employment generation in South Africa has generally decreased since 1990 (MARTINS and ANELICH, 2000). During the process of economic liberalization in South Africa since the end of the apartheid regime in 1994, the employers of the country have increasingly responded to a growing international competition in the from of company closures and worker retrenchment. Ways to either casualize employment or to externalize production were found. Although recent surveys showed that there was a decrease of unemployment in the last years, the number of people employed in the informal sector increased (GOLDMAN, 2003). The high unemployment rate of South Africa also resulted in a certain increase of self-employment, which mostly rose within the informal sector (MULLER, 2003).

The employment situation of South Africa apparently differs from that of most other developing countries, in which a large informal sector compensates for deficient formal employment opportunities so that the open unemployment is usually limited. The informal sector of South Africa is small, whilst there is widespread open unemployment (KINGDON and KNIGHT, 2004, SKINNER, 2006). It was estimated that, in 2001, the informal economy of South Africa contributed between 8 and 12% to the country's gross domestic product (BUDLENDER *et al.*, unpublished, as cited by SKINNER, 2006). In 2007, 23.6% of South Africa's economically active population were unemployed and 15.2% were active in the informal sector (SSA, 2008).

Major reasons for this comparatively small size of the informal sector of South Africa may be certain obstacles that make it difficult for work seekers to enter the informal economy such as inadequate access to credit and infrastructure as well as an inadequate provision of necessary services. Moreover, the incomes generated by informally employed South Africans can be assumed to be significantly lower when compared to the formal economy of the country. This may be another reason (KINGDON and KNIGHT, 2004).

A comprehensive examination of South Africa's informal sector was carried out to a comparatively limited extent so far due to a deficient availability of data to researchers (MULLER, 2003). Data concerning enterprise owners, their households and the characteristics of their operations is greatly missing. Also, there is little information concerning the business environment in which they are active as well as their relationships with the state (SKINNER, 2006). Nevertheless, progress was made in recent years regarding the quality of information obtained on informality in South Africa (MULLER, 2003).

In South Africa, informality is present in urban as well as rural areas, in city centres as well as in peri-urban or suburban communities and in informal settlements (PEBERDY, 2000). According to the 1995 October Household Survey, 55.2 % of South Africans active in the informal sector worked in urban areas, whilst 44.8% worked in non-urban areas (MARTINS and ANELICH, 2000). Due to the given societal structure of South Africa, its' informal sector is greatly dominated by blacks (SIMON and BIRCH, 1992, DEVEY *et al.*, 2006). In 1998, SSA defined the informal sector of the country as follows: "The informal sector consists of those businesses which are unregistered. They are generally small in nature, and are seldom run from business premises, using instead homes, street pavements or other informal arrangements" (SSA, 1998).

ROGERSON (2000) classified the informal enterprises of South Africa into two categories. The first category is the "survivalist informal enterprise". It is carried out by people unable to

access regular wage employment or the economic sector of their choice. These enterprises usually generate a low or very low income. Little capital investment and almost no special skills are needed to start such an enterprise. The second category is the "micro enterprise" or "growth enterprise". These enterprises are usually very small and, in many cases, only the owner is involved into them. Usually, business licenses, formal premises, operating permits and accounting procedures are absent. In most cases, the capital base is limited and only rudimentary business skills are required. Nevertheless, many of these enterprises have the potential to develop into small but formal businesses (ROGERSON, 2000).
SKINNER (2006) conducted interviews with 507 informal enterprise owners within the Durban municipal area. This particular survey can be assumed to confirm that the informal sector of South Africa is absorbing the poor and retrenched, as in nearly every second case the enterprise owner has become unemployed before starting his current business. Moreover, the survey indicated a close correlation of poverty to informal employment in South Africa (SKINNER, 2006). However, MEAD and MORRISSON (1996) disagreed with this and pointed out that other studies could not identify any clear correlation between poverty and informal employment.

The survey conducted by SKINNER (2006) also indicated that, in the case of South Africa, the formal and informal economy seem to be strongly linked, as a large proportion of informal business operators stated that formal enterprises would be their major suppliers. These strong linkages were as well identified by DEVEY *et al.* (2006), who pointed out numerous forward and backward linkages between the formal and informal economy. Nevertheless, the forward linkages within the informal sector of South Africa seem to be less strong as the vast majority of informally operating persons apparently sells their products and services to private persons and households (SKINNER, 2006).
Apparently, in South Africa, most informal enterprises are rather established out of the need of individuals to conduct informal activites to sustain themselves than out of the need that new enterprises fill observed market demands (ROGERSON, 2000). The relative importance of the informal and formal economy of South Africa under consideration of open unemployment and ethnicity is displayed by Table 1.

Table 1: Formal and informal employment in South Africa in 1999

	Ethnicity by sector (%)	
	Black and coloured	White
Employee, formal sector	36.9	69.4
Employee, informal sector	9.6	2.4
Self-employed, formal	1.0	14.3
Self-employed, informal	7.0	5.4
Unemployed	45.5	8.5

Data from ALIBER (2003), modified.

The informal sector of South Africa comprises a vast variety of vending, productive, service and trade activities (PEBERDY, 2000). DEVEY *et al.* (2003) found that the informal sector of South Africa provides an extraordinary high level of employment in wholesale and retail. In particular, the informal sale of food, soft drinks, alcoholic beverages, fuel and light, cigarettes and tobacco, washing and cleaning items as well as personal care items is widespread (MARTINS and ANELICH, 2000).

In post-apartheid South Africa, a considerable international migration into the country has developed and a strong internationalization of the country's informal economy is currently taking place. As a consequence, a growing number of informal businesses is established by migrants from Asia, central and southern Africa and, increasingly, from West Africa (ROGERSON, 2000).

2.3.2 Street food vending in South Africa

"Street foods" can be defined as "foods and beverages prepared and/or sold by vendors (informal traders) in streets and other public places for immediate consumption or consumption at a later time without further processing or preparation" (WHO, 1996). The sale of food items on the street is commonly practiced in many countries of the developing world that are characterized by limited formal employment opportunities and rapid urbanization. In the developing world, street food vending is an important source of employment (DAWSON and CANET, 1991). More importantly, it is an important source of income for lowly educated people in these countries (UMOH and ODOBA, 1999) and for women in particular (UMOH and ODOBA, 1999, DAWSON and CANET, 1991).

In South Africa, the sale of ready-to-eat foods at locations such as public transport centres and "taxi ranks" (taxi stations) is widely common (MOSUPYE and VON HOLY, 2000). Currently, street food vending can be assumed to be the single largest employer in the informal sector of South Africa and is a major contributor to the economy of the country (VON HOLY and MAKHOANE, 2006). For 1999, it was estimated that South African private households spent ZAR 4,399.4 million (€ 676.54 million (OANDA, 2009)) on food purchased for consumption away from home (MARTINS and ANELICH, 2000).

There was only limited scientific data available concerning the microbiological quality and safety of foods sold in the streets of South Africa until the late 1990s, while such information was already generated in other third world countries, including other African states. During this time, street foods were generally regarded as unsafe and the sector as one that should be outlawed (VON HOLY and MAKHOANE, 2006). Indeed, the conditions under which street food vendors carry out their businesses in most cases appear to be not suitable for food preparation and sale (MOSUPYE and VON HOLY, 2000, MARTINS and ANELICH, 2000). Street food vendors often appear to be largely ignorant even in terms of basic food safety issues. Therefore, street vended foods are often subjected to dangerous abuses at virtually all stages of handling (EKANEM, 1998).

As Street food businesses are mostly carried out at places such as bus terminals, industrial sites and market places in order to exploit areas with numerous clienteles, street food vendors are often hardly able to meet all food safety requirements. The personal hygiene of operators is often deficient. Adequate shelters, running water, washing facilities as well as toilet facilities are not available in most cases (FAO & WHO, 2005b). In many cases, the same bucket or bowl of water is used for the washing of hands, utensils and dishes. Moreover, waste water as well as garbage may be discarded in the streets and therefore lead to the attraction of rodents and insects. Disinfection is carried out very seldomly (CARDINALE *et al.*, 2005).

Another constraint to the safety of South African street foods that is observed frequently is the inadequate protection of foods from dust and flies, which may carry foodborne pathogens. Time temperature abuses can be observed as well, for example in the form of the underroasting of meat products. Also, problems in maintaining adequate storage temperatures for already

prepared food items appear to be common (EKANEM, 1998). Utensils used are often of a nature that may result in food contamination, especially in form of the leaching of toxic heavy metals or simply because of unsanitary exposure to the environment (FAO & WHO, 2005b). Because it is likely that street food venders buy raw materials at lower prices, they also may, in some cases, use lower-grade materials (ABDOU, 2002).

Nevertheless, some studies revealed that food prepared on the streets can also be safe and, in such cases, provide sustainable alternative outlets for consumers (MARTINS and ANELICH, 2000, FAO & WHO, 2005b). For example, according to the results from one study carried out on South African street foods it was concluded that street foods traded in the city of Johannesburg are generally of acceptable quality and safety (VON HOLY and MOSUPYE, 1999). This study was probably one of the very first comprehensive scientific researches dedicated to the safety of street foods vended in South Africa (VON HOLY and MAKHOANE, 2006).

The study examined 51 food samples, 18 dish water samples and 18 swap samples taken from six street food vendors in three replications over a period of four months. The food samples were taken from fried steaks, beef stews, chicken stews, gravies and salads. For all samples, aerobic plate counts, *enterobacteriaceae* counts, spore counts and coliform counts were determined. The incidence of the foodborne pathogens *E. coli 0157:H7*, *B. cereus*, *C. perfringens*, *Campylobacter* spp., *L. Monocytogenes*, *Salmonella* spp., *Staphylococcus aureus*, *Vibrio* spp. and *Yersinia enterocolitica* was determined. *B. cereus* was found in 22% of the food samples and *C. perfringens* in 16%, but counts were less than 1 log CFU/g. They could only be detected after an enrichment. Therefore it can be assumed that they were present in the foods at low levels. Strains of *Salmonella* spp. and a non-*E. coli 0157:H*$^+$ were found in only one food sample each. Other foodborne pathogens were not detected in any sample. The bacterial counts in the food samples appeared to be lower than those reported by similar studies conducted in Zambia and Nigeria as well as in other countries outside of Africa (VON HOLY and MOSUPYE, 1999).

Nevertheless, It appears to be worrying that, due to a currently very strong rural-urban migration, thousands of entrepreneurs emerged who are providing self-manufactured basic meals prepared under pathetic conditions in rapidly growing squatter camps around South African cities. Greatly unsatisfactory hygienic conditions are prevailing in these locations. The street foods traded in these locations are therefore purchased beyond any form of guaranty and regulation (PARSONS, 1995).

However, VON HOLY and MAKHOANE (2006) pointed out that the safety of South African street foods can only be ensured sustainably if all stakeholders, including the street food vendors themselves, food control authorities and academic structures, are working together to improve the sector while being aware of their roles and responsibilities during this process. The availability of certain facilities such as toilets to street food vendors can be beneficiary to the hygiene of food preparation and a lack of such facilities is assumed to substantially affect the maintenance of hygiene standards in a negative way. It can also be expected that an adequate training and the provision of relevant information to street food vendors may improve the situation (EKANEM, 1998, MARTINS and ANELICH, 2000).

The contribution of street food vending to the national economy is increasingly recognized on the political level. Thirteen acts that are more or less suitable for the regulation of street foods were so far applied in South Africa such as the Health Act (Act 56 of 1974) with its' regulation 918 (MARTINS and ANELICH, 2000).

Many local authorities started to enforce food hygiene by law (MARTINS and ANELICH, 2000) and have undertaken initiatives for the improvement of the quality of street foods traded in their areas of jurisdiction, for example the Ethekwini Metropolitan Council, the Ehlanzeni District Municipality and the Johannesburg Metropolitan Council. Training courses in terms of basic food safety issues and basic facilities for the maintenace of food safety such as the access to running water were provided (VON HOLY and MAKHOANE, 2006).

2.4 Food safety

2.4.1 General aspects of food safety and the HACCP-system

Food safety can be defined as "all conditions and measures that are necessary during the production, processing, storage, distribution and preparation of food to ensure that, when ingested, it does not represent an appreciable risk to health" (MIYAGISHIMA *et al.*, 1995). It refers to potential hazards that are associated with foods and which can cause ill-health in humans (HENSON, 2003). Food safety clearly is a matter of public health and should attract the necessary attention in any public health programme. Furthermore, because food safety is of relevance for governments, industry and consumers to the same extent, any approach towards the assurance of food safety should be coordinated between them (MIYAGISHIMA *et al.*, 1995).

In terms of food safety, between privileged and unprivileged countries, the gap might not be as remarkable as in other areas, due to the fact that foodborne diseases are prevalent in both, rich societies and poor ones. Nevertheless, people in rich societies are generally suffering mild diseases as a consequence of hazardous lifestyles such as the preference for raw foods and an inadequate handling of foods, while poor communities often have to struggle with a strong prevalence of serious and life-threatening diseases such as infant diarrhoea, cholera, typhoid fever and fluke infection (KÄFERSTEIN and ABDUSALAM, 2002).
A food safety hazard can be defined as "a biological, chemical, or physical agent in or property of food that may have an adverse health effect". A food related risk is defined as "a function of the probability of an adverse effect and the magnitude of that effect, consequential to a hazard in food" (SCHLUNDT, 2002). The different food safety hazards are summarized by Table 2.
Microbiological hazards to food safety comprise pathogenic strains of bacteria, viruses, helminthes, protozoa and algae. Certain toxic products that are produced by them are raising concerns, too (ROONEY and WALL, 2003). Foodborne diseases that are caused by microbiological hazards in particular have become a major constraint to public health. Regarding this, strong increases in the incidence of diseases caused by microorganisms that are mainly transmitted by food such as *Salmonella* spp. and *Campylobacter* spp. were reported from many countries over the last decades. Moreover, new and serious hazards have been identified in the food chain, such as enterohaemorrhagic *E. coli* and bovine spongiform encephalopathy (WHO, 2002).
Chemical hazards can either be inorganic or organic (ROONEY and WALL, 2003). They comprise residues of pesticides in food of plant origin and antibiotic drugs in food of animal origin as well as heavy metals. Moreover, they include allergens or toxins possibly contained in genetically modified organisms (GMOs) (UNNEVEHR and HIRSCHHORN, 2000).

Microbiological and chemical food contamination remains a major reason of diseases, whereby, besides human suffering, enormous economic losses are occurring (FAO & WHO, 2005a). Finally, there are different physical hazards such as dirt and glass and other foreign matter that may enter food items (ROONEY and WALL, 2003).

Table 2: Food safety hazards

Microbiological hazards	Chemical hazards	Physical hazards
- Bacteria - Viruses - Helminths - Protozoa - Algae - Genetically modified organisms (GMOs) - Toxins produced by the above mentioned	- Pesticide residues - Fertilizer residues - Heavy metals - Veterinary drug residues - Residues from processing and packaging (e.g. nitrosamines) - Allergens, toxins (potentially in GMOs)	- Foreign matter (e.g. glass, dirt)

Based on ROONEY and WALL (2003), expanded.

Contaminants may enter the food accidentally during growth, cultivation or preparation or might accumulate during food storage, form in the food through the interaction of chemical components or may be concentrated from the natural components of the food. While microbiological foodborne disease often can be related directly to a pathogen that may be present in foods, this is rather difficult for chemical hazards (SCHLUNDT, 2002).

Epidemiological studies have revealed that, on a global level, the major reason for foodborne diseases is the occurrence of a time-temperature abuse during food preparation. This may result in the survival or growth or both of pathogens. Moreover, the development of toxins to ill-making levels can happen as a consequence of this. Mostly either the storage of prepared food at temperatures that favour the growth of pathogenic bacteria as well as the formation of toxins or an inadequate cooking or reheating of food before consumption lead to this time-temperature abuse (NOUT and MOTARJEMI, 1997).

Worldwide, food safety is consistently receiving more and more attention as a result of the increased recognition of the importance of links between food and health (UNNEVEHR, 2003). In all countries and regions of the world, food safety has become a fundamental public health issue (FAO & WHO, 2005a). In 1963, the Codex Alimentarius Commission was created by the FAO and WHO. Food standards, guidelines and related texts such as codes of practice should be developed under the Joint FAO/WHO Food Standards Programme. The protection of the health of consumers, the assurance of fair trade practices in the food trade and the promotion of coordination of all food standards work undertaken by international governmental and non-governmental organizations were defined as major objectives (CAC, 2009).

In regard to the growing demand from consumers all over the world for safe food, the World Organisation for Animal Health (OIE) interacts with relevant organisations to achieve the mitigation of foodborne risks to human health that can be associated with hazards arising from animal production. In 2002, the permanent "Working Group on Animal Production Food Safety" (APFSWG) was established for the coordination of all food safety activities carried out by OIE. The Working Group comprises of internationally recognized experts from the FAO, the WHO and the Codex Alimentarius Commission (OIE, 2009).

In most industrialized countries, well developed food safety models are ensuring a reasonable level of food quality and safety (LATHAM, 1997). However, most developing countries deserve

a strengthening of their food safety activities, particularly in the area of food legislation including food standards, to become able to face their responsibilities (OYEWOLE, 1997). Food safety models from developed countries largely failed, for example, in most sub-saharan African countries (OMORE *et al.*, 2001). In these countries, food safety is mainly left to the responsibility of consumers (SCHILLHORN VAN WEEN, 2005). There are inadequate food-safety systems as well as an unsatisfactory capacity for the detection and management of food safety problems (RANDOLPH *et al.*, 2007). They are outdated or implemented with inadequate sets of laws and tools (ABDOU, 2002). Poor countries lack of qualified staff as well as facilities to enforce sustainable food safety standards on their markets (LATHAM, 1997).

The assurance of food quality and safety can only be achieved through the implementation of quality-control systems throughout the entire food chain. One of the most effective options for the food sector to protect public health is to base food management programmes on so-called "HACCP systems". HACCP stands for "Hazard Analysis and Critical Control Point" (ROONEY and WALL, 2003).

The HACCP concept was developed in the 1960s as a system for the assurance of the safety of food products. HACCP can be defined as "a system which identifies, evaluates and controls hazards which are significant for food safety" (ICMR, 2000). HACCP systems are risk management programmes in the form of preventative approaches towards sustainable food safety (COLEMAN and MARKS, 1999). A key advantage of the HACCP system over conventional reactive approaches is the possibility to identify potential hazards and inadequate practices at an early stage of food processing (EHIRI *et al.*, 1995). Therefore, HACCP systems are essentially different to traditional approaches that rely chiefly on the sampling of end-products and their inspection (ABABOUCH, 2000). HACCP has seven principles. These principles are (FSIS, 1998):

- **Hazard analysis:** The determination of potential food safety hazards and identification of preventive measures to prevent, eliminate or reduce them to acceptable levels.
- **Identification of critical control points:** Critical control point are points, steps or procedures during food production, processing and preparation, at which control can be applied to prevent, eliminate or reduce a food safety hazard to an acceptable level.
- **Establishment of critical limits for each critical control point:** A critical limit is the maximum or minimum value to which the control of a physical, biological, or chemical hazard at a critical control point is necessary to prevent, eliminate, or reduce it to an acceptable level.
- **Establishment of critical control point monitoring requirements:** Monitoring activities are required to guarantee that the production, processing and preparation of food is under control at each critical control point.
- **Establishment of corrective actions:** These are actions that become necessary when a deviation from an established critical limit is identified. Any HACCP plan needs to identify the corrective actions that will be conducted if such deviations take place. This way it is intended to make sure that products that are potentially dangerous to health or that are adulterated otherwise as a result of the deviation will not enter commerce for human consumption.

- **Establishment of record keeping procedures:** Certain documents (such as the hazard analysis and written HACCP plan) and records to be able to document the monitoring of critical control points, critical limits, verification activities as well as the handling of processing deviations need to be maintained.
- **Establishment of procedures to verify that the HACCP system is working as intended:** Validation makes sure that all processes carried out are in compliance with the design of a plant or business in order to maintain its' ability to successfully ensure the production, processing and preparation of products safe for human consumption. Personal HACCP plans need to be validated. Verification makes sure that the HACCP plan applied is adequate and working as planned. Reviews of HACCP plans, Critical control point records, critical limits and microbiological sampling as well as analyses may be included into the process of verification. Microbiological testing is one of several verification activities (FSIS, 1998).

When reviewing its' seven principles, the HACCP system is a scientific, rational and systematic approach to identify, assess and control hazards that may occur during the production, processing, preparation or the use of food. This way, the consumption of unsafe food can be avoided for the sake of the health of consumers (MOTARJEMI *et al.*, 1996). The identification of critical control points of production, processing and preparation, as well as of parameters for these critical control points, guarantees product safety if maintained (COLEMAN and MARKS, 1999).

Multinational food producers are generally the fastest adopters of the HACCP system. While the degree of development as well as the degree of industrialization varies amongst developing countries, those countries which are comparatively important food exporters, such as Morocco (olives and fish), Uruguay (meat) and Malaysia (fish), generally have more advanced HACCP-based approaches to maintain the safety of food products destined for export (MOTARJEMI *et al.*, 1996). Nevertheless, in the food industries of most developing countries, the awareness of the necessity of HACCP systems is currently increasing (JIRATHANA, 1998).

However, to stay realistic, a systematic implementation of HACCP-based food safety approaches throughout developing countries cannot be expected to take place very soon (MOTARJEMI *et al.*, 1996). Different to industrialized countries, constraints and problems obstruct the development and application of HACCP in the developing world. In developing countries, there are often only few or even no local experts of HACCP. Foreigners need to be employed at considerable expenses, which can, in many cases, not or not fully be afforded by government bodies or by the local food processing industry. These overseas experts may only improve the situation substantially if they are able to make themselves aware of the specific problems of the countries in which they shell promote HACCP adoption. Also, many HACCP trainings held by these experts in developing countries appear to be chiefly of abstract character. They do not offer the possibility to trainees to sustainably learn about HACCP in practice, especially concerning their particular products and processes. Another problem in developing countries is the fact that, in many cases, inexperienced and under-qualified persons are chosen to take part in these HACCP-training courses (JIRATHANA, 1998).

An apparent brain-drain, whereby qualified personnel moves to other economies in order to obtain higher salaries surely further complicates the situation in many developing countries. Besides this, the insufficient skills of the English language of large parts of the populations of many developing countries also contributes to these problems, as the great majority of available foreign experts uses English and the majority of literature dedicated to HACCP is

only available in English language (JIRATHANA, 1998). However, this is not a problem in the case of South Africa in particular. In many developing countries underdeveloped logistic conditions are another major constraint to the implementation of HACCP systems (HENSON *et al.*, 2000).

2.4.2 Food safety issues in terms of game meat

The initial microbiological condition of game carcasses is assumed to vary greatly. Nevertheless, the available data on the microbiological quality of game animal carcasses soon after evisceration is greatly incomplete. The microbiological condition of game meat is predetermined by microorganisms, which each species is carrying on the hide, in the gastro-intestinal tract or in the muscle tissue itself. Other factors influencing the hygienic quality are the way the animal is killed and the dressing, butchering and storage conditions (GILL, 2007).

Nevertheless, the succession of events between killing game animals and selling game meat products to consumers is often unsatisfactory in regard to carcass and meat handling (FÉRON *et al.*, 1998). Although it can be assumed that deep tissues of healthy game animals are usually sterile, these may be contaminated if high numbers of bacteria enter the brain or blood stream of animals when they are killed. If carcasses are eviscerated several hours after the fatal shot only, a swelling of intestines may occur in the meantime due to the formation of gases. This increases the likeliness that intestines will be damaged during evisceration so that carcasses are contaminated by ingesta (GILL, 2007). Moreover, the time difference between the cooling and the cutting of carcasses needs to be considered to be of high food safety relevance because this is the period during which the product is most susceptible to microbiological growth and spoilage (FIELD, 2004).

Inadequate harvesting procedures such as inaccurate shots, the generation of excessive stress for the animal as well as inadequate cooling and exsanguination may result in inferior meat quality (HOFFMAN *et al*., 2004). The fact that the skinning and butchering may only be carried out up to several days later and in a more or less distant location may be problematic as well (GILL, 2007). In game meat, bacterial counts are higher than they are in the meat of domestic livestock, particularly if it was aged. This is why storage times at refrigerator temperatures should be limited. If game animals were harvested in hot weather or if gun shot wounds are extensive, game meat should not be aged. Under such conditions, a strong microbiological growth will be facilitated. Moreover, no aging should be carried out if an animal was excessively stressed prior to the fatal shot (FIELD, 2004). Furthermore, in game meat, certain amounts of lead may be contained in the form of fine metallic residues of the ammunition used (HALDIMANN *et al.*, 2002, IQBAL *et al.*, 2009), although contaminated tissue is usually removed (GILL, 2007).

Reviewing this, in certain cases, food safety rules and standards are virtually or completely absent in the processing and marketing of game meat products and the quality of products traded on the markets is varying widely (NTIAMOA-BAIDU, 1997) Although this cannot be said for commercial game harvests in general, food safety rules, standards and regulations are not always adhered by biltong hunters in terms of the production of game meat products destined for the general public (RAMRAJH, 2009, personal communication).

The South African game industry is a free market that can be accessed by both, individual game ranchers and game meat producers. Domestically, the market currently does not have

standardized quality regulations (HOFFMAN *et al.*, 2004) and no quality grading system for game meat that is sold within South Africa has been implemented so far. Under such conditions, the sale of game meat of inferior quality (e.g. DFD-meat) is possible for any individual game meat trader (HOFFMAN *et al.*, 2005a).
In terms of diseases, food safety concerns were raised for game meat products, too (FIELD, 2004). However, the extent to which the presence of foodborne pathogenic bacteria can be associated with game meat remains unclear (GILL, 2007). The incidence of meat-related illnesses associated with game meat products are not more common than cases associated with domestic meat (FIELD, 2004).
The contamination of game meat with *Salmonella spp.* is assumed to be rather uncommon, whilst a contamination with generic *E. coli* is assumed to occur more often. However, concerning this, further research is needed (GILL, 2007). Amongst parasitic diseases associated with game, trichinosis may be best known (FIELD, 2004). *Trichinella zimbabwensis* is highly prevalent (38.5%) in wild nile crocodiles in South Africa (LA GRANGE *et al.*, 2009). However, trichinosis is greatly limited to carnivorous game (MCCRINDLE, 2009, personal communication). Nevertheless, there are other diseases associated with South African game animals. However, not all of them are of relevance in terms of public health. Anthrax, Foot-and-mouth Disease, Rinderpest, Rift Valley Fever, East Coast Fever and Corridor Disease can be called the economically most relevant diseases, which affect game (SKINNER, 1970).
Also tick infestation can be assumed to be one of the major problems prevailing in game ranching. Different blood parasites can be transmitted by ticks and must therefore be regarded as the cause of diseases or even death in various game animal species (SCHRODER *et al.*, 2006).
Tuberculosis embodies a risk to human health. Although the presence of bovine tuberculosis in kudu and some small ungulates was already assumed in 1929, the presence of the disease in South African game was only recognized in the 1980s and early 1990s when infected buffaloes were identified in different regions of the country. Soon after the recognition of infected buffaloes, the spill over of the disease to other species (e.g. lion and kudu) was documented (MICHEL *et al.*, 2006).

2.4.3 Food safety authorities in South Africa

Different to first world countries, in South Africa, the implementation of food safety standards such as HACCP and systems of documentation to prove the compliance to the requirements set by the relevant acts is not mandatory but voluntary in all sectors of the national economy. Concerning this, the ground nut industry, that was regulated recently, is the only exception (JACKSON, 2009). Nevertheless, South African companies that export food often need to implement HACCP together with all its' prerequisite-programme so that they are allowed to export their produce. When implemented, these HACCP-systems are then controlled by accredited HACCP auditors, as often as necessary (ANELICH, 2002).
In 1994, South Africa became a member of the Codex Alimentarius Commission. Because South Africa has ratified the agreements of the World Trade Organization (WTO), it is obliged to harmonize its' national food standards with the Codex' standards, guidelines and recommendations.

Also, South Africa needs to comply to the WTO's agreement on sanitary and phytosanitary measures (SPS), which aims to ensure that the measures applied by a country to maintain human, animal and plant health are based on science and the application of risk assessment (ANELICH, 2002).
South Africa's National Codex Committee comprises of the food safety related sections of the Department of Health and of sections of the Department of Agriculture dealing with plant and animal quality and health. Additionally, the National Codex Committee includes the Department of Foreign Affairs and the South African Bureau of Standards (SABS), which is in charge of canned meat products containing more than 10% meat and all fish as well as fish products (ANELICH, 2002).
In South Africa, food control authorities develop their own national food safety hygiene standards, guidelines and related texts. The development or modification of standards may either be directly initiated by the food control authorities or by stakeholders of the food industry. International trends can be assumed to influence these decisions, too. Additionally, a few years ago, a voluntary group called FLAG (Food Legislation Advisory Group) was founded in South Africa. The group consists of government representatives and representatives from the food industry, research councils, consumer groups and academia. FLAG aims to assist the government in the effort to incorporate as much science and experiences as possible into the development of food safety standards and related texts (ANELICH, 2002).
The Directorate for Food Control of the National Department of Health is directly in charge of all matters associated with food safety at national level. The provincial food health control is the executive responsibility of the nine provincial health authorities. After the public health sector was restructured following the elections in 1994, the executive responsibility of health food control as a component of a comprehensive environmental health service was allocated to them (MARTINS and ANELICH, 2000).
The coordination of food control amongst the nine provincial components and the Directorate is realized through the Interprovincial Port Health Committee and the National Environmental Health Forum, which are coming together twice a year. The responsibility for health promotion services, intersectoral collaboration, community participation and for the rendering of environmental health services to communities is given to District health systems. These include local authorities (MARTINS and ANELICH, 2000).
The responsibility of consumer protection in South Africa is given to both, the Department of Health and the Department of Agriculture (JACKSON, 2009). Together, these two departments administer 14 different Acts that are related to food issues. Some parastatals such as the SABS are also involved (ANELICH, 2002). The Department of Agriculture has to ensure good agricultural practices, control the country's abattoirs and to develop as well as to enforce food quality standards. Moreover, it has the responsibility for certain labelling standards as well as for certain imports and exports. Furthermore, the responsibility for the registration of GMOs and for agricultural remedies is held by the Department of Agriculture. The national SPS enquiry point is another responsibility of this department. Additionally, the Department of Agriculture is authorized to conduct inspections of perishable products that shall be exported from South Africa (FAO & WHO, 2006).
The Department of Health operates on national, provincial and local level. Generally, it is in charge of the development of food safety and nutrition standards and different food hygiene issues excluding abattoirs. Also, certain aspects of food labelling, the quality of certain products as well as certain imports activities are the responsibility of the Department of Health.

Basically, the national Department of Health shall coordinate food control activities within the country, whilst the provincial departments do this on provincial level. Whilst the national Department of Health develops policy and legislation, the provincial departments shall develop provincial norms and standards. The provincial departments of Health are supported by the national Department of Health together with which they are monitoring the local authorities within the provinces. The local authorities shall enforce legislation, conduct health promotion activities and investigate complaints. Moreover, they shall identify and control health hazards and they are in charge of compliance monitoring and intersectoral collaboration (FAO & WHO, 2006). As a third authority besides the Departments for Agriculture and Health, the responsibility of enforcing compulsory standards for frozen seafood as well as canned meat and fish products is given to the National Compulsory Specifications Regulator (JACKSON, 2009).

Two acts are in place to regulate food handling, food composition and food labelling. These are the recently amended Foodstuffs, Cosmetics and Disinfectants Act, Act 54 of 1972, and Regulation 918 of the Health Act, Act 56 of 1974. Additionally, the Department of Agriculture has issued laws in order to control agricultural products such as the Meat Safety Act of 2000 and laws for the regulation of which kinds of pesticides and veterinary products can be applied in agricultural production. The Meat Safety Act (No. 40 of 2000) was promulgated in November 2000 to replace the Abattoir Hygiene Act (No. 121 of 1992) (JACKSON, 2009).

Regulation 918 of the Health Act is defining in which way a food handling facility should be managed in respect of hygiene, pest control, access to water and training of the personnel in charge of food handling. In regard to Regulation 918, owners of such facilities need to apply for a certificate of acceptability which should be prominently displayed. The certificate shows that the establishment was inspected by the local environmental health practioner and that it is in compliance with the conditions demanded by the regulation. However, this certificate of acceptability is only issued once without expiring before a facility moves or is sold, what is a loophole in terms of food safety maintenance and regulation. Regulation 918 is applying to all retail stores, restaurants, hotels and street food vendors (JACKSON, 2009). However, Regulation 918 rather governs general hygiene requirements for facilities of the food sector as well as the transport of food than the introduction of HACCP principles by entrepreneurs operating in the sector (FULLER, 2007).

Although food products should be monitored in order to assure their compliance with the regulations under the Foodstuffs Cosmetics and Disinfectants Act, the laboratories responsible for the testing of food products continue to be shared with the Forensics Department. This means that they are not under the direct control of the Directorate of Food control and, often, food samples decline to be tested so that the regulations turn out to be enforced inadequately. In the face of this, there is a great need for additional testing facilities. Nevertheless, the South African food industry has become aware of different weaknesses prevailing in the national food safety control system as it widely has adopted approaches of self-regulation: According to many formal retailers, their suppliers are submitted to checks in terms of food safety issues (JACKSON, 2009).

Eventually, it must be said that the South African food control system needs to be called inefficient. This was already concluded in 1996. Generally, the strong fragmentation of the system that results in a lack of communication and the duplication of efforts can be called the primary underlying reason for the system's inefficiency.

A coordinated voice or body in terms of food control issues keeps on missing and multiple jurisdictions as well as an outdated and overlapping legislation apparently hampers an effective regulation of food control in South Africa (FAO & WHO, 2006). Furthermore, there is an overlap of functions between the Department of Health and the Department of Agriculture. This results in a wastage of resources available and needed for the maintenance of an efficient food control (ANELICH, 2002).
The enforcement of the legislation is carried out beyond any coordination and both, a national monitoring programme as well as a national database are non-existent (FAO & WHO, 2006). "Multiple decision making" is another problem prevailing within the food control system of South Africa. Although the South African food control authorities are in the process of harmonizing the country's legislation with the standards of the Codex Alimentarius Commission, in some areas, these standards remain totally absent (ANELICH, 2002).
By today, the Department of Agriculture was restructured as a first step towards the establishment of one single integrated food control system and to solve problems of fragmentation and inadequate coordination. The South African Food and Quarantine Inspection Services have come to life along with the creation of three new directorates: Animal health, plant health and food safety quality assurance. Also, the national legislation of South Africa currently is on the way to create a framework that is supportive for the realization of the compulsory adoption of the HACCP-system in the different areas of the food sector (FAO & WHO, 2006). Draft regulations for the implementation of HACCP were already prepared and they are now awaiting approval. According to these draft regulations, the HACCP-implementation shall be mandatory but will be enforced over a certain transition time only. This transition time will differ from one area of the food sector to the next (ANELICH, 2002).

2.4.4 Current food safety regulations for South African game meat

The Meat Safety Act, which was promulgated in 2000, includes game under the definition of "animal". All game meat that is destined for paying guests has to be processed through a registered abattoir that has a meat inspection service (KZN AEA, 2005). However, biltong hunters cannot be assumed to consistently adhere to this, as they may sell game meat directly to licensed butcheries and supermarkets. Therefore, in practice, this regulation predominantly applies to the commercial production of game meat for export (RAMRAJH, 2009, personal communication).
The owner of any game abattoir is required to employ qualified meat inspection personnel. A game abattoir can, according to the Meat Safety Act, only be set up if the following requirements are fulfilled (KZN AEA, 2005):

- A filled-in application for registration.
- Letters of no objection from the Department of Water Affairs and the Department of Health.
- Construction plans.
- Application for the approval by the Department of Environmental Affairs.
- The area within the abattoir fence needs to be rezoned as food handling premises by traditional and local government affairs.
- The area around the abattoir must be free of dust and mud (e.g. grass, cement, gravel).

- Offloading- and dispatch areas must be cemented, drained and curbed.
- Inside the premises, there must be adequate lighting and ventilation.
- All abattoir workers must be certified to be fit to handle an edible product by a medical practioner.
- All abattoir workers need to be supplied with protective clothing including overall, plastic apron, gumboots and hard hat.
- All animals slaughtered at the abattoir must be inspected by a qualified person authorized by the Office for Veterinary Public Health.
- Inspected carcasses must be marked with a "pass" stamp if fit for animal/human consumption (KZN AEA, 2005).

Only in the case of slaughter exclusively for own consumption all this is not required. If otherwise, it has become an offense to slaughter game animals in any place other than at a registered game abattoir for which there is a valid certificate of registration. If encountered, all game meat products that do not comply with the requirements of the Meat Safety Act will be confiscated and destroyed under control. Additionally, identified perpetrators are facing legal actions. In regard to commercial game harvests for the production of game meat destined for export, the following needs to be provided when approaching the Office for Veterinary Health to conduct such a game harvest (KZN AEA, 2005):

- Registration certificate of the farm where the harvest will take place.
- Registration certificates of the hunters who will conduct the harvest.
- Licenses of the hunters.
- Medical certificates of the whole hunting team.
- Written document regarding the planned harvest including the following:

    1.) Dates and times of the harvest.
    2.) Farms and directions to them.
    3.) Type and number of animals to be harvested.
    4.) Number of vehicles used.
    5.) Procedure from shooting to loading of carcasses into the chiller trucks.
    6.) Number of chiller trucks available (KZN AEA, 2005).

No mixing of warm and chilled carcasses is allowed. It needs to be assured that the carcasses will reach a core temperature below 7°C within 24 hours. As mentioned in Chapter 2.2.3, the carcasses need to reach the export abattoir within 72 hours. According to the Office for Veterinary Public Health, a meeting prior to the authorization of any proposed game harvest will only be arranged if all needed documentation is provided. In this meeting, all the partners involved should be present in order to make sure that everybody knows what is expected from him (KZN AEA, 2005).

