DEVELOPMENT OF RISK COMMUNICATION STRATEGIES TO IMPROVE CONTROL OF *CYSTICERCOSIS BOVIS* IN NORTH CENTRAL NAMIBIA

by

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DEDICATION

To my husband and our lovely daughter, **Punaje**.

DECLARATION

I, **Lorna Tuwilika Shikongo-Kuvare**, hereby declare that the work on which this thesis is based is original and that neither the whole work nor part of it has been, is being, or shall be submitted for another degree at this or an other university, institution for tertiary education or professional examining body.

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Lorna Tuwilika Shikongo-Kuvare

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Date

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SUMMARY

DEVELOPMENT OF RISK COMMUNICATION STRATEGIES TO IMPROVE CONTROL OF *CYSTICERCOSIS BOVIS* IN NORTH CENTRAL NAMIBIA

BY

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Between 60-70% of Namibia's population practice subsistence agro-pastoralism on communal land that constitutes 41% of the total land area. *Cysticercosis bovis* is found worldwide, but most often in rural developing countries, where unhygienic conditions are coupled with poor cattle management practices and lack or absence of meat inspection. Because livestock is so important to the economy and social structure of the majority of people in Namibia, risks from zoonotic diseases transmitted from domestic animals to humans are a constant threat and are therefore of major concern. In addition, *C.bovis* is also emerging as a public health risk not only in these rural communities but also in urban areas where many infected cattle are transported, informally slaughtered and consumed. This disease has a negative impact on food safety, and thus is related to Veterinary Public Health (VPH) strategies in Namibia. Over the period from 2000 to 2004, 3232 (8%) measles detections were recorded from the 40 373 cattle slaughtered at Meatco Oshakati Abattoir. *C.bovis* is considered important from both an economic (loss of income to cattle owners) and human health (it is a zoonosis) point of view.

The aim of the study was to do an analysis of the level of *C.bovis* in bovine carcasses at the abattoir, in order to identify geographical areas where the disease is prevalent in cattle in North Central Namibia and to develop a risk communication strategy, to improve the control of this disease in the target population (subsistence cattle farmers in the study area).

Meat inspection was carried out for a period of 12 months and the abattoir records examined covered two years (2004 –2005). Results showed that incidence for *C.bovis* of cattle originating from Oshikoto Region were high: (12%). Omusati and Oshana Regions had an incidence of 7% and a much lower incidence of *C.bovis* (5%) was reported in cattle from the Ohangwena Region.

Structured interviews with 95 farmers (99% male and 1% female) in all the four Regions of the study area, were carried out using a set of questionnaires (Appendix A). The questionnaires had provision for numerical data and comments concerning changes, constraints and suggestions for improving dissemination of information and extension services in the target areas.

It was noted that between 5% and 13 % of respondents had neither pit latrines nor waterborne sewage. This leads to the conclusion that a significant proportion of the rural population is defecating in an area which is available to the cows grazing close to the homestead or cattle post. In addition, 61% of cattle from this area are marketed through informal marketing and many of them are slaughtered informally with no meat inspection taking place. This provides a high risk of infestation for the consumer, which perpetuates the parasite in the rural population. The educational level showed that 24% had no formal education and 33% had only primary school education. The language spoken by 93% of respondents is Oshiwambo and although only 20% speak English or Afrikaans, extension materials, including visual material, is not available in the vernacular. Between 58% and 96% of the respondents from the four Regions had no knowledge of the disease and how it could be diagnosed and controlled in both people and cattle. In Oshikoto

Region, where the incidence in slaughtered cattle was the highest, only 4% of the respondents knew about *C.bovis* in cattle.

The results obtained for language proficiency advocates for extension materials to be developed in Oshiwambo (which 93% of the target population are able to read and write). Skills training using visual aids and personal communication in Oshiwambo would be needed for other 7% who are illiterate.

From the above, it was concluded that extension is needed to reduce the incidence of *C.bovis* in cattle. The most important extension messages, as determined by an expert opinion survey of veterinarians in Namibia, were firstly that families should be treated for tapeworms and secondly that they should only buy meat that has been inspected after slaughter at an abattoir.

It was recommended that stakeholders in the livestock industry, and the state as well as the Department of Health should be made aware of the high level of cysticercosis and the equally high level of ignorance about the disease in rural areas of North Central Namibia. Veterinary and agriculture staff should be motivated to communicate and combine efforts to assist each other, as transport is expensive and one of the main constraints to successful extension because of the great distances in North Central Namibia. Funding should also be found for production of extension materials in the vernacular.