2.5 Participatory approaches in developmental research projects

Participatory approaches are increasingly recommended as efficient tools when targeting sustainable development (VAN DEN HOVE, 2006). Today it is widely accepted that top-down, input oriented approaches rarely meet the needs of people living in particular areas (KROLL and KRUGER, 1998).

Rushed as well as unself-critical development projects can be assumed to lack the necessary time and sensitivity to get far beyond formal mutual misunderstanding (CHAMBERS, 1994). Previous studies dealing with food safety indicated that participatory approaches are very helpful in overcoming problems of information collection in the case of research issues that are constrained by problems such as data scarcity, an insufficient building of stakeholder ownership and difficulties in ensuring a sustainable risk management. If risks are assessed, managed and communicated in a way that is appropriate to the preconditions in developing countries, substantial capacities in food safety management may be built and evidences of impact may be provided. "Farm to fork approaches" are promising when it is aimed to determine, where risks can be managed most sufficiently (ILRI, 2007).

As change is connected to perceptions, it is only achievable by listening to people and by observing a situation objectively. Therefore all interactions and, both, intrinsic and extrinsic variables of a particular system should be identified, analyzed and evaluated in a participatory way. Similar to an ecosystem, intrinsic factors are affected and influenced by extrinsic factors. Intrinsic factors of a system may be people, food and foodborne diseases. Extrinsic factors may be environmental, socio-economic and socio-political factors. The interdependency between all these variables in any system can only be determined if the evaluation is holistic. People capital and the access to resources but also all constraints should be included (MCCRINDLE, 2003).

Today it is widely recognized that local people in many cases are able to map, model, observe, quantify, estimate, compare, rank, score and diagram. Often, they are capable to generate and analyze information far beyond professional expectations. They are able to analyze and present problems, desires, knowledge and preferences (CHAMBERS, 1994).

Already in the early 1970s, it was realized that development professionals focusing on developing countries had to cope with the failure of formal data collection methods applied for the recovery of cost-effective and reliable data. As a consequence, the "Rapid Rural Appraisal" (RRA) was developed in the 1980s. It aimed to merge the knowledge and skills of target communities with scientific knowledge in developmental projects (CATLEY and MOHAMMED, 1996). Retrospectively, the development of the RRA can be regarded as a response to biased perceptions derived during developmental projects when methods such as the brief rural visit by urban-based professionals were common (CHAMBERS, 1994).

The "Participatory Rural Appraisal" (PRA) was developed as an advancement of the RRA. It relies even stronger on the participation of potential beneficiaries from developmental projects (CATLEY and MOHAMMED, 1996) and was developed in the early 1990s. Since then, it consistently gained importance. The PRA is an approach to allow local people to express, enhance, share and analyze their knowledge in regard of their living conditions as well as to actively plan and act (CHAMBERS, 1994).

Non-governmental organizations significantly contributed to innovations made in regard to PRAs. Nevertheless, government agencies are increasingly adopting as well as adapting PRA approaches and methods. Both, RRAs and PRAs need practitioners and facilitators to follow

basic principles in order to be effective. Some of these principles are valid for RRAs and PRAs, whilst some additional ones are emphasized in PRAs only. Common principles of the RRA and PRA are (CHAMBERS, 1994):

- **Reversal learning:** The direct learning from local people in the study area and the face-to-face gaining of insight into the physical, technical and social knowledge of people.
- **Rapid and progressive learning:** The conscious exploration and the flexible utilization of methods, opportunism, improvisation, iteration and cross-checking by not strictly following a planned programme but being adaptable during the learning process.
- **Offsetting of biases:** Learning about the concerns and priorities of local people by acting relaxed instead of rushing, listening instead of lecturing, probing instead of moving on to the next topic, acting unimposing instead of important and by seeking out poorer people and women in particular.
- **Optimization of tradeoffs:** Relation of the costs of learning to the usefulness of information generated under the consideration of tradeoffs between quantity, relevance, acuracy and topicality.
- **Triangulating:** Cross-checking, progressive learning and approximation through plural investigation by evaluating and comparing findings from several (but often three) methods in terms of types of items or sets of conditions, points in a range or distribution, individuals or groups of interest, places, times, disciplines, investigators or questioners and combinations of these.
- **Seeking diversity:** The look for and the learning from exceptions, singularities, deviators and outliers in any distribution. The purposatively sampling in a nonstatistical manner may be involved in the process of seeking diversity. This goes beyond triangulation as it is deliberately looked out for contradictions, anomalies and differences, notices and investigates these and includes negative case analysis (CHAMBERS, 1994).

The PRA gives more attention to the offsetting of biases and on the necessary changes in outsiders' behavior when compared to the RRA. Although having much in common with the RRA, the PRA clearly differ from the RRA in terms of the ownership of information as well as the nature of the process. Information generated during an RRA is more triggered and extracted by outsiders during a process of information collection. They determine the agenda, obtain and take possession of information (CHAMBERS, 1994).
Differently, during a PRA, outsiders act rather passive when it comes to the collection of information. They rather watch, listen and learn. The generation of information much more involves local people, who generate, analyze, own and share it as part of a process of their empowerment. In PRAs, local people are allowed and encouraged to dominate, to determine much of the agenda as well as to collect, to express and to analyze information. Outsiders are facilitators, learners and consultants (CHAMBERS, 1994).
In the scope of a PRA, more developed and verified methods comprise participatory mapping and modeling, transect walks, matrix scoring, well-being grouping and ranking. The compilation of seasonal calendars, institutional diagramming, the analysis of trends and

chances as well as analytical diagramming is usually all carried out by local people. Compared to the RRA, principles additonally incorporated in PRAs are (CHAMBERS, 1994):

- **They do it:** The facilitation of self-consistent investigation, analysis, presentation and learning by local people in order to enable them to generate and own the outcomes and to learn from them. In many cases, a process is initiated by the facilitator and a subsequent interruption of this process is avoided.
- **Self-critical awareness:** The continuous and self-critical examination of own behaviour by incorporating errors and by welcoming errors as an opportunity to learn. Failure must be faced in a positive manner as "failing forward" and dominant behaviour must be corrected.
- **Personal responsibilty:** Taking personal responsibility for all actions taken rather than depending on the authority of manuals or on an inflexible set of rules.
- **Sharing:** The sharing of information and ideas with local people, between them and with different practitioners to encourage photocopying and non-attribution. Field camps, training and experiences must be shared between different organizations, countries and regions (CHAMBERS, 1994).

Rewieving this, the common principles of the RRA and PRA are greatly epistemological, whilst the ones exclusively incorporated in the PRA are mainly personal and focus on the behaviour of outsiders and their roles and attitudes. In many cases, PRA practitioners are surprised what happens in the first place as they experience a sense of personal discovery of the unexpected. Indeed, some facilitators of PRA are cheerful about this sense of liberation and discovery that is facilitated by such participatory research methods. The validiy of such approaches is underlying in the closeness of the reality of findings, whilst their reliability is determined by the constancy of findings obtained (CHAMBERS, 1994).

2.6 Risk assessment in participatory research

Risk assessment can be defined as "the process of accessing the possible adverse health effects in humans resulting from exposure to substances or other potential hazards" (DESHPANDE, 2002). In the context of food safety, risk assessment is a structured and science-based process to determine the risk associated with any type of biological, chemical or physical hazard in food. The overall objective is the provision of estimates on the probability of disease occurrence through the characterization of the nature and likelihood of harm when humans are exposed to food safety relevant agents in food. Typically, this comprises qualitative as well as quantitative information and brings along a certain degree of scientific uncertainty (WHO, 2009).

The risk assessment process has four major steps, namely hazard identification, hazard characterization, exposure assessment and risk characterization (SCHLUNDT, 1999, WHO, 2009). Hazard identification is the collection, organization and evaluation of all information available on a pathogen or a nutrient. Hazard characterization involves the determination of the relationship between a pathogen and any adverse effects. Exposure assessment is conducted in order to determine how much of a pathogen might be ingested in a serving of food. Risk characterization is conducted to evaluate the risk and related information (WHO, 2009).

Risk assessment is a component of risk analysis that is increasingly accepted throughout the world as a very important component of national food control programmes (ROONEY and WALL, 2003). It consistently gained importance as a structured model to improve food control in order improve food safety, to reduce the incidence of foodborne illnesses and to facilitate the domestic and international trade of food (FAO & WHO, 2004).

Risk assessment should be the starting point of any risk analysis (SCHLUNDT, 1999). It is the science-based component of risk analysis (FAO & WHO, 2004). Risk assessment is an iterative process. Goals are targeted and achieved by multidisciplinary teams. Within the risk analysis framework, certain principles need to be followed in order to identify and select risks by using a decision-tree based approach (ABUL GOUTONDJI, 2007).

As a first step in risk assessment, risk contexts need to be established. In the next step, the risks have to be accessed (AG, 2005). Risk assessments should be simple and the process must be transparent and undergo regular peer reviews by government and non-government experts. It should be comprehensive and accessible to the public. Resources needed for risk assessment must be identified and realistic time frames must be established prior to the conduction of the process. The successful conduction of risk assessment is entirely based on an open exchange of information and ideas within and amongst the team involved in the risk analysis framework (ABUL GOUTONDJI, 2009).

The structured information provided by risk assessment makes it possible to identify possible interventions that may result in the improvement of public health and to weigh options against each other. Such options can be regulatory actions or different voluntary activities and educational initiatives. Moreover, risk assessment can be applied to identify data gaps and to determine what research activity may bring along the greatest value in terms of the impact on public health. Risk assessment can also be applied by the food industry when more effective HACCP plans need to be developed. In international trade, risk assessments are of importance, too. They assure that countries establish food safety requirements that are scientifically sound and provide a means for the determination of equivalent levels of public health protection between countries. Otherwise, countries may set requirements that are inadequately connected to food safety so that artificial obstacles to trade may be created (WHO, 2009).

During the 22nd Session of the Codex Alimentarius Commission in 1997, the setting up of a joint FAO/WHO expert group to conduct risk assessment on microbiological hazards was suggested. In 1998, the Codex Executive Committee strongly expressed its' emphasis on the necessity for the immediate establishment of a scientific advisory body on microbiological aspects of food safety and on microbiological risk assessments in particular. In 2000, the World Health Organization (WHO), adopted a resolution that called for the recognition of food safety as an essential component of public health by its' member states. Moreover, it called for the development of systems that would facilitate the reduction of the burden of foodborne disease and for the establishment of an expert advisory body on microbiological risk assessment in particular (WHO, 2009).

By recognizing the importance of risk assessment as a science-based approach to fair trade, the WTO requires each member country's food safety measures to be based on it. In addition, WTO members need to carry out science-based risk assessments when limits for health risks in foods shall be determined as this was settled in the SPS agreement (WHO, 2009)

Currently, the Codex Alimentarius Commission, which establishes international food safety standards, is developing principles for the use of risk assessment in establishing such standards. The JEMRA (Joint Expert Meeting on Microbiological Risk Assessment) was established by

the FAO and WHO to facilitate the provision of expert advice on microbiological food safety risk assessment. Currently, the JEMRA is reviewing and interpreting existing microbiological risk assessments on a number of pathogen/commodity combinations identified. Furthermore, the likeliness of beneficial impacts on food safety is evaluated for different risk management options (WHO, 2009).

Historically, concerns in regard to toxic chemicals in food led to the development of risk assessment as a tool for food safety maintenance. Therefore, its' application to microbiological pathogens brings along certain difficulties. Different to chemical, environmental, or toxicological contaminants, bacteria may multiply as conditions change during the movement of food from the farm to the table. Nevertheless, progress was made in the development of predictive models and other tools to meet the technical requirements for quantifying estimates of risk. Moreover, a limited availability of relevant data obstructs the achievement of the precision necessary for quantitative risk assessments. For example, the accurate estimation of the relationship between the quantity of a biological agent and the frequency and magnitude of adverse effects to human health is obstructed by a limited availability of data. The information available on exposure assessment is limited as well (WHO, 2009).

In microbiological risk assessment in particular, mathematical models are applied for the description of the introduction of pathogens into food, their replication in food over time, their destruction by heat treatment and their consumption with food in regard to subsequent illnesses. The variability and uncertainty in these values can be described by probability distributions. These are mathematical representations of the relative likeliness that a random variable will take on a specific value (WHO, 2009).

Amongst different approaches of risk assessment, participatory risk assessment allows the involvement and the empowerment of participants as well as to rapidly generate reasonable and valid data (GRACE *et al*., 2008b). Participatory risk assessment is an approach that is applied to gain insights into how risks are generated and how they are reducible and it can be applied in virtually any context and within any specific sector. Participatory risk assessment was developed over the last three decades to developmentally engage communities using highly participatory methodologies. Nevertheless, it is not justified to integrate personal opinions in a participatory risk assessment process, neither ethically nor scientifically (HOLLOWAY *et al.*, 2008).

Participatory risk assessment emphasizes a bottom-up approach and aims to empower communities by giving them the opportunity to actively participate in the definition of problems, the finding of solutions, the implementation of activities and the evaluation of results obtained from interventions. Participatory risk assessment is a useful tool to better understand the underlying reasons for prerequisites and practices identified amongst respondents (HOLLOWAY *et al.*, 2008).

Appropriate risk management strategies can be identified and promoted, especially if the active involvement of the relevant local and provincial departments is given. If well conducted, participatory risk assessment is very effective in building a shared understanding of local risks and possible ways to mitigate them. Moreover, the cooperation and trust amongst the participants can be strengthened, whilst this appears to be just as important as the generation of reliable results. This strengthening of cooperation and trust is especially important in areas and settlements where the participants do not know each other well or where the cooperation with local officials can be regarded as limited (HOLLOWAY *et al.*, 2008).

3 MATERIALS AND METHODS

3.1 Conceptual framework

The study focused on the formal and informal marketing of game meat products within South Africa. South Africans who hunt game animals on a private basis and for sport and recreation, known locally as "biltong hunters", and commercial game harvesters were included as key stakeholders of the South African game industry. Informal meat traders and indigenous tribes were included as potential stakeholders and end-users of benefits from the game industry in the form of meat or edible by-products of either no or a limited marketability to biltong hunters and commercial game harvesters. The role-players in the game meat marketing chain are the State Veterinary Services and officials and inspectors from the Department of Health. Their role in the control and monitoring of the domestic game meat marketing chain is currently not legislated.

Conceptually, the study was based on two different marketing chains. For simplification, these marketing chains will be called "Marketing Chain I" and "Marketing Chain II". One experiment for "Marketing Chain I" and two observational studies ("Observational Study I and II") for "Marketing Chain II" were conducted to complement the two marketing chains of interest.

"Marketing Chain I" describes the informal trade of meat products in informal markets as a potential domestic marketing chain for South African game meat products. Informal meat traders are usually patronised by low income workers and village inhabitants, near bus, train and taxi stations (end-users). Particulary for poor households, the informal trade is an important source of affordable food. A survey was conducted with n = 51 informal meat traders using structured interview techniques, combined with observations using a structured observation sheet and photographs. Additionally, n = 25 meat samples (seven raw and 18 prepared ones) were collected for microbiological analysis from n = 21 purposively selected respondents. These were interviewed for a second time using a short structured questionnaire. The information generated for "Marketing Chain I" was used to construct a flow chart. This was done to evaluate whether game meat products could be utilized through this existing informal marketing chain for red meat and poultry.

Once the variables were established the hypothesis was tested in an experiment. Game meat was supplied to informal meat traders to see if they could process it by cooking so that there would be a minimal food safety risk to consumers. Eight raw and n = 8 cooked meat samples were collected for microbiological analysis and a structured observation sheet was applied for the documentation of prerequisites and practices. A short structured group interview was conducted and photographs were taken.

"Marketing Chain II" describes "biltong hunting". It is an established domestic formal marketing chain for game meat products that are marketed through supermarkets and butcheries. An opinion survey was conducted with n = 9 of these biltong hunters using structured interview techniques to estimate the type of hunting and marketing done. A commercial game harvest for the production of export meat was attended to investigate and draw a flow chart of both, biltong hunting and this even more formal game meat marketing chain (Observational Study I). A structured observation sheet was applied. Moreover, the time difference between fatal shot and throat cut for exsanguination as well as between throat cut

and evisceration was recorded for seven animals shot during the game harvest. The data generated was triangulated by informal interviews with stakeholders (seven professional hunters involved in the game harvesting) and role-players (two senior state veterinarians and a local animal health technician).

In addition a clan of Ovahimba was visited and a group interview was conducted using a structured questionnaire, in combination with a structured observation sheet and photographs, to evaluate the possibility of supplying indigenous rural tribes with affordable, edible game meat by-products from commercial game harvests for a more efficient utilization of game resources and to improve food security (Observational Study II).

The identification of hazards and the participatory assessment of risks to food safety and product quality that potentially prevail within and between the two Marketing Chains was the major objective of the study. Thus, prerequisites and hygiene practices during meat product handling were of interest. For each category, potential hazards and risks to food safety and product quality were identified and assessed.

In regard to edible by-products, currently non-existent product flows between stakeholders and potential end-users were documented and evaluated in terms of their potentials and limitations. All steps of participatory risk assmessment were conducted excepting exposure assessment, which was not practicable (see Chapter “Discussion”).

Critical control points to minimize or eliminate hazards and risks to food safety and product quality were identified and documented using a flow chart. Mainly microbiological (microbiological contamination and multiplication) hazards were considered and the risk of occurrence was qualitatively estimated for each hazard at each stage of the marketing chains. Ways to to facilitate improved access to edible by-products from game hunts and harvests for informal meat traders and indigenous tribes of the region were suggested.

The conceptual framework of the study is summarized by Table 3. The research work was carried out in cooperation with the Department of Paraclinical Sciences of the University of Pretoria in South Africa between March, 23rd, 2009 and June, 20th, 2009.

Table 3: Conceptual framework

<table>
<tr><td rowspan="6">Objectives of the study</td><td colspan="3">Identification of potential hazards and participatory assessment of risks to food safety and product quality for stakeholders and end-users.</td></tr>
<tr><td colspan="3">Documentation and evaluation of prerequisites and practices of product handling, opinions and perceptions for stakeholders and end-users.</td></tr>
<tr><td colspan="3">Identification and evaluation of linkages and interactions between the formal and informal marketing chains, stakeholders and end-users.</td></tr>
<tr><td colspan="3">Documentation and evaluation of the flow of game meat and by-products between different stakeholders and end-users, with a special focus on potential hazards and risks to food safety and product quality.</td></tr>
<tr><td colspan="3">Identification and evaluation of ways to improve the efficiency of the utilization of game meat by-products.</td></tr>
<tr><td colspan="3">Provision of intervention points for the elimination or minimization of identified hazards and risks and for a more efficient utilization of edible game meat by-products.</td></tr>
<tr><td>Method</td><td colspan="3">Participatory risk assessment
(hazard identification, hazard characterization, risk characterization)</td></tr>
<tr><td>Focus</td><td colspan="2">Marketing Chain I</td><td>Marketing Chain II</td></tr>
<tr><td>Research area</td><td colspan="2">KwaZulu-Natal</td><td>KwaZulu-Natal, Gauteng, Northern Cape</td></tr>
<tr><td rowspan="5">Characteristics</td><td colspan="2">Informal</td><td>Formal to semi-formal</td></tr>
<tr><td colspan="2">Legal</td><td>Legal</td></tr>
<tr><td colspan="2">Limited regulation</td><td>Regulated to semi-regulated</td></tr>
<tr><td colspan="2">Local trade</td><td>Regional and local trade</td></tr>
<tr><td colspan="2">Semi-commercial and subsistence</td><td>Commercial and semi-commercial</td></tr>
<tr><td>Sample size(s)</td><td colspan="2">N = 51 informal meat traders,
n = 21 informal meat traders (out of N),
25 meat samples (7 raw; 18 prepared)</td><td>n = 9 biltong hunters</td></tr>
<tr><td rowspan="3">Information generation</td><td colspan="2">Standardized and structured questionnaires</td><td rowspan="3">Standardized and structured questionnaire (opinion survey)</td></tr>
<tr><td colspan="2">Standardized and structured observation sheet</td></tr>
<tr><td colspan="2">Analysis of meat samples</td></tr>
<tr><td>Supplements</td><td>Experiment:
Preparation of formally derived game meat under informal conditions</td><td>Observational Study I:
Commercial game harvest for the production of game meat for export</td><td>Observational Study II:
Provision of game animal protein (edible by-products) to indigenous tribes</td></tr>
<tr><td>Research area</td><td>Pretoria North, Gauteng</td><td>Kimberley, Northern Cape</td><td>Ruacana, Namibia</td></tr>
<tr><td>Sample size(s)</td><td>4 informal meat traders,
16 meat samples
(8 raw; 8 prepared)</td><td>7 animals,
7 professional hunters</td><td>35 Ovahimba people</td></tr>
<tr><td rowspan="2">Information generation</td><td>Structured questionnaire (group interview)</td><td>Informal discussions and interviews (jointly and individually)</td><td>Structured questionnaire (group interview)</td></tr>
<tr><td>Structured observation sheet</td><td>Structured observation sheet</td><td>Structured observation sheet</td></tr>
<tr><td>Measurements</td><td>Microbiological analysis of meat samples</td><td>Crucial time differences during meat obtainment</td><td>---</td></tr>
</table>

As summarized in Chapter 3.1 as well as in Table 3, different means for the generation of information were applied to different key informants. For the participatory risk assessment, these key informants were categorized into role-players, stakeholders and end-users (Table 4). A role-player is "a person with specifically assigned tasks or functions within a programme, project or process". A stakeholder is "a person, group or organization that has direct or indirect stake in an organization because it can affect or be affected by the organization's actions, objectives and policies". An end-user is "a person or organization that actually uses a product, as opposed to the person or organization that authorizes, orders, procures or pays for it" (BD, 2009).

Table 4: Key informants of the study

Role-players	Academics (University of Pretoria)	Prof. CME McCrindle Dr. N Qekwana Dr. E Van Zyl
	State Veterinary Services (North Region, KwaZulu-Natal)	Dr. D Mtshali (Manager) Dr. S Ramrajh (Deputy Manager) Z Mbatha (Local Health Technician)
Stakeholders		Informal meat traders
		Biltong hunters
		Professional game harvesters
End-users		Community members (mainly through observation)
		Ovahimba

3.2 Study areas

For the survey of n = 51 informal meat traders in the scope of Marketing Chain I, the study area included the towns of Pongola, Jozini, Mkuze, Hlabisa, Tshejuba, Nongoma and Hluhluwe, within the District Municipalities of Zululand and Umkhanyakude in Northern KwaZulu-Natal. KwaZulu-Natal has the biggest population of all South African provinces and about 20% of the country's population lives there (ADATO *et al.*, 2007).

Although not the poorest province of South Africa, KwaZulu-Natal is characterized by high poverty rates, inequalities in the distribution of income between various population subgroups, as well as unemployment (PROVIDE PROJECT, 2005). It is one of the South African provinces with the lowest human development index and a comparatively common rural poverty. Besides unemployment, major problems are illiteracy, a poor infrastructure and a lack of resources. Production factors like land, capital, credit as well as appropriate technology, inputs, training, extension and markets are also lacking. Food insecurity is a major problem due to the inability of many households to produce sufficient amounts of food to last until the next harvest (MTSHALI, 2002).

The Zululand District Municipality had about 964.000 inhabitants in 2006. Sixty-two percent of all households did not have access to electricity, whilst 64% did not have access to piped water in 2006. Seventy-one percent of the population of Zululand was younger than 29 years and more than 82% of the population were living below the poverty line (2006).

Unemployment is very high and only 16% of the residents were employed in 2006. Approximately 39% of the residents of Zululand did not have any education. The prevalence of HIV/AIDS in Zululand ranged around 27% in 2006 (DPLG, 2006).
The Umkhanyakude District Municipality had an assumed population of more than 610.000 in 2008. Large towns or cities with strong economies are not present in this municipal area. Eighty percent of households did not have access to electricity and about 46% of the population did not have any scholar education in 2008. The Umkhanyakude District Municipality has some of the highest rates of unemployment and poverty rates in South Africa and 83% lived below the poverty line in 2008. Only about 13% of the population was formally employed. An estimated 70% of the population was younger than 18 years in 2008 (UDM, 2008).
The experiment conducted, the preparation of game meat by informal meat traders, was carried out at a train station in Pretoria North / Gauteng Province. Pretoria is situated about 50 km north of Johannesburg and is the administrative capital of South Africa (DAC, 2007).
In terms of Marketing Chain II, the opinion survey with biltong hunters could not be limited to one particular province or area of South Africa. It heavily depended on the availability and willingness of respondents. Four biltong hunters were interviewed in KwaZulu-Natal (one in Pongola and three in Richards Bay). In Pretoria, two other biltong hunters were interviewed. Another biltong hunter resided in the Free State Province and was interviewed over the phone from Pretoria. In Kimberley / Northern Cape, two biltong hunters were interviewed as well.

Observational Study I, the commercial game harvest, was attended on a game ranch 40 km out of the town of Kimberley / Northern Cape. Although it is South Africa's largest province in terms of area, the Northern Cape is sparsely populated (BRADSTOCK, 2005). Game ranching is an important contributor to the Northern Cape economy (VAN DER WAAL and DEKKER, 2000). One game harvesting team could be found that was willing to arrange the attendance of a commercial game harvest during the study. However, The game harvest attended was the only operation of this kind that was eventually conducted by this particular harvesting team, within the time frame of active research. Therefore, there was no choice between different harvesting locations.
Observational Study II, the visit and group interview with a clan of the Ovahimba people, was carried out close to Ruacana, in the far north of Namibia. Ruacana is a village in the Omusati Region of Namibia (ORC, 2006). The study areas are illustrated by Figure 2.

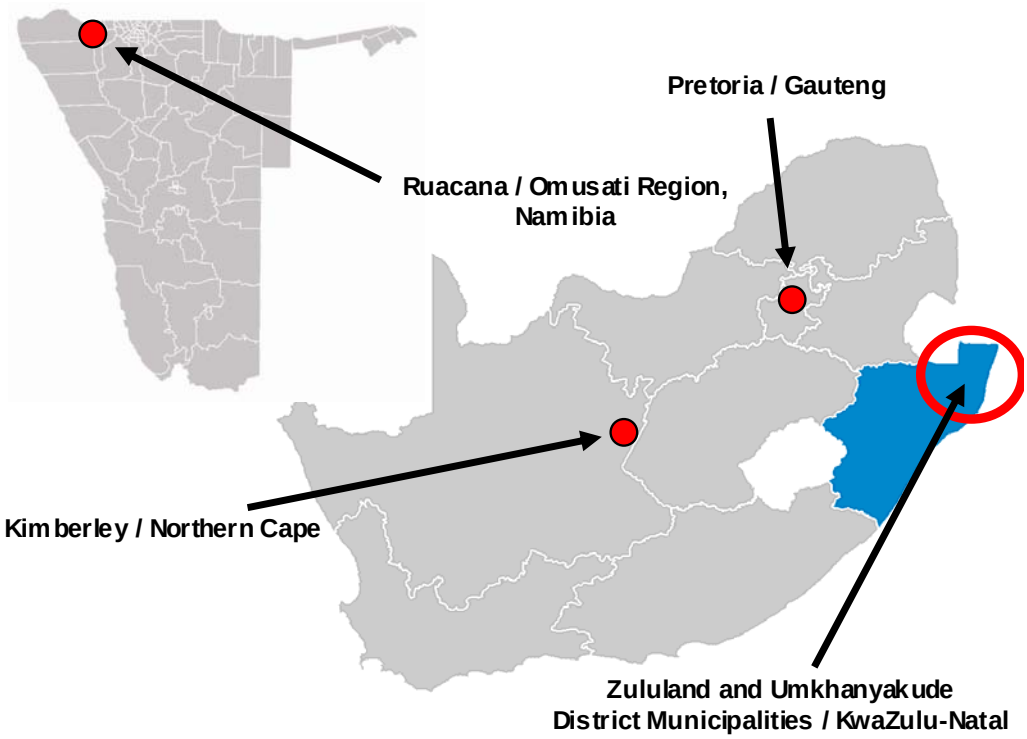

Figure 2: The study areas in South Africa and Namibia

Sources:
Map of South Africa with KwaZulu-Natal:
http://upload.wikimedia.org/wikipedia/commons/b/bb/South_Africa_Provinces_showing_KZ.png
Map of Namibia: http://upload.wikimedia.org/wikipedia/commons/6/6c/Regionen_und_Wahlkreise_in_Namibia_hellgrau.png
Note: Both maps were accessed on 16/08/2009.
Namibia is shown in a smaller scale than South Africa, as most research work was conducted within South Africa.

Marketing Chain I

3.3 The informal trade of meat products

3.3.1 Selection of locations and respondents and the execution of interviews

The selection of the Zululand and Umkhanyakude District Municipalities as an area that is popular for the informal trade of meat and, potentially, game meat, was proposed by the Department of Paraclinical Sciences of the University of Pretoria in cooperation with Dr. Shashi Ramrajh from Richards Bay.
For the survey with informal meat traders, different towns within the District Municipalities of Zululand and Umkhanyakude were selected. Due to organizational, financial and logistic reasons not all towns within the two District Municipalities could be considered in the survey. In Zululand, the towns of Pongola, Nongoma and Tshejuba were selected. In Umkhanyakude, the survey was conducted in the towns of Jozini, Mkuze, Hlabisa and Hluhluwe.
Every person who informally traded meat products in public was considered as an informal meat trader. For the purpose of this research, red meat and chicken products were considered meat and if the trader sold other food products along with them this was not a disqualification.

The targeted sample size was 50 informal meat traders. The total number of informal meat traders within the study area was unknown and probably varied from week to week. Therefore, no random sampling frame could be developed. The targeted sample size of 50 was determined after having carried out transect drives through the study area prior to sampling. After this it was assumed that there were less than 100 informal meat traders in the area.
For sampling, every town within the study area was visited once. All informal meat traders encountered in the different towns during these days were interviewed. In every town of sampling, one respondent was questioned after another, as encountered. None of them refused to be interviewed. Eventually, a total of 51 respondents were identified and interviewed.
The printed version of questionnaire was not prepared in the Zulu language, but in English only. When visiting the different towns within the study area, an assistant familiar with the area and with the capability to speak Zulu was present at all times for personal security, translation and for greater acceptance by respondents. For all 51 interviews, the same assistant was used as the respondents' English language proficiency was either weak or nonexistent. One informal meat trader was interviewed at a time and directly at the same place as they conduced sales of the meat products. No group interviews were conducted. After each interview, prerequisites, as well practices, applied by the respondents in terms of product handling and the maintenance of food safety and product quality were documented in an observation sheet. In some cases, photographs were taken as well.
All interviews were conducted between approximately 10h00 and 14h00 and during week days only. The interviewing of one respondent mostly required between 5 and 10 minutes and this time frame was exceeded very rarely and only if a respondent needed to serve customers during the interview. When interviews were conducted in Mkuze and Hluhluwe, the ambient temperature was comparatively low (around 20°C) and it was a rainy and very windy day.

During the other days of sampling, the ambient temperature ranged at least around 25°C and it did not rain. It was not very windy during these days. In Jozini, the ambient temperature was even higher and ranged around 30°C and there was no wind.
The greatest number of informal meat traders (16) were interviewed in Jozini (Table 5). Although only one respondent was interviewed in Nongoma it was assumed that there was more than just one informal meat trader in town. Due to a tense atmosphere resulting from the general South African election, only one interview could be conducted there.

Table 5: Geographical dispersion of respondents and time of interviews

Location	Respondents	Percent	Time of interview
Jozini	16	31.37	10h00 - 12h00
Pongola	11	21.57	11h00 - 13h00
Mkuze	11	21.57	10h00 - 12h00
Hluhluwe	6	11.76	12h00 - 14h00
Hlabisa	5	9.80	12h00 - 14h00
Tshejuba	1	1.96	12h00 - 14h00
Nongoma	1	1.96	10h00 - 12h00
Total	**51**	**100**	

3.3.2 The questionnaire

The questionnaire for informal meat traders was standardized and subdivided into different sections, namely "general information" (including demographics), "product range" and "food safety" (Annex 8.2.1). "General information" comprised data on age and gender, contact details, the business organisation and the sector involvement of respondents. Moreover, the level of education of informal meat traders was recorded. However, eventually no name and contact details were recorded from the respondents as they generally turned out unwilling to provide this information.
The type of business was classified as informal retailer, open market vendor or street food vendor. Respondents were classified as street food vendors if they predominantly sold ready-to-eat meat products in the streets of the towns within the study area, or along the roads between. These respondents were not operating their businesses inside open market areas provided by the municipalities. Respondents were considered as open market vendors if they operated within open market premises provided by the municipalities. Respondents were considered as informal retailers if they traded a substantial variety of other goods in addition to meat products, or if they did not fit in either of the other two categories.
In the section "product range", the actual or potential involvement of respondents in the trade of game meat products was determined. The section "food safety", targeted the food safety related knowledge of the respondents and individual perceptions. The degree of technical support for food safety maintenance and the applied food handling practices were identified and recorded.
The questionnaire for informal meat traders predominantly consisted of multiple choice questions to enable a subsequent analysis of different statistical categories (e.g. "yes" and "no"). In the case of questions that dealt with numbers or amounts (e.g. minutes), the answers were filled into an empty space.

3.3.3 The observation sheet

The observation sheet for informal meat traders was standardized and subdivided into the sections "general information", "infrastructure and availabilities", "premises", "product handling" and "product range and preparation" (Annex 8.2.2). The section "general information" was limited to the recording of date and time. In the section "infrastructure and availabilities", basic prerequisites such as the location, the nature of road and the availability of running water, electricity, toilets and ablutions were characterized. The section "premises" dealt with the characterization of the business premises in terms of inputs into premises and product preparation. Also, hygienic issues of the premises were characterized. The initially intended recording of ambient temperature and humidity could not be carried out for technical reasons. In the section "product handling", practices of product handling, display, storage and packing applied by informal meat traders were recorded. In the section "product range and preparation", prerequisites and practices of product preparation applied by respondents were described.
In the observation sheet, variables were scored from 0 to 5. These included:

- The presence of flies and dust at business premises,
- the cleanliness of business premises,
- the cleanliness of washing water, as well as
- the presence of rubbish, dirty water and mud around business premises.

3.3.4 Meat sampling and the second interviewing of selected respondents

Because the predominant focus of the study was game meat, only respondents trading beef were taken into consideration for the sampling of meat for microbiological analysis. Beef meat has many characteristics in common with the meat of other ungulates. Therefore, beef was assumed to be more similar to game meat than other domestic meats such as pork or chicken. Due to technical reasons, only informal meat traders in the towns of Pongola, Jozini and Mkuze could be considered for the collection of meat samples. Initially, 23 respondents were selected: Nine in Mkuze, eight in Pongola and six in Jozini. In Mkuze, two of them were not encountered during the day of sampling. Therefore, 21 out of the initial 51 respondents were considered (see Table 6). All of them were female.
Initially it was intended to collect one raw and one prepared beef sample from each selected respondent. However, in most cases, only either raw or prepared beef samples could be collected because respondents had either not started product preparation at the time of sample collection or they had already run out of raw stock. Raw as well as prepared beef samples could only be collected from four respondents. One of the selected respondents only offered chicken meat at the day of sampling. For this reason, one chicken meat sample was collected besides beef meat samples. Therefore, in total, 17 prepared beef samples, seven raw beef samples and one prepared chicken meat sample were collected from the 21 respondents.

Table 6: Samples obtained from informal meat traders

Respondent	Type of sample(s)	Location	Respondent	Type of sample(s)	Location
1	Prepared and raw beef	Mkuze	13	Prepared beef	Jozini
2	Prepared and raw beef	Mkuze	14	Prepared beef	Jozini
3	Prepared beef	Mkuze	15	Prepared beef	Jozini
4	*Not encountered*	Mkuze	16	Prepared beef	Pongola
5	Prepared beef	Mkuze	17	Raw beef	Pongola
6	Prepared beef	Mkuze	18	Prepared and raw beef	Pongola
7	Prepared beef	Mkuze	19	Prepared beef	Pongola
8	Prepared and raw beef	Mkuze	20	Raw beef	Pongola
9	*Not encountered*	Mkuze	21	Raw beef	Pongola
10	Prepared beef	Jozini	22	*Prepared chicken*	Pongola
11	Prepared beef	Jozini	23	Prepared beef	Pongola
12	Prepared beef	Jozini			

Each sample collected had a surface area of at least 2 cm^2, compliant to the guidelines of a laboratory in Pietermaritzburg / KwaZulu-Natal that was assigned with the microbiological analysis. Each sample was stored in a separate sterile sampling jar with an air-proof lid. Every jar was labelled for a subsequent re-identification of both, the sample and the respondent.
The samples were stored inside a cooler box with ice blocks from the moment of obtainment and were transported to the laboratory in this cooler box. The samples were collected on two consecutive days. The first day, samples were taken in Jozini and Mkuze. The next day, samples were drawn in Pongola. Thereby, the samples taken on the first day were stored overnight in a refrigerator. After the collection of samples in Pongola on the second day, all sterile sampling jars were transported in a cooler box with ice to Vryheid / KwaZulu-Natal, where they were picked up by a courier who delivered them to the assigned laboratory.
While collecting meat samples, a short standardized and structured interview was conducted. The questionnaire consisted of five questions and focused on perceptions of consumers and traders in regard to game meat, as well as the problems and desires identified by people operating in the informal trade of meat (Annex 8.2.3). All questions were open. Prior to the start of the interview, each respondent received information on the basic findings from the previously applied questionnaire and observation sheet. When meeting the selected respondents in Pongola, the Zulu assistant who facilitated the collection of information from the 51 initial respondents was present. When visiting Mkuze and Jozini, another Zulu assistant did the translation.

3.3.5 Microbiological analysis of meat samples from informal meat traders

The total aerobic plate count as well as the presence of *E. coli* / coliforms were determined by culture methods in a laboratory in Pietermaritzburg / KwaZulu-Natal. In terms of the exact methodologies applied for the obtainment of results, the laboratory declined to provide any details. Because the methods of microbiological analysis are not standardized throughout South African laboratories, no assumptions can be made which methods were applied to obtain the results received. Nevertheless, the laboratory stated that the total aerobic plate count as well as the presence of *E. coli* / coliforms were determined after culture on agar plates. Identification of *E. coli* and coliforms was done visually using indicator plates which changed colour after growth.

3.4 Experiment: Preparation of game meat by informal meat traders

3.4.1 Preparation of meat, meat sampling and the interviewing of participants in Gauteng

Following analysis of the data obtained from the study area, it was found that informal meat traders were happy to include game meat in their product range. At this stage it was no longer possible to do further experiments in the original study area, but informal markets exist throughout South Africa and a location close to the University of Pretoria Veterinary Faculty was chosen to see if game meat could be safely prepared by informal meat traders. This was done to test the hypothesis that game meat could be diverted into the informal market to provide a safe and affordable source of protein for low income consumers. This also tested the assumption that beef could be used as a model for cooking of game meat.

Four informal meat traders at the "Wonderboom" train station between Wonderboom and Pretoria North, in Pretoria, Gauteng, were purposely selected and supplied with game meat to prepare it for consumption. They were approached two days prior to the experiment. All of the selected were black, Sotho and female. They operated the same business together on a daily basis. Therefore, they prepared the different batches of meat in collaboration and were not considered as four independent respondents but as one unit. The cooking was done in traditional pots over open fires.

The "Wonderboom Station" was selected as it is a very busy place frequented by a large number of people all day long. Most of them can be assumed to be commuters as a large taxi rank is located right besides the train station. More than 50 informal traders were located there and could be found on both sides of the train station, at the taxi rank as well as on top of bridges spanning the rail tracks and roads.

Five batches of impala meat and three batches of springbok meat (all "skenkels"), each weighing about 500g, were purchased prior to the start of the experiment from a formal retail outlet (registered butcher). Before handing the game meat over to the participants, raw meat samples weighing approximately 50g each were steriley taken from each batch, at a food laboratory in the Section of Veterinary Public Health at the Veterinary Faculty of the University of Pretoria, to be stored inside a sterile sampling bag. For clear identification of the different meat packages, each was labelled with a different number.

Besides game meat, the participants were supplied with all other ingredients needed such as spices and vegetables. At the time of the pre-arrangement of the experiment, the participants had the opportunity to prepare a "shopping list" for these different ingredients that would be used in a traditional meat stew. The vegetables used were potatoes, onions, carrots and tomatoes. Spices included salt, pepper, chillie powder and beef stock cubes. It was made clear to the participants that every batch of meat should be cooked for at least 45 minutes. This time was obtained from informally interviewing Zimbabwean citizens (n=3) studying at the University of Pretoria, as due to current economic conditions in Zimbabwe, game meat is commonly consumed. Every batch of meat was cooked separately in a pot and the pots were cleaned with water and detergent prior to the cooking of a subsequent batch. This way, every meat package could be identified clearly also in a cooked state.

After the preparation of each batch of meat, one sample weighing about 50g was steriley collected from each batch and stored within a sterile sampling bag inside a cooler box. For identification, the sterile sampling bags containing the prepared meat samples were labelled

with the same number as their raw counterparts but in a different colour. Each prepared meat sample was taken immediately after the pots were taken off the fire. The samples were immediately transported to the laboratory for culture.
During meat preparation, the four participants were subjected to a short structured group interview. The questionnaire consisted of seven questions and focused on perceptions of traders and consumers in regard to game meat as well as problems and desires identified by people operating in the informal trade of meat. Moreover, all four respondents and four customers identified were asked how they liked the game meat after they had eaten some of it (Annex 8.2.4). All questions were open. Because the participants spoke English only to a very limited extent, an assistant translated all questions asked and answers into Sotho. This assistant was present throughout the experiment to communicate with the respondents.
Prerequisites and practices applied by the participants were recorded before and throughout the game meat cooking experiment. An observation sheet similar to that used in the original study area was used to assess hygienic conditions of the business premises and the surroundings and the availability of basic services for the maintenance of food safety and product quality (Annex 8.2.5). Moreover, photographs were taken.

3.4.2 Microbiological analysis of game meat samples before and after cooking

In the food laboratory in the Section of Veterinary Public Health at the Veterinary Faculty of the University of Pretoria, two replicates were analysed for each meat sample obtained. For both raw and cooked meat samples the total aerobic plate count as well as the *E. coli* / coliform count were determined.
Per replicate, approximately 10g of meat was cut off from each 50g-sample with sterile knives and stored in an appropriately labelled and sterile plastic bag. Then 100 ml of autoclaved Peptone Buffer solution was added to each sample bag. Samples were homogenized for two minutes in a stomacher. Following this, 1 ml was taken from each sample bag and serial dilutions carried out. Two duplicates each for the dilutions 1:10, 1:100 and 1:1000 were plated on aerobic plates for each sample in order to the determine the total aerobic plate count. For the determination of the *E. coli* / coliform count of the samples, 3-M-plates were used. For each sample, duplicates of undiluted 1 ml were plated on 3-M-plates. Samples were incubated inside an incubator for 24 hours at 37 ºC. Following sample incubation, both the total aerobic plate count and the *E. coli* / coliform count were visually quantified for each sample by using a manual colony counter.

3.5 Data analysis

Data obtained from the n = 51 informal meat traders as well as from the microbiological analyses was analyzed statistically. The datasets generated for Marketing Chain II (biltong hunters, game harvest and Ovahimba) were too small to justify any statistical analysis. All statistical analysis of data was conducted by using SAS 9.1.3. (SAS INSTITUTE, NORTH CAROLINA / U.S.A.). The majority of datasets generated for Marketing Chain I were either of nominal or ordinal scale.
As far as applicable and relevant, the proportions (%) and the exact confidence intervals (α = 0.05) were determined for the different categories of variables obtained from interviews with, and observations of, informal meat traders. The binomial test applied considers only two categories per variable.

Therefore, if one variable had more than two categories, all other categories despite the one to be tested needed to be combined to form one category only (Annex 8.1.1).
In the survey conducted with informal meat traders in KwaZulu-Natal, independent data of either nominal or ordinal scale and therefore independent variables were generated. For independent variables of nominal scale, independence tests were conducted as far as possible and coherence was assumed. With these independence tests, the Phi-coefficient (Phi, between 1 and -1), a measure for the strength of coherence, and the exact p-value, a measure for the significance of coherence, were determined (Annex 8.1.2). For independent variables of ordinal scale, correlation was tested only if a logical correlation was assumed or likely. The Spearman's Rank Correlation Coefficient (SpCC) as well as the p-value of the correlations were determined. Regarding this, besides the age, the level of education and all scorings, the results from the analysis of meat samples obtained from the respondents in KwaZulu-Natal were treated as data of ordinal scale (Annex 8.1.3).
Because a raw sample was used as a control and a sample was analysed after cooking, from each batch of game meat during the experiment done in Pretoria, this was considered a paired dataset. Therefore, dependent variables were generated. These were treated as data of ordinal scale. For these variables it was tested if they correlate with each other. The Phi-coefficient as well as the p-value of the correlation were obtained (Annex 8.1.4).
In the statistical analysis, the two replicates generated for each meat sample in a prepared as well as cooked state were as separate units in terms of the presence of bacteria in general, *E. coli* and coliforms. Therefore, statistically, n = 32 observations were considered (n = 16 for raw game meat and n = 16 cooked game meat). The statistical analyses applied to the different types of data obtained is illustrated by Table 7.

Table 7: Statistical analysis of data (Marketing Chain I)

Data	Type	Statistical tool applied
All data (if relevant)	Proportions of categories; Exact 0.05-confidence intervals for proportions	Binomial test (for one class proportion after another per variable)
Independent data of nominal scale (if relevant)	Coherence (strength and significance)	Fisher's Exact Test
Independent data of ordinal scale (if relevant)	Correlation (strength and significance)	Spearman's Rank Correlation
Paired data of ordinal scale (if relevant)	Correlation (strength and significance)	Cochran-Mantel-Haenszel-Test

Marketing Chain II

3.6 Formal to semi-formal domestic game meat trade

3.6.1 Selection of biltong hunters and the execution of interviews

An opinion survey was conducted with South African biltong hunters using a structured interview with a standardised questionnaire. Any person who permanently resided in South Africa and who hunted game animals for sport (trophy hunting) or obtaining game meat was considered as a "biltong hunter" (this name is used in South Africa as traditionally game meat was always made into biltong). Selection criteria did not include the demographical characteristics or occupation of the hunter, whether or not the meat was consumed or sold, which species were hunted or the number of years experience. If hunters were related to a previously interviewed respondent, they were not interviewed, as they may have had the same replies.

The targeted size of the opinion survey was n = 10 biltong hunters. In South Africa, there are about 200,000 biltong hunters (DAMM, 2005, PATTERSON and KHOSA, 2005). No random sampling frame was developed. Instead, a purposive selection of biltong hunters for structured interviews was based on the availability, accessibility and willingness of these persons to be interviewed due to time constraints for the study.

Nine biltong hunters were included in the survey as respondents. One further hunter declined to reply after having been provided with an electronic version of the questionnaire. Seven biltong hunters were interviewed face to face. Two biltong hunters were interviewed over the phone. No group interviews were conducted.

3.6.2 The questionnaire

The questionnaire for biltong hunters was standardized and subdivided into different sections (Annex 8.2.6). The section "general information" comprised information on age and gender, contact details, the level of education and farm ownership. The names and contact details were not recorded, as was done with the informal traders, to maintain confidentiality. However, information regarding hunting experience and practices as well as the importance of hunting for the overall income was recorded.

In the section "game animal species", information about species and quantities hunted as well as about the utilization and sale of game meat was generated. The section on "the game meat sector" targeted personal perceptions about the current state and potential of the South African game industry in terms of meat production and marketing. Personal opinions about utilization and marketing of offal were of central interest.

The section "food safety in domestic game meat production", focused on general knowledge of food safety and aimed to unveil practices of product handling applied and equipment used to maintain food safety and product quality. Biltong hunters were asked to estimate the time difference between the fatal shot and the throat cutting for exsanguination, as well as between the fatal shot and the commencement of evisceration. If the throat is cut too late after shooting, the heart will have ceased to beat and the carcase will not bleed out completely (exsanguination). The time difference between killing and exsanguination is considered to be crucial for meat hygiene and safety, as blood remaining in the vessels will result in poor

keeping quality and the multiplication of bacteria in meat (FAO, 2004). Additionally, personal opinions in terms of food safety standards and the future potential of the game meat industry were asked.
The questionnaire for biltong hunters predominantly consisted of multiple choice questions to enable a subsequent analysis of different statistical categories (e.g. "yes" and "no"). In the case of questions that dealt with numbers or amounts (e.g. minutes), the answers were filled into an empty space. Additionally, the questionnaire comprised a few open questions. The answers obtained from biltong hunters to these questions were filled into an empty space. Per interview, between 30 minutes and one hour were required as all respondents were very communicative.

3.7 Observational Study I: Commercial game harvest for the export of game meat

A team of seven professional game harvesters was joined during the execution of a two-day commercial game harvest for the production of export meat on a game ranch about 40 km outside the town of Kimberley / Northern Cape. The attendance of this particular game harvest was arranged by Dr. Shashi Ramrajh, who was in regular contact with the harvesting team in charge of the operation. It was originally planned that the game harvest would be observed within the study area in Pongola, as previously several such operations occurred there during the game harvesting season (May to August). However, the export of game meat from the whole of South Africa in the 2009 hunting season was severely constrained by the global economic downturn and almost no commercial harvesting operations took place during this period in 2009. There was thus no choice between different locations for the attendance of a commercial game harvest as the operation attended was the only operation of this kind that was conducted by the harvesting team within the time frame of the study.
The major focus of the observational study was the recording of the time difference between the fatal shot and throat cutting for exsanguination, as well as of the time difference between throat cutting and the commencement of evisceration (and therefore primary meat inspection) for the comparison to estimates previously recorded from biltong hunters. An additional focus was the marketing chain for game meat and edible by-products that are not exported and the extent to which informal meat traders of the region or people in need such as poor indigenous tribes are able to legally access and utilize these products.
To be able to record the time differences, one professional game harvester was accompanied in his vehicle during the harvesting of animals. This was the same professional game harvester at all times. During the two days of game harvest, the prerequisites of the game harvest and the practices applied in terms of product handling and the maintenance of food safety and product quality were documented in a structured observation sheet (Annex 8.2.7). During this contact period, informal discussions and interviews were held jointly and individually with all of the game harvesters.

3.8 Observational Study II: The acceptance of game meat and edible by-products by a clan of the Ovahimba

A clan of Ovahimba, indigenous people of Namibia, was interviewed in the far north of Namibia close to Ruacana in the Omusati Region. The clan resided in huts in the bush about 1 km off the main and tarred road to the Epupa Falls and the Angolan border post. To both the Angolan border post to the north west, as well as the town of Ruacana to the south east of the settlement, the distance was an estimated 5 km.

The selection of the particular Ovahimba clan for the observational study was based on personal experience in Namibia. The selected clan was visited in 2008 for the first time and the contact with them was maintained. However, the observational study could eventually not be pre-arranged with the respondents as the clan member who owned a mobile phone had lost this prior to the departure to Namibia. Therefore, the clan was visited without prior notification.
Compared to other groups of Ovahimba inside the Kunene Region, the particular clan visited resides rather close to urban areas where the communities have adopted modern clothes and habits and it might be assumed that this impact is stronger in comparison with more rural clans with traditional habits and clothing. Nevertheless, although some members of the clan appeared to readily use modern consumer goods such as mobile phones and T-shirts, the group lived in clear material poverty and in most individual cases, maintained the traditional Ovahimba culture in terms of dressing and lifestyle.
Two full days were spent in the study area, living in the settlement with the clan members. The number of people present in the location consistently changed during this time as some persons left the location from time to time, whilst other persons arrived. Nevertheless, throughout the two days, predominantly women and children were present. This is easily explainable within the cultural norms of the Ovahimba people where the younger men are generally nomads, whilst the women and children reside in permanent settlements together with the elderly men.

The Ovahimba were supplied with 3 kg of springbok meat, which was formally purchased at an Oshakati Supermarket and stored inside a cooler box with ice blocks before handed over. Due to cultural aspects associated with the Ovahimba, such as the fact that there is an apparent hierarchy within each group and that they are usually all related to each other if living together, a structured group interview was carried out. The structured questionnaire focused on the extent to which hunting and game meat consumption are part of Ovahimba culture and on the identification of prerequisites and practices of meat handling applied by the clan in regard to the maintenance of food safety and product quality.
The acceptance of game meat and edible by-products by the Ovahimba was determined. Although only game meat was supplied, they were also asked about the acceptability of offal, heads and feet of game animals. The questionnaire applied consisted of 34 questions and was not divided into different sections (Annex 8.2.8). All questions were open. The printed version of the questionnaire was prepared in English language.
The group discussion was carried out in the evening of the second day of the stay. The respondents were gathered around their fire place whilst preparing and eating the springbok meat received. As the Ovahimba did not speak English, two assistants capable of speaking fluent Ovahimba served as translators. Both of them were of the Namibian Ovambo tribe and were consistently present throughout the observational study and alternately served as translators and assisted in facilitating the contact and discussions with the Ovahimba.
At the time of the interview, eleven women, three men and 21 children were present in the location. After translation of the questions, consensus was reached about the answers by group discussions in the vernacular and then the questions were predominantly answered by four of the elder women. The three men and the children did not participate in the discussions, probably because cooking of meat is the work of the women in the tribe.To complete the questionnaire with the group, about two hours were required.

Besides the questionnaire, all observations regarding the prerequisites and practices in terms of meat handling by the Ovahimba that appeared to be relevant in the scope of the observational study were consistently recorded throughout the two days in the settlement, using a structured observation sheet (Annex 8.2.9).

3.9 The development of a flow chart to illustrate the marketing chains for game meat products within South Africa

Product flows and production as well as processing steps in the scope of the production of game meat for export were derived from the observation of game harvesting, informal discussions with game harvesters (n = 7) and observations made during the harvesting process ("Results" 4.6). Role-players were interviewed informally. Appropriate literature was utilized as well (e.g. FIELD, 2004, HOFFMAN and WIKLUND, 2006, GILL, 2007)

For biltong hunters, product flows and both, production and processing steps were derived from the interviewing of the selected (n = 9) respondents (see Tables 45, 47-49, 52 and 53) and from informal discussions with them. Moreover, relevant information was obtained from the informal interviewing of role-players and from the review of existing literature (e.g. DAMM, 2005, PATTERSON and KHOSA, 2005).

Due to the focus and aims of the study, informal meat traders were included into the flow chart as potential stakeholders of the South African game industry (see "Results" 4.1, 4.2 and 4.3 and Tables 13, 15 and 23) and poor community members ("Results" 4.7) were considered as potential end-users, although these product flows are not yet taking place. Potential product flows towards informal meat traders and poor community members were established by consulting role-players, by evaluating the information generated from professional game harvesters and biltong hunters and by reviewing existing literature (e.g. EKANEM, 1998, ROGERSON, 2000, 2001, MOSUPYE and VON HOLY, 2000, PATTERSON and KHOSA, 2005, VON HOLY and MAKHOANE, 2006, SKINNER, 2006).

Within actual (existing) product flows as well as production and processing steps, potential hazards were identified by observing prerequisites and practices applied by stakeholders and end-users and by interviews. The review of existing literature played a key role in hazard identification. Moreover, role-players were interviewed informally. For the proposed but so far non-existent product flows to informal meat traders and poor communities, the fact that game meat products are not yet handled at this stages of the marketing chains, was disregarded. Instead, the focus was on meat handling in general, in regard to prerequisites and practices. Concerning the currently non-existent product flows towards informal meat traders and poor communities, existing product flows were used to draw conclusions on potential hazards and to estimate the risks of their occurrence as far as comparable (e.g. transport of products over certain distances).

The identified hazards were characterized based on information generated from the key informants of the study. As far as possible, the findings from the observation and recording of prerequisites and practices applied by stakeholders and end-users were used for hazard characterization besides informally interviewing role-players. For risk characterization, information provided by role-players has been of key importance. Nevertheless, as far as practicable, the nature of the risks of the occurrence of potential hazards was determined through observation. As far as relevant data could be generated, the magnitude of these risks was estimated as a proportion of respondents behaving in a risky fashion by applying

suboptimal practices of product handling or by having inadequate prerequisites for the maintenance of food safety and product quality. This way, critical control points for their mitigation could be suggested.

Exposure assessment was the only component of participipatory risk assessment that could not be carried out in the scope of the study. It was not practicable as foodborne illnesses mostly occur one to three days after the consumption of contaminated products and because it is not ethically correct to ask respondents for their medical history. Moreover, it is difficult to prove an association between food and illness so that additional measures such as the collection of human faeces would have been necessary (McCRINDLE, 2009, personal communication).

4 RESULTS

Marketing Chain I

4.1 Informal meat traders

4.1.1 General information

Although they were generally unwilling to provide personal details, the great majority of respondents willingly stated their age. Forty-eight out of the n = 51 informal meat traders (94.12%) were classified as street food vendors, while only two were classified as open market vendors and only one respondent as an informal retailer. The single respondent who was classified as an informal retailer was a 29-year old female who walked through the town of Pongola carrying a cooler box out of which she sold frozen game meat chops to by-passers.
All informal meat traders were grouped into three age categories of similar size. The youngest respondent was 19 years old, whilst the oldest was 56. Overall, the average age of informal meat traders was 36.5 years (± 1.3). More than 90% of all informal meat traders interviewed were females. Forty-seven respondents (92.16%) called the informal trade of meat products a primary activity for income generation. All four respondents who described the informal trade of meat as a secondary source of income were female. Two of them were 50 years and older. Table 8 deals with the age, gender and sector involvement of respondents.

Table 8: Age terciles, gender and sector involvement of respondents

Age terciles (years)		Respondents	Average age (years)	
19 to 32		15	25.87	
33 to 40		16	36.06	
41 to 56		17	46.29	
Not answered		3	5.88	
Total Average (Standard deviation)		**36.5**	1.30	
Gender	Respondents	Percent (within confidence interval, $\alpha = 0.05$)		
Female	46	78.59	90.20	96.74
Male	5	3.26	9.80	21.41
Sector involvement	Respondents	Percent (within confidence interval, $\alpha = 0.05$)		
Primary activity	47	81.12	92.16	97.82
Secondary activity	4	2.18	7.84	18.88

More than half of all respondents stated that they were educated at a secondary school, although they may not always have graduated (Table 9).

Table 9: Level of education stated by respondents

	Respondents	Percent (within confidence interval, α = 0.05)		
University	0		0	
Post-Secondary	1	0.05	1.96	10.45
Secondary	27	38.46	52.94	67.07
Primary	19	24.13	37.25	51.92
No school	3	1.23	5.88	16.24
Unclear	1	0.05	1.96	10.45

If only the two categories "primary school and lower" and "secondary school and higher" are included and excluding missing values, then there is a significantly negative correlation between these three age categories presented in Table 8 and the level of education obtained ($p=0.029$, SpCC = -0.328, $\alpha = 0.05$). Younger respondents seemingly had better educational opportunities than older ones. With increasing age, the level of education obtained declined.

4.1.2 Product range

Concerning the number of different meats and meat products traded, n = 26 informal meat traders traded one product only (50.98%, CI = 36.60% – 65.25%). Twenty-four respondents traded two products (47.06%, CI = 32.93 – 61.54). Only one respondent traded three different meat products (1.96%, CI = 0.05 – 10.45). In this particular case, chicken gizzards besides beef and chicken meat.

Twenty-nine respondents traded either beef or chicken or both (56.86%, CI = 42.25 – 70.65). When including chicken gizzards and both, beef offal and headparts, only two respondents were identified who traded meat products that have neither been derived from cattle nor from chickens (3.92%, CI = 0.48 – 13.46). Surprisingly, only one respondent traded game meat (1.96%) and no respondents selling either lamb or goat meat could be identified (Table 10).

Table 10: Meat products traded by respondents

	Respondents	Percent (within confidence interval, α = 0.05)		
Beef and chicken	15	17.49	29.41	43.83
Beef	9	8.40	17.65	30.87
Chicken	5	3.26	9.80	21.41
Beef and boerewors	4	2.18	7.84	18.88
Chicken gizzards	4	2.18	7.84	18.88
Beef offal	3	1.23	5.88	16.24
Beef headparts	3	1.23	5.88	16.24
Chicken gizzards and boerewors*	3	1.23	5.88	16.24
Chicken and boerewors	2	0.48	3.92	13.46
Pork	1	0.05	1.96	10.45
Beef, chicken and chicken gizzards	1	0.05	1.96	10.45
Game	1	0.05	1.96	10.45

Respondents, who traded more than one meat product, were asked for customer preferences (Table 11).

Table 11: Customer preference (respondents with more than one product only)

	Respondents	Percent (within confidence interval, α = 0.05)		
Beef over chicken	10	21.13	40.00	61.33
No preference	6	9.36	24.00	45.13
Beef over boerewors	4	4.54	16.00	36.08
Chicken over beef	3	2.55	12.00	31.22
Chicken gizzards over boerewors	1	0.10	4.00	20.35
Chicken over beef and chicken gizzards	1	0.10	4.00	20.35

Amongst respondents who traded more than one meat product where beef was included, there is a significant coherence between the customer preference and the products offered (p=0.009, Phi = 0.564, α = 0.05). As long as beef is offered, there seems to be a clear preference of beef by customers (Table 12). This is logical, since a customer seeking beef would always look for a trader selling beef.

Table 12: Customers preference (respondents trading beef and chicken products together only)

	Respondents	Percent (within confidence interval, α = 0.05)		
Beef	10	35.43	62.50	84.80
Chicken	4	7.27	25.00	52.38
No preference	2	1.55	12.50	38.35

Only one respondent could be identified, who regularly sold game meat. This respondent was encountered in Pongola and was the only respondent that was classified as an informal retailer. Another respondent said that she obtained impala offal for her street food business about three times a year (each time one 10-kg-bucket from a butchery). This respondent was encountered in Pongola, too. When asked if they would obtain game meat and edible game meat by-products such as offal for their businesses if it would be available legal and cheaply, the majority (n = 30 / 58.82%) of informal meat traders said they would. The question if they think that their customers would actually buy the game meat and edible by-products if they would offer it, was answered by the respondents with a very similar trend, as most of them (n = 32 / 62.75%) agreed (Table 13). One respondent mentioned that the trade of game meat "may be illegal".

Table 13: Trade of game meat and its' perceived acceptance amongst customers

Trade of game meat and/or edible by-products

	Respondents	Percent (within confidence interval, α = 0.05)		
Never	49	86.54	96.08	99.52
Sometimes (offal)	1	0.05	1.96	10.45
Regularly (meat)	1	0.05	1.96	10.45

Would purchase and trade game meat and edible by-products if available legally and cheaply

	Respondents	Percent (within confidence interval, α = 0.05)		
Yes	30	44.17	58.82	72.42
No	14	15.89	27.45	41.74
Don't know	7	5.7	13.73	26.26

Customers would buy game meat and by-products if offered

	Respondents	Percent (within confidence interval, α = 0.05)		
Yes	32	48.08	62.75	75.87
No	12	12.79	23.53	37.49
Don't know	7	5.70	13.73	26.26

No significant coherence could be identified between the location of the informal meat trade businesses and the question, whether game meat and edible by-products would be purchased by the operators if available legally and cheaply ($p = 0.215$, Phi = 0.395, $\alpha = 0.05$). By excluding the towns of Nongoma and Tshejuba, where only one respondent was encountered in each town, no significant coherence could be identified between these variables as well ($p = 0.169$, Phi = 0.362, $\alpha = 0.05$). Similarly, there is no significant coherence between the location of informal meat trade businesses and the opinion of respondents, whether customers would buy game meat and edible by-products ($p = 0.838$, Phi = 0.838, $\alpha = 0.05$). By excluding Nongoma and Tshejuba, no significant coherence could be identified, too ($p = 0.726$, Phi = 0.203, $\alpha = 0.05$).

There is clearly no coherence between the question, whether informal meat traders offer beef alone or with other products and the question whether they would purchase game meat and edible by-products available legally and cheaply or not or no answer ($p = 1.000$, Phi = -0.035, $\alpha = 0.05$). This is also the case in terms of the coherence of these respondents' opinion about whether their customers would buy game meat and edible by-products if offered a choice of buying game meat products or beef ($p = 1.000$, Phi = -0.003, $\alpha = 0.05$).

4.1.3 Food safety

When the informal meat traders were asked to name the most important influence in terms of the decision on where to buy meat products for their businesses, it turned out that, for almost half of respondents, the price was the only and most important influence. Table 14 provides a detailed overview over the different factors of influence mentioned by the respondents.

Table 14: Most important factor of influence when deciding where to buy meat products

	Respondents	Percent (within confidence interval, α = 0.05)		
Price	25	34.75	49.02	63.40
Freshness	11	11.29	21.57	35.32
Price and freshness	9	8.40	17.65	30.87
Price, freshness and distance	2	0.48	3.92	13.46
Species/kind of meat	2	0.48	3.92	13.46
Relationship to supplier	1	0.05	1.96	10.45
Don't know	1	0.05	1.96	10.45

It was found that almost all (96.08%, CI = 86.54 – 99.52) of respondents appeared to derive their raw stock from the formal economy. Butcheries were the most important suppliers of informal meat traders (Table 15). They were mentioned by n = 38 respondents (74.51%, CI = 60.37 – 85.67) at least along with other types of suppliers. One respondent (1.96%) stated to buy live cattle from a farm and then slaughters the animal informally at home in order to sell the meat on the open market. Another respondent (1.96%) said that she purchased game meat from a hunter she knew in order to sell it in town.

Table 15: Suppliers of informal meat traders

	Respondents	Percent (within confidence interval, α = 0.05)		
Butchery	32	48.08	62.75	75.87
Supermarket	10	9.82	19.61	33.12
Butchery andSupermarket	5	3.26	9.80	21.41
Butchery and Abattoir	1	0.05	1.96	10.45
Wholesaler	1	0.05	1.96	10.45
Farm (live animal for home-slaughter)	1	0.05	1.96	10.45
Hunter (frozen pieces)	1	0.05	1.96	10.45

Thirty-seven respondents (72.55%) did not have any equipment to keep their raw products cool at their business premises (Table 16). However, concerning these n = 37 respondents, seven of them (18.92%) stated to cook or fry their products at home in advance and, therefore, to transport exclusively prepared foodstuffs to their places of business. Another four respondents (10.81%) said they would usually, on a daily basis, buy the required raw products in the early morning from retail shops close to their business premises and would then prepare these directly at the spot. However, the other n = 26 informal meat traders (70.27%) did not undertake any measures of this kind.

Table 16: Refrigeration of raw products at business premises and the handling of raw products by respondents not applying any refrigeration of raw products at their premises

Refrigeration of raw products at business premises	Respondents	Percent (within confidence interval, α = 0.05)		
None	37	58.26	72.55	84.11
Cooler box	12	12.79	23.53	37.49
Refrigerator	2	0.48	3.92	13.46
Raw product handling by the 37 respondents without refrigeration facilities				
	Respondents	Percent (within confidence interval, α = 0.05)		
Uncooled transport and storage at the business premises	26	53.02	70.27	84.13
Preparation immediately after purchase	7	7.96	18.92	35.16
Preparation at home	4	3.03	10.81	25.42

Thirty-eight respondents (74.51%) did not cool their raw products when transporting them to their businesses from at home or from shops (Table 17). One respondent, who apparently kept raw meat products in a cooler box during business hours, said she did not cool them when transporting them from the retail shop to the place of business. Only eleven respondents (21.57%) apparently cooled their raw products when transporting them to their places of business. They used cooler boxes. Two respondents who had access to refridegerators at their business premises said that they would not transport raw meat products on a daily basis. However, these two respondents stated to not cool their raw products when either bringing them there from at home (one respondent) or transporting them from the retail shop directly to the place of business (one respondent).

Table 17: Cooling of raw products during transportation

	Respondents	Percent (within confidence interval, α = 0.05)		
No	38	60.37	74.51	85.67
Yes	11	11.29	21.57	35.32
No transport	2	0.48	3.92	13.46

Twenty-eight informal meat traders (54.90%) stated that, at home, they would usually store their raw stock not longer than overnight. Fifteen other respondents (29.41%), said that they would obtain raw products on a daily basis. Nevertheless, seven respondents (13.73%) admitted to store raw products up to three or four days. Only one respondent (1.96%) stated to store raw meat products for around a week before selling them. Thirty-two informal meat traders (62.75%) said they had a refrigerator either at home or at their business premises, where the meat products would be stored. Two respondents (3.92%) did not have a refrigerator neither at home nor at the business premises. One of them was the open market vendor, who purchased live cattle. He admitted to slaughtering the animals informally in order to sell the meat, although this is prohibited by law in South Africa (RAMRAJH, 2009, personal communication). He claimed to have a refrigerator at home. However this was not large enough to store all the meat obtained from a slaughtered animal.

Concerning Table 18, there is a highly significant coherence between the storage mean used and the maximum storage period applied by respondents ($p = <0.0001$, $Phi = 0.969$, $\alpha = 0.05$). With only two categories for the storage mean, “cooled” and “not cooled” as well as only two categories for the storage time, “overnight at the maximum” and “longer”, a significant

coherence between the variables (p = 0.041, Phi = -0.305, α = 0.05) can be observed, too. Regarding this it can be said that the likeliness that meat products are cooled when stored by respondents significantly increases with increasing storage periods.

Table 18: Maximum storage period and mean for storage applied by informal meat traders

Maximum storage from purchase to sale	Respondents	Percent (within confidence interval, α = 0.05)		
Overnight-storage	28	40.34	54.90	68.87
Sold same day (no storage)	15	17.49	29.41	43.83
3 to 4 days	7	5.70	13.73	26.26
One week	1	0.05	1.96	10.45
Mean for storage	Respondents	Percent (within confidence interval, α = 0.05)		
Refrigerator	32	48.08	62.75	75.87
No storage	15	17.49	29.41	43.83
Freezer	2	0.48	3.92	13.46
Uncooled at home	2	0.48	3.92	13.46

It can be seen from Table 19 that the majority of informal meat traders (62.75%), said that, at the end of a day of business, leftovers would be taken home and consumed there.

Table 19: Handling of already prepared leftovers by respondents

	Respondents	Percent (within confidence interval, α = 0.05)		
Take home and eat	32	48.08	62.75	75.87
No leftovers	10	9.82	19.61	33.12
Try to sell the next day	9	8.40	17.65	30.87

The great majority of respondents (n = 43 / 84.31%) stated that rubbish that is generated during the execution of their businesses, would be dumped in communal bins. One informal meat trader claimed not to produce any rubbish. This particular respondent was the one classified as an informal retailer. The findings in terms of rubbish disposal are presented in Table 20.

Table 20: Dealing with rubbish disposal

	Respondents	Percent (within confidence interval, α = 0.05)		
Throw rubbish into communal bin	43	71.41	84.31	92.98
Leave rubbish behind	6	4.44	11.76	23.87
Truck comes and fetches rubbish	1	0.05	1.96	10.45
No rubbish	1	0.05	1.96	10.45

Most respondents appeared to not have any special working clothes, as indicated by Table 21.

Table 21: Change of working clothes

	Respondents	Percent (within confidence interval, α = 0.05)		
No special clothes	39	62.51	76.47	87.21
Daily	8	7.02	15.69	28.59
When Convenient	4	2.18	7.84	18.88

No respondent took a break from business throughout the day. All respondent started working earlier or later in the morning and then finished selling in the afternoon or evening. The daily business hours of respondents are displayed in Table 22. Thus, only the time respondents spent at their places of business was considered, with the exclusion of travelling time. Most respondents started their businesses in the early morning hours, sometimes as early as 3 o'clock. The businesses of these respondents often were located at or close to taxi ranks and bus shelters. These locations, are already frequented by travellers and commuters who are potential clients, in the early morning hours.

Table 22: Daily business hours of respondents

Business hours	Daily hours	Respondents	Business hours	Daily hours	Respondents
3h00 – 18h00	15	1	7h30 – 17h00	9.5	1
5h00 – 19h00	14	1	8h00 – 17h30	9.5	1
6h30 – 19h30	12.5	1	5h45 – 17h00	9.25	1
7h30 – 20h00	12.5	1	9h00 – 18h00	9	1
3h00 – 15h00	12	1	7h00 – 16h00	9	1
4h00 – 16h00	12	1	8h00 – 17h00	9	2
7h00 – 19h00	12	1	8h00 – 16h30	8.5	1
5h00 – 17h00	12	2	7h00 – 15h00	8	2
6h30 – 17h30	11	2	9h00 – 17h00	8	2
6h00 – 17h00	11	3	8h00 – 16h00	8	8
7h00 – 17h30	10.5	1	8h00 – 15h30	7.5	1
8h00 – 18h00	10	1	9h00 – 16h00	7	3
6h00 – 16h00	10	2	6h00 – 13h00	7	1
7h00 – 17h00	10	5	8h00 – 14h30	6.5	1
7h00 – 16h30	9.5	1	6h00 – 12h00	6	1

Most respondents (n = 35 / 68.63%) said that more or less everybody who passed them would be a potential buyer and that they could not identify a particularly important group amongst their customers (Table 23).

Table 23: Most important customer group identified by respondents

	Respondents	Percent (within confidence interval, $\alpha = 0.05$)		
No special group	35	54.11	68.63	80.89
Taxi commuters	8	7.02	15.69	28.59
Employees	3	1.23	5.88	16.24
Truckers	2	0.48	3.92	13.46
Hospital staff/visitors	1	0.05	1.96	10.45
Bus-Depot-workers	1	0.05	1.96	10.45
Mechanics	1	0.05	1.96	10.45

4.1.4 Observation of prerequisites and practices of product handling

Most informal meat traders interviewed (n = 33 / 64.71%) were encountered in commercial areas. One had established his business next to the entry gate of a hospital. One respondent, the only one classified as informal retailer, could not be allocated to any certain type of road as she did not make use of a permanent place of business. Thirty-eight respondents (74.51%, CI = 67.37 – 85.67) appeared to be located next to a solid road that either was tarred or constructed

out of paving stones and generally near to a taxi or bus station. There is a significant coherence between the location of an informal meat trader and the question whether he or she was operating next to a solid or non-solid road ($p = 0.019$, Phi = 0.506, $\alpha = 0.05$). By excluding the locations Nongoma and Tshejuba with one respondent only, this significance remains ($p = 0.093$, Phi = 0.496, $\alpha = 0.05$). This finding indicates that the quality of road infrastructure differed from one town to the next. In detail, the distribution of the 51 respondents over the different types of areas as well as the nature of the adjacent road is presented by Table 24.

Table 24: Business area and nature of road next to premises

Business area				
	Respondents	Percent (within confidence interval, $\alpha = 0.05$)		
Commercial area	33	50.07	64.71	77.57
Trabsport area	14	15.89	27.45	41.74
Recreational area	2	0.48	3.92	13.46
Hospital area	1	0.05	1.96	10.45
Mobile (no permanent area)	1	0.05	1.96	10.45
Nature of road next to premises				
	Respondents	Percent (within confidence interval, $\alpha = 0.05$)		
Tarred	36	56.17	70.59	82.51
Paving stones	2	0.48	3.92	13.46
Gravel	12	12.79	23.53	37.49
Mobile (no permanent place)	1	0.05	1.96	10.45

Forty-six respondents (90.20%) did not have access to any running water at or close to their places of business. Out of the five informal meat traders (9.80%) who claimed to have access to running water, three (5.88%, CI = 1.23 – 16.24) stated they accessed water from municipal taps close to their places of business. The other two obtained water from a nearby garage and from a tap in a nearby junkshop, respectively. Remarkably, four out of these five respondents (80%) were based in Pongola. Regarding this, there is a significant coherence ($p = 0.006$, Phi = 0.468, $\alpha = 0.05$) between the location of respondents and the access to running water if the variable "location" is only subdivided into the two categories "Pongola" and "other". Table 25 shows the accessibility of running water and the methods of water maintenance applied by the respondents. Mostly they were required to bring along their own water from their homes on a daily basis or did not use any water whilst operating their businesses.