CHAPTER 1

INTRODUCTION

1.1 Background and motivation

Between 60-70% of Namibia's population practice subsistence agro-pastoralism on communal land, that constitutes 41% of the total land area (NPC, 2004). Livestock, including cattle, sheep, goats, swine, donkeys, and poultry, is used for savings, and as such plays an important part in rural society. The livestock available in the country compares well with international standards and the inner strength and innovative qualities of the human resources in Namibia augurs well for the future (Rawlinson, 1994).

In addition, meat and milk are important dietary components for the majority of the population. Extension services were virtually non-existent in many parts prior to independence in 1989 and they remain weak (Schmidt-Dumont, 1994). The same author has reported that accesses to agricultural advice, credit, new technologies and markets were virtually non-existent. Schmidt-Dumont (1994) also noted that the outcome of this has been the incidence of underdeveloped and inappropriate farming systems with a progressive decline in output.

The modes of extension in Namibia used by the Directorate of Veterinary Services (DVS) in animal health-oriented extension shortly after independence included farmers' days, farmer training courses, study groups, occasional lectures and pamphlet distribution (Schmidt-Dumont, 1994).

No defined veterinary models for prevention of cysticercosis are available, and it is not clear to what extent bovine cysticercosis has been addressed in extension in Namibia. The *modus operandi* in the field differs from area to area depending

on the needs of the farmers and the abilities of the State Veterinarian in charge of the area (Schmidt-Dumont, 1994).

C.bovis is found worldwide, but most often in rural developing countries, where unhygienic conditions are coupled with poor cattle management practices and lack or absence of meat inspection (Carlos *et al*., 2003). Because livestock is so important to the economy and social structure of the majority of people in Namibia, risks from zoonotic diseases transmitted from domestic animals to humans are a constant threat and are therefore of major concern (NASSP, 2003). In addition, *C.bovis* is also emerging as a public health risk not only in these rural communities but also in urban areas where many infected cattle are transported, informally slaughtered and consumed (Carlos *et al*., 2003). These authors further reported that this disease has a negative impact on food safety, and this is related to Veterinary Public Health (VPH) strategies in Namibia.

In recent years demographic, economic and socio-political changes have caused a significant migration of rural populations to urban settlements, where they often live in poverty and under unsanitary conditions. Some of these immigrants are carriers of gastrointestinal parasites, including *Taenia saginata*. This disease is clearly tied to meat hygiene measures as well as animal feeding practices (Waltner-Toews, 2004).

Over the period from 2000 to 2004, 3232 (8%) *C.bovis* detections were recorded from 40 373 cattle slaughtered at Meatco Oshakati Abattoir (Table 3.1). Public health concern is growing and there is an increase need of public and private initiatives for the surveillance and the control of the complex human taeniasis and bovine cysticercosis. Farmers need access to information regarding taeniasis and cysticercosis control and livestock management supporting their ability to decide where to invest their resources to increase production and improve VPH (Carlos *et al*., 2003).

The result from this study will be of significant importance to all beneficiaries, who are farmers, particularly from the study area; government as policy makers (in making their veterinary, extension and trade services more responsive), the abattoir (meat processors), and research, training and health institutions, as well as other stakeholders within the agricultural sector. However, education, and in particular by increasing the awareness of different health professionals, and facilitating communication and collaboration between veterinary, public health and agricultural personnel can do much. This will help to approach and control parasitic zoonotic diseases such as *T.saginata* in an efficient and effective way as possible (Cripps, 2000).

The study will also highlight the aspects related to, and make few recommendations on meat quality and production, meat hygiene, public health, and extension, which are considered very important to livestock development.

1.2 Research Problem

There are significant levels of *C.bovis* in cattle in the study area. This study explores possible causes and some ways in which to improve the situation.

1.3 Hypotheses

Through trace-back of cattle carcasses found positive for cysticercosis at the abattoir in the four Regions of the study area, geographical foci for exposure to the organism can be identified so that appropriate veterinary extension materials can be developed specifically for cattle farmers in the study area.

1.4 Objectives

The main objectives of this research are:

- To do situational analysis of the level of *C.bovis* infestation in bovine carcasses at the Oshakati abattoir in order to identify geographical areas where the disease is prevalent in cattle.

- To develop a risk mitigation and communication strategy to improve the control of this disease in the target population (small-scale and subsistence cattle farmers in four Regions in North Central Namibia).