Table 25: Availability of running water to respondents and methods of water maintenance

Access to running water at or close to business premises				
	Respondents	Percent (within confidence interval, $\alpha = 0.05$)		
No	46	78.59	90.20	96.74
Yes	5	3.26	9.80	21.41
Water maintenance for cooking and washing				
	Respondents	Percent (within confidence interval, $\alpha = 0.05$)		
Bring own water	42	69.13	82.35	91.6
Access at/near spot	5	3.26	9.80	21.41
No use of water	4	2.18	7.84	18.88

Because the majority of respondents without access to running water brought along their own water, ablutions for washing hands and dishes were widely encountered across the different Informal meat traders (n = 47, 92.16%, CI = 81.12 – 97.82). Only one respondent turned out to have access to electricity at the business premises. With the electricity, this particular respondent operated a refrigerator used for the storage of raw meat products. This particular respondent had a self-made shack and, at night, could rely on the guardance of his premises by security guards employed by an adjacent supermarket. Another respondent, who also used a refrigerator at the business premises, did run it with gas due to a lack of electricity.
Forty-two respondents (82.35%, CI = 69.13 – 91.60) claimed to have access to public toilets when necessary. One respondent stated to use the toilet of a nearby shop. Eight respondents (15.69%, CI = 7.02 – 28.59) claimed not to have access to any toilet at or close to their business premises. However, there is no significant coherence between the different towns and the access to toilets ($p = 0.258$, $Phi = 0.414$, $\alpha = 0.05$). By excluding the two respondents in Nongoma and Tshejuba, no significance can be determined either ($p = 0.526$, $Phi = 0.262$, $\alpha = 0.05$).
Twenty-seven respondents (52.94%) had set up their business premises on bare ground such as grass or soil (Table 26). There is no significant coherence between the location of respondents and whether their business premises were set up on bare ground or if they had some kind of solid floor ($p = 0.087$, $Phi = 0.448$, $\alpha = 0.05$). If the two respondents interviewed in Nongoma and Tshejuba are excluded, still no significant coherence can be determined between the two variables of interest ($p = 0.101$, $Phi = 0.40$, $\alpha = 0.05$).

Table 26: Nature of floor of business premises

	Respondents	Percent (within confidence interval, $\alpha = 0.05$)		
Soil/bare ground	27	38.46	52.94	67.07
Paving stones	9	8.40	17.65	30.87
PVC/Plastic	5	3.26	9.80	21.41
Cement	4	2.18	7.84	18.88
Gravel	2	0.48	3.92	13.46
Concrete	2	0.48	3.92	13.46
Metal	1	0.05	1.96	10.45
Mobile (no permanent kind of floor)	1	0.05	1.96	10.45

Looking at Table 27, most informal meat trading premises (n = 35 / 68.63%) did not have any walls. Seven respondents (13.73%) had constructed their own shacks to use them as permanent business premises. Another 4 respondents (7.84%) utilized abandoned caravans.

Table 27: Nature of walls of business premises

	Respondents	Percent (within confidence interval, $\alpha = 0.05$)		
No walls	35	54.11	68.63	80.89
Shack	7	5.70	13.73	26.26
Caravan	4	2.18	7.84	18.88
Tent	2	0.48	3.92	13.46
Cement	1	0.05	1.96	10.45
Container	1	0.05	1.96	10.45
No permanent premises	1	0.05	1.96	10.45

Table 28 is presenting the different types of roofs encountered at the different business premises. Similarly to the findings in respect of the walls, the majority either had no roof (n = 19 / 37.25%) or just a very simple one (n = 12 / 23.53%).

Table 28: Nature of roof of business premises

	Respondents	Percent (within confidence interval, α = 0.05)		
No roof	19	24.13	37.25	51.92
Cloth, plastic (tent/sheet) or umbrella	12	12.79	23.53	37.49
Shack	7	5.70	13.73	26.26
Caravan	4	2.18	7.84	18.88
Shelter provided by municipaltity	4	2.18	7.84	18.88
Self-made shelter	3	1.23	5.88	16.24
Container	1	0.05	1.96	10.45
No permanent premises	1	0.05	1.96	10.45

The cleanliness of the surroundings of the businesses of informal meat traders was classified as either very clean, acceptable or dirty (Table 29).

Table 29: Cleanliness of business surroundings

	Respondents	Percent (within confidence interval, α = 0.05)		
Acceptable	38	60.37	74.51	85.67
Dirty	10	9.82	19.61	33.12
Very clean	2	0.48	3.92	13.46
No permanent surroundings	1	0.05	1.96	10.45

Different scorings in terms of hygiene issues were carried out in the scope of the observation of prerequisites and practices (Table 30). The number of flies, the amount of dust and the cleanliness of business premises of respondents were each scored from 0 to 5, whereby 0 stood for “no flies”, “no dust” and “excellently clean business premises” respectively. Analogous, 5 referred to “a lot of flies”, “a lot of dust” or “very dirty business premises” respectively. Moreover, the cleanliness of washing water was scored from “0” to “5”, whereby 0 ment “excellent” and 5 ment “poor”. However, the washing water of nine respondents (17.65%) could not be scored. When these respondents were interviewed, they had not made use of their washing water yet and the containers filled with water were still untouched. Another four respondents (11.76%) did, as presented earlier, not make use of any water. Finally, the general presence of rubbish, dirty water and mud at and around the business premises was scored from “0” to “5”. Thereby, “0” ment “none” and “5” stood for “a lot”.

Table 30: Scorings of hygiene of business premises

Flies in premises (SCORE 0-5):

Scoring	Respondents	Percent
No flies 0	31	60.78
Very few flies 1	15	29.41
Flew flies 2	0	0
Some flies 3	2	3.92
Numerous flies 4	0	0
A lot of flies 5	2	3.92
No classification	1	1.96

Dust in premises (SCORE 0-5):

Scoring	Respondents	Percent
No dust 0	33	64.71
Very little dust 1	15	29.41
Little dust 2	2	3.92
Some dust 3	0	0
Much dust 4	0	0
A lot of dust 5	0	0
No classification	1	1.96

Cleanliness of business premises (SCORE 0-5):

Scoring	Respondents	Percent
Excellent 0	4	7.84
Good 1	9	17.65
Satisfactory 2	26	50.98
Suboptimal 3	9	17.65
Inadequate 4	2	3.92
Poor / very dirty 5	0	0
No classification	1	1.96

Cleanliness of washing water (SCORE 0-5):

Scoring	Respondents	Percent
Excellent 0	2	3.92
Good 1	7	13.73
Satisfactory 2	17	33.33
Suboptimal 3	4	7.84
Inadequate 4	6	11.76
Poor / very dirty 5	2	3.92
No classification	9	17.65
No water	4	7.84

Rubbish/dirty water/ mud at or near business premises (SCORE 0-5):

Scoring	Respondents	Percent
None 0	3	5.88
Very few 1	4	7.84
Few 2	19	37.25
Some 3	15	29.41
Much 4	6	11.76
A lot 5	3	5.88
No classification	1	3.92

There is a significant correlation between the presence of dust and flies in the premises of informal meat traders ($p < 0.0001$, SpCC = 0.553, $\alpha = 0.05$), also if only two categories for each variable ("present", "not present") are considered ($p < 0.0001$, SpCC = 0.656, $\alpha = 0.05$). Dustier premises seemed to attract more flies. The correlation between the presence of dust and the cleanliness of business premises is significantly negative ($p = 0.012$, SpCC = -0.353, $\alpha = 0.05$). Premises rated as cleaner than others were less dusty. However, there is no significant correlation between the cleanliness of business premises and the presence of flies ($p = 0.055$, SpCC = -0.273, $\alpha = 0.05$). But if the scoring of flies is only expressed in the two categories "present" and "not present", then there is a significant correlation between the variables ($p = 0.039$, SpCC = -0.293, $\alpha = 0.05$).
There is no significant correlation ($p = 0.736$, SpCC = 0.056, $\alpha = 0.05$) between the time of the interview and the scoring of the cleanliness of the washing water encountered. Nevertheless, the correlation between the access to running water and the scoring of the cleanliness of the washing water turned out significant ($p = 0.022$, SpCC = -0.371, $\alpha = 0.05$). If running water was available at or close to the business premises, the washing water tended to be cleaner when encountered. There is no significant correlation between the location and the presence of rubbish, dirty water and mud ($p = 0.378$, SpCC = -0.127, $\alpha = 0.05$), also not if the respondents in Nongoma and Tshejuba are excluded ($p = 0.243$, SpCC = -0.172, $\alpha = 0.05$).
Slightly more than half of all respondents (52.94%) kept their prepared meat products covered until they were sold (Table 31).

Table 31: Display of already prepared products by respondents

	Respondents	Percent (within confidence interval, $\alpha = 0.05$)		
In pot, covered	22	29.35	43.14	57.75
In bucket, covered	2	0.48	3.92	13.46
In plastic-box, covered	1	0.05	1.96	10.45
In cooler box, covered	2	0.48	3.92	13.46
Total	**27**	**38.46**	**52.94**	**67.07**
On grill, uncovered	22	29.35	43.14	57.75
Metal plate, uncovered	1	0.05	1.96	10.45
On plate, uncovered	1	0.05	1.96	10.45
Total	**24**	**32.93**	**47.06**	**61.54**

The coherence between the method of product preparation (cooking, grilling or both) and if respondents are covering the prepared products is highly significant ($p = < 0.0001$, Phi = 0.747, $\alpha = 0.05$). The covering of already prepared meat products until sale was more common amongst respondents who cooked them in a pot than amongst those who roasted them on a grill. Almost all (96.00%, CI = 79.65 - 99.90) of the n = 25 respondents who offered more than one product apparently practiced an adequate spatial separation of different products at display. The only respondent (4%, 0.10 – 20.35), who did obviously not adequately separate different meat products at display was a female who offered chicken gizzards together with boerewors in Jozini. Thereby, she apparently kept the two different products piled on each other in one corner of her grill.

All but one respondent (98.04%, CI = 89.55 – 99.95) did handle food and other things such as money or cigarettes without washing hands in between. Nevertheless, n = 41 respondents (80.39%, CI = 66.88 – 90.18) did obviously make use of utensils when handling meat products and other food items.
Forty-six respondents (90.2%, CI = 78.59 – 96.74) stated to dispose their waste water by throwing it onto the ground close to their premises. Differently, five respondents (9.80%, CI = 3.26 – 21.41) indicated that they would poor waste waters into drainage systems, which they pointed out close to their premises. Thirty respondents (58.82%) used take-away boxes made of styrofoam and analogous to these used by many formal fast food retailers (Table 32).

Table 32: Wrapping of products for take-away

	Respondents	Percent (within confidence interval, α = 0.05)		
Take-away-boxes (styrofoam)	30	44.17	58.82	72.42
Plastic-bag	12	12.79	23.53	37.49
"no take away is done"	5	3.26	9.80	21.41
No packing	2	0.48	3.92	13.46
Plastic-bag and paper	1	0.05	1.96	10.45
Newspaper	1	0.05	1.96	10.45

In the great majority of cases (n = 48, 94.12%), neither livestock, nor dogs or pigeons scavenging close to the business premises could be detected. Only in the case of three respondents, one in Jozini, Hlabisa and Hluhluwe each, scavenging livestock was encountered. In two cases (3.92%, CI = 0.48 – 13.46) this were chickens and in one case (1.96%, CI = 0.05 – 10.45) one sheep was encountered.
Table 33 shows that n = 46 informal meat traders (90.20%) sold exclusively ready-to-eat products to their customers. Only one respondent could be encountered who traded exclusively raw meat. This was the already mentioned informal retailer in Pongola.

Table 33: Types of products offered by informal meat traders

	Respondents	Percent (within confidence interval, α = 0.05)		
Ready-to-eat	46	78.59	90.20	96.74
Both	4	2.18	7.84	18.88
Raw	1	0.05	1.96	10.45

As shown by Table 34, most respondents (n = 29) exclusively grilled their products over the fire. There is a significant coherence between the location and the way of product preparation (p = 0.014, Phi = 0.658, α = 0.05). In Jozini, Mkuze and Hluhluwe, the majority of respondents grilled meat products over a fire. Differently, in Hlabisa, none out of five respondents used a grill and in Pongola only four out of eleven did so. If the two respondents in Nongoma and Tshejuba are excluded, the coherence turn out to be more significant (p = 0.011, Phi = 0.623, α = 0.05).

Table 34: Product preparation by respondents

	Respondents	Percent (within confidence interval, α = 0.05)		
Grilling over fire	29	42.25	56.86	70.65
Cooking in pot	17	20.76	33.33	47.92
Both	4	2.18	7.84	18.88
No preparation	1	0.05	1.96	10.45

In regard to the cooking fuel used for product preparation, Table 35 is providing a detailed overview. Wood (37.25%) and charcoal (33.33%) were most frequently used.

Table 35: Cooking fuel used by respondents

	Respondents	Percent (within confidence interval, α = 0.05)		
Wood	19	24.13	37.25	51.92
Charcoal	17	20.76	33.33	47.92
Gas	8	7.02	15.69	28.59
Paraffin	3	1.23	5.88	16.24
Electricity	1	0.05	1.96	10.45
Wood and charcoal	1	0.05	1.96	10.45
Wood and gas	1	0.05	1.96	10.45
No preparation	1	0.05	1.96	10.45

There is a highly significant coherence between the location of respondents and the cooking fuel used for product preparation ($p = 0.004$, Phi = 0.736, $\alpha = 0.05$). For cooking fuel, three categories (wood, charcoal and other) were considered. One respondent in Hluhluwe was not considered as both, wood and charcoal were used, what made a classification impossible. When the two respondents in Nongoma and Tshejuba are excluded, this significance is still very high ($p = 0.005$, Phi = 0.681, $\alpha = 0.05$). Regarding this, in Hluhluwe all six respondents used wood whilst in Pongola only three out of the eleven respondents made use of this kind of cooking fuel. In Jozini only three out of the 16 respondents turned out to use wood. However, charcoal turned out to be a popular cooking fuel for informal meat traders in Jozini in particular, as eleven out of the 16 respondents used it.

4.2 Meat sampling and the second interviewing of selected respondents

4.2.1 Microbiological analysis of meat samples

The aerobic bacterial plate count as well as the presence of *E. coli* / coliforms were deterimed. In this context, the bacterial growth was rated, the purity of this growth was determined and bacterial strains present in the samples were identified. As shown by Table 36, eight samples did not show any bacterial growth after 48 hours.

Table 36: Analysis of meat samples from informal meat traders

Respondent	Sample type(s)	Growth rating	Purity	Identification
1	Raw beef	Heavy	Mixed	Mixed growth/contaminants
1	Prepared beef	None (48 h)	None (48 h)	None (48 h)
2	Raw beef	Heavy	Mixed	Mixed growth/contaminants
2	Prepared beef	None (48 h)	None (48 h)	None (48 h)
3	Prepared beef	Scanty	Mixed	No significant isolates
4	Not encountered	---	---	---
5	Prepared beef	None (48 h)	None (48 h)	None (48 h)
6	Prepared beef	Moderate	Mixed	Mixed growth/contaminants
7	Prepared beef	Scanty	Mixed	No significant isolates
8	Raw beef	Heavy	Mixed	Mixed growth/contaminants
8	Prepared beef	Scanty	Mixed	No significant isolates
9	Not encountered	---	---	---
10	Prepared beef	Scanty	Mixed	No significant isolates
11	Prepared beef	Heavy	Mixed	Mixed growth/contaminants
12	Prepared beef	None (48 h)	None (48 h)	None (48 h)
13	Prepared beef	None (48 h)	None (48 h)	None (48 h)
14	Prepared beef	Scanty	Mixed	No significant isolates
15	Prepared beef	None (48 h)	None (48 h)	None (48 h)
16	Prepared beef	None (48 h)	None (48 h)	None (48 h)
17	Raw beef	Heavy	Mixed	Mixed growth/contaminants
18	Raw beef	Heavy	Mixed	Mixed growth/contaminants
18	Prepared beef	Heavy	Mixed	Mixed growth/contaminants
19	Prepared beef	Heavy	Mixed	Coliforms (more than 1 type)
20	Raw beef	Heavy	Mixed	Mixed growth/contaminants
21	Raw beef	Heavy	Mixed	Coliforms (more than 1 type)
22	Prepared chicken	Heavy	Mixed	Mixed growth/contaminants
23	Prepared beef	None (48 h)	None (48 h)	None (48 h)

There is a significantly negative correlation between the state of the samples (raw or prepared) and the bacterial growth rating ($p = 0.0004$, $SpCC = -0.649$, $\alpha = 0.05$). For statistical analyis, “scanty” and “moderate” growth were combined to one category in order to avoid too many categories and therefore too small statistical classes, as a “moderate growth” was only determined in one case only. Prepared meat samples clearly turned out to be of a better microbiological quality than raw meat samples in terms of the presence and multiplication of bacteria. All samples for which no bacterial growth could be determined were prepared ones. The correlation between the state of the samples (raw or prepared) and the purity of growth is significantly negative, too ($p = 0.0329$, $SpCC = -0.428$, $\alpha = 0.05$). However, this result was probably obtained because all samples for which no bacterial growth could be determined were prepared ones. All others showed a mixed growth. The correlation between the state of the samples (raw or prepared) and the identification of bacterial growth turns out to be significanty negative as well ($p = 0.002$, $SpCC = -0.581$, $\alpha = 0.05$). As in terms of growth rating, this showes that prepared meat samples clearly turned out to be of a better microbiological quality regarding the strains of bacteria present. However, in most cases ($n = 10$), a mixed growth with contaminants was determined. In two cases, coliforms were identified. Nevertheless, these were detected in one raw and one prepared meat sample. Therefore, although the overall incidence of coliforms in the samples was low, prepared meat samples do not appear to be superior over raw ones regarding the presence of coliforms in particular.

4.2.2 The interview with respondents selected for meat sampling

In regard to the question what they would change in terms of their working conditions if they would be able to, 18 out of the 21 respondents (60% of all statements, 85.71% of respondents) stated that they would like to upgrade their shelter or business premises (sometimes amongst other issues). If no shelter at all was present, than these respondents desired to have one (Table 37).

Table 37: Most desired modification of working conditions (more than one answer is acceptable)

	Number of statements (ranking)	Percent of stall statements (within confidence interval, $\alpha = 0.05$)		
Improve/built shelter	18	40.60	60.00	77.34
More tables and chairs	4	3.76	13.33	30.72
Store room for fixed assets	2	0.82	6.67	22.07
Move to other place	1	0.08	3.33	17.22
Entertain customers	1	0.08	3.33	17.22
Charge reasonable prices	1	0.08	3.33	17.22
Cleaner surroundings	1	0.08	3.33	17.22
Offer greater goods variety	1	0.08	3.33	17.22
Install water tap	1	0.08	3.33	17.22

In terms of the biggest problem they are facing during their daily activity, 16 respondents (30.77% of all statements) identified the lacking availability of running water at or close to their business premises as the major problem with which they are confronted (Table 38). Eight of them (15.38% of all statements) added that they have to bring water from their homes on a daily basis. Concerning this, one respondent said that she would have to "steal" the required water from the nearby petrol station in order to avoid the transportation of water on a daily basis.

Table 38: The biggest business-related problem of informal meat traders (more than one answer is acceptable)

	Number of statements (ranking)	Percent of all statements (within confidence interval, $\alpha = 0.05$)		
Lack of water at the spot	16	18.72	30.77	45.10
Daily transport of water	8	6.88	15.38	28.08
Inadequate shelter	7	5.59	13.46	25.79
Price increase of stock	3	1.21	5.77	15.95
No store room	3	1.21	5.77	15.95
Daily transport of firewood	2	0.47	3.85	13.21
Insecure tenure	2	0.47	3.85	13.21
Need to pay rent	2	0.47	3.85	13.21
Need to steal water	1	0.05	1.92	10.26
Contract limits flexibility	1	0.05	1.92	10.26
Lack of business space	1	0.05	1.92	10.26
Few tables and chairs	1	0.05	1.92	10.26
Store room is distant	1	0.05	1.92	10.26
Limited number of buyers	1	0.05	1.92	10.26
Toilets in no good condition	1	0.05	1.92	10.26
Too much theft	1	0.05	1.92	10.26
Daily purchase of charcoal	1	0.05	1.92	10.26

When asked for their personal opinion and during informal discussions around the questions, regarding the major findings from the previous interviewing of informal meat traders, the most important was considered to be the lack of access to water (see Table 39) followed by a lack of electricity. One respondent said that, if electricity was available, she could use a microwave to warm up foods. Also, she said, gas would be expensive, which was confirmed by a second respondent. However, one informal meat trader said that electricity would not be that important to her as she would be able to afford gas. Another respondent, also said that, compared to water, electricity would not be that important. Nevertheless, one respondent said that, due to the lack of electricity, she would be forced to stock her business on a daily basis as raw stock cannot be stored for long periods of time at the business premises due to the absence of a refrigerator or freezer. However, she said that electricity in the premises might not be safe due to a "generally strong wind" that may damage current lines. Another respondent said that electricity would be good to keep the food fresh for a longer period of time. Also, one respondent stated that, with electricity, her customers could be entertained by TV or radio during eating. Two informal meat traders said that the availability of electricity would make it unneccessary to buy and to carry firewood on a daily basis. It was felt that the contributions to this question gave a good chance of participatory contributions by the traders and would possibly be a starting point in future formalization of the market.

Table 39: Personal opinions regarding the findings of the previous survey (more than one answer is acceptable)

	Number of statements (ranking)	Percent of all statements (within confidence interval, $\alpha = 0.05$)		
Access to running water would be good	11	15.42	28.95	45.90
Access to electricity would be good	7	7.74	18.42	34.33
No wood transport if electricity	2	0.64	5.26	17.75
Gas is expensive, electricity would be nice	2	0.64	5.26	17.75
Electricity is not that important	2	0.64	5.26	17.75
Electricity would allow to use microwave	1	0.07	2.63	13.81
Need to stock daily because no electricity	1	0.07	2.63	13.81
Electricity may not be safe at the spot	1	0.07	2.63	13.81
Electricity allows longer storage of food	1	0.07	2.63	13.81
Electricity allows customer entertainment	1	0.07	2.63	13.81
Electricity and water should be provided	1	0.07	2.63	13.81
Electricity and water are good for customers	1	0.07	2.63	13.81
No electricity: Need to buy firewood regularly	1	0.07	2.63	13.81
Taxi charges extra for firewood and water	1	0.07	2.63	13.81
Would be good to be registered to raise claims	1	0.07	2.63	13.81
I can attract buyers with nice caravan anyhow	1	0.07	2.63	13.81
My shelter and assets should be better	1	0.07	2.63	13.81
I want to be able to lock assets at spot	1	0.07	2.63	13.81
Don't know	1	0.07	2.63	13.81

Twelve respondents (57.14%) said that, if they would prepare heads, feet and offal of game animals for customers, then they would cook it. Interestingly, market research and customer service were also a consideration, as one respondent stated that she would ask the customers

first how they would like it. Then, based on the received answers, she would decide how to prepare it. These findings are summarized in Table 40.

Table 40: Preparation of game heads, feets and offal if received

	Respondents	Percent
Cook it	12	57.14
Grill	6	28.57
Don't know	2	9.52
Ask customers first	1	4.76

When asked how much they could afford to pay for heads, feet and offal of game animals, the informal meat traders did either not understand the context of the question or they did not know an answer to it. Therefore, for all respondents, the daily expenses for red meat on the basis of one kilogram were recorded. There were great variations but, generally said, it can be assumed that most informal meat traders can afford to pay between ZAR 30 and ZAR 40 per kg of red meat (€ 2.54 to € 3.39 (OANDA, 2009)) at supermarkets or butchers. In the formal retail of South Africa, cheaper cuts of beef and lamb can be purchased within this price interval. Currently, special cuts of beef such as steak are usually offered at a price ranging around ZAR 50.00 to ZAR 90.00 (€ 4.23 to € 7.62 (OANDA, 2009)) per kilogram. At the abattoir, the price is about ZAR 20 per kg (€ 1.69 (OANDA, 2009)), but then the amount that must be bought is over 200 kg. Lamb generally tends to be more expensive than beef. Goat meat was not encountered in the formal retail shops within the study area.

4.3 Experiment: Preparation of game meat by informal meat traders

4.3.1 The observation of prerequisites and practices of meat handling and product preparation

As explained under "Materials and Methods", the results of the interviews with informal meat traders in KwaZulu-Natal indicated that game meat and edible game meat by-products could be sold in informal markets. In order to test the feasibility and food safety aspects of this possibility, formally purchased game meat was given to informal meat traders to prepare it at an informal market at Wonderboom station in Gauteng.

Right next to where the game meat was prepared, public toilet facilities were installed. From there, the participants obtained the water needed for the preparation of game meat. They were the only toilet facilities at the train station and probably they were utilized by all informal traders and, potentially, by many by-passers, too. The water obtained looked clean, although no microbiological analysis was carried out, however it was municipal water and had been filtered and chlorinated.

The business premises as well as the surroundings were rather dirty. Some areas were muddy, probably due to the discharge of water or due to leaking water pipes as it has not rained for several days prior to the experiment. On the ground, a lot of waste materials such as packaging material could be detected. The ground around the respondents' businesses was bare soil. Probably due to the regular use of large quantities of firewood it was blackened by ashes.

The four respondents all wore scarves covering their hair, but none of them wore gloves when handling the meat. One respondent wore a full apron. The respondents did not use a shelter but just had two tables and some chairs for their own use. One table was used by the respondents to

cut up the vegetables used for meat preparation. Before this, one respondent cleaned the surface of the table with water and detergent. In the area of cooking and meat preparation, no flies could be detected. There was no wind and no dust could be detected.

4.3.2 The preparation of the game meat

None of the respondents washed hands before handling the meat. In order to wash off the residues of blood attached to the meat, the respondents washed the meat pieces in a bowl of water by hand, prior to putting them into the pot. This water then was discarded onto the ground. For cooking fuel, wood was used. This wood was obtained from discarded freight pallets and was not lacquered. The meat was cooked in traditional metal pots which were kept covered throughout the cooking process. To stir the meat in the different pots, the same fork was used across all four respondents.
The same fork was then used to put meat samples into the sterile sampling bags. The respondents cooked every batch of meat in water only for some time before adding the other ingredients. Every batch of meat was cooked between 33 and 57 minutes. The different cooking times as well as the weight of samples taken are presented in Table 41.

Table 41: Duration of cooking of different meat batches and weight of samples

Species and sample number	Cooking (min)	Succession*	Raw sample (g)	Cooked sample (g)
Impala 1	42	2	10.08	10.02
Impala 2	50	2	10.21	10.17
Impala 3	57	1	10.12	10.16
Impala 4	45	1	10.00	10.21
Impala 5	50	3	10.04	10.25
Springbok 1	33	5	9.99	10.24
Springbok 2	43	4	10.15	10.09
Springbok 3	50	4	10.02	10.08

*Meat batches having the same number were put onto the fire the same time. The meat batches with the number 1 were cooked first, the meat batch with the number 5 were cooked last.

4.3.3 Microbiological analysis of game meat samples

As a result from the microbiological analyses, the bacterial load of the raw meat turned out to be higher than that one of the cooked meat (Table 42). *E. coli* could be identified in the case of one raw game meat sample (12.5%) and coliforms were present in all but one raw game meat sample (87.5%). No *E. coli* and no coliforms could be detected in cooked meat and, generally, if one exception is overlooked, the aerobic plate counts obtained from cooked meat samples turned out to be very low.

Table 42: Results from the microbiological analysis of raw and cooked game meat samples from the experiment

RAW GAME MEAT			
Sample	**TPC *(mean)**	***E. coli***	**Coliform count**
	Colonies per ml	**Colonies/ml**	**Colonies/ml**
Impala 1	660	0	0
	415	0	0
Impala 2	4100	0	5
	5400	0	7
Impala 3	15250	0	214
	11100	0	226
Impala 4	955	0	3
	900	0	4
Impala 5	2000	0	1
	1700	0	3
Springbok 1	11600	0	18
	9400	0	10
Springbok 2	13600	6	131
	12700	3	110
Springbok 3	1550	0	10
	4100	0	4
COOKED GAME MEAT			
Sample	**TPC* (mean)**	***E. coli***	**Coliform count**
	Colonies per ml	**Colonies/ml**	**Colonies/ml**
Impala 1	320	0	0
	400	0	0
Impala 2	1	0	0
	0	0	0
Impala 3	1	0	0
	1	0	0
Impala 4	0	0	0
	2	0	0
Impala 5	0	0	0
	1	0	0
Springbok 1	0	0	0
	0	0	0
Springbok 2	0	0	0
	0	0	0
Springbok 3	0	0	0
	0	0	0

*Total plate count.

There is a significantly negative correlation between the state of game meat samples (raw and cooked) and the question if bacteria are present ($p = 0.001$, Phi = -0.626, $\alpha = 0.05$). This is also the case in view of the presence of coliforms ($p < 0.0001$, Phi = -0.882, $\alpha = 0.05$).
Therefore, the microbiological quality of cooked game meat samples turns out to be significantly better compared to that one of raw game meat samples in terms of the presence of bacteria in general and the presence of coliforms. However, exclusively in terms of the presence of *E. coli* there is no significant coherence between the different states of samples (raw and cooked) and their presence ($p = 0.151$, Phi = -0.258, $\alpha = 0.05$), although no *E. coli* were detected in cooked meat samples.

4.3.4 The participatory group interview

All four informal meat traders would regularly trade game meat if it would be available legally and cheaply. All of them agreed to as well utilize offal, heads and feet of game animals this way under these conditions. None of them ever prepared game meat before in any way. Therefore, none of them could give an opinion on whether it would be possible to sell game meat or not. According to the four participants in the experiment, their exposure to rain due to a lacking proper shelter is their major problem in regard to their daily activity. They would like to have a cleaner working environment without all the rubbish and debris present and they would like to upgrade their premises by, for example, cementing the ground and building a proper shelter. They also stated that it would be good to have more chairs and tables for themselves as well as for customers and that, with a proper shelter, the food traded by them would be less exposed to the environment. After the meat was tried by all four informal meat traders as well as by four customers, all of them stated to like the taste of the game meat. Three of them additionally said that, to them, the game meat tasted similar to pork, which was a little bit surprising.

4.4 The statistical representativeness, expressiveness and reliability of information generated for Marketing Chain I

Although all informal meat traders encountered during sampling were interviewed, the sample generated in the District Municipalities of Zululand and Umkhanyakude cannot be called statistically representative for the overall situation within the study area, as the total number of informal meat traders within the area is unkown. Moreover, not all towns and settlements within the two District Municipalities of interest were visited for sampling. The sampling method applied brought along a systematic error as every town was only visited once for the sampling of the $n = 51$ informal meat traders. Some potential respondents may not have operated their businesses during these particular days.
Due to the limited sample size of $n = 51$ respondents, generally, the variance of the generated datasets was comparatively high. This becomes apparent when reviewing the width of confidence intervals ($\alpha = 0.05$) for the different results. Generally, the confidence intervals were rather wide. Moreover, although statistically significant, the observed coherences and correlations turned out to be rather weak in most cases. Therefore, the high variance of datasets reduces the expressiveness and reliability of information generated.
The results from the microbiological anlysis of game meat samples from the experiment conducted in Pretoria cannot be called statistically representative as well as only four informal meat traders were considered and the total number of informal meat traders in Pretoria is not

known. Moreover, the four informal meat traders were purposely selected for the experiment, operated one business together and all game meat originated from the same formal retailer.

Marketing Chain II

4.5 Biltong hunters

4.5.1 General information

All nine biltong hunters interviewed were male South Africans (Table 43). Three of them were of German descend. The other six were of South African descent. The two youngest biltong hunters interviewed were 25 years of age, whilst the oldest was 58 years old. Four of the biltong hunters owned game ranches and one of them owned a livestock farm. Not all biltong hunters interviewed were involved in the hunting and meat sectors, in terms of their occupation. The sampled biltong hunters appeared to have higher levels of education, although one respondent declined to mention the level of education achieved. Only two biltong hunters called hunting a primary source of income. Both have qualified as professional hunters.

Table 43: Basic information of biltong hunters

Respondent	Gender	Descend	Age	Location	Property
1	Male	German	45	Pongola	Game farm
2	Male	German	57	Richards Bay	None
3	Male	German	53	Richards Bay	None
4	Male	South African	43	Richards Bay	None
5	Male	South African	25	Kimberley	Game farm
6	Male	South African	25	Kimberley	Game farm
7	Male	South African	58	Free State	Domestic livestock farm
8	Male	South African	29	Pretoria	Game farm
9	Male	South African	55	Pretoria	None

Respondent	Occupation	Level of education	Importance of hunting for overall income
1	Owns veterinary clinic and hunting lodge	University	Secondary source of income
2	Owns butchery	Unclear	Hobby
3	Engineer	University	Secondary source of income
4	Medical Practicioner	University	Hobby
5	Outfitter (professional hunter)	University	Primary source of income
6	Owns Gun shop	Post secondary	Hobby
7	Owns Arab Stud ranch (professional hunter)	Post secondary	Primary source of income
8	University employee	University	Hobby
9	Lecturer (PHD) at University	University	Hobby

Most respondents had hunted game animals for at least 20 years (Table 44). The two biltong hunters with less hunting experience also were the two youngest respondents in the survey (25 years of age). In the scope of their hunting activities some respondents included trophy hunting, the guidance of other trophy hunters or both. However, the shooting of game animals for the obtainment of meat for home consumption was a common reason for hunting amongst biltong hunters and traditionally, this meat would have been intended both for cooking and the making of game biltong.

Table 44: Hunting experience and hunting-related activities

	Activities conducted in the scope of hunting			
Respondent	Hunting conducted for:	Trophy hunting	Guide trophy hunters	For home consumption
1	More than 25 years	Yes	Yes	Yes
2	More than 25 years	Yes	No	Yes
3	More than 25 years	No	Yes	Yes
4	20 - 25 years	Yes	No	Yes
5	5 - 10 years	Yes	Yes	Yes
6	10 - 15 years	Yes	Yes	Yes
7	More than 25 years	Yes	Yes	Yes
8	20 - 25 years	Yes	Yes	Yes
9	20 - 25 years	No	No	Yes

4.5.2 Game animal species

The majority of the different respondents were predominantly hunting on privately owned land that was not owned by themselves such as hunting lodges (Table 45). Only one respondent stated to predominantly hunt on his own land. However, this particular respondent owned a hunting lodge. Five out of the nine biltong hunters said they sold the game meat obtained from hunting, and butcheries were identified as the most important recipients. Only two respondents said that the carcasses of animals shot during trophy hunting were condemned.

Table 45: Hunting locations, the sale of game meat and the utilization of trophy animals

Respondent	Where is hunting done?	Recipient of game meat	Utilization of trophy animals (hunted or obtained from others, e.g. guided trophy hunters)
1	Own Property	Own lodge	Condemn
2	Other private properties	Butcheries and Supermarket	Meat
3	Other private properties	No sale	Biltong
4	Other private properties	No sale	Meat
5	Everywhere	Butcheries	Meat
6	Everywhere	Butcheries	Meat
7	Everywhere	Butcheries and Supermarket	Meat
8	Other private properties	No sale	Biltong
9	Other private properties	No sale	Condemn

The number of animals shot annually per biltong hunter turned out to vary widely between the different respondents (Table 46). The answers of respondents in respect of the question, which animal species they hunt most frequently differed as well. However, the springbok and the impala were most frequently named by biltong hunters.

Table 46: Animals shot annually, species hunted most frequently and marketing potential of different species

Respondent	Animals shot per year	Species most frequently hunted	Species with greatest marketing potential
1	289	Impala	Springbok and impala
2	5 to 6	Don't know	Springbok
3	15	Blue Wildebeest	Impala
4	20	Blue Wildebeest	Impala
5	250	Don't know	Springbok
6	more than 1000	Don't know	Springbok
7	ca. 1000	Don't know	Not Zebra, Hartebeest, Wildebeest, Warthog
8	10 to 15	Blue Wildebeest	For trophy: buffalo, sable, roan, kudu; for meat: eland
9	2 to 3	Blesbok, springbok, impala	Kudu, impala and springbok

As shown in Table 47, all biltong hunters generally saw a limited or unimportant potential in terms of the market for offal. Four out of nine respondents turned out to be unable to quantify the potential of the market for other by-products such as hides and horns. Only one respondent saw a high potential for these products.

Table 47: Market potential and trade of offal and other by-products

Respondent	Market for offal	Market for other by-products	Selling of offal	Selling of other by-products
1	Limited	Limited	No	Horns, hides
2	Unimportant	Unimportant	No	No
3	Limited	High	No	Hides
4	Limited	Limited	No	No
5	Unimportant	Don't know	No	No
6	Limited	Don't know	Some parts to butcher	No
7	Don't know	Don't know	No	No
8	Unimportant	Don't know	No	No
9	Unimportant	Trophy: high, other: noexistent	No	No

When looking at Table 48, all respondents either gave the offal and other by-products of game animals to the farm workers or left it behind for the vultures.

Table 48: Destiny and trade of offal and other by-products

Respondent	Destiny of offal	Price for offal	Price for hides*	Price for horns
1	Labour and vultures	Not traded	ZAR 30 / raw hide	ZAR 30 / pair of horns
2	Labour	Not traded	Not traded	Not traded
3	Labour	Not traded	ZAR 500 / prepared hide	Not traded
4	Labour	Not traded	Not traded	Not traded
5	Vultures	Not traded	ZAR 30 / raw hide	Not traded
6	Labour, vultures, butcher	ZAR 5 per kg	Not traded	Not traded
7	Labour	Not traded	Not traded	Not traded
8	Labour	Not traded	Not traded	Not traded
9	Labour	Not traded	Not traded	Not traded

*Average exchange rate 01/01/2009 – 28/09/2009: 1 ZAR = € 0.08468 (OANDA, 2009).

No respondent used or sold the hooves. However, some claimed to give them to their dogs as a kind of toy. Every biltong hunter was asked if it would be profitable for him to sell offal

cheaply to locals instead of either condemning it or giving it away for free. Regarding this, Table 49 shows that almost all biltong hunters included into the survey are regularly asked by locals for offal when hunting.

Table 49: Profitability of offal trade and offal demand by locals

Respondent	Is the sale of offal profitable?	Do locals ask for offal?
1	Yes	Regularly
2	No	No
3	No	Regularly
4	No	Regularly
5	No	Regularly
6	No	Regularly
7	Yes	Regularly
8	No	Regularly
9	No	Regularly

Eight out of the nine respondents allocated the greatest marketing potential to biltong compared to other game meat products such as fresh meat or processed products (e.g. sausages and ham). Table 50 shows the different aspects identified by the biltong hunters as the biggest obstacle for a further expansion of the game meat market.

Table 50: The greatest obstacle for a further expansion of the game meat market

Respondent	Major obstacle(s) identified
1	Inadequate promotion/advertisment
2	Inadequate infrastructure from farm to buyer, demand for special cuts dominates
3	Land redistribution / resettlement programmes
4	Inadequate promotion/advertisment
5	Inadequate promotion/advertisment
6	Black people and their poaching activities
7	Focus should consider different markets, game industry is not professional enough
8	The sport and trophy aspect is more important than meat production
9	Domestic meat is cheaper, competition with tourists makes hunting expensive, no infrastructure farmer-consumer

4.5.3 Food safety in domestic game meat production

Seven out of nine biltong hunters stated that it is absolutely necessary to implement common quality standards and meat inspections into the marketing chains of game. Every respondent was asked to estimate the time difference between the fatal shot and the commencement of the exsanguination of the animal with the throat cut. They also were asked for the method applied for exsanguinating the animals and to estimate the time difference between the exsanguination of game animals and evisceration. About half of respondents eviscerated carcasses right at or close to the spot, where the animal collapsed. Their answers are summarized in Table 51.

Table 51: Approximate time difference between fatal shot and exsanguination and method of exsanguination

Respondent	Estimated time difference: Shot – exsanguination	Method of exsanguination	Estimated time difference: Exanguination – evisceration (location of evisceration)
1	Less than 2 minutes	On ground	5 minutes (at or close to the spot)
2	Less than 10 minutes	On ground	About 30 minutes (slaughter facility of farm/ranch)
3	Less than 6 to 7 minutes	On ground	About 30 minutes (slaughter facility of farm/ranch)
4	Less than 5 minutes	On ground or on vehicle	Less than 30 minutes (at or close to the spot)
5	About 60 minutes	Slaughter room on farm	About 60 minutes (slaughter facility of farm/ranch)
6	Less than 2 minutes	On vehicle	Less than 60 minutes (at or close to the spot)
7	Less than 5 minutes	Heart shot (internal exsanguination)	Less than 30 minutes (at or close to the spot)
8	30 seconds to 1 minute	On ground	15 minutes to 30 minutes (at or close to the spot)
9	2 minutes to 3 minutes	On ground or on vehicle	30 minutes to 60 minutes (slaughter facility of farm/ranch)

In regard to the question if biltong hunters shoot animals first and then try to sell or give away the meat or if they shoot them "on order" (meaning that they only shoot what is ordered by clients, friends or family members), no clear tendency could be identified (Table 52). Nevertheless, most respondents (n = 5) claimed to cool carcasses prior to selling them or giving them away for free. If traded or given away for free by biltong hunters, game meat is apparently provided in the form of whole but eviscerated and dressed carcasses in most cases (n = 5).

Table 52: Principle of game hunt for meat use, methods of cooling and kind of products traded or given away

Respondent	Shooting first or on order?	Cooling of carcasses	Form of game meat traded or given away
1	On order	Cool house	Carcass eviscerated and dressed
2	Both	No cooling	Pieces or carcass evisverated and dressed
3	Shoot first	Cool house	Portioned half carcass eviscerated and dressed
4	Both	First cool house than freezer	Pieces eviscerated and dressed
5	On order	Cool house	Carcass eviscerated and dressed
6	Shoot first	Cool house and freezer	Carcass eviscerated and dressed
7	On order	Cool house	Carcass eviscerated and dressed
8	Both	No storage	Carcass eviscerated and dressed
9	On order	No sale	No sale / giving away

From Table 53 it can be seen that most biltong hunters transport game meat to the buyer or their homes by themselves. Table 53 also deals with the question about whether a refrigerated vehicle is used when transporting game meat or not and displays the maximum transport distance.

Table 53: The supply of game meat to customers

Respondent	Delivery or pick up?	Use of refrigerated vehicle?	Maximum transport distance
1	Picked up by buyer	No transport	No transport
2	Delivery	yes	More than 200 km
3	Picked up by buyer	No transport	No transport
4	Delivery	No	More than 100 km
5	Delivery	No	Less than 50 km
6	Delivery	Yes	More than 200 km
7	Picked up by buyer	Yes (for transport to home)	More than 200 km
8	Delivery to butcher, buyer picks up there	Yes if more than 1 hour	More than 200 km
9	No sale / giving away	No	More than 200 km

The nine biltong hunters gave different answers in regard to the question, if they think more game meat could be sold in future if the marketing and promotion would be enhanced. These are summarized in Table 54.

Table 54: Could more game meat be sold with an enhanced marketing and promotion?

Respondent	Do you think an improved marketing and promoton could result in an increased sale of game meat products?
1	Yes, if people would be made more aware of quality in regard to the organic aspect and the leanness
2	Commercial game farming increased due to increased demand but still ist' presence in retail is limited
3	There are more health conscious people, no growth hormones&antibiotics, good for obese and heartsick people
4	Don't know
5	Yes
6	Yes
7	No answer
8	Yes, because it is much healthier than other meats (no cholesterol) and it is cheaper
9	It's not easy to get hold of it, Cool chain from farm to supermarket is virtually non-existent, if maintained it will flourish!

Out of the seven biltong hunters who claimed to trade game meat, only two stated that this would be lucrative (one) or very lucrative (one) for them in terms of their overall income. Another one quantified it as “rentable” whilst all others insisted that this would just be a measure to cover their hunting-related expenditures. Most respondents claimed to hunt within certain time periods, which are all during the South African autumn and winter. This is the country’s “traditional” hunting season. However, two respondents stated to hunt all year round.

Most respondents used a 0.308 mm-calibre gun when hunting (n = 4). All answers are illustrated in Table 55. South Africa has stringent gun control laws and only licences hunters have access to certain weapons.

Table 55: Kind of gun used

Respondent	Gun used (calibre)	Respondent	Gun used
1	0.234 and 0.22	6	0.308 mm
2	0.308 mm, 0.762 mm and 0.375 mm	7	0.308 mm
3	0.375 mm	8	0.308 mm and 0.243 mm
4	0.3006 mm and 0.375 mm	9	0.303 mm
5	0.300 mm and 0.416 mm		

4.6 Observational Study I: Commercial game harvest for the export of game meat

4.6.1 The research area and the observation of prerequisites and practices

The prevalent vegetation on the game ranch was "bushveld". Acacia bushes between 1 and 2 m in height were growing densely and made it hard to see the game. The game harvest was carried out by seven professional hunters all employed by the Mosstrich game abattoir in Mosstrich / Western Cape Province. All professional hunters were male and white South Africans. They were accompanied by numerous slaughterers, game trackers and farm labourers. In the case of this particular game harvest, paying overseas tourists was given the opportunity to participate. According to the request by the land owner, only female blue wildebeests, elands and red hartebeests as well as both genders of gemsboks should be harvested. All animals should be killed by head shots. During the game harvest 26 game animals were harvested, namely eight gemsbok, eight blue wildebeest, six elands and four red hartebeests.

The game harvest was carried out with seven collecting vehicles. This have been 4x4-drives. Their loading area was modified into a mobile shooting stand to accompany hunters and trackers. On both sides of this shooting stand, devices for the vertical hanging of carcasses for exsanguination were installed. Each collecting vehicle was driven by one professional hunter, whilst the shooting of game animals was exclusively done by tourists accompanying these vehicles. It may be due to the fact that tourists conducted the shooting that several miss-shots as well as inadequate shots occured during this particular game harvest. Numerous animals were injured. During the operation, the majority of professional hunters also expressed their dislike of the idea of involving tourists into commercial game harvests. It was probably only because of the economic downturn and the few game harvests taking place in 2009, that this occurred.

The first day of the game harvest, the mobile abattoir was set up. It was set up on bare ground and did not include a roof or any walls. Hunting started about 19h00 when there was a sufficient darkness. All seven collecting vehicles went out into different directions. Each collecting vehicle carried one hunter and one tracker on its' shooting stand. A strong spot light was used by the tracker to look out for game. When game was sighted, it was blinded by the tracker with a spot light. If a blinded game animal belonged to the species and gender of interest, it was shot by the hunter. All animals harvested during the game harvest were shot individually. A shooting of game animals "in bunches" did not take place. The throat cut took place immediately at the spot where the animals collapsed. Sometimes, game animals collapsed in hardly accessible spots after being hit so that they needed to be recovered using a cable winch.

The carcasses were not hung by the hindlegs at the devices on both sides of the shooting stand as the carcasses of the animals hunted have been to large and heavy to do so, therefore, the carcasses were loaded onto the shooting stand with their head and the cut throat towards the back end of the collecting vehicle.
Evisceration took not place in the field. Instead, the collecting vehicles regularly returned to the mobile abattoir to deliver carcasses, which were immediately eviscerated by the slaughter staff. About 23h00 pm, the hunting ended for the day and the primary meat inspection was carried out. This was done by those (n =3) of the professional hunters who were accredited meat inspectors. Due to low ambient temperatures the carcasses were left hanging in the mobile abattoir overnight. The next morning, a chiller truck from the Mosstrich abattoir arrived and all carcasses obtained during the previous night were stored inside of it.
The second day of the game harvest, hunting was conducted in the morning from about 08h00 to 13h00 and in the afternoon from about 15h00 to 18h00. Although hunting during daylight, a tracker was present on the shooting stand again to support the hunter and the driver in looking out for game. Then it started raining and the shooting scheduled after dark had to be cancelled. During the second day, some professional hunters remained consistently at the mobile abattoir to carry out the primary meat inspection right after the evisceration of carcasses. The whole time throughout the game harvest, the ambient temperature was rather low (about 17-19°C) and colder in the mornings and evenings (about 5°C). All offal, heads and feet obtained was basically left behind in the field, although the edible parts were used as food or taken home by the game trackers, slaughter staff and farm labourers.

4.6.2 The recording of time differences

The time difference between the fatal shot and the throat being cut for the commencement of exsanguination could be recorded for seven game animals. The maximum time difference between the fatal shot and the commencement of the exsanguination of animals was slightly more than three minutes. Also, for each of these seven animals, the time difference between the throat cut and evisceration could be recorded. The maximum time difference between the fatal shot an the commencement of evisceration was 83 minutes (Table 56). Unfortunately, four animals were only wounded and disappeared into the bush.

Table 56: Time differences recorded during the game harvest

Individual	Species	Time of fatal shot	Time of throat cut	Time difference: fatal shot – throat cut (min)	Start of evisceration	Time difference: fatal shot – evisceration (min)
1	Hartebeest	20h00	20h03	02:34	21h23	83
2	Hartebeest	20h11	20h13	01:29	21h25	74
3	Gemsbok	22h04	22h06	01:58	22h31	27
4	Wildebeest	10h09	10h12	03:03	10h38	29
5	Gemsbok	12h03	12h06	02:38	12h31	28
6	Wildebeest	16h22	16h23	01:12	16h52	30
7	Gemsbok	17h22	17h24	02:06	17h45	33

4.7 Observational Study II: The Ovahimba

The observational study with the clan of the Ovahimba tribe served as an example of traditional harvesting and consumption of game. An informal group discussion was held with them around this topic, as described under Materials and Methods.

The game meat supplied to the Ovahimba was well accepted by them. It was well cooked in a metal pot over a fire place and was served with porage. They stated to like and enjoy it very much. They said that they would also eat the offal, heads and feet of game animals if these were provided legally as well as cheaply or free of charge. If provided, they would be willing to pick up the meat and offal themselves if a collection point could be arranged in the town of Ruacana. Whether provided in a frozen state or fresh would not influence their acceptance. If it would be necessary to pay for game meat and by-products, they made clear that their willingness to buy these products would strongly depend on the price, as well as on the kind of product offered. Further they said that the availability or non-availability of other products for certain prices in the retail of their area would also influence their willingness to purchase game meat and by-products.

The Ovahimba admitted to purchasing meat from domestic animals on a more or less regular basis. Livestock is not slaughtered regularly and for this reason they are forced to purchase meat. However, the Ovahimba were unable to exactly quantify how often meat is purchased by members of the clan within a certain time frame: They stated that this would depend on the question if meat would be available from a slaughter or not. According to them, any Ovahimba clan that slaughters an animals usually provides other clans close to them with meat as well. The respondents could not give a clear answer concerning the question about what kind of meat is most commonly purchased. According to them, the decision which meat to buy heavily depends on what is available at what price.

When asked if they would hunt game animals by themselves, the Ovahimba pointed out that, on the one hand, hunting would be an old tradition of their culture but, on the other hand, they would be scared of the nature conservation authority when considering hunting and therefore would usually not do so. In their case, hunting would be regarded as poaching as no game would be on their own land and they would only be allowed to hunt if they obtained a hunting licence. Traditional hunting would not be allowed and hunting licences were only available for shooting animals. Nevertheless, the respondents commonly admitted that they would like to hunt, although they were aware that a license is currently required to be able to conduct game hunting. However, they stated to be supplied with game meat “through certain ways” from time to time and that some people in the area had hunting licenses.

When asked where they would carry out hunting if they should do so, they identified the surrounding area and stated to usually “not go too far”. Hunting is traditionally carried out by men and older boys but not by women or children. Traditionally, bow and arrow are used. The hunters then use their dogs in order to bring down the animals shot. Then, the throat of the animal is cut with a knife.

Concerning the question, how often and how regularly they would hunt game animals, the respondents pointed out once more that hunting would be illegal without a license and therefore declined to give any clear answer concerning their hunting activities. They stated that “everything available” would be hunted if they had the opportunity. Nevertheless, different persons of the clan identified the species springbok, impala, steenbok, duicker, kudu and iguana as most important. No clear answer could be obtained regarding game animal species

that may be preferred by them. If they would encounter an injured game animal that is unable to flee they stated to usually kill and eat it. Differently, an obviously diseased animal would not be utilized for food, although it may be given to their dogs. The respondents pointed out that, in the last years, they were supplied with game meat by the nature conservation authority from time to time. However, they said, this did not happen often in recent years.

The Ovahimba made it clear that, in the last years and especially since the independence of Namibia in 1990, the game population in the area had consistently declined. In regard to this, they added that their living area experienced a strong increase of population density in recent years what resulted in a declining game animal population. The Ovahimba stated that, in their area, there was no longer much game around. Moreover, they claimed not to know to which extent outsiders would conduct hunting in their area. However, in their opinion, such activities were very limited within the area near to them.

When asked if they would prefer game meat or domestic meat, the different respondents of the group interview commonly identified domestic meat as the meat preferred by them due to its' taste. Most commonly, they said, the Ovahimba prefer goat meat to beef. However, they were unable to point out particular aspects they liked regarding game meat and domestic meat.

The Ovahimba stated that they generally store meats uncooled but out of reach of their dogs and other animals, on the roof of their huts or hanged in a tree. They further pointed out that it would usually not be stored longer than overnight. Meat is usually given away to other clans in the area if there are amounts that cannot be consumed by the members of a clan within a reasonable time frame. Nevertheless, some group members added that, from time to time, larger amounts of meat may also be dried by hanging them onto the hut roof or onto a tree. This is similar to biltong.

The Ovahimba made clear that they prefer meat that is well cooked or well roasted respectively instead of medium raw or even raw meat at the time of consumption. They stated to usually well cook or roast the meat with spices and to serve it together with porage. At any time, a fire place with fire wood is used as heat source. The spicing of the meat takes places prior to cooking or roasting it and may be carried out again during the cooking or roasting process if necessary. The water used for cooking is transported over about 1 km from a tap in large containers that are carried by donkeys. When asked how they would see if a piece of meat is not good for consumption anymore, the Ovahimba explained that they would determine this in terms of the look and smell of meat. Such meat, they stated, would be rather given to their dogs than being consumed. They claimed to never have fallen sick in any way subsequent to meat consumption.

When asked for what price they would usually sell a goat, the Ovahimba stated that there would be no fixed price. Goats as well as cattle are sold in emergency situations only in order to generate emergency cash. Regarding this, the price asked consistently depends on the particular situation and circumstances. When asked for how much they would sell game, they made clear that they are not selling game as they would normally not be supplied with this kind of meat regularly and because the game meat trade would not be allowed without certain permits.

4.8 The flow chart derived from the results of the study

As mentioned under "Materials and methods", an objective of this study was to draw a flow chart to illustrate the marketing chains for game meat, in both, formal and informal markets in South Africa. The strong focus of the study on the actual as well as potential ways of marketing game meat and edible by-products such as offal within South Africa preconditioned the intensive documentation and evaluation of all actual and possible product flows as well as production and processing steps that are taking place in this scope. The flow chart was constructed after reflection on the observations and data recorded. Therefore, no matter if product movements as well as production and processing steps embodied potential hazards to the maintenance of food safety and product quality, all were included (Figure 3).

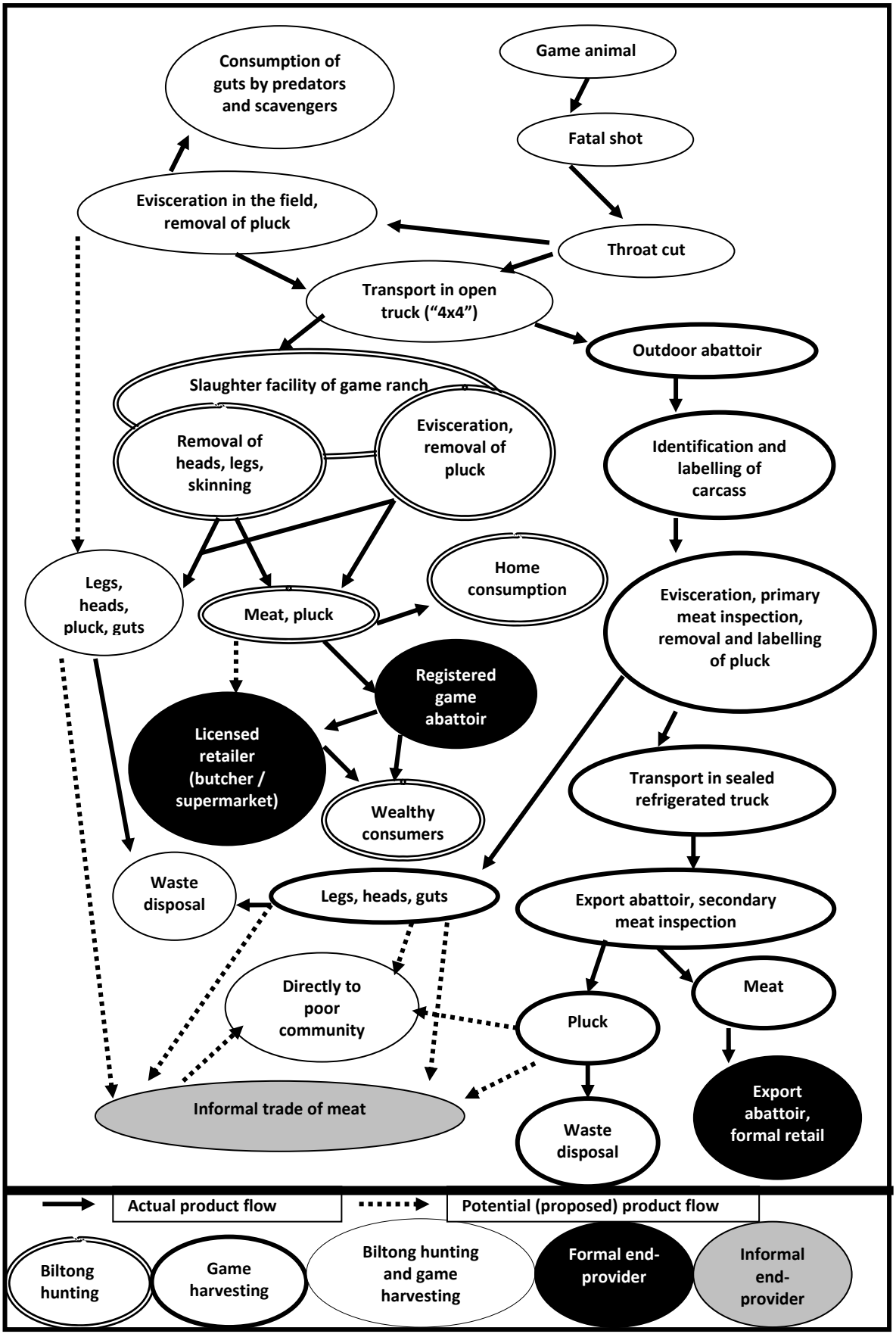

Figure 3: The actual and potential domestic marketing chains of game meat and edible by-products within South Africa

In terms of product flows that are labelled as “potential” (currently non-existent) in Figure 3, it should be said that, although labelled as “potential” in the flow chart, the supply of licensed butcheries and supermarket with game meat that bypasses registered game abattoirs seems to be rather common amongst biltong hunters. Four out of five respondents who claimed to trade game meat did this, whilst only one adhered to South African law (KZN AEA, 2005) and delivered meat destined for the public to his own registered game abattoir before offering it to paying customers in his hunting lodge restaurant. Therefore, this “potential” product flow demostrably exists to a certain extent. This brings along potential hazards to food safety and product quality as game meat products traded this way are obviously not approved by qualified meat inspectors. Nevertheless, this has not been the only potential hazard identified, as this will become apparent in the Chapter “Discussion”.

One might also wonder why the flow chart presented does not contain a potential product flow from biltong hunting directly to poor communities. However, based on the findings of the study, this potential product flow was assumed to be unrealistic as biltong hunters turned out to not generate high enough quantities of edible by-products at one time to facilitate this product flow when compared to commercial game harvests.

5 DISCUSSION

5.1 Critical control points in the marketing chain where there is a risk of hazards occurring

The study identified different potential hazards to food safety and product quality that prevail in the different product flows as well as production and processing steps along the marketing chains for South African game meat products illustrated in Figure 3. Generally, these potential hazards either originate from inadequate prerequisites for the maintenance of food safety and product quality, or from insufficient practices of product handling applied by stakeholders and end-users. However, sometimes a combination of both, potentially increases the potential magnitude of the risk of the occurrence of these hazards.

In this context, based on an intensive evaluation of the marketing chains for South African game meat products, critical control points for the mitigation or eradication of potential hazards to food safety and product quality can be provided by the study. In Figure 4, these critical control points are illustrated as arrows, each with a code number linked to the type and magnitude of the risk of a hazard, in the flow chart.

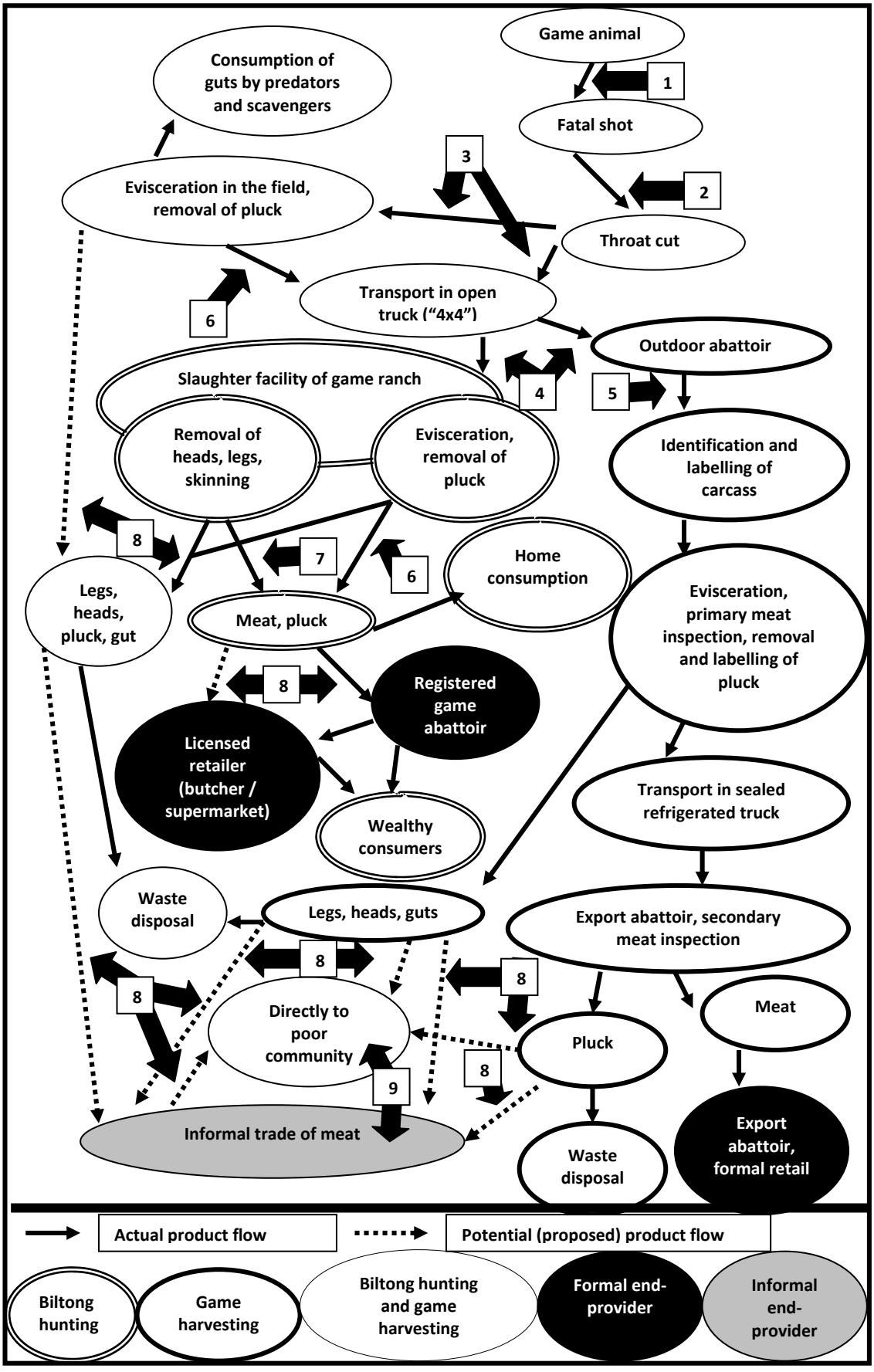

Figure 4: Critical control points where hazards to food safety could potentially be present

KEY-Numbers 1-9 indicate the kind of hazards present. See Table 57 for details.

In Table 57, the hazards that underlie the critical control points presented in Figure 4 are decribed. The magnitude of each of the risks has been estimated qualitatively. The risks associated with potential hazards in the flow chart up to the informal marketing stage are explained. Concerning this, the informal marketing chain will be discussed in detail later on.

Table 57: Qualitative risk assessment estimated for potential microbiological hazards in the marketing chains for game meat

Code	Description of hazard	Level of risk*
1	Stress to animal (glycogen depletion) leads to poor meat quality and poor meat shelf life.	0 (game harvest) n.a. (biltong hunting)
2	Body shot can result in damage to the digestive system and the contamination of carcasses with faeces or ingesta.	0 (game harvesters) 1 (biltong hunting)
3	A delayed throat cut and/or the exsanguination of carcasses without hanging them up vertically on the hind legs, may lead to insufficient exsanguination resulting in the accumulation of bacteria in tissues.	2 (game harvest) 3 (biltong hunting)
4	Time-temperature hazard: If evisceration is delayed, especially in hot weather, gut bacteria multiply, gas may be produced, carcass bloats and bacteria enter tissues.	0 (game harvest) 2 (biltong hunting)
5	If the outdoor-abattoir does not have walls and/or a roof carcasses might be contaminated by dust and/or insects (e.g. flies) and/or other animals (e.g. rodents/ dogs) if left overnight.	0 (game harvest) n. (biltong hunting)
6	Carcasses might become contaminated during evisceration due to a lack of experience of the eviscerator.	n. (game harvest) 2 (biltong hunting)
7	Lack of expertise in dressing carcass and/or unsanitary conditions may bring along high risks of bacterial contamination.	n. (game harvest) 2 (biltong hunting)
8	Time-temperature hazard: Cold chain might not be maintained sufficiently and result in an increased formation and growth of microorganisms in the tissues.	n. (game harvest) 2 (biltong hunting)
9.1 9.2 9.3 9.4	The lack of knowledge of recognized meat hygiene practices, a lack of basic prerequisites for the maintenance of food safety and product quality, the lack of hygiene by traders and unsanitary surroundings might result in reduction of the microbiological quality of products destined for human consumption. For details see Table 58.	

*KEY: 0 = highly unlikely, 1 = unlikely, 2 = likely, 3 = highly likely, n.a. = not assessable, n. = negligible.

5.2 Potential hazards and risks to food safety and product quality

Stakeholders: Commercial game harvesters and biltong hunters

Commercial game harvests are usually carried out during a sufficient darkness (HOFFMAN and WIKLUND, 2006) so that the excessive stressing of animals and therefore the occurrence of detrimental effects on the quality and shelf life of the meat obtained can be assumed to be

minimal. Studies conducted by KRITZINGER *et al.* (2003) and HOFFMAN and FERREIRA (2000) suggested that the professional night harvest of game does not bring along detrimental effects on meat quality. Moreover, professional game harvesters are precise marksmen and misses as well as injuries that result in immense stress for individual animals can be assumed to occur very seldomly (HOFFMAN and WIKLUND, 2006, GILL, 2007). Summarizing this, the risk of the occurrence of Hazard 1 (Table 57) can be regarded as highly unlikely for commercial game harvests, even if carried out during the day.

However, when looking at biltong hunters, hunting game animals during the day is common as more emphasis is given to sport and recreation. Although the selected biltong hunters did not appear to stress game animals excessively as shooting is usually done from a vehicle or hide, varying hunting practices were identified amongst them. None of them could be observed when hunting but the methods applied are definitely not as standardized as in the case of commercial game harvests. Therefore, the risk of the occurrence of Hazard 1 (Table 57) in biltong hunting may be considered to be higher than in commercial game harvesting but simply cannot be estimated for the approximately 200,000 biltong hunters in South Africa (DAMM ,2005, and PATTERSON and KHOSA, 2005).

The risk of the occurrence of Hazard 2 (Table 57) can be estimated to be higher for biltong hunters than for commercial game harvests. According to an extensive survey with 676 biltong hunters (VAN DER MERWE and SAAYMAN, 2008), one biltong hunter on average hunted 11.8 animals annually in 2007. Although n = 4 respondents claimed to shoot more than 200 animals per year in the opinion survey, the majority of biltong hunters must therefore be expected to shoot rather few animals per hunting season. Similarly to VAN DER MERWE and SAAYMAN (2008), the other five respondents shot 20 animals per year at the maximum.

Compared to this, the head of the harvesting team observed stated that one professional game harvester may shot well more than 1,000 animals per year. Therefore, it can be assumed that shooting skills are less pronounced amongst biltong hunters. As a consequence, body shots may occur more frequently during biltong hunting (GILL, 2007). Only 5% of biltong hunters attended training courses to become professional hunters in 2007, whilst most courses attended focused on weapon safety and competency (VAN DER MERWE and SAAYMAN, 2008). In the opinion survey, only two respondents had qualified as trophy hunters, although n = 8 respondents conducted biltong hunting since at least ten years.

However, in regard to the latter, it may as well be concluded that biltong hunters in most cases have a sound hunting experience to greatly avoid body shots. Furthermore, n = 6 guided trophy hunters on a regular basis and n = 4 shot more than 200 animals per year. Therefore, the risk of the occurrence of Hazard 2 (Table 57) in biltong hunting can still be assumed to be unlikely. Additionally, all biltong hunters stated to hunt for home consumption, at least amongst other reasons, and can therefore be regarded as being concerned about meat quality. As shown by VAN DER MERWE and SAAYMAN (2008), for 37% of biltong hunters the obtainment of meat is the most important driving factor.

Moreover, the opinion survey suggests that biltong hunters tend to even utilize trophy carcasses for meat and biltong, although trophy hunting can be associated with negative effects on meat quality due to stress to the animal and a usually delayed commencement of exsanguination (MCCRINDLE and RAMRAJH, 2009, personal communication). Furthermore, as for commercial game harvesters, body shots result in financial losses for biltong hunters, too.

In most cases (n = 8) they used private properties such as game ranches or farms for hunting and are required to pay for the animals hunted. Concerning this, the impossibility or a greatly reduced usability of carcasses for meat due to body shots cannot be assumed to be willingly taken by them.
However, because professional game harvesters are hunting game animals for living and because they are required to prove their qualification as precise marksmen, their shooting skills can be regarded as being very pronounced. Body shots are greatly disliked as they substantially reduce the proportion of marketable meat per carcass. This became apparent when all professional hunters (n = 7) expressed their dislike about including paying overseas tourists into commercial game harvests. Therefore, in regard to Hazard 2 (Table 57), the occurrence of body shots can be assumed to be highly unlikely if game is harvested commercially.
During the game harvest attended, the throat was cut for all animals three minutes after the fatal shot at the maximum. However, the carcasses were not hung vertically by the hind legs for exsanguination. This embodies the risk that bacteria accumulate in tissues (Hazard 3, Table 57). The game harvesters said that they would only hang the carcasses of smaller species such as springbok and impala by the hind legs on both sides of the collecting vehicle for exsanguination. Indeed, for larger species (e.g. eland), the devices on the collecting vehicles were insufficient. This insuffiency should be an intervention point for authorities responsible for the regulation of South African game harvests.
Nevertheless, this may be much easier said than done as appropriate devices for hanging larger carcasses by the hind legs greatly reduce the carrying capacity of collecting vehicles and therefore the economic efficiency of harvests. Moreover, game animals often collapse in hardly accessible spots after being hit so that they need to be recovered using a cable winch. The use of larger harvesting vehicles that are suitable to carry substantial numbers of larger carcasses hung by the hind legs may be the only apparent solution. However, this would greatly reduce the mobility of harvesters in the field compared to the rather small 4x4 drives used currently.

Although n = 4 biltong hunters estimated a time difference between fatal shot and throat cut in accordance to the recordings made during the commercial game harvest and another four estimates came close to the recordings, Hazard 3 (Table 57) was identified in biltong hunting even more clearly. Some respondents additionally pointed out that exsanguination is carried out on the ground and at the spot on a regular basis because of the strong emphasis of sportive and recreational aspects that results in the non-use of a vehicle as a shooting stand in many cases. VAN DER MERWE and SAAYMAN (2008) found that only 14% of biltong hunters were hunting from a vehicle. Some respondents in the opinion survey pointed out that carcasses often cannot be hung in a tree as trees are often either not present at the spot where the animal collapsed or because trees are not strong enough to hold the carcass. The hanging of carcasses in a tree may as well not be feasible in many cases simply because biltong hunters are hunting alone and the carcasses are too heavy to be lifted by one person instead of waiting for the collecting vehicle to arrive at the spot. Indeed, according to VAN DER MERWE and SAAYMAN (2008), nearly 20% of biltong hunters preferred to hunt alone in 2007.
Moreover, the common execution of trophy hunting by biltong hunters (n = 6) and the common utilization of trophy carcasses for meat (n =7) nourishes the assumption that meat from carcasses were the throat was cut substantially later than three minutes after killing the animal is frequently given away or marketed for human consumption, although only one respondent admitted that a time difference of about 60 minutes may occur.

However, this may have been an estimate of the time based on a heart shot, as used by trophy hunters, where throat cutting is not required for exsanguination as the animal bleeds out into its carcass cavities.
Nevertheless, this finding from the opinion survey clearly differs from the survey of VAN DER MERWE and SAAYMAN (2008), who found that only 10% of biltong hunters conduct trophy hunting. Eventually, when summarizing this, the risk of the occurrence of Hazard 3 (Table 57) can be estimated as highly likely in biltong hunting, whilst being likely in game harvesting.