1.5 Work plan

- To investigate the incidence of cysticercosis at the Oshakati abattoir using previous records and ongoing current records of *C.bovis* positive cattle carcasses;

- To use trace-back records to identify the origin of the animals showing cysticercosis on slaughter and identify the producers of MeatCo Oshakati Abattoir;

- If trace-back proves difficult, to collaborate with the state veterinary services to improve traceability by interviewing the persons who deliver the cattle to the abattoir;

- In these areas, a random sampling of Regions, villages and individuals will be done to identify at least 100 respondents from areas where the incidence of *C.bovis* is high and controls from areas where the incidence of *C.bovis* in cattle is low;

- A structured interview will be done with these respondents to describe the epidemiology of cysticercosis and identify socio-economic and environmental factors that contribute to the high incidence of the disease in cattle;

- To use expert opinion survey by veterinary personnel in the study area who are aware of cultural norms of the target audience to evaluate different images and concepts to be used in extension material; and

- To use these findings to develop appropriate extension materials that can be used by animal health and extension technicians working in the four Regions in the study area.

CHAPTER 2

LITERATURE REVIEW

According to the Food and Agriculture Organization (FAO) of the United Nations: *"Risk communication was defined by the March 1995 Consultation on the Application of Risk Analysis to Food Safety Issues as an interactive process of exchange of information and opinion on risk among risk assessors, risk managers, and other interested parties. The practical application of risk communication in relation to food safety involves all aspects of communications among risk assessors, risk managers and the public. This includes the mechanisms of delivery; message content; timeliness of the communication; the availability and use of supporting materials and information; and the purpose, credibility and meaningfulness of the communication. With increased public concern regarding food safety, greater demands are placed on risk communicators to involve the public and other interested parties in an interactive dialogue and to explain the magnitude and severity of risks associated with food borne hazards in clear and comprehensible terms that convey credibility and trustworthiness. This requires communicators to recognize and overcome gaps in knowledge as well as obstacles inherent in the uncertainties of scientific risk assessment."*

(FAO, 2005)

This statement is the core of the research project. Cysticercosis is recognised as one of the most important food associated zoonoses worldwide. The epidemiology of the disease is well understood and the control measures have been recognised for centuries. Despite this, the incidence of *C.bovis* in cattle and *T.saginata* infestation in humans has remained virtually constant. The problem thus lies in how this risk is being communicated and whether it can be improved upon.

2.1 *Taenia saginata*

Parasitic zoonoses are those parasites that are transmitted between vertebrate animals and man (Carlos *et al*., 2003). Taeniasis/Cysticercosis is a tapeworm-related parasitic zoonosis, occurring in human small intestines at the adult stage, whereas the larval stage occurs in cattle muscles, causing bovine cysticercosis (Wanzala *et al*., 2002). Bovine cysticercosis is a muscular infection of cattle caused by the larvae of the human intestinal cestode *T.saginata* (Onyango-Abuje *et al*., 1996). The parasite is recycled back to humans when they ingest meat from infected cattle (Waltner-Toews, 2004).

The economic significance of this parasite may be considerable, due to downgrading and condemnation of carcasses (Dorny *et al*., 2002) and it is cosmopolitan in its distribution (Dorny *et al*., 2000; Dorny *et al*., 2002). It is estimated that the incidence of *T.saginata* varies between 1-10% worldwide (Onyango- Abuje *et al*., 1996).

The adult stage of *T. saginata* is a large opaque white or yellow worm usually 4-5 meters long consisting of thousands of segments (proglottids) arranged in a chain (strobila) (Witenberg, 1964). It may grow from 3-7 metres in length (FAO), 2005). The head or scolex is the attachment organ and has four suckers and a rostellum that may be unarmed (Flisser *et al*., 2004b). The scolex is the size of a pinhead, and it is followed by a short and undivided Region, the neck, from which proglottids proliferate forming a long chain, the strobila, which has the appearance of a ribbon and can possess more than 1000 proglottids (Flisser *et al*., 2004b). The strobilas increase in dimensions so that the rear end of the tapeworm has the broadest and longest proglottids. Mature proglottids are filled with eggs, they break off and are excreted in the faeces where they fragment and release the ova (FAO, 2005). Finding typical eggs in the stool of the human host is the gold standard for the diagnosis. In general, the adult *T.solium* is smaller and more delicate than *T.saginata*, and the gravid proglottids are differentiated by

counting the number of lateral uterine branches (Pawlowski, 2002). *T.saginata* has 15 to 20 branches, while *T.solium* 7 to 13 branches (Stanford University, 2005).

2.1.1 Life cycle of *T.saginata*

Humans are the definitive host of *T. saginata* (Giesecke, 1997). The life cycle begins with the ingestion of raw or undercooked beef containing *T.saginata* larvae (Stanford University, 2005). The larvae are released after digestion of the shell of the tapeworm cyst and they mature in the upper small intestine. Adult worms may inhabit the gastro-intestinal tract for as long as 25 years (Matt, 1989). Mature tapeworms will release 10 single gravid proglottids daily via the faeces or they are spontaneously released from the anus as they are motile (Stanford University, 2005). According to Michael (1997) herbivorous animals ingest the eggs, and once released after digestion of the shell of the egg, larvae penetrate the gastro-intestinal wall and migrate to the skeletal muscle (Fig 2.1). Intrauterine infection of a bovine foetus has also been recorded by the FAO (2005). Cattle are usually infested while still young and then become resistant to re-infestation; the cysticercus develops fully within 8-12 weeks, and has a lifespan of several years (Giesecke, 1997). The life cycle is shown in Fig 2.1.