The risk of the occurrence of Hazard 4 (Table 57) in the scope of commercial game harvests appears to be highly unlikely when recalling the recordings made during Observational Study II (Table 55) as the maximum time difference between the fatal shot and the commencement of evisceration was less than 1.5 hours and most animals were eviscerated about 30 minutes after the kill. Moreover, the South African legislation for the production of game meat for export has defined two hours as the maximum time difference allowed to pass by between these two points in time (HOFFMAN and WIKLUND, 2006, DVS, 2007), meaning the game harvesters have been "well in time" when the recordings where carried out.
Furthermore, commercial game harvests are greatly limited to the South African winter (HOFFMAN *et al.*, 2004). Then, ambient temperatures are low and the risk of hazardous bacterial growth is reduced as carcasses cool down more rapidly. In the case of the particular game harvest attended, carcasses were not eviscerated in the field but were first transported to the mobile abattoir. If conducted in the field, evisceration may have commenced much more rapidly. Nevertheless, the methodology observed is commonly applied during commercial game harvests (KRITZINGER *et al.*, 2003, HOFFMAN and WIKLUND, 2006, GILL, 2007). In regard to this, a clear standpoint from the authorities responsible for South African game harvests seems to be required.
According to the opinion survey both, the evisceration directly at the spot (n = 5) as well as the transport to the slaughter facility (n = 4) of the game ranch where hunting was conducted seem to be equally common amongst biltong hunters. Practices applied such as the combination of meat obtainment and trophy hunting and the common hunting without vehicle can be assumed to facilitate the delay of evisceration in many cases. Moreover, as two respondents stated that they hunted all year round, biltong hunters do not seem to strictly limit their hunting activities to the winter months. However, especially during hotter times of the year, the risk of the occurrence of Hazard 4 (Table 57) must be considered to be likely in biltong hunting.
Biltong hunters commonly use slaughter facilities provided by game ranches if no evisceration takes place in the field. In comparison, during commercial game harvests, outdoor abattoirs are commonly used. If these do not have any walls and no roof and are set up on bare ground, hazards to food safety may occur due to the exposure of carcasses to environmental influences such as a contamination with dust or insects and their exposure to rain. However, because game harvests are greatly limited to the winter months, the presence of insects is limited due to low ambient temperatures. Nevertheless, the exposure of carcasses to rain and dust and other animals such as dogs is possible all year round, especially if the eviscerated carcasses are left hanging in the mobile abattoir overnight as this was observed.
A viable solution could be the mandatory use of outdoor abattoirs that result in less exposure of carcasses to the environment by having a roof and walls that are at least attached if overnight storage is carried out, although this limits the effect of wind as a cooling mechanism through

evaporation in regard to skinned carcasses. However, it should be said that an overnight storage of carcasses in an outdoor abattoir is not consistently applied in the scope of commercial game harvests (HOFFMAN and WIKLUND, 2006). Much more, this appears to be a measure in the case of delayed chiller truck arrivals or an additional option for short-term storage at adequately low ambient temperatures. Generally, carcasses are labelled and stored in a chiller truck as soon as possible. Thus the risk of the occurrence of Hazard 5 (Table 57) can be assumed to be highly unlikely for commercial game harvests. However, a roof and walls should still be available when needed to eliminate it completely.
The risk of the occurrence of Hazard 6 (Table 57) is negligible in commercial game harvests. The operators are professional hunters with substantial knowledge concerning all aspects of evisceration and three out of the seven game harvesters were accredited meat inspectors. They carried out primary meat inspection and supervised the slaughter staff in regard to evisceration. The qualifications and experience of staff employed in commercial game harvesting was not verified, although it was stated that laymen are never employed. However, Hazard 6 (Table 57) can be considered likely in biltong hunting.
Likewise, the risk of the occurrence of Hazard 7 (Table 57) is negligible in commercial game harvests but must be considered likely in biltong hunting. Concerning both, Hazard 6 and 7 (Table 57), it was assumed that biltong hunters are rarely very skilled butchers (FIELD, 2004). Moreover, only about 11% of biltong hunters attended courses about meat processing in 2007 (VAN DER MERWE and SAAYMAN, 2008).
The risk of the occurrence of Hazard 8 (Table 57) is negligible for commercial game harvests as the operators are required to adhere to certain standards and regulations in order to be able to export the game meat obtained and because all procedures need to follow specified guidelines set by the controlling authorities (HOFFMAN and WIKLUND, 2006). Nevertheless, a time-temperature abuse may occur concerning the proposed linkage of commercial game meat production to informal meat traders and poor communities as a potential supplier of edible by-products. As soon as these products leave the marketing chain of export meat, the standards and regulations for the export of game meat may be less adhered, depending on who (e.g. game meat exporters, other companies, private persons) will eventually facilitate these product flows. Concerning this, a certain likeliness must be assumed for the risk of the occurrence of Hazard 8 (Table 57) within these proposed product flows. Nevertheless, it cannot be estimated as these product flows are currently non-existent.
Different from game harvesting, in regard to biltong hunting, standards and regulations are almost non-existent (HOFFMAN *et al.*, 2004, HOFFMAN *et al.*, 2005a). This becomes apparent when considering that four out of five respondents, who claimed to trade game meat, stated that they could directly sell it to licensed butcheries and supermarkets instead of delivering it to registered game abattoirs, although this is not as yet demanded by South African law (KZN AEA, 2005). For biltong hunters, there are no standards and regulations in place concerning the cooling and transport of carcasses even when destined for the general public. In fact, three out of seven respondents who stated that they transport game meat admitted to not using a refrigerated vehicle, although this transports may be over distances of more than 200 km. Moreover, no respondent identified the lack of common standards and regulations in biltong hunting as a major obstacle for a further expansion of game meat production and marketing. Therefore, the risk of the occurrence of Hazard 8 (Table 57) must be assumed to be likely.

Also for the proposed product flows from biltong hunting to informal meat traders, Hazard 8 must be assumed to be potenially present. However, the risk of its' occurrence cannot be estimated for these currently non-existent product flows.

Potential stakeholders: Informal meat traders

As it becomes apparent in Figure 4 and Table 57, several major constraints to food safety and quality that are potentially prevailing in the informal trade of meat were revealed, some of which were potentially very detrimental to meat safety and quality. Compared to commercial game harvesters and biltong hunters, the presence of potential hazards at the level of informal meat traders seems to be especially caused by insufficient prerequisites for the maintenance of food safety and product quality, although inadequate practices of product handling seem to play a key role, too (Table 58).

Table 58: Qualitative risk assessment estimated for potential microbiological hazards in the informal trade of meat

Code	Description of hazard	Level of risk*
9.1	An insufficient knowledge of recognized meat hygiene practices can result in an unacceptable microbiological quality of products destined for human consumption.	2
9.2	An limited or non-existent availability and accessibility of basic prerequisites for the maintenance of food safety and product quality (e.g. electricity, running water) might result in a reduction of the microbiological quality of products destined for human consumption.	3
9.3	Lack of hygiene by informal meat traders may facilitate the accumulation of foodborne pathogens in meat products.	2
9.4	Unsanitary surroundings may cause the contamination of informal meat trade businesses with foodborne pathogens that may accumulate in products traded.	2

*KEY: 0 = highly unlikely, 1 = unlikely, 2 = likely, 3 = highly likely.

EKANEM (1998) identified common and dangerous abuses at virtually all stages of handling for African street foods and notes that street food vendors appear to be largely ignorant in terms of even basic food safety issues. After entering informal marketing chains, the quality of these products is often compromised by widely inadequate prerequisites and product handling practices. Regarding this, similar results were obtained in the current study.

Most informal meat traders (74.51%) did not cool their raw products when transporting them from at home or from the shops to their places of business. A similar result (90%) was obtained by MARTINS and ANELICH (2000) in a larger survey. This is a potential hazard to food safety as an increased bacterial growth rate in these products can be expected when their core temperature increases. The longer the transport, the higher is the risk of the occurrence of this time-temperature abuse hazard (FAO, 2004). Whilst 37 respondents did not cool their raw products at all during the execution of their daily activities, 26 of them also did not undertake any alternative means of food preservation such as the purchase of stock on a daily basis in order to prepare it directly after purchase or the preparation of food at home prior to the start of

their business. However, especially the latter would not be optimal as well as long holding times may be strongly correlated with high bacterial counts (CARDINALE *et al*., 2005).
Moreover, almost half of the respondents interviewed (47.06%) did not cover already prepared meat products until they were sold. According to MOSUPYE and VON HOLY (2000), under these conditions, these products are inadequately protected against flies and dust. However, because the coherence between the method of product preparation (cooking, grilling or both) and whether respondents are not covering the prepared products is highly significant ($p = < 0.0001$) this practice is obviously much more commonly applied by respondents who grill the meat. The practice of nine informal meat traders (17.65%) to take prepared leftovers home in order to try to sell them the next day, must be called detrimental as well. Such products may be less acceptable regarding their microbiological quality (VON HOLY and MAKHOANE, 2006). Nevertheless, the finding that the majority of respondents (n = 30, 58.82%) used styrofoam boxes like those used by many formal fast food retailers to pack food items for take away was unexpected and welcome. The use of such special take away boxes is an important aspect of food safety maintenance. In the absence of styrofoam boxes, less suitable materials such as newspapers or cardboard may be used, although no respondent in this particular survey turned out to use such materials, even when not using styrofoam boxes.
The study also implies that, when meat products are prepared informally within the study area, no health hazards must be expected from the cooking fuel itself as wood, charcoal or a combination of both turned out to be the dominant materials. Potentially hazardous substances such as petrol, terpentine or plastic materials were not used by any respondent.
However, when summarizing the information generated on the product handling by informal meat traders, the risk of the occurrence of Hazard 9.1 (Table 58) can be estimated as being likely. Food safety issues seem to receive limited attention from informal meat traders and an improvent of the food safety knowledge of respondents appears to be relevant for the study area. This becomes apparent by the finding that the majority of informal meat traders selected for meat sampling (85.71%) called the construction of a proper shelter or the upgrading of their present one their biggest business related desire. Food safety issues could as well not be identified amongst the strongest desires of the participants in the game meat cooking experiment. Regarding this, business-related modifications seem to receive more attention than inputs towards an improved maintenance of food safety and product quality.
As a potential resolution of these inadequacies, the adequate education and training of informal meat traders in regard to food safety issues such as foodborne hazards, personal hygiene and product handling was already recommended earlier (WHO, 1996, EKANEM, 1998, MARTINS and ANELICH, 2000). This could be a promising tool to strengthen the food safety knowledge of informal meat traders. For example, within the Ethekwini Metropolitan Council, street food vendors are currently receiving essential food hygiene training, in order to ensure their compliance with at least minimum hygiene regulations (VON HOLY and MAKHOANE, 2006). However, any training programmes will only be fruitful if adequate prerequisites that support the maintenance of food safety and product quality are available in the locations of informal meat trade such as the access to running water, electricity, waste disposal services, drainage systems and toilets (EKANEM, 1998, MARTINS and ANELICH, 2000).
Regarding this, the great majority of respondents (n = 46, 90.20%) had no access to running water at or close to their places of business. Similarly, a survey conducted in the Gauteng Province by MARTINS and ANELICH (2000) showed that the great majority of street food vendors did not have any access to running water (80%) at or close to their business premises

and concerns were already raised earlier (EKANEM, 1998, MOSUPYE and VON HOLY, 2000, MARTINS and ANELICH, 2000). Regarding this, a significant correlation between the access or non-access to running water at or close to the business premises and the cleanliness of the washing water indicates that, indeed, the washing water tended to be cleaner if running water was available.

The significant coherence between the location of respondents and the access to running water if the variable "location" is subdivided into the two categories "Pongola" and "other" suggests that Pongola is superior over the other towns within the study area in terms of the provision of running water to informal meat traders. Neverthleless and altogether, the availability of running water to respondents within the study area remains detrimental. Concerning this, n = 16 of the informal meat traders (76.19%) selected for meat sampling identified the lack of running water at or close to their business premises as a major problem in regard to their daily activity. and n = 11 respondents (52.38%) pointed out that an access to running water at or close to their business premises would be very much appreciated.

One might agree that the broad provision of electricity to informal meat traders is a task much more challenging than the general provision of running water, although only one respondent (1.96%) had a permanent access to electricity at his place of business. One might be of the opinion that this may not really be necessary, too. Informal meat traders may not be capable to pay for this electricity or for refrigerators. Also, even if locker rooms would be provided, the setting up of refrigerators on a daily basis may not be feasible for them. Moreover, when interviewing the respondents selected for meat sampling, it turned out that, compared to the lack of running water, they regarded the lack of electricity as a much smaller constraint of their working conditions then the lack of running water.

The finding that most respondents (90.2%) did not make use of any drainage system when pouring away their waste water but, instead, discarded it on the ground at or close to their business premises partly is in line with a survey conducted by MARTINS and ANELICH (2000) and needs to be called detrimental to food safety maintenance. According to MOSUPYE and VON HOLY (2000) who identified this problem earlier, such a practice might attract rodents, livestock, pigeons and insects, although in most cases no livestock or other animals were encountered. Most premises did not neither have walls (68.63%) nor roofs (37.25%), even not a simple one such as a tarpaulin. Therefore, generally, their exposure to environmetal influences (e.g. rain, dust) with negative effects on food safety and product quality must be assumed to be given, no matter if located next to solid or non-solid roads.

However, toilet facilities appear to be available to a rather satisfactory extent within the towns in the study area (to n = 43 respondents, 84.31%). Because there is no significant coherence between the different towns and the access to toilets, the situation does apparently not differ accross the area of research. Moreover, in every town, at least one public toilet facility or semi-public facility (e.g. at petrol stations) was encountered. Nevertheless, it should be pointed out that some researchers concluded that the availability of toilet facilities to street food vendors is unsatisfactory (EKANEM, 1998, MARTINS and ANELICH, 2000, FAO & WHO, 2005b).

Indeed, many respondents appeared to be located rather far from the facilities they pointed out during the interview. Furthermore, most respondents were operating their businesses alone with nobody else looking after the premises and customers when being absent. It may therefore be expected that, in some cases, the toilet facilities may not strictly be used at any time in need.

In a nutshell, there is a greatly inadequate availability and accessibility of basic prerequisites for the maintenance of food safety and product quality to informal meat traders within the study area. Especially in terms of the widely common lack of electricity and running water, the risk of the occurrence of Hazard 9.2 (Table 58) must be estimated as being highly likely.
A first step towards a viable resolution of these food safety relevant inadequacies could be the provision of public water taps and simple cooling facilities such as cooler boxes to informal meat traders. Their use could then be enforced by law following a certain transition period. However, the installation of water taps and drainages and the provision of common cool houses in areas popular for informal meat trade seems to be the most sustainable approach in the long run. The provision of additional public toilet facilities in areas popular for the informal trade of meat products would further contribute to the mitigation of foodborne hazards.
The investments needed to achieve this can be assumed to be reasonable within the study area as the installation of some taps and drainages as well as of one common cool house and public toilet facility per town should be sufficient due to the small size of towns. Moreover, the installation of taps and drainages and the construction of common cool houses and puplic toilets as well as their maintenance would bring along employment within the study area.
Taps and cool houses could be locked during the night and informal meat traders could be supplied with keys to use the taps and their private sections within the cool houses in order to avoid unauthorized use, theft as well as vandalism. Raw products could be directly stored and cooled after purchase and their transport to and from home would become superfluous. Furthermore, they would benefit from this by being enabled to purchase larger amounts of raw meat products at the time of special offers.
Nevertheless, it should be kept in mind that informal meat traders gain the possibility to store prepared products for extended time periods if the use of refrigerators becomes possible, what may have detrimental effects on consumers' safety. That is why, for example, although providing basic services to street food vendors, the usage of refrigerators by street food vendors was not allowed by the Johannesburg Metropolitan Council (VON HOLY and MAKHOANE, 2006).
Besides the fact that, with Regulation 918, a legal framework for the maintenance of food safety by street food vendors is already in place (JACKSON, 2009), the applicability of measures of this kind was already proved in South Africa. According to VON HOLY and MAKHOANE (2006), for example, the Ehlanzeni District Municipality in the Mpumalanga Province has allocated informal street food vendors to specific sites and, at the same time, provided basic facilities such as cleaning services, running water, wash basins, storage facilities and toilets to them. The vendors are capable to pay the maintenance of these facilities by themselves. Also, the vendors need to fulfill certain minimum requirements based on the national hygiene regulations (VON HOLY and MAKHOANE, 2006).
According to the study, the possession of adequate cooling facilities by informal meat traders seems to be much more common in their homes (66.67%) than in their business premises (3.92%). Therefore, the widely common lack of running water, electricity and cooling facilities in their business locations must be assumed to be the major gap in food safety control between the purchase of the raw product stock and the customers' table. The common lack of such basic infrastructure in regard to the informal food trade was already pointed out by EKANEM (1998). The obvious negligence of this gap in food safety control during the business hours of respondents is aggravated by the widespread non-use of even simple cooling facilities, namely cooler boxes, by informal meat traders.

In regard to the safety and quality of products traded informally, the finding that most respondents (n = 49, 96.08%) purchased their raw products from formal retailers appears very satisfactory in the first place and further emphasizes this major gap in the maintenance of food safety and product quality. Because exclusively livestock meat was purchased by informal meat traders from formal retail outlets, these products can be assumed to have passed primary as well as secondary meat inspection and to be suitable for human consumption at least until leaving the formal marketing chain. However, if game meat products shall be traded informally, some concerns must be raised. This will be further explained later on.

Moreover, the claim of most informal meat traders to have refrigerators or freezers in their homes should not be taken for granted. Despites the fact that this was not controlled, according to the DPLG (2006), in Zululand, 62% of all households did not have access to electricity in 2006. In Umkhanyakude, this can even be assumed for 80% (UDM, 2008). When weighing the answers recorded from respondents against the numbers provided by the DPLG (2006) and the UDM (2008), no clear conclusion can be drawn on the possession and use of refrigerators and freezers by the respondents in their homes. Further investigation is recommended to determine if the substantial lack of adequate cooling facilities at their business premises must be assumed to be given in their homes as well. If this should be the case, the provision of suitable cooling facilities in areas popular for informal meat trade gains further importance, although one third of informal meat traders claimed to not store meat products at all (29.41%) but to purchase them on a daily basis.

In contrast to MOSUPYE and VON HOLY (2000) and EKANEM (1998), facilities for an adequate rubbish disposal were provided to a greatly satisfactory extent within the study area and obviously were used by most respondents. Also, the cleanliness of business surroundings was classified as "acceptable" in most cases, although rubbish materials were detected at least in some distance. However, the surroundings of ten businesses were classified as "dirty". In one particular case, discarded animal bones as well as toilet paper, indicating the possible presence of human faeces, were detected very close to the place of product preparation.

Although the majority of respondents did not have any, the importance of special working clothes in terms of food safety issues and hygiene must be questioned as it remains unclear what other activities are carried out by the different respondents without changing the clothes worn when selling food products. However, the result clearly differs from that one obtained by MARTINS and ANELICH (2000) who found that, in Gauteng, the great majority of street food vendors (86%) had special working clothes.

The scorings carried out in regard to the hygiene of informal meat trade businesses (Table 30) should not be used to draw conclusions in any way. When reviewing the recording of observations, the results may be influenced too heavily by environmental factors such as the season, the temperature and windiness and other factors such as the time of the observation itself (before, during or after lunch time) to be interpreted. Nevertheless, when summarizing all results obtained on hygiene issues and the surroundings of informal meat trade businesses, the risks of the occurrence of Hazard 9.3 and Hazard 9.4 (Table 58) can be considered as likely.

Potential end-users: The Ovahimba

Simply because of the complete absence of electricity as well as running water at their settlement, the handling of meat products by the selected Ovahimba clan must be assumed to bring along hazards and risks to food safety (Table 59). Concerning this, especially the risk of the occurrence of Hazard 9.2 (Table 59) can be estimated to be likely.

This assumption also cannot be cleared out by the claim of the Ovahimba to never have fallen sick subsequently to the consumption of meat.

Table 59: Qualitative risk assessment estimated for potential microbiological hazards for the Ovahimba

Code	Description of hazard	Level of risk*
8	Time-temperature hazard: Cold chain might not be maintained sufficiently and result in an increased formation and growth of microorganisms in the tissues.	1
9.1	An insufficient knowledge of recognized meat hygiene practices can result in an unacceptable microbiological quality of products destined for human consumption	1
9.2	An limited or non-existent availability and accessibility of basic prerequisites for the maintenance of food safety and product quality (e.g. electricity, running water) might result in a reduction of the microbiological quality of products destined for human consumption.	2
9.3	Lack of hygiene by informal meat traders may facilitate the accumulation of foodborne pathogens in meat products	1
9.4	Unsanitary surroundings may cause the contamination of informal meat trade businesses with foodborne pathogens that may accumulate in products traded.	1

*KEY: 0 = highly unlikely, 1 = unlikely, 2 = likely, 3 = highly likely.

The risk of the occurrence of Hazard 8 (Tables 57 and 59) in the scope of meat handling practices applied by the Ovahimba can be expected to be unlikely as they stated to usually store meat for overnight at the maximum. Although this cannot be controlled, the comparative proximity of the selected clan to the town of Ruacana nourishes the assumption that large quantities of meat that cannot be consumed within a suitable time frame are usually not purchased at one time as formal retailers are in walking distance. If purchased, meat products are not transported over extended time periods. Moreover, the Ovahimba stated to usually cook or roast meat products very well prior to consumption, what reduces the risk of foodborne hazards.

The prerequisites and practices of the maintenance of food safety and product quality practiced by the Ovahimba did not change substantially over thousands of years and appear to be suitable for their personal health. In view of this, the risks of the occurrence of the Hazards 9.1, 9.3 and 9.4 (Table 59) may be considered to be unlikely for the Ovahimba in particular. However, this should not be assumed for other poor communities on a general basis. It must be pointed out clearly that the observational study with the Ovahimba was not expected to allow the drawing of conclusions on poor communities in general from the beginning.

Indeed, potential hazards associated with the prerequisites and practices of product handling applied by poor communities must be expected to vary from one group of interest to the next as prerequisites and practices can be expected to vary as well. Therefore, no possible ways to mitigate the identified inadequacies can be provided on a general basis.

Nevertheless, for the Ovahimba in particular, their training and education concerning basic food safety issues may be a promising tool to increase their ability of using their limited prerequisites more efficiently in terms of the maintenance of food safety and product quality.

5.3 Linkages and interactions between formal and informal marketing chains, stakeholders and end-users

The study identified strong linkages and interactions between the formal economy and the informal meat trade within the study area in terms of business supplies. Almost all informal meat traders apparently derived their raw stock out of formal marketing chains. This is in line with a survey conducted by SKINNER (2006). Similarly, MARTINS and ANELICH (2000) and DEVEY *et al.* (2006) pointed out numerous forward and backward linkages between the formal and informal economy of South Africa. However, the extent of the dependence of the informal economy onto formal suppliers is reportedly depending on the products or services traded (TOKMAN, 1978). In respect of this, it may be concluded that the informal trade of meat within the study area is rather depending on formal suppliers. Moreover, formal practices seem to increasingly infiltrate the informal trade of meat in the study area as most respondents (n = 30, 58.82%) turned out to use styrofoam boxes analogous to those used by many formal fast food retailers.
However, in terms of game meat products in particular, virtually no linkages and interactions could be identified between biltong hunters and commercial game harvesters on the one hand and informal meat traders as well as the Ovahimba on the other, as virtually no product movements could be identified between them. For these potential stakeholders and end-users of the game industry, the legal and cheap access to game meat and edible by-products appears to be greatly limited as only one informal meat trader (1.96%) apparently traded such products regularly. The Ovahimba were never provided with products generated by biltong hunting or commercial game harvests. If game meat products were provided to them, this was exclusively performed by the local nature conservation authority (e.g. carcasses of problem animals).

Nevertheless, this should not be assumed to be valid for the overall situation of the Ovahimba as other clans live in areas with a higher density of game animals. More game may be hunted in such locations and the provision of these clans with edible by-products may therefore have more potential than this was the case near Ruacana. However, for informal meat traders, the weak linkage to the game industry may be expected to prevail within South Africa in general as the study area is very popular for biltong hunting and game harvesting (RAMRAJH, 2009, personal communication).
The virtually non-existent access to edible by-products for informal meat traders and the Ovahimba can be assumed to predominantly originate from a substantial lack of supply of these products by biltong hunters and commercial game harvesters, as all but one biltong hunter ascribed an either unimportant or limited potential to the marketing of game offal and commercial game harvesters have generally been of the same opinion. In the scope of both, biltong hunting and commercial game harvesting, the marketing of edible by-products seems to be rather uncommon as stated by most biltong hunters (n = 8) and by all professional hunters (n =7) involved into the game harvest attended. Edible by-products generated during the attended game harvest were greatly left behind in the field and the professional hunters made clear that this would generally be the case in the scope of commercial game harvests.

5.4 Possible ways to improve the efficiency of the utilization of game meat by-products

In South Africa, the efficient utilization of edible by-products is already practiced by national slaugther chicken producers as chicken heads and feet are frequently traded through South African supermarkets, whilst this is not yet the case for edible game meat by-products. Nevertheless, potential ways of facilitation may be present.

Most importantly, the analysis of meat samples obtained from informal meat traders in KwaZulu-Natal as well as during the experiment conducted in Pretoria indicates that the microbiological quality of informally prepared meat is suitable for human consumption. This may appear surprising when recalling all the inadequacies identified in terms of the maintenance of food safety and product quality by informal meat traders.

In regard to the meat samples collected from informal meat traders in KwaZulu-Natal, prepared meat turned out to be of a significantly higher microbiological quality than raw meat. Coliforms could be isolated in only two cases (8%), whereby coliforms do not necessarily need to be food safety relevant organisms. Such an analysis was not carried out. Moreover, one of these two samples was raw meat. Although determined in almost every second sample (44%), a heavy growth of bacteria does also not necessarily involve foodborne pathogens.

The results from the microbiological analysis of game meat samples from the experiment conducted in Pretoria as well suggest that the informal preparation of meat does not necessarily compromise the microbiological quality of products traded. A significantly negative correlation between the state of samples (raw/cooked) and the presence of bacteria as well as the presence of coliforms suggests that the presence of microorganisms obviously was reduced greatly during the cooking process. Neither *E. coli* nor coliforms could be isolated in the meat samples subsequently to their preparation, whilst the total aerobic plate counts were mostly zero or very low.

In a study conducted by MOSUPYE and VON HOLY (2000), the bacterial counts of raw meat samples collected from street food vendors tended to be higher than those obtained from prepared ones as well. Mostly, these differences were significant as well and it was concluded that, in South Africa, street-vended foods are generally safe for human consumption. Nevertheless, the cooling chain needs to be maintained adequately as this was the case in the experiment. Especially this prerequisite may limit the value of the findings as this, when reviewing the potential hazards identified, cannot be assumed to be guaranteed for products traded by South African informal meat traders in general.

Especially in regard to the inadequacy of prerequisites for food safety maintenance as well as detrimental food handling practises identified for the informal trade of meat, the numerous concerns raised previously cannot be cleared out instantly. No matter if, in future, game meat by-products shall be traded by informal meat traders to the general public or not, their prerequisites and practices for the maintenance of food safety and product quality need to be upgraded. The current situation must be considered insufficient. To which extent this as well applies to poor communities in general cannot be said for sure because exclusively the Ovahimba have been exemplarily considered in the study.

Moreover, if game meat products shall be traded informally or provided to poor communities, some concerns in terms of the supply itself must be raised as well. These products can be assumed to by-pass primary and secondary meat inspection in many cases and potential hazards where identified within the proposed product flows towards informal meat traders and poor communities (see Figure 4, Table 57).

As pointed out earlier, biltong hunters may not necessarily deliver game meat products to registered game abattoirs so that meat inspection is bypassed. Especially in regard to products not desired by formal retailers such as heads and feet it can be assumed that, if directly transferred from biltong hunting to informal meat traders, this may be conducted in the absence of any standards and regulations. More importantly, these products may not undergo any meat inspection before being traded and consumed. Furthermore, as mentioned earlier, biltong hunters seem to not commonly cool carcasses when transporting them over certain distances. Therefore, the risk of the occurrence of Hazard 8 (Tables 57 and 59) must be expected.
Products derived from commercial game harvests may be delivered to informal meat traders and poor communities prior to secondary meat inspection as they may leave this marketing chain already at the location of game harvest (see Figures 3 and 4). They may as well be subjected to Hazard 8 (Tables 57 and 59) to a certain extent depending on who will carry out the transfer of products (e.g. game meat exporters, other companies, private persons) and to which extent standards of commercial game harvests will be further adhered.
Summarizing this, the realization of the proposed provision of informal meat traders and poor communities with edible by.products from the game industry will only be beneficial to them if sufficient standards and regulations are set up for these product flows at the same time and if their adherence by stakeholders and potential facilitators is maintained. This necessity may greatly limit the willingness of stakeholders to do so as well as their profitability of doing so.

In regard to this, commercial game harvests appear to be more suitable for the provision of edible by-products to informal meat traders and poor communities than biltong hunting. Besides the fact that these materials are obtained in high quantities during short time periods, their current set of standards and regulations is clearly superior to biltong hunting. Differently, biltong hunters generally produce small amounts of edible by-products at one time what impedes an efficient and easy marketing of these products. Moreover, as only one biltong hunter stated to trade certain parts of offal (e.g. liver) and n = 7 respondents have been of the opinion that the marketing of offal would not be profitable, the preparedness and willingness of biltong hunters to market these edible by-products appears to be greatly limited. Many respondents pointed out that the cleaning and packing of offal would be very labour intensive so that they prefer to abdicate offal marketing.
Most biltong hunters stated to conduct hunting either as a secondary source of income (n =2) or as a hobby (n = 5). Therefore, they appear to be relatively independent from hunting in terms of financial aspects in most cases. Therefore, most of them do not really need to trade edible by-products or even meat.
It can be expected that most biltong hunters and commercial game harvesters would only engage into the trade of edible by-products if this would be lucrative for them. Nevertheless, most biltong hunters (n = 8) and also some commercial game harvesters (n = 3) claimed to regularly being asked for non-used but edible by-products by locals when hunting. This indicates a certain demand for these products.
Indeed, informal meat traders mostly appeared to be willing to utilize edible by-products from game hunts and harvests for their businesses if available legally and cheaply (n = 30). Concerning this, n = 32 respondents have been of the opinion that game meat by-products could be successfully traded to customers. This contradicts the assumption of HOFFMAN *et al.* (2005a), who concluded that game meat is of only little importance in the diet of black South Africans compared to coloureds and, particularly, whites.

Moreover, a general cash shortage and risk averseness seems to prevail amongst the informal meat traders in the study area, whereby several indicators could be identified such as the finding that the price of the product obviously is a major factor of influence in the decision where to buy meat products (n = 36, 70.59%). Furthermore, the fact that only one respondent offered more than two different meat products and that the great majority of respondents (90.20%) apparently limited their product preparation activities to one methodology only (grilling or cooking), nourishes this asumption. Probably, most respondents only offered products and preparations that, in their experience, turned out to sell best.
No respondent turned out to make a break during a day of business. Business hours were usually long to serve a maximum number of customers, what can be regarded as another indicator for a prevailing risk averseness and cash shortage. Moreover, the majority of informal meat traders apparently operated businesses that were kept very simple in terms of their lining. They often just consisted of a cooking and/or frying facility as well as some chairs and tables for customers. Walls (68.73%) and roofs (37.25%) were widely absent. Regarding this, due to the suspected risk averseness coupled with cash shortage, informal meat traders may desire to maintain their flexibility and mobility within both, the area and the sector itself.

Indeed, a key finding of the evaluation of the informal sector in African countries is the fact that most small informal enterprises do actually not grow at all over time (MCPHERSON, 1996, MEAD and LIEDHOLM, 1998). Furthermore, informally operating people are usually required to sell their products cheaper than formal competitors in order to remain in the market and the elasticity of their income is usually low (TOKMAN, 1978).
In a nutshell, it can be assumed that edible by-products obtained during biltong hunting and commercial game harvests would be readily absorbed by the informal trade of meat products within the study area. Especially when reviewing the suspected risk averseness and cash shortage amongst them, they can be expected to purchase edible game meat by-products for their businesses as long as such products are accessible legally and cheaply.
No significant coherence could be identified between the location of the informal meat trade businesses and wether game meat would be purchased by their operators if available legally and cheaply. Analogously, no such significant coherence could be identified whether informal meat traders think that their customers would purchase game meat by-products when offered. Therefore, the acceptance of game meat products by respondents seems to be a general tendency within the study area that is not dependent on the location.
Similarly, the Ovahimba turned out to be very willing to utilize edible game meat by-products as a source of animal protein. However, the appreciation of these products by the Ovahimba obviously declines if they are not provided for free. Therefore, they may only purchase edible game meat by-products if offered cheaper than other meat products. Because this can as well be assumed for informal meat traders, there is an obvious necessity of creating a price advantage for edible game meat by-products over other meat products in formal retail if an efficient absorption of these products by the informal meat trade as well as by the Ovahimba shall be facilitated. Such a marketing constraint brings along conflicts between the marketability of these products and the rentability for biltong hunters and commercial game harvesters of doing so. This can be assumed to strongly determine success or non-success when striving after a more efficient utilization of edible game meat by-products.

5.5 The effectiveness of materials and methods applied in the process of the achievement of objectives

Because, in KwaZulu-Natal, all informal meat traders were interviewed in Zulu language only, inaccurate translations and phrasings and therefore bias must be expected to have taken place to a certain extent. Similarly, the four participants in the game meat cooking experiment were interviewed in Sotho. However, it cannot be quantified to which extent this might have influenced the outcome of results.

Moreover, some preset aims of the study could not be fully achieved. Concerning this, in KwaZulu-Natal, the collection of one raw and and one prepared beef sample from each informal meat trader selected for sampling turned out to be not feasible. Because of the inclusion of overseas tourists operating as hunters, the data generated during the attended commercial game harvest attended may not be fully representative for game harvesting under normal conditions in South Africa. Moreover, the conditions given if animals are shot "in bunches" could not be observed as game was exclusively shot individually during this particular game harvest.

Biltong hunters were not observed when hunting. This can be regarded as a weakness of the study as practices applied by them could not be directly observed. Therefore, in upcoming studies, this aspect should receive more attention in order to verify the findings made. This way, a more efficient identification and characterization of hazards and risks to food safety as well as of inadequacies in terms of the utilization of edible by-products may be possible for the hunters' end of domestic marketing chains of game meat.

The fact that all datasets generated in the study are not statistically representative limits the expressiveness and reliability of all statistical calculations, although many are well in line with previous studies. Moreover, due to the small datasets generated, there is a generally high variance of data that results in generally wide confidence intervals ($\alpha = 0.05$) for the different variables of interest. This reduces the statistical expressiveness of results obtained. Because of this lacking representativity and an inadequate data reliability, the whole study conducted should be regarded as an observational study to generate information for subsequent studies to look into this topic.

Nevertheless, because all components of participatory risk assessment except exposure assessment were conducted, a substantial integration of participatory aspects in the process of the achievement of primary objectives was realized to a very satisfactory extent. As far as practicable, the principles of a PRA were followed by the study.

When considering the methods applied to develop the flow chart, it becomes apparent that, moreover, HACCP principles, were applied in the study in order to identify potential hazards to food safety and to estimate the risks of their occurrence along the domestic marketing chains for game meat products in South Africa. Participatory methods (structured and informal interviews, direct observations, group interviews, key informants) were used to achieve the duties of a HACCP team (HACCP principles 1 and 2, see "Literature Review" 2.4.1), which usually comprises experts at an abattoir or factory.

Furthermore, the experimental preparation game meat under informal conditions embodies a valuable approach for the verification and back-checking of findings generated in regard to a more efficient utilization of game meat by-products. Any imitation in the scope of the topic is strongly recommended.

6 CONCLUSION

The study conducted should be treated an observational (qualitative) study. When summarizing the basic findings of the study, it is recommended to dedicate further research to the South African game industry in regard to prevailing hazards and risks to food safety and product quality. The study identified a variety of hazards that may prevail within the domestic marketing chains for South African game meat products. If no efforts will be undertaken to mitigate or eradicate these hazards, consumers' health may be jeopardized in the long run.

In terms of current stakeholders, biltong hunting in particular must be assumed to bring along hazards and risks of food safety relevance in terms of the provision of products to the general public for consumption. Nevertheless, in commercial game harvesting, which is highly regulated when compared to biltong hunting, some loopholes for the occurrence of foodborne hazards were identified, too. However, most inadequacies were identified for the informal trade of meat products as a potential stakeholder of the South African game industry.

In particular, the lack of adequate prerequisites as well as unsatisfactory product handling practices amongst informal meat traders on the one hand and the lack of standards and regulations in biltong hunting on the other hand were identified as major causes of food safety related insufficiencies. Regarding the first, promising intervention points are provided by the study. Regarding the latter, the domestic South African game meat product trade is currently being reviewed and legislation updated in terms of standards and regulations. The information from this study will probably be used in this legislative process, as one of the key informants, Dr S Ramrajh, is involved in this process.

There is unused potential in terms of a more efficient utilization of these edible by-products. Currently, a general depreciation of the value and marketing potential of these products at the hunters' end of the marketing chain seems to be a major reason for their insufficient utilization. Indeed, the access of informal meat traders and poor indigenous communities to edible by-products from game hunts and harvests appears to be greatly limited, although the proposed recipients and end-users of edible game meat by-products appeared to be generally willing to utilize them. Nevertheless, especially in regard to the different potential hazards and risks to food safety and product quality, which were identified within the existing and proposed product flows, this matter calls for further research and investigation. Of course, if an efficient by-product flow is to be realized between formal and informal marketing chains, such inadequacies need to be smoothed out. The current study should be regarded as an impetus for doing so.

7 REFERENCES

ABABOUCH L, 2000. The role of government agencies in assessing HACCP. Food Control 11 (2): 137-142.

ABDOU AE, 2002. Application of food safety in developing countries. WHO Mediterranean Zoonoses Control Centre. Information Circular No. 54. June 2002. PDF-File, 16, Pages, pages 6-9. Accessed 09.11.08 at http://www.mzcp-zoonoses.gr/pdfen/circ_54.pdf

ABUL GOUTONDJI, 2007. Preventing water pollution by dairy products: Risk assessment and comparison of legislation in Benin and South Africa. Submitted in partial fulfilment of the requirements for the degree of a Magister Scientiae (Veterinary Science) in the Department of Paraclinical Sciences, Faculty of Vererinary Science, University of Pretoria, South Africa, PDF-File, 252 page. Accessed 15/09/2009 at http://upetd.up.ac.za/thesis/available/etd-10302008-165039/unrestricted/dissertation.pdf

ADAMS WM, 2004. Chapter 2: Good hunting, pp. 19-42. In: Ed.: ADAMS WM, Against Extinction – The story of conservation, Earthscan, London, 311 pages. Accessed 05/09/2009 at http://books.google.de/books?id=jJ38la9nQdEC&pg=PA263&lpg=PA263&dq=Against+Extinction,+Earthscan,+London+(2004),&source=bl&ots=_FvJQ20B6e&sig=FOSCOHQJ-r5KhjVFUhw90ynlJU&hl=de&ei=QxeiSpqOEJegngOB9OnlDw&sa=X&oi=book_result&ct=result&resnum=5#v=onepage&q=&f=false

ADATO M, LUND F and MHLONGO P, 2007. Methodological Innovations in Research on the Dynamics of Poverty: A Longitudinal Study in KwaZulu-Natal, South Africa. World Development 35 (2): 247-263.

AERNI P, 2002. Public attitudes towards agricultural biotechnology in South Africa. Final report, a joint research project of the Center of International Development (CID). Harvard University, USA, and the Southern African Labour and Development Research Unit (SALDRU), University of Cape Town, South Africa, PDF-File Pages 1-30. Accessed 02/03/2009 at http://www.afee.ethz.ch/people/aStelle/aernip/Publications/SAreport-south-Africa.pdf,

ALIBER M, 2003. Chronic poverty in South Africa: Incidence, causes and policies. World Development 31 (3): 473-490.

ANELICH L, 2002. Principles and guidelines for incorporating quantitative risk assessment in the development of microbiological food hygiene standards, guidelines and related texts. Paper presented during the FAO/WHO Consultation. "Principles and guidelines for incorporating microbiological risk assessment in the development of food safety standards, guidelines and related texts". Kiel, Germany, 18-22 March 2002, PDF-File, 3 pages, no pagination. Accessed 09/07/2009 at ftp://ftp.fao.org/es/esn/jemra/kiel_southafrica.pdf

ASHLEY C and JONES B, 2001. Joint ventures between communities and tourism investors: experience in Southern Africa. Published in: International Journal of Tourism Research 3 (2) – Special issue on fair trade in tourism, March 2001, 36 pages, pp 1-36. Accessed 07/03/2009 at http://www.retour.net/Resourcecenter/WebDocuments/documents/pro%20poor%20tourism_files/ProPoorTourism/Joint%20ventures%20in%20Souther%20Africa.pdf

ASIBEY EOA, 1974. Wildlife as a source of protein in Africa south of the Sahara, Biological Conservation 6 (1): 32-39.

AUSTRALIAN GOVERNMENT. 2005, Department of Health and Aging, Office of the Gene Technology Regulator, Risk Analysis Framework, PDF-File, 118 pages. Accessed 15/09/2009 at http://www.ogtr.gov.au/internet/ogtr/publishing.nsf/Content/raf-3/$FILE/raffinal2.2.pdf

BAKER JE, 1997. Development of a model system for touristic hunting revenue collection and allocation, Tourism Management 18 (5): 273-286.

BEHR C and GREUEL E, 1977. Lebensmittelhygienische Aspekte bei der Wildbretgewinnung (*in German*). Zeitschrift für Jagdwissenschaft 23 (1): 41-49.

BENSINK JC, DOBRENOV B, MULENGA MP, BENSINK ZS and McKEE JJ. 2002, The microbiological quality of beef tripe using different processing techniques. Meat Science 62: 85-92.

BIGALKE RC, 2000. Functional relationships between protected and agricultural areas in South Africa and Namibia. In Eds.: PRINS HHT, GROOTENHUIS JG and DOLAN TT. Wildlife conservation by sustainable use. Springer, 496 pages, pp. 169-202. Accessed 03703/2009 at http://books.google.de/books?hl=de&lr=&id=YoRKKE2lRf8C&oi=fnd&pg=PA169&dq=illegal+hunting+meat+%22south+africa%22&ots=3lXMTsW6Tb&sig=Lh0D-1VJVqNvt5Io5trqaSi8kW4

BOND I, CHILD B, DE LA HARPE D, JONES B, BARNES J and ANDERSON H, 2004. Chapter 3: Private land contribution to conservation in South Africa. In Ed.: CHILD B., Parks in transition: Biodiversity, rural development and the bottom line. 267 pages, pp. 29-61. Earthscan, London. Accessed 04/09/2009 at http://books.google.de/books?id=3l7GrfttI9cC&pg=PA29&lpg=PA29&dq=%22Private+land+contribution+to+conservation+in+South+Africa%22+Bond&source=bl&ots=P4AHCuvudr&sig=xi2l3yZhT55UyhfbAHI_WzbfHvg&hl=de&ei=CLgSovOPMuHsAbRqPDSBA&sa=X&oi=book_result&ct=result&resnum=1#v=onepage&q=%22Private%20land%20contribution%20to%20conservation%20in%20South%20Africa%22%20Bond&f=false

BORGERHOFF-MULDER M and COPPOLILLO P, 2005. Chapter 2: The Evolution of Policy. In Eds.: BORGERHOFF-MULDER M and COPPOLILLO P, Conservation: Linking ecology, economics and culture, 372 pages, pp. 27-52. Princeton University Press, Princeton. Accessed 05/09/2009 at http://books.google.de/books?id=sctUJHkFyk0C&dq=%22Conservation:+Linking+Ecology,+Economics+and+Culture%22&printsec=frontcover&source=bn&hl=de&ei=C1GiSpTLM5if_AaS0oWCQ&sa=X&oi=book_result&ct=result&resnum=4#v=onepage&q=&f=false

BOTHMA J, 2002. Some economics of game ranching. In Ed.: PENZHORN B, Proceedings of a symposium on game ranch management 2002, pp. 23-40. South Africa.Wildlife Group of the South African Veterinary Association, Onderstepoort, South Africa (as cited by LINDSEY *et al.*, 2006a).

BRADSTOCK A, 2005. Key experiences of land reform in the Northern Cape Province of South Africa. Policy & Research Series, FARM-Africa, PDF-File, 38 pages, pages 1-38. Accessed 04/08/2009 at http://www.sarpn.org/documents/d0001251/P1426-FarmAfrica_Jan2005.pdf

BUDLENDER D, BUWEMBO R and SHABALALA N, 2001. The informal economy: Statistical data and research findings. Country case study: South Africa, Unpublished document prepared for Women in Informal Employment: Globalising and Organising, Durban (as cited by Skinner, 2006).

BUSSINESS DICTIONARY, 2009, accessed 23/09/2009 at www.businessdictionary.com

CARDINALE E, PERRIER GROS-CLAUDE JD, TALL F, GUÈYE EF and SALVAT G, 2005. Risk factors for contamination of ready-to-eat street-vended poultry dishes in Dakar, Senegal, International Journal of Food Microbiology 103(2): 157-165.

CARO TM, PELKEY N, BORNER M, SEVERRE ELM, CAMPBELL KLI, HUISH SA, OLEKUWAI J, PFARM B and WOODWORTH BL, 1998. The impact of tourist hunting on large mammals in Tanzania: An initial assessment. African Journal of Ecology 36 (4): 321-346. Accessed 05/09/2009 at http://www3.interscience.wiley.com/cgi-bin/fulltext/119116380/PDFSTART

CARO TM, YOUNG CR, CAULDWELL AE and BROWN DDE, 2009. Animal breeding systems and big game hunting: Models and application. Biological Conservation 142: 909-929.

CARRUTHERS J, 2008. Wilding the farm or farming the wild"? The evolution of scientific game ranching in South Africa from the 1960s to the present. In Ed.: SKINNER JD, Transactions of the royal society of South Africa 63 (2): 160-181. Accessed 28/02/2009 at http://www.sawma.co.za/images/Carruthers.pdf

CATLEY AP and MOHAMMED AA, 1996. The use of livestock-disease scoring by a primary animal-health project in Somaliland. Preventive Veterinary Medicine 28 (3):175-186.

CHAMBERS R, 1994. Participatory Rural Appraisal (PRA): Analysis of Experience. World Development 22 (9): 1253-1268.

CHILD GS, 1991. People's participation in wildlife utilization in Africa. Landscape and Urban Planning 20 (1-3): 159-162.

CODEX ALIMENTARIUS COMMISSION, 2009. Accessed 20/09/2009 at http://www.codexalimentarius.net/web/index_en.jsp

COLEMAN ME and MARKS HM, 1999. Qualitative and quantitative risk assessment. Food Control 10 (4-5): 289-297.

COOK CW, 1977. Use of rangelands for future meat production. Journal of Animal Science 45 (6): 1476-1482.

COUSINS JA, SADLER JP and EVANS J, 2008. Exploring the role of private wildlife ranching as a conservation tool in South Africa: Stakeholder perspectives. Ecology and Society 13 (2): 17 pages, no pagination. Accessed 08/03/2009 at http://www.ecologyandsociety.org/vol13/iss2/art43/main.html

DAMM GR, 2005. Hunting in South Africa: Facts, risks, opportunities. African Indaba 3 4/5): 1-23. Accessed 28/02/2009 at http://www.africanindaba.co.za/Conservation/damm_hunting_southafrica_2005.pdf

DAWSON RJ and CANET C, 1991. International activities in street foods, Food Control 2 (3): 135-139.

DEPARTMENT OF ARTS AND CULTURE, Republic of South Africa, 2007. Delegate Handbook. 8th Meeting of the International Advisory Committee (IAC) of the "Memory of the World" (MOW) Programme, Pretoria, South Africa.
Diep in die Berg Conference Centre, Pretoria, South Africa, 11-15 June, 2007, PDF-File, 10 pages, pages 1-10. Accessed 04/08/2009 at http://www.national.archives.gov.za/rms/delegate_handbook.pdf

DEPARTMENT: PROVINCIAL AND LOCAL GOVERNMENT, 2006. Zululand nodal economic development profile. Section 2: An overview of Zululand- Word-Dokument, 19 pages, pp. 5-6. Accessed 13/07/2009 at http://www.zululand.org.za/WebSite/Settings/PageTemplates/ContentPage1.aspx?ItemID=293

DESHPANDE SS, 2002. Chapter 6: Measurement of toxicants and toxicity. In Ed.: DESHPANDE SS, Handbook of food toxicology, 903 pages, pp. 119-162. Marcel Dekker Inc., New York, U.S.A.. Accessed 20/09/2009 at http://books.google.de/books?id=Mk-IdNTTJB0C&pg=PA142&lpg=PA142&dq=%22risk+assessment+can+be+defined%22&source=bl&ots=UU8E4uY0Ba&sig=4gueKJV4SHH370FudjcunMFpnPI&hl=de&ei=ouy1Soi8ENqLsAb19nuDA&sa=X&oi=book_result&ct=result&resnum=4#v=onepage&q=%22risk%20assessment%20can%20be%20defined%22&f=false

DEVEY R, SKINNER C and VALODIA I, 2003. Informal economy employment data in South Africa: A critical analysis. Development Policy research Unit. Paper presented at the TIPS AND DPRU FORUM 2003. The Challenge of Growth and Poverty: The South African Economy Since Democracy. 8 - 10 September 2003, Indaba Hotel, Johannesburg, pp. 1-50. Accessed 03/03/2009 at http://www.commerce.uct.ac.za/Research_Units/DPRU/Conf2003PDF/p_devey_skinner_valodia.pdf

DEVEY R, SKINNER C and VALODIA I, 2006. Second Best? Trends and linkages in the informal economy in South Africa. Development Policy Research Unit. Working Paper 06/102. PDF-File, 27 pages, pp. 1-27. Accessed 01/08/2009 at http://www.sarpn.org.za/documents/d0002003/Economy_SA_Feb2006.pdf

DIRECTORATE: VETERINARY SERVICES, 2007. Meat inspectors manual – Game. Ed.: BERGH T. Veterinary Public Health, National Department of Agriculture. Pretoria, South Africa. PDF-File, 133 pages. Accessed 25/09/2009 at http://www.nda.agric.za/Vetweb/VPH/Manuals/GameManual.pdf

DU TOIT JG, 2007. Report: Role of the Private Sector in theWildlife Industry. Tshwane, Wildlife Ranching SA/Du Toit Wilddienste. 87 pp. (as cited by CARRUTHERS, 2008).

EHIRI JE, MORRIS GP and McEWEN J, 1995. Implementation of HACCP in food businesses: The way ahead. Food Control 6 (6): 341-345.

EKANEM EO, 1998. The street food trade in Africa: Savety and socio-environmental issues. Food Control 9 (4): 211-215.

ELOFF T, 2002. The economics of the game industry in South Africa. In Eds.: EBEDES H, REILLEY W, VAN HOVEN W and PENZHORN B, Sustainable conservation in practice, pp. 78–86 (as cited by VAN ZYL and FERREIRA, 2004, HOFFMAN *et al.*, 2005b).

FAO, 2004. Good practices for the meat industry. FAO Animal Production and Health, Manual 2, 291 pages.

FAO & WHO, 2004, Risk assessment of *Listeria monocytogene*s in ready-to-eat foods, Technical report, Microbiological Risk Assessment Series 5, Rome, Italy, PDF-File, 307 pages. Accessed 19/09/2009 at ftp://ftp.fao.org/docrep/fao/010/y5394e/y5394e.pdf

FAO & WHO, 2005a. Food safety risk analysis, An overview and framework manual. Rome, Italy and Geneva, Switzerland. 86 pages, PDF-File. Accessed 03/10/08 at http://www.fsc.go.jp/sonota/foodsafety_riskanalysis.pdf

FAO & WHO, 2005b. Informal food distribution sector in Africa (street foods): Importance and challenges. FAO/WHO Regional Conference on Food Safety for Africa. Harare (Zimbabwe), 3-6 October 2005. Accessed 21/09/08 at http://www.sarpn.org.za/documents/d0001652/index.php

FAO & WHO, 2006. Overview of national approaches to facilitate HACCP application in Small and/or less developed businesses. FAO guidance to governments on the application of HACCP in small and/or less developed food businesses. FAO Food and Nutrition Paper 86, PDF-File, 92 pages, pp. 62-65. Accessed 09/07/2009 at ftp://ftp.fao.org/docrep/fao/009/a0799e/a0799e00.pdf

FAOSTAT, 2009. Food and Agriculture Organization of the United Nations. Accessed 18/03/2009 at http://faostat.fao.org/

FÉRON E, TAFIRA JK, BELEMSOBGO U, BLOMME S, DE GARINE-WICHATITSKY M, 1998. Animal resources – Transforming wild African herbivores into edible meat for local communities. Sustainable use of impala *(Aepyceros melampus)* in the CAMPFIRE Program, Zimbabwe. Revue d'Elevage et de Médecine Vétérinaire des Pays Tropicaux, 51:265-272.

FIELD RA, 2004. Species of meat animals – Game. In Ed.: JENSEN WK, Encyclopedia of Meat Sciences, Elsevier, Amsterdam, pp. 1302-1308.

FOOD SAFETY AND INSPECTION SERVICE, 1998. United States Department of Agriculture, Washington D.C.. Key facts – The seven HACCP principles. Accessed 16/09/2009 at http://www.fsis.usda.gov/OA/background/keyhaccp.htm

FULLER L, 2007. Food safety: HACCP awareness and legislation. Editorial. South African Journal of Clinical Nutrition 20 (20): 48-49. Accessed 08/07/2009 at http://www.sajcn.co.za/index.php/SAJCN/article/viewFile/176/169

GIBSON CC and MARKS SA, 1995. Transforming rural hunters into conservationists: An assessment of community-based wildlife management programs in Africa. World Development 23 (6): 941-957.

GILL CO, 2007. Microbiological conditions of meats from large game animals and birds. Meat Science, 77(2):149-160.

GILL and JONES SDM, 1992. Evaluation of a commercial process for collection and cooling of beef offals by a temperature function integration technique. International Journal of Food Microbiology 15: 131-143.

GOLDMAN T, 2003. Organizing in South Africa's Informal Economy: An Overview of Four Sectoral Case Studies. In Focus Programme on Boosting Employment through Small Enterprise Development Job Creation and Enterprise Department. International Labour Office Geneva, pp 1-90. Accessed 03/03/2009 at http://bravo.ilo.org/dyn/empent/docs/F2093826523/WP60-2003.pdf

GRACE D, RANDOLPH T, OLAWOYE J, DIPELOU M and KANG'ETHE E, 2008a. Participatory risk assessment: a new approach for safer food in vulnerable African communities. *Development in Practice* 18(4):611-618.

GRACE D, RANDOLPH TF, MWIINE F, KANG'ETHE E and NASINYAMA G, 2008b. Chapter 11: City dairying in Kampala: Integrating benefits and harms. In Eds.: COLE D, LEE-SMITH D and NASINYAMA G, Healthy city harvests: Generating evidence to guide policy on urban agriculture. International Potato Center (CIP). Convener for Urban Harvest and Makerere University Press, Lima, pp 193-210. Accessed at 22/12/2008 at http://www.cipotato.org/publications/pdf/004361.pdf

HALDIMANN M, BAUMGARTNER A and ZIMMERLI B, 2002. Intake of lead from game meat – a risk to consumers' health? European Food Research Technology 215: 375-379.

HENSON S, 2003. The economics of food safety in developing countries. ESA Working Paper No. 03-19. Agricultural and Development Economics Division, Food and Agriculture Organization of the United Nations (FAO), December 2003. PDF-File, 102 Pages. Accessed 20/10/08 at http://www.eldis.ids.ac.uk/vfile/upload/1/document/0708/DOC23314.pdf

HENSON S, LOADER R, SWINBANK A, BREDAHL M and LUX N, 2000. Impact of sanitary and phytosanity measures on developing countries, Report. Centre for food economics research, Department of Agricultural and Food Economics, University of Reading, PDF-File, 105 pages. Accessed 03/10/08 at http://www.cepea.esalq.usp.br/pdfs/134.pdf

HOFFMAN LC, 2000a, The yield and carcass chemical composition of impala (*Aepyceros melampus*), a southern African antelope species, Journal of The Science of Food and Agriculture 80: 752-756.

HOFFMAN LC, 2000b, Meat quality attributes of night-cropped Impala (*Aepyceros melampus)*, South African Journal of Animal Science 30 (2): 133-137.

HOFFMAN LC, 2008, The yield and nutritional value of meat from African ungulates, camelidae, rodents, ratites and reptiles, Meat Science 80: 94-100.

HOFFMAN LC and FERREIRA AV, 2000, pH decline of the *M. longissimus thoracis* of night-cropped Grey Duiker (*Sylvicapra grimmia*), short communication, South African Journal of Animal Science 30(1): 16-17.

HOFFMAN LC, MULLER M, SCHUTTE De W, and CRAFFORD K, 2004, The retail of South African game meat: current trade and marketing trends, South African Journal of Wildlife Research 34(2): 123-134.

HOFFMAN LC, MULLER M, SCHUTTE De W, CALITZ FJ and CRAFFORD K, 2005a, Consumer expectations, perceptions and purchasing of South African game meat, South African Journal of Wildlife Research 35(1): 33-42.

HOFFMAN LC, KRITZINGER B and FERREIRA AV, 2005b, The effects of region and gender on the fatty acid, amino acid, mineral, myoglobin and collagen contents of impala *(Aepyceros melampus)* meat, Meat Science 69: 551-558.

HOFFMAN LC and WIKLUND C, 2006, Game and venison – meat for the modern consumer, Meat Science, 74(1):197-208.

HOFFMAN LC, KROUCAMP M and MANLEY M, 2007, Meat quality characteristics of springbok *(Antidorcas marsupialis)*. 4: Sensory meat evaluation as influenced by age, gender and production region, Meat Science 76 (4): 774-778.

HOLLOWAY A, ROOMANEY R (principal authors), **PHARAOH R, SOLOMON FJ and COUSINS D** (contributing authors), 2008. Chapter 3: Participatory risk assessment – Preparatory steps In Eds.: Weathering the storm – Participatory risk assessment for informal settlements. Disaster Mitigation for Sustainable Livelihoods Programme. Periperi Publications, University of Cape Town, Rondebosch 7701, South Africa. PDF-File, 201 pages, pp 23-42. Accessed 23/12/2008 at http://www.preventionweb.net/files/4163_weathering.pdf

HUTTON JM and LEADER-WILLIAMS N, 2003. Sustainable use and incentive-driven conservation: Realigning human and conservation interests. Oryx 37 (2): 215-226. Accessed 05/09/2009 http://www.kent.ac.uk/sac/dice/resources/HuttonLWSustainable%20use.pdf

ILRI, 2007. Safe food, fair food: Building capacity to improve the safety of animal source foods and ensure continued market access for poor farmers in sub-saharan Africa. Proposal submitted to the BMZ, 26 pages.

INDIAN COUNCIL OF MEDICAL RESEARCH, 2000. Application of Hazard Analysis and Critical Control Point for improvement of quality of processed food. ICMR Bulletin 30 (5). PDF-File, 6 pages, no pagination. Accessed 20/09/2009 at http://www.icmr.nic.in/bumay2000.pdf

IQBAL S, BLUMENTHAL W, KENNEDY C, FUYUEN YY, PICKARD S, FLANDERS WD, LORINGER K, KRUGER K, CALDWELL KL and BROWN MJ, 2009. Hunting with lead: Association between blood lead levels and wild game consumption. Environmental Research. In press, corrected proof, available online 10 September 2009 at sciencedirect.com

JACKSON L, 2009. Food safety in South Africa – Is the consumer the missing link in the Food chain. The Food Safety Network, a web-based platform for providing industry and the consumer with easy access to information relating to food safety and service providers involved in food safety. PDF-File, 6 pages. Accessed 08/07/2009 at www.thefoodsafetynetwork.co.za/.../Food%20safety%20in%20South%20Africa.pdf

JIRATHANA P, 1998. Constraints experienced by developing countries in the development and application of HACCP. Food Control 9 (2-3): 97-100.

JONES JL, 2005. Transboundary Conservation in Southern Africa: Exploring conflict between local resource access and conservation. Centre for Environmental Studies, University of Pretoria, South Africa, 32 pages. Accessed 02/03/2009 at http://www.maweb.org/documents/bridging/papers/jones.jennifer.pdf

KÄFERSTEIN F and ABDUSALAM M, 2002. Food safety in the 21st century. WHO Mediterranean Zoonoses Control Centre Information. Circular No. 54, June 2002. PDF-File, 16 Pages, pp- 3-5. Accessed 09/11/08 at http://www.mzcp-zoonoses.gr/pdfen/circ_54.pdf

KEPE T, 1997. Communities, Entitlements and Nature Reserves: The Case of the Wild Coast, South Africa. IDS Bulletin, 13 pages. Accessed 02/03/2009 at http://dlc.dlib.indiana.edu/archive/00000071/00/kepe.pdf

KIM E-K, LEE S-J, JEON B-T, MOON S-H, KIM B and PARK T-K, 2009. Purification and characterisation of antioxidative peptides from enzymatic hydrolysates of venison protein. Food Chemistry 114: 1365-1370.

KINGDON G. G. and KNIGHT J., 2004. Unemployment in South Africa: The nature of the beast. World Development 32 (3): 391-408.

KOHN TA, KRITZINGER B, HOFFMAN LC and MYBURGH KH, 2005. Characteristics of impala *(Aepyceros melampus)* skeletal muscles. Meat Science 69: 277-282.

KRITZINGER B, HOFFMAN LC and FERREIRA AV, 2003. A comparison between the effects of two cropping methods on the meat quality of impala *(Aepyceros melampus)*. South African Journal of Animal Science 33 (4): 233-241.

KROLL T and KRUGER AS, 1998. Closing the gap: Bringing communal farmers and service institutions together for livestock and rangeland development. Journal of Arid Environments 39 (2): 315-323.

KWAZULU-NATAL AGRICULTURE AND ENVIRONMENTAL AFFAIRS, 2005. Hand-out for the meeting with the KwaZulu-Natal Game Ranchers Association. Pongola, October, 27th, 2005, unpublished.

LA GRANGE LJ, MARUCCI G and POZIO E, 2009. *Trichinella zimbabwensis* in wild Nile crocodiles *(Crocodylus niloticus)* of South Africa. Veterinary Parasitology 161: 88-91

LA NEVE F, CIVERA T, MUCCI N and BOTTERO MT, 2008. Authentication of meat from game and domestic species by SNaPshot minisequencing analysis. Meat Science 80 (2): 216-224.

LATHAM MC, 1997. Chapter 34: Improving food quality and safety, In Ed.: LATHAM MC, Human nutrition in the developing world. 508 pages, pp. 329-340. FAO Food and Nutrition Series No. 29, Food and Agriculture Organization of the United Nations (FAO), Rome, Italy.

LEADER WILLIAMS N, MILLEDGE S, ADCOCK K, BROOKS M, CONWAY A, KNIGHT M, MAINKA S, MARTIN EB and TEFERI T, 2005. Trophy Hunting of Black Rhino *Diceros bicornis*: Proposals to Ensure Its Future Sustainability. Journal of International Law and Policy 8: 1-11. Accessed 05/09/2009 at http://www.rhinoresourcecenter.com/ref_files/1213446124.pdf

LEOPOLD A, 1986. Game Management. The University of Wisconsin Press, Madison, (first published 1933). PDF-File, 481 pages. Accessed 03/09/2009 at http://books.google.de/books?id=Qz4GzWL4kgQC&dq=LEOPOLD,+A.+1986.+Game+Management&printsec=frontcover&source=bl&ots=P_dryj4KX9&sig=ijqink584QyqfsaMqv0wPcbmWlc&hl=de&ei=MwegSvG2G4ab_AaGg5zjCw&sa=X&oi=book_result&ct=result&resnum=6#v=onepage&q=LEOPOLD%2C%20A.%201986.%20Game%20Management&f=false

LEWIS D and JACKSON J, 2005. Safari hunting and conservation on communal land in southern Africa. In Eds.: WOODROFFE R, THIRGOOD S abd RABINOWITZ A, People and wildlife: Conflict or coexistence? 497 pages, pp. 239–251. Cambridge University Press, Cambridge, United Kingdom. Accessed 05/09/2009 at http://books.google.de/books?id=7mN0uMGhQUC&pg=PA239&lpg=PA239&dq=%22Safari+hunting+and+conservation+on+communal+land+in+southern+Africa%22&source=bl&ots=D09OJgnx4m&sig=GXUHKGwBrAnmiGrhS3kqrwTqdzc&hl=de&ei=RjuiSrawA8KKsAaR7vnSBA&sa=X&oi=book_result&ct=result&resnum=1#v=onepage&q=%22Safari%20hunting%20and%20conservation%20on%20communal%20land%20in%20southern%20Africa%22&f=false

LINDSEY PA, FRANK LG, ALEXANDER R, MATHIESON A and ROMANACH SS, 2006a. Trophy Hunting and Conservation in Africa: Problems and One Potential Solution. Conservation Biology 21 (3): 880-883.

LINDSEY PA, ALEXANDER R, FRANK LG, MATHIESON A and ROMANACH SS, 2006b. Potential of trophy hunting to create incentives for wildlife conservation in Africa where alternative wildlife-based land uses may not be viable. Animal Conservation 9: 283-291.

LINDSEY PA, ROULET PA and ROMANACH SS, 2007. Economic and conservation significance of the trophy hunting industry in sub-Saharan Africa. Biological Conservation 134: 455-469.

LIU D-C, 2002. Better utilization of by-products from the meat industry. Food & Fertilizer Technology Center for the Asian and Pacific Region. PDF-File, 15 pages, pp. 1-15. Accessed at 27/08/2009 at http://www.agnet.org/library/eb/515/

LUCK K, 2005. Farm Workers and Land Tenure Reform: The Case of Game Farming in Hope Fountain in the Eastern Cape. Social Dynamics 31 (1): 84-103.

LUXMOORE R, 1985. Game farming in South Africa as a source in conservation (Abstract). Oryx 19 (4): 225-231. Accessed 04/09/2009 at http://journals.cambridge.org/action/displayAbstract?fromPage=online&aid=4959952&fulltextType=RA&fileId=S0030605300025667#

MARTINS JH and ANELICH LE, 2000. Improving street foods in South Africa. Conducted for FAO, Rome, Italy. PDF-File, 86 pages, pp-1-10. Accessed 06/03/2009 at http://www.doh.gov.za/department/foodcontrol/streetfood/02.pdf

MAYAKA TB, HENDRICKS T, WESSELER J and PRINS HHT, 2005. Improving the benefits of wildlife harvesting in Northern Cameroon: A co-management perspective. Ecological Economics 54: 67-80.

McCRINDLE CME, 2003. Experiences in participatory action research to promote animal health and food safety in rural, peri-urban and settlement areas in South Africa. In: ALARPM 6th and PAR 10th World Congress, September 21-24, 2003. University of Pretoria, South Africa, pp 1-10. Accessed 16/12/2008 at http://www.up.ac.za/academic/education/alarpm/PRP_pdf/McCrindle.PDF

McCRINDLE CME, 2009. Personal communication. University of Pretoria, Department of Paraclinical Sciences, Section Veterinary Public Health, Private Bag X04, Onderstepoort 0110, South Africa.

McPHERSON MA, 1996. Growth of micro and small enterprises in southern Africa. Journal of Development Economics 48: pp. 253-277.

MEAD DC and MORRISSON C, 1996. The informal sector elephant. Word Development 24 (10): 1611-1619.

MEAD DC and LIEDHOLM C, 1998. The Dynamics of Micro and Small Enterprises in Developing Countries. World Development 26 (1): 61-74.

MICHEL AL, BENGIS RG, KEET DF, HOFMEYR M, DE KLERK LM, CROSS PC, JOLLES AE, COOPER D, WHYTE IJ, BUSS P and GODFROID J, 2006. Wildlife tuberculosis in South African conservation areas: Implications and challenges. Veterinary Microbiology 112 (2-4): 4th International Conference on Mycobacterium bovis, pp. 91-100.

MIYAGISHIMA K, MOY G, MIYAGAMA S, MOTARJEMI Y and KÄFERSTEIN FK, 1995. Food safety and public health. Food Control 6 (5): 253-259.

MOSSMAN AS, 1975. International game ranching programs. Journal of Animal Science 40 (5): 993-999.

MOSTERT R and HOFFMAN LC, 2007. Effect of gender on the meat quality characteristics and chemical composition of kudu *(Tragelaphus strepsiceros)*, an African antelope species. Food Chemistry 104 (2): 565-570.

MOSUPYE FM and VON HOLY A, 2000. Microbial hazard identification and exposure assessment of street food vending in Johannesburg/South Africa. International Journal of Food Microbiology 61 (2/3): 137-145.

MOTARJEMI Y, KÄFERSTEIN F, MOY G, MIYAGAWA S and MIYAGISHIMA K, 1996. Importance of HACCP for public health and development: The role of the World Health Organization. Food Control 7 (2): 77-85.

MTSHALI SM, 2002. Household Livelihood Security in Rural KwaZulu-Natal, South Africa – Summary. PhD-Thesis. Wageningen University, Dissertation no. 3232, no pagination. Accessed 05/03/2009 at http://library.wur.nl/wda/abstracts/ab3232.html

MULLER C, 2003. Measuring South Africa's informal sector: An analysis of national household surveys. Development Policy Research Unit. Working Paper 03/71, PDF-File, 22 pages, pp 1-19. Accessed 03/03/2009 at http://www.commerce.uct.ac.za/Research_Units/dpru/WorkingPapers/PDF_Files/wp71.pdf

NEWTON KG and GILL CO, 1980. The microbiology of DFD fresh meats: A review, Meat Science 5: 223-232.

NOUT MJR and MOTARJEMI Y (on behalf of all workshop participants), 1997. Assessment of fermentation as a household technology for improving food safety: A joint FAO/WHO workshop. Food Control 8 (5-6): 221-226.

NTIAMOA-BAIDU Y, 1997. Wildlife and food security in Africa, FAO Conservation Guide 33. Food and Agriculture Organization of the United Nations, no pagination. Accessed 18/12/2009 at http://www.fao.org/docrep/w7540e/w7540e00.htm

NUDING MA, 2002. Wildlife Management in Namibia: The conservancy approach. In Eds.: O'RIORDAN T and STOLL-KLEEMANN S, Biodiversity, sustainability and human communities: Protecting beyond the Protected. PDF-File, 317 pages, pp 189-209. Cambridge University Press, pp. 189–209. Accessed 05/09/2009 at http://books.google.de/books?id=idDtvBjNVlgC&dq=%22Biodiversity,+Sustainability+and+Human+Communities:%22&printsec=frontcover&source=bl&ots=L5BU4N60Ua&sig=SKFwNdEZnvWulyOhfgF4HnvmVlE&hl=de&ei=Fr-iSrC5KtWc_Ab2k7m-CQ&sa=X&oi=book_result&ct=result&resnum=1#v=onepage&q=&f=false

OANDA – The currency Site, 2009. Accessed 25/09/2009 at http://www.oanda.com. The following currency exchange rates were derived: Average exchange rate for ZAR to € for the years 1999, 2000 and the period 01/01/2009 – 28/09/2009; average exchange rate of US$ to € for the year 2004.

OIE (World Organisation for Animal Health), 2009. Animal Production Food Safety, HTML-File. Accessed 20/09/2009 at http://www.oie.int/eng/secu_sanitaire/en_introduction.htm

OMORE A, STAAL SJ, KURWIJILLA L, OSAFO E, ANING G, MDOE N and NURAH G, 2001. Indigenous markets for dairy products in Africa: Trade-offs between food safety and economics. Proceedings of Symposium on Dairy Development in the Tropics, 2 November 2001. Utrecht University, Utrecht (Netherlands). PDF-File, 4 pages. Accessed 05/10/08 at http://www.smallholderdairy.org/publications/Conference/Omore%20et%20al-2001-Raw%20milk%20market%20food%20safety%20%20econ-Utrecht.pdf

OMUSATI REGIONAL COUNCIL, 2006. Omusati Regional Profile 2006. PDF-File, 24 pages. Accessed 04/08/2009 at http://www.omusatirc.gov.na/images/omusati_regional_council_profile_2006.pdf

ONYANGO CA, IZUMIMOTO M and KUTIMA PM, 1998, Comparison of some physical and chemical properties of selected game meats, Meat Science 49 (1): 117-125.

OYEWOLE OB, 1997. Lactic fermented foods in Africa and their benefits. Food Control 8 (5-6): 289-297.

PARSONS A, 1995. Food control and regulation in South Africa – some personal comments. Food Control 6 (5): 311-315.

PATTERSON JT and GIBBS PA, 1979. Vacuum-packaging of bovine edible offal. Meat Science 3 (3): 209-222.

PATTERSON C and KHOSA P, 2005. Background research paper: A status quo study on the professional and recreational hunting industry in South Africa. TRAFFIC – the wildlife trade monitoring network. Prepared for the Panel of Experts appointed by the Minister of Environmental Affairs and Tourism. Word-Document, 57 pages. Accessed 02/08/2009 at http://www.deat.gov.za/HotIssues/2005/29062005/25102005/PoE%20Research%20Status%20quo%20of%20hunting%20industry%20final.doc

PEBERDY S, 2000. Mobile entrepreneurship: Informal sector cross-border trade and street trade in South Africa. Development Southern Africa 17 (2): 201-219.

PHASA, 2009. Professional Hunter's Association of South Africa. Accessed 09/08/2009 at http://www.phasa.co.za/index.php?pid=1

POLLOCK NC, 1969. Some observations on game ranching in southern Africa. Biological Conservation 2 (1): 18-24.

PROVIDE PROJECT, 2005. The provincial decision-making enabling project. Background Paper 205: 1 (5). A profile of KwaZulu-Natal: Demographics, poverty, inequality and unemployment. Elsenburg, South Africa. Project Leader: PUNT C, PDF-File, 26 pages. Accessed 07/09/2009 at http://www.elsenburg.com/provide/documents/BP2005_1_5%20Demographics%20KZ.pdf

RADDER L, 2003. Understanding consumer decision-making in adopting wild venison: A suggested framework. Journal of Food Products Marketing 9 (1): 15-29.

RADDER L and LE ROUX L, 2005. Factors affecting food choice in relation to venison: A South African example. Meat Science 71 (3): 583-589.

RAMRAJH S, 2009. Personal communication. Deputy Manager Veterinary Public Health, State Veterinary Services, North Region, 4th Floor ABSA-Building, Private Bag X1048, Richards Bay 3900, KwaZulu-Natal, South Africa.

RANDOLPH TF, SCHELLING E, GRACE D, NICHOLSON CF, LEROY JL, COLE DC, DEMMENT MW, OMORE A, ZINSSTAG J and RUEL M, 2007. Invited Review: Role of livestock in human nutrition and health for poverty reduction in developing countries. Journal of Animal Science, Volume 85 (11): 2788-2800.

RILEY RR, SAVELL JW, SHELTON M and SMITH GC, 1989. Carcass and offal yields of sheep and goats as influenced by market class and breed. Small Ruminant Research 2: 265-272.

ROGERSON CM, 2000. Emerging from Apartheid's shadow: South Africa's informal economy. Journal of International Affairs 53 (2): 673-695.

ROGERSON, CM, 2001. In search of the African miracle: Debates on successful small enterprise development in Africa. Habitat International 25: 115-142.

ROONEY R and WALL PG, 2003. Food safety. In Eds: CABALLERO B, TRUGO L, FINGLAS P, Encyclopedia of Food science and Nutrition. World Health Organization, Geneva, Switzerland. Food Safety Authority of Ireland, Dublin, Ireland. 6000 pages, pp 2682-2688.

SCHILLHORN VAN WEEN TW, 2005. International trade and food safety in developing countries. Food Control 16 (6): 491-496.

SCHLUNDT J, 1999. Principles of food safety risk management. Food Control 10 (4-5): 299-302.

SCHLUNDT J, 2002. New directions in foodborne disease prevention. International Journal of Food Microbiology, Volume 78 (1-2): 3-17.

SCHRODER B, UYS AC and REILLY BK, 2006. A survey of free-living ixodid ticks on a commercial game farm in the Thabazimbi District, Limpopo Province, South Africa. Journal of the South African Veterinary Association 77(3): 141–144.

SEMAN DL, DREW KR, CLARKEN PA, LITTLEJOHN RP, 1988. Influence of packaging method and length of chilled storage on microflora, tenderness and colour stability of venison loins. Meat Science 22: 267-282.

SHERIDAN JJ and LYNCH B, 1988. The influence of processing and refrigeration on the bacterial numbers on beef and sheep offals. Meat Science 24: 143-150.

SIMON D and BIRCH SL, 1992. Formalizing the informal sector in a changing South Africa: Small-scale manufacturing on the Witwatersrand. World Development 20 (7): 1029-1045.

SIMS-CASTLEY R, KERLEY GIH, GEACH B and LANGHOLZ J, 2005. Socio-economic significance of ecotourism-based private game reserves in South Africa's Eastern Cape Province. In Ed.: GORIUP P, Protected Area Programme 15 (2). PDF-File, 87 pages, pp 6-18. Newbury, UK. Produced by the NatureBureau, UK. Accessed 28/02/2009 at http://cmsdata.iucn.org/downloads/parks_15_2.pdf#page=8

SKINNER JD, 1970. Game-ranching in Africa as a source of meat for local consumption and export, Tropical Animal Health and Production 2: 151-157. PDF-File, 6 pages. Accessed 05/08/2009 at http://www.springerlink.com/content/k04380322j64g742/fulltext.pdf

SKINNER C, 2006. Falling though the Policy Gaps? Evidence from the informal economy in Durban, South Africa. Urban Forum 17 (2): 125-148.

SOUTH AFRICAN GAME RESERVES, 2009. Copyright: ROOCROFT G (2002-2008). Accessed 19/03/2009 at http://www.south-african-game-reserves.com

STATISTICS SOUTH AFRICA, 1998. Unemployment and employment in South Africa. Pretoria, South Africa. PDF-File, 80 pages. Accessed 08/09/2009 at http://www.statssa.gov.za/publications/EmployUnemploy/EmployUnemploy1997.pdf

STATISTICS SOUTH AFRICA, 2008. Labour force survey. Historical revision. March series 2001-2007. Pretoria, South Africa. PDF-File, 31 pages. Accessed 08/09/2009 at http://www.statssa.gov.za/qlfs/docs/March_Series_Historical_revisions.pdf

STRYDOM PE, 2004. Ethnic meat products – Africa. In Ed.: KLINTH JENSEN W, Encyclopedia of Meat Sciences: 440-441.

SUBBA D, 2002. Acceptability and nutritive value of keropok-like snack containing meat offal. International Journal of Food Science and Technology 37: 681-685.

TOKMAN VE, 1978. An exploration into the nature of informal-formal sector relationships. World Development 6 (9/10): 1065-1075.

TRAFFIC, 1997. Food for thought: the utilization of wild meat in Eastern and Southern Africa. TRAFFIC East/Southern Africa, Nairobi, Kenya. PDF-File, 34 pages. Accessed 06/09/2009 at www.traffic.org/general-reports/traffic_pub_gen7.pdf

TWISS MP, THOMAS VG and LAVIGNE DM, 1996. Sustainable game farming: Considerations for Canadian policy makers and legislators. Journal of Sustainable Agriculture 9 (1): 81-94.

UMKHANYAKUDE DISTRICT MUNICIPALITY, 2008. Final IDP Document 2008/09 FY. PDF-Document, 67 pages, no pagination. Accessed 13/07/09 at http://www.kzntopbusiness.co.za/site/user_data/files/umkhanyakude2008_09.pdf

UMOH VJ and ODOBA MB, 1999. Safety and quality evaluation of street foods in Zaria/Nigeria. Food control 10 (1): 9-14.

UNNEVEHR LJ, 2003. Overview: Food safety in food security and food trade. International Food Policy Research Institute (IFPRI), 2020 Focus 10, Brief 1 of 17. September 2003. PDF-File, 38 Pages, Pages 3-4, accessed 09/11/08 at http://www.ifpri.org/2020/focus/focus10/focus10.pdf

UNNEVEHR L and HIRSCHHORN N, 2000. Food safety issues in the developing world. World Bank Technical Paper Number 469. Published by World Bank Publications. PDF-File, 72 Pages. Accessed 14/10/08 at http://books.google.de/books?hl=de&lr=&id=9Me4brSVJ2QC&oi=fnd&pg=PR7&dq=%22food+safety+improvement%22&ots=vkxICSFKeF&sig=jmW11WQc1bngwon1y5CEeqi3WuY#PPA3,M1

VAN DEN HOVE S, 2006. Between consensus and compromise: acknowledging the negotiation dimension in participatory approaches. Land Use Policy 23:10-17.

VAN DER MERWE P and SAAYMAN M, 2008. The national profile and economic impact of biltong hunters in South Africa. Institute for Tourism and Leisure Studies, North-West University (Potchefstroom Campus), Private Bag X6001, Potchefstroom 2520, South Africa. PDF-File, 46 pages. Accessed 05/08/2009 at http://www.sahunt.co.za/uploads/Socio-economic%20profile%20of%20hunters%20in%20SA.pdf

VAN DER WAAL C and DEKKER B, 2000. Game ranching in the Northern Province of South Africa. South African Journal of Wildlife Research 30(4): 151–156. Accessed 03/09/2009 at http://209.85.129.132/search?q=cache:-uQNhVWMJtgJ:www.ru.nl/aspx/download.aspx%3FFile%3D/contents/pages/524568/vanderwaal2000safrjwildlres.pdf%26structuur%3Dplantecology+van+der+waal+and+dekker&cd=1&hl=de&ct=clnk&gl=de&client=firefox-a (PDF or HTML-File).

VAN ZYL L and FERREIRA AV, 2004. Physical and chemical carcass composition of springbok *(Antidorcas marsupialis)*, blesbok *(Damaliscus dorcas phillipsi)* and impala *(Aepyceros melampus)*. Small Ruminant Research 53 (1-2): 103-109

VON HOLY A and MOSUPYE FM, 1999. Microbial quality and safety of ready –to-eat street-vended foods in Johannesburg / South Africa. Journal of Food Protection 62 (11): 1278-1284 (13 pages in online source). Accessed 22/09/08 at http://www.doh.gov.za/department/foodcontrol/streetfood/15.pdf

VON HOLY A and MAKHOANE FM, 2006. Improving street food vending in South Africa: Achievements and lessons learned. International Journal of Food Microbiology 111 (2): 89-92.

WHO, 1996. Essential safety requirements for street-vended foods (revised edition). Food Safety Unit, Division of Food and Nutrition, World Health Organization. PDF-File, 41 pages. Accessed 08/09/2009 at http://www.who.int/foodsafety/publications/fs_management/en/streetvend.pdf

WHO, 2002. Global Strategy for Food Safety – Safer food for better health. PDF-File, 27 pages. Accessed 20/09/2009 at http://www.who.int/foodsafety/publications/general/en/strategy_en.pdf

WHO, 2009. About microbiological risk assessment (MRA) in food. HTML-File, no pagination. Accessed 16/09/2009 at http://www.who.int/foodsafety/micro/about_mra/en/index.html

8 ANNEX

8.1 Statistics

8.1.1 SAS-Procedure applied for the obtainment of exact confidence intervals (α = 0.05) for proportions

```
data ab;
input "category of variable" " frequency";
datalines;
'category of interest'   'n = frequency of occurrence/observation'
'other'                  'N- n = sum of all occurrences/observations other than n'
;
proc freq data=ab;
weight frequency;
exact chisq;
tables "proportion A" * "proportion B" /chisq;
run;
```

Note: Each proportion of interest ("proportion A") was always was tested against the sum of all other proportions ("proportion B") of the variable of relevance in order to determine the confidence interval for the proportion of interest. For one variable, this procedure was repeated until the confidence intervals have been determined for all proportions: The binomial test applied does only considers two different categories per variable.

8.1.2 Independent data: Coherences

SAS-procedure applied:

```
data a;
input "variable 1"  "variable 2"  frequency;
datalines;
(n = category 1 of variable 1)   (n = category 1 of variable 2)  frequency
(n = category "n"  of variable 1)   (n = category "n" of variable 2)  frequency
;
proc freq data= a;
weight frequency;
exact chisq;
tables "variable 1" * "variable 2" /fisher chisq;
run;
```

SAS-Outputs:

1.) products offered (beef and/or other, no beef) and customer preference (beef, other)	8.) storage time (same day, next day, 3 to 4 days, week) and storage mean (freezer, refrigerator, uncooled, no storage)	15.) location (hlabisa, nongoma, jozini, pongola, tshejuba, mkuze, hluhluwe) and nature of floor (non-solid, solid)
Statistics for Table of product by prefer Phi Coefficient 0.5641 Fisher's Exact Test Cell (1,1) Frequency (F) 14 Left-sided Pr <= F 1.0000 Right-sided Pr >= F 0.0087 Table Probability (P) 0.0087 Two-sided Pr <= P 0.0087 Sample Size = 25	Statistics for Table of time by mean Phi Coefficient 0.9694 Fisher's Exact Test Table Probability (P) 1.744E-12 Pr <= P 7.969E-11 Sample Size = 51	Statistics for Table of location by floor Phi Coefficient 0.4480 Fisher's Exact Test Table Probability (P) 5.778E-05 Pr <= P 0.0873 Effective Sample Size = 50 Frequency Missing = 1

2.) location (hlabisa, nongoma, jozini, tshejuba, pongola, mkuze, hluhluwe) and decision to purchase (yes, no/don't know)	9.) storage time (overnight at maximum, longer than overnight) and storage mean (cooling ,no cooling)	16.) location (no tshejuba, no nongoma) and nature of floor (non-solid, solid)
2.) Statistics for Table of location by purchase Phi Coefficient 0.3948 Fisher's Exact Test Table Probability (P) 1.732E-04 Pr <= P 0.2153 Sample Size = 51	9.) Statistics for Table of time by mean Phi Coefficient -0.3050 Fisher's Exact Test Cell (1,1) Frequency (F) 26 Left-sided Pr <= F 0.0285 Right-sided Pr >= F 1.0000 Table Probability (P) 0.0285 Two-sided Pr <= P 0.0405 Sample Size = 51	16.) Statistics for Table of location by floor Phi Coefficient 0.3995 Fisher's Exact Test Table Probability (P) 2.798E-04 Pr <= P 0.1006 Effective Sample Size = 48 Frequency Missing = 1
3.) location (no tshejuba, no nongoma) and decision to purchase (yes, no/don't know)	10.) location (hlabisa, nongoma, jozini, pongola, tshejuba, mkuze, hluhluwe) and nature of road (solid, not solid)	17.) product preparation (in pot, on grill, both) and product display (covered, not covered)
Statistics for Table of location by purchase Phi Coefficient 0.3620 Fisher's Exact Test Probability (P) 5.076E-04 Pr <= P 0.1690 Sample Size = 49	Statistics for Table of location by road Phi Coefficient 0.5062 Fisher's Exact Test Table Probability (P) 3.736E-05 Pr <= P 0.0192 Effective Sample Size = 50 Frequency Missing = 1	Statistics for Table of preparation by display Phi Coefficient 0.7474 Fisher's Exact Test Table Probability (P) 1.563E-08 Pr <= P 5.508E-08 Effective Sample Size = 50 Frequency Missing = 1
4.) location (hlabisa, nongoma, jozini, pongola, tshejuba, mkuze, hluhluwe)and opinion if customers would buy (yes, no/don't know)	11.) location (no tshejuba, no nongoma) and nature of road (solid, not solid)	18.) location (hlabisa, nongoma, jozini, pongola, tshejuba, mkuze, hluhluwe) and product preparation (in pot, on grill, both)
Statistics for Table of location by buy Phi Coefficient 0.2537 Fisher's Exact Test Table Probability (P) 0.0016 Pr <= P 0.8384 Sample Size = 51	Statistics for Table of location by road Phi Coefficient 0.4963 Fisher's Exact Test Table Probability (P) 6.511E-05 Pr <= P 0.0093 Effective Sample Size = 48 Frequency Missing = 1	Statistics for Table of preparation by location Phi Coefficient 0.6575 Fisher's Exact Test Table Probability (P) 1.445E-07 Pr <= P 0.0144 Effective Sample Size = 50 Frequency Missing = 1
5.) location (no tshejuba, no nongoma) and opinion if customers would buy (yes, no/don't know)	12.) location (Pongola, other) and access to running water (yes, no)	19.) location (no tshejuba, no nongoma) and product preparation (in pot, on grill, both)
Statistics for Table of location by buy Phi Coefficient 0.2027 Fisher's Exact Test Table Probability (P) 0.0041 Pr <= P 0.7262 Sample Size = 49	Statistics for Table of location by water Phi Coefficient 0.4684 Fisher's Exact Test Cell (1,1) Frequency (F) 39 Left-sided Pr <= F 0.9998 Right-sided Pr >= F 0.0058 Table Probability (P) 0.0056 Two-sided Pr <= P 0.0058 Sample Size = 51	Statistics for Table of preparation by location Phi Coefficient 0.6226 Fisher's Exact Test Table Probability (P) 7.179E-07 Pr <= P 0.0110 Effective Sample Size = 48 Frequency Missing = 1
6.) "beef offered" (yes, no) and decision to purchase (yes, no/don't know)	13.) location (hlabisa, nongoma, jozini, pongola, tshejuba, mkuze, hluhluwe) and access to toilets (no,yes)	20.) location (hlabisa, nongoma, jozini, tshejuba, pongola, mkuze, hluhluwe) and cooking fuel used (wood, charcoal, other)
Statistics for Table of beef by purchase Phi Coefficient -0.0354 Fisher's Exact Test Cell (1,1) Frequency (F) 14 Left-sided Pr <= F 0.5187 Right-sided Pr >= F 0.7131 Table Probability (P) 0.2319 Two-sided Pr <= P 1.0000 Sample Size = 51	Statistics for Table of location by Toilet Phi Coefficient 0.4140 Fisher's Exact Test Table Probability (P) 0.0014 Pr <= P 0.2582 Sample Size = 51	Statistics for Table of location by fuel Phi Coefficient 0.7357 Fisher's Exact Test Table Probability (P) 3.304E-09 Pr <= P 0.0040 Sample Size = 50

7.) "beef offered" (yes, no) and opinion if customer buy game (yes, no/don't know)	14.) location (no tshejuba, no nongoma) and toilets (no,yes)	21.) location (no tshejuba, no nongoma) and cooking fuel used (wood, charcoal, other)
7.) Statistics for Table of beef by buy Phi Coefficient -0.0034 Fisher's Exact Test Cell (1,1) Frequency (F) 13 Left-sided Pr <= F 0.6092 Right-sided Pr >= F 0.6348 Table Probability (P) 0.2440 Two-sided Pr <= P 1.0000 Sample Size = 51	14.) Statistics for Table of location by Toilet Phi Coefficient 0.2617 Fisher's Exact Test Table Probability (P) 0.0101 Pr <= P 0.5257 Sample Size = 49	21.) Statistics for Table of location by fuel Phi Coefficient 0.6814 Fisher's Exact Test Table Probability (P) 3.662E-08 Pr <= P 0.0047 Sample Size = 48

8.1.3 Independent data: Correlations

SAS-procedure applied:

```
data a;
input "variable 1"  "variable 2"  frequency;
datalines;
(n = category 1 of variable 1)   (n = category 1 of variable 2)  frequency
...
(n = category "n"  of variable 1)   (n = category "n" of variable 2)  frequency
;
proc corr spearman data= a;
var "variable 1"  "variable 2";
run
```

SAS-Outputs:

1.) age (3 classes, see results) and level of education ("primary school and lower" /"secondary school and higher")	5.) Cleanliness of business premises (inadequate, suboptimalsatisfactory, good, excellent) and flies (none, few, some, many)	9.) Location (hlabisa, nongoma, jozini, tshejuba, pongola, mkuze, hluhluwe) and Rubbish/dirt/mud (none, few, some, average, much, very much)
Spearman Correlation Coefficients, N = 47 Prob > |r| under H0: Rho=0 age education age 1.00000 -0.31805 0.0294 education -0.31805 1.00000 0.0294	Spearman Correlation Coefficients, N = 50 Prob > |r| under H0: Rho=0 Cleanliness Flies Cleanliness 1.00000 -0.27339 0.0547 Flies -0.27339 1.00000 0.0547	Spearman Correlation Coefficients, N = 50 Prob > |r| under H0: Rho=0 Location Rubbishdirt Location 1.00000 -0.12731 0.3783 Rubbishdirt -0.12731 1.00000 0.3783
2 dust (none, few, some) and flies (none, few, some, many)	6.) cleanliness of business premises (inadequate, suboptimal, satisfactory, good, excellent) and flies (not present, present)	10.) Correlation between Location (no tshejuba, no nongoma) and Rubbish/dirt/mud (none, few, some, average, much, very much)
Spearman Correlation Coefficients, N = 50 Prob > |r| under H0: Rho=0 Dust Flies Dust 1.00000 0.55335 <.0001 Flies 0.55335 1.00000 <.0001	Spearman Correlation Coefficients, N = 50 Prob > |r| under H0: Rho=0 Cleanliness Flies Cleanliness 1.00000 -0.29310 0.0389 Flies -0.29310 1.00000 0.0389	Spearman Correlation Coefficients, N = 48 Prob > |r| under H0: Rho=0 Location Rubbishdirt Location 1.00000 -0.17188 0.2427 Rubbishdirt -0.17188 1.00000 0.2427
3.) dust (none, present) and flies (none, present)	7.) time of interview (10-12, 11-13, 12-14) and cleanliness of washing water (inadequate, suboptimal, satisfactory, good, excellent)	11.) Meat samples from informal traders: state of sample (raw, prepared) and bacterial growth (none, scanty/moderate, heavy)

3.) Spearman Correlation Coefficients, N = 50 Prob > |r| under H0: Rho=0 Dust Flies Dust 1.00000 0.65585 <.0001 Flies 0.65585 1.00000 <.0001	7.) Spearman Correlation Coefficients, N = 38 Prob > |r| under H0: Rho=0 Time WashWater Time 1.00000 0.05644 0.7364 WashWater 0.05644 1.00000 0.7364	11.) Spearman Correlation Coefficients, N = 25 Prob > |r| under H0: Rho=0 state growth state 1.00000 -0.64915 0.0004 growth -0.64915 1.00000 0.0004
4.) dust (none, few, some) and cleanliness of business premises (inadequate, suboptimal, satisfactory, good, excellent)	8.) access to running water (yes, no) and cleanliness of washing water (poor, inadequate, suboptimal, satisfactory, good, excellent).	12.) Meat samples from informal traders: state of sample (raw, prepared) and purity of growth (mixed growth, no growth)
Spearman Correlation Coefficients, N = 50 Prob > |r| under H0: Rho=0 Cleanliness Dust Cleanliness 1.00000 -0.35347 0.0118 Dust -0.35347 1.00000 0.0118	Spearman Correlation Coefficients, N = 38 Prob > |r| under H0: Rho=0 Runn Water Wash Water RunnWater 1.00000 -0.37054 0.0220 WashWater -0.37054 1.00000 0.0220	Spearman Correlation Coefficients, N = 25 Prob > |r| under H0: Rho=0 state purity state 1.00000 -0.42779 0.0329 purity -0.42779 1.00000 0.0329

13.) Meat samples from informal traders: state of sample (raw, prepared) and identification of bacterial growth (no significant isolates, mixed growth/contaminants, coliforms)	13.) Spearman Correlation Coefficients, N = 25 Prob > |r| under H0: Rho=0 state Identification state 1.00000 -0.58074 0.0023 Identification -0.58074 1.00000 0.0023

8.1.4 Paired data: Correlations

SAS-procedure applied:

```
datalines;
data a;
input "variable 1"  "variable 2"  frequency;
datalines;
(n = category 1 of variable 1)   (n = category 1 of variable 2)  frequency
(n = category "n"  of variable 1)   (n = category "n" of variable 2)  frequency
;
proc freq data = a;
weight frequency;
table "variable 1" * "variable 2" / exact chisq cmh1;
run;
```

SAS-Outputs:

1.) Experiment: state of sample (raw/cooked) and presence of bacteria (yes, no)	2.) Experiment: state of sample (raw/cooked) and presence of coliforms (yes, no)	3.) Experiment: state of sample (raw/cooked) and presence of *E. coli* (yes, no)
Statistics for Table of state by bacteria Phi Coefficient -0.6255 Sample Size = 32 Summary Statistics for state by bacteria Cochran-Mantel-Haenszel Statistics (Based on Table Scores) Nonzero Correlation DF 1 Probl 0.0005 Value12.1304	Statistics for Table of state by coliform Phi Coefficient -0.881 Sample Size = 32 Summary Statistics for state by coliform Cochran-Mantel-Haenszel Statistics (Based on Table Scores) Nonzero Correlation DF 1 Value 24.1111 Prob <.0001	Statistics for Table of state by coli Phi Coefficient -0.2582 Sample Size = 32 Summary Statistics for state by coli Cochran-Mantel-Haenszel Statistics (Based on Table Scores) Nonzero Correlation DF 1 Value 2.0667 Prob 0.1506

8.2 Questionnaires and observation sheets

8.2.1 Questionnaire for informal meat traders

A. GENERAL INFORMATION Code

DEMOGRAPHY (CONFIDENTIAL)

1 Individual data Date and time:

1.1 Name

1.2 Address

1.3 Phone

1.4 Cell

1.5 Gender | male | | female | | V1 | | 0 to 1

1.6 Type of business

Informal retailer			
Open market vendor			
Street food vendor		V2	2 to 4

1.7 Age V3 years

1.8 Level of education

no school			
primary			
secondary			
post secondary			
university			
unclear		V4	5 to 10

1.9 Importance of business

Primary activity for income			
Secondary activity			
Minor activity		V5	11 to 13

B. PRODUCT RANGE

2.1 What kind of meat do you most frequently sell?

Beef			
Pork			
Chicken			
Lamb			
Goat			
Game		V6	14 to 19

2.2 What kind of meat do customers mostly buy/prefer?

Beef	
Pork	
Chicken	
Lamb	
Goat	
Game	

V7 [ ][ ] 20 to 25

2.3 Have you ever got game meat or edible by-products (offal, heads,feet) from hunters, farmers or from a game harvest that you could trade?

Consistently/very regularly	
Sometimes	
Seldomly or never	
don"t want to say	

V8 [ ][ ] 26 to 29

If no, move to question 3.10

2.4 If consistently/very regularly/sometimes: From where/ from whom?

Farmer/friends or family work on farm	
Nature conservation authority	
game harvest	
friends	
don't know from where -someone brought	
don't want to say	

V9 [ ][ ] 30 to 35

2.5 If consistently/very regularly/sometimes: How much game meat/edible by-products do you sell per year?

[ ]

V10 [ ][ ]

2.6 If consistently/very regularly/sometimes: Which species are most popular/ most frequently received?

Springbok	
Gemsbok	
Kudu	
Eland	
Zebra	
Impala	
Hartebeest	
Wildebeest	
Warthog	
Don't know	

V11 [ ][ ] 36 to 45

2.7 if consistently/very regularly/sometimes: In what form do you usually obtain game meat and edible by-products?

complete carcass	
carcass in hide but eviscerated	
carcass, no hide, eviscerated	
pieces still in hide	
pieces without hide	
pieces frozen	
don't want to say	

V12 [ ][ ] 46 to 52

2.8 If consistently/very regularly/sometimes: Which species do your customers generally prefer the most?

Springbok	
Gemsbok	
Kudu	
Eland	
Zebra	
Impala	
Hartebeest	
Wildebeest	
Warthog	
Don't know	

V13 [ ][ ] 53 to 62

2.9 If seldomly or never: Would you purchase game meat and edible by-products for your business?
if you could get it legally and cheaply?

yes	
no	
don't know	

V14 [ ][ ] 63 to 65

2.10. If seldomly or never: Do you think that your customers would buy game meat and edible by-products if you would offer it?

yes	
no	
don't know	

V15 [ ][ ] 66 to 68

C. FOOD SAFETY

3.1 What is most important for you when you decide where to buy meat for your business?

Species	
Availability	
Freshness	
Price	
Relationship to supplier	
Distance	
Legal	
Other (Specify)	

V16 [ ][ ] 69 to 76

3.2 Where do you usually purchase the meat products for your business?

Butchery	
Supermarket	
Wholesaler	
Other (please specify):	

V17 ☐☐ 77 to 80

3.3 Do you have refrigeration facilities at your place of business?

yes, cooler box	
yes, other (specify)	
no	
other (please specify)	

V18 ☐☐ 81 to 84

3.4 For what period of time do you store raw meat at home until it is sold at the maximum?

sold same day	
next day	
3 to 4 days	
5 to 6 days	
one week	
more than one week	
more than one month	
don"t want to say	

V19 ☐☐ 85 to 92

3.5 How do you carry out long term storage of meat?

freezer	
refrigerator	
Cooler box with ice pack	
container with ice	
uncooled at home (e.g. shaded)	
No long term storage	
other (please specify):	

V20 ☐☐ 93 to 99

3.6 What do you do with leftovers after a day of business?

Try to sell the next day	
Take home for myself/family	
give to somebody else (friends)	
throw away	
feed to dogs	
don"t want to say	
other (specify):	

V21 ☐☐ 100 to 106

3.7 Dealing with rubbish disposal

leave behind	
throw in communal bin	
take home	
other (please specify):	

V22 | | | 107 to 110

3.8 Do you cool your raw products during transportation?

yes		no		V23		111 to 112

3.9 How often do you change your working clothes?

do not have special working clothes	
daily	
when convenient	
other (please specify):	

V24 | | | 113 to 116

3.10. What are your daily business hours?

3.11 Who are your predominant customers?

taxi commuters	
school pupils	
other (please specify):	

V25 | | | 117 to 119

3.12 Any other comments/observations

8.2.2 Observation sheet for informal meat traders

DEMOGRAPHICS- Confidential

Same as Code Number | Code

A. GENERAL INFORMATION:

1.1 Date and time | DDMMYY | H

1.2 Location | Address/Description | V1 | 0-1

A. Infrastructure and availabilities

2.1 Location

residential area	
transport area	
industrial area	
commercial area	
recreational area	
construction site	
hospital area	

V2 | 2 to 8

2.2 Nature of road

tarred	
gravel	
cement	
grass/soil	

V3 | 9 to 12

2.3 Running water

yes		no		V4	13 to 14

2.4 Electricity

yes		no		V5	15 to 16

2.5 Toilet

yes	
no	
other(specify):	

V6 | 17 to 19

2.6 ablutions

yes	
no	
other(specify):	

V7 | 20 to 22

B. Premises

3.1 Nature of floor

cement	
concrete	
soil/bare ground	
PVC/plastic	
wood	
flagstones	
other (specify):	

V8 [ ][ ] 23 to 29

3.2 Cleanliness of surroundings

dirty	
acceptable	
very clean	

V9 [ ][ ] 30 to 32

3.3 Nature of walls

no walls	
cement	
concrete	
metal	
PVC/plastic	
wood	
tent	
caravan	
vehicle	
other (specify):	

V10 [ ][ ] 33 to 42

3.4 Nature of roof

no roof	
cement	
concrete	
PVC/plastic	
wood	
metal	
tent	
straw/grass	
other (specify):	

V11 [ ][ ] 43 to 51

	SCORE 0-5
3.5 Flies in premises and/or on meat?	
3.6 Dust in premises?	
3.7 Temperature in premises? (degree C)	
3.8 Humidity in region	

C. Product handling

4.1 Product display

on grill	
in pot	
other (specify):	

V12 ☐☐ 52 to 54

4.2 Cleanliness of business premises SCORE 0-5 ☐

4.3 Food covered?

yes		no		V13 ☐☐	55 to 56

4.4 Adequate spatial separation of different products at display?

yes		no		V14 ☐☐	57 to 58

Code: ☐

4.5 Handling of food and other things without washing hands in between?

yes		no		V15 ☐☐	59 to 60

4.6 Use of utensils/gloves when handling food?

yes		no		V16 ☐☐	61 to 62

4.7 Hygiene/Cleanliness of washing water? SCORE 0-5 ☐

4.8 Waste water disposal?

throw on the ground	
throw in water drainage	
throw in toilet	
other (specify):	

V17 ☐☐ 63 to 66

4.9 How are products wrapped for buyers?

plastic	
paper	
newspaper	
take-away-box	
other:	

V18 ☐☐ 67 to 71

4.10. Scavenging livestock/dogs/pigeons?

livestock	yes	no
dogs	yes	no
pigeons	yes	no
other (specify):		

V19 ☐☐ 72 to 75

4.11 Rubbish/dirty water/mud SCORE 0-5

D. Product range and preparation

5.1 Meat products traded?

raw products	
ready to eat products	
both	

V20 [ ][ ] 76 to 78

5.2 Relation raw meat products: ready to eat meat products

more than 50:50	
about 50:50	
less than 50:50	

V21 [ ][ ] 79 to 81

5.3 Preparation of ready to eat products?

cooking in pot	
grilling over fire	
both	

V22 [ ][ ] 82 to 84

5.4 Cooking fuel?

wood	
gas	
straw/foliage	
electricity	
charcoal	
other (specify):	

V23 [ ][ ] 85 to 90

5.5 Comments/observations/photograph number

8.2.3 Questionnaire for meat sampling in KwaZulu-Natal

1. What would you change about your daily working conditions if you would be able to do so?

2. What is the biggest problem you are facing in terms of your daily activity?

3. What is your personal opinion regarding the basic findings from the previously applied questionnaire that we have presented to you?

4. How would you prepare game offal, heads and feet if you would use these products for your business?

5. How much could you afford to pay for game offal, heads and feet in order to purchase it for your business?

8.2.4 Questionnaire for the experiment

1. Would you regularly trade game meat if it would be available legally and cheaply?

2. Would you also utilize offal, heads and feet of game animals?

3. Did you ever prepare game meat before and, if yes, ho regularly, at which occasion and for what reason?

4. Do you think it would be a good business to sell game meat or would you like to sell other meats such as beef or chicken instead?

5. What would you call the biggest problem that you are facing in terms of your daily work at this train station?

6. If you could choose one thing, what would you desire to improve your daily working and business conditions?

7. How do you like the game meat?

8.2.5 Observation sheet for the experiment

Prerequisites:

Prerequisites, Water, electricity,
surroundings, hygiene, clothing, assets

Practices:

Meat handling,cooking, hygiene practices

8.2.6 Questionnaire for biltong hunters

A. GENERAL INFORMATION Code

DEMOGRAPHY (CONFIDENTIAL)

1 Individual data

Date and time:

1.1 Name	
1.2 Address	
1.3 Phone	
1.4 Cell	
1.5 age	
1.6 gender	

1.7 Ownership

Farm (domestic stock)		
Game farm/ranch		
other (specify):		V 1 1 to 3

1.8 Level of education

no school		
primary		
secondary		
post secondary		
university		
unclear		V2 4 to 9

1.9 Importance of hunting

primary activity for income		
secondary activity		
minor activity		
hobby		V3 10 to 13

1.10. Since when do you conduct hunting?

more than 25 years		
20-25 years		
15-20 years		
10-15 years		
5-10 years		
less than 5 years		V4 14 to 19

1.11 Do you do do trophy hunting?

yes		no		V5 20 to 21

1.12 Do you guide/assist trophy hunters?

yes		no		V6			22 to 23

1.13 Do you shoot for home consumption (biltong/meat)?

yes		no		V6			24 to 25

B. GAME ANIMAL SPECIES

2.1 Where do you predominantly hunt?

own property	
other private properties	
game reserve/park	
other (specify):	

V7 | | | 26 to 29

2.2 If for meat sale, to whom do you predominantly sell meat/carcasses?

V8 | | |

2.3 If trophy hunting, how do you utilize the carcass/the meat?

V9 | | |

2.4 Approximately how many animals do you shoot per year?

V10 | | | animals

2.5 Which of the followin species do you most frequently hunt? (Numbers)

Springbok	
Gemsbok	
Kudu	
Eland	
Zebra	
Impala	
Hartebeest	
Wildebeest	
Warthog	
Other (specify):	

V11 | | | 30 to 39

C. THE GAME MEAT SECTOR

In your opinion, which of the following species has the greatest marketing potential?

3.1 SCORE 1-10

Springbok		
Gemsbok		
Kudu		
Eland		
Zebra		
Impala		
Hartebeest		
Wildebeest		
Warthog		
Other (specify):		

V12 [ ][ ] 40 to 49

3.2 How would you describe the market for offal?

high potential	
limited potential	
unimportant	
other (specify):	

rtrtr

V13 [ ][ ] 50 to 54

3.3 How would you describe the market for other by-products (hides, horns etc.)?

high potential/florishing	
limited	
unimportant	
other (specify):	

V14 [ ][ ] 54 to 57

3.4 What do you do with offal and by-products?

give away	
sell	
feed to vultures	
other (specify):	

V15 [ ][ ] 58 to 60

3.5 If given away to whom?

V16 [ ][ ]

3.6 If sold, what approximate price/kg/unit?

offal/kg	
hides/unit	
hooves/horns/kg	
other (specify):	

V17 [ ][ ] ZAR
V18 [ ][ ] ZAR
V19 [ ][ ] ZAR
V20 [ ][ ]

3.7 Would it be profitable to sell offal cheaply to locals?

yes	
no	
don't know	

V21 [ ][ ] 61 to 63

3.8 Did you experience that locals asked you for offal?

yes, regularly	
yes, sometimes	
no	
don't know	

V22 [ ][ ] 64 to 67

3.9 In your opinion which of the following game meat product groups has the greatest marketing potential?

Biltong	
Other processed products (e.g. sausage)	
Fresh meat	

V23 [ ][ ] 68 to 70

3.10. In your opinion, what is the greatest obstacle for a further expansion of the game meat market?

Inadequate promotion/advertisement	
Inadequate quality control/standards	
Low marketing potential of species	
Unsatisfactory product quality	
Game meat production is limited compared to domestic livestock	
Other (specify):	

V24 [ ][ ] 71 to 76

D. FOOD SAFETY IN DOMESTIC GAME MEAT PRODUCTION

4.1 What what do you think about possible implementation of common quality standards and meat inspections into the production chains of game

Absolutely necessary	
I do not care/think of it	
Not really necessary	

V25 [ ][ ] 77 to 79

4.2 Would you personally welcome such implementations?

Yes	
No	
Don't care/does not matter to me	
Don't know	

V26 [ ][ ] 80 to 83

4.3 Estimate the time difference between the fatal shot and the commencement of exsanguination!

	V27	min

4.4 If exsanguination: Method of exsanguination?

on ground		
on truck		
Hang in tree or poles		
Other (specify)		

V28 84 to 87

4.5 Estimate time from exanguination to and evisceration (and therefore usually primary meat Inspection)

V29

4.6 Do you cool carcasses before sale/delivery?

in cool house	
yes, freezer	
Refrigerated truck	
no storage: Immediate sale/delivery	
Other (specify)	

V30 88 to 92

4.7 Do you trade carcass by-products (e.g. hides, horns)?

regularly	
sometimes	
no	

V31 93 to 95

4.8 If regularly or sometimes: To whom do you trade them?

V32

4.9 Do you "shoot on order" or do you first shoot and then try to sell it?

on order	
first shoot	
both	
Other(specify)	

V33 96 to 99

4.10. How do you predominantly sell game meat?

whole carcasses	
whole carcass, eviscerated	
whole carcass, eviscerated, without hide	
other (specify):	

V34 [ ][ ] 100 to 103

4.11 Do you transport the meat to the buyer or does the buyer come to you?

transport	
buyer comes	
Other (specify)	

V35 [ ][ ] 104 to 106

4.12 If transport, over what distance do you transport game to buyers at the maximum.

more than 200 km	
more than 100 km	
more than 50 km	
less than 50 km	
less than 25 km	

V36 [ ][ ] 107 to 111

4.13 If transport, do you use a refrigerated vehicle?

yes		no	

V37 [ ][ ] 112 to 113

4.14 What is most important for you when selecting an individual to be shot?

Health status	
gender	
Species	
age	
Demand of buyer	
other (specify):	

V38 [ ][ ] 114 to 119

4.15 What legislations/permit/permissions do you need to hunt game?

V39 [ ][ ] permits

4.16 Do you think more game meat could be sold in future if the marketing/ promotion would be enhanced? Explain.

V40 | | |

4.17 How would you call the sale of game meat for your business?

very lucrative	
lucrative	
rentable	
covering costs	
causing financial loss	

V41 | | | 120 to 124

4.18 Is there a special season in the year during which you shoot more game than during other times of the year?

yes,	
no	

V42 | | | 125 to 126

4.19 Kind of gun used

22 mm	
38 mm	
other	
If other specify	

V43 | | | 127 to 129

8.2.7 Observation sheet for Observational Study I

Prerequisites:
Technologies, devices, equipment,
vehicles, staff etc.

Practices:
Procedures of hunting and carcass/product handling

8.2.8 Questionnaire for Observational Study II

1. How did you like the game meat we have brought for you?
2. Would you eat the offal, head and feet of game animals?
3. Would you eat it if you would be supplied for free with offal, heads and feet of game?
4. Would you pick it up yourself at a collection point in Ruacana?
5. Would you also accept it if it would be frozen at the time of pick-up?
6. Do you hunt game animals?
7. Where do you hunt game animals?
8. Who of the group carries out hunting (men, boys etc.)
9. How often/regularly do you hunt game animals?
10. What species do you predominantly hunt?
11. How do you hunt/kill game animals?
12. How do you store/conserve the meat?
13. Which game species do you prefer?
14. To what extent do other people hunt game animals on your land/in your area?
15. To which extent are you depending on game animal use?
16. How did the game population change (numbers, species) in recent years?
17. Do you prefer game meat or domestic meat and why?
18. What would you do if you should encounter an injured game animal that cannot flee?
19. What would you do if you should encounter an obviously diseased game animal that cannot or does not flee?
20. How long do you store fresh meat before consumption at the maximum and how do you store it?
21. How often do you get provided with meat by the nature conservation authority?
22. How do you like your meat (well-done, medium, rare)?
23. How do you see if a meat is not good for consumption any more?
24. What do you do if you want to prepare a piece of meat but this meat does not look very good anymore?
25. Did you sometimes feel sick after eating meat and which sickness did you suffer?
26. Which meat do you most commonly consume?
27. What price could you pay for game meat, offal, heads and feet?
28. How do you cook/prepare meat?
29. Do you ever buy meat?
30. If yes, how often do you buy game meat?
31. If yes, what kind of meat do you most commonly buy?
32. Do you ever sell livestock and how regularly?
33. If yes, for how much would you sell a goat or a cattle?
34. For how much would you sell game meat if you would have some for sale.

8.2.9 Observation sheet for Observational Study II

Prerequisites:

Water, electricity, surroundings, assets

Practices:

Meat handling, storage, cooking, hygiene practices