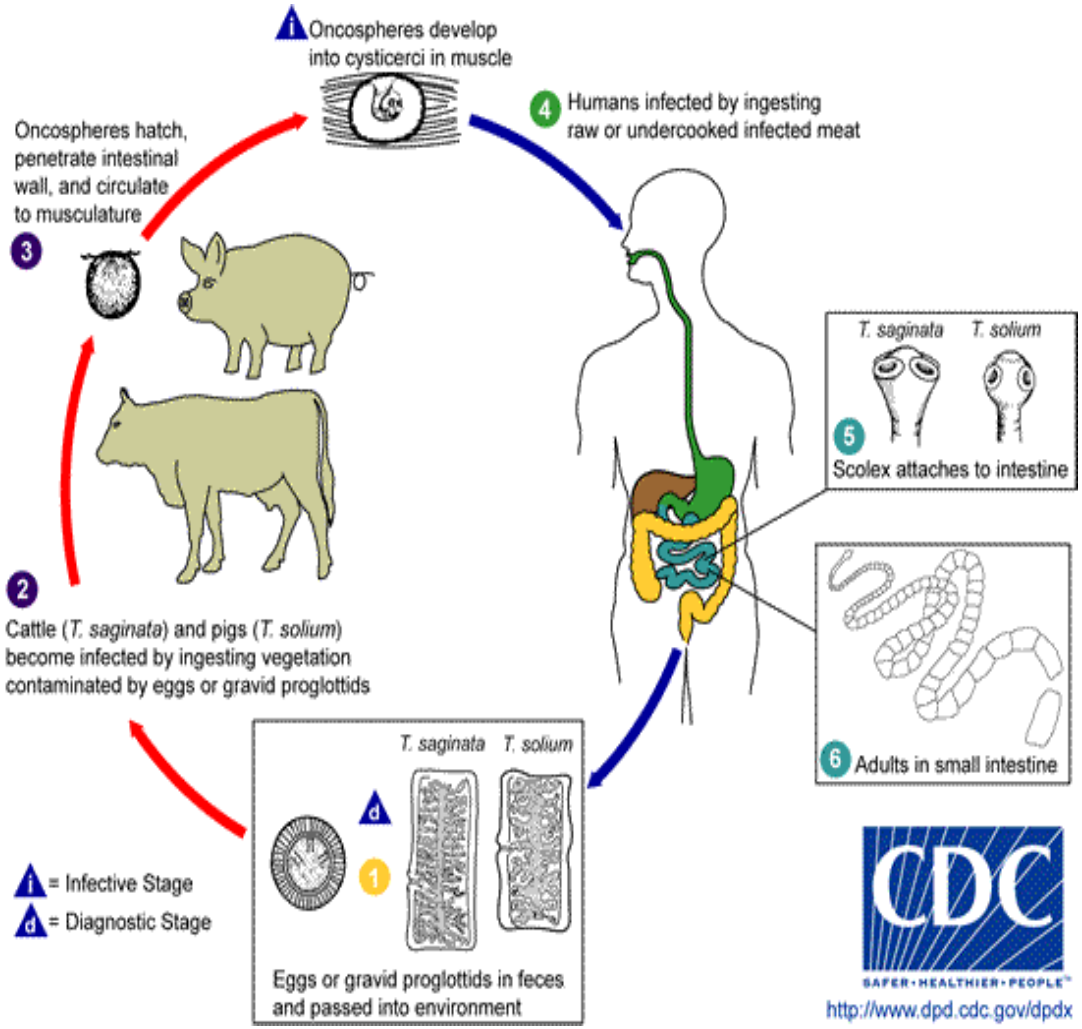


Fig 2.1: Life cycle of *Taenia saginata* and *Taenia solium*

Source: Centre for Disease Control, 2005

2.1.2 Distribution of *T.saginata*

Tapeworms in man and cysticercosis in cattle are distributed worldwide, but occur more particularly in underdeveloped countries (Du Preez, 1997) moreover in rural areas in the developing countries of Africa (Dorny *et al*, 2000) and South Africa (Giesecke, 1997), where access to safe water and basic sanitations are limited. The incidence of infestation varies according to the geographical distribution of animals and man, the level of socio-economic development and standard of meat hygiene control.

2.1.3 Signs of *T.saginata* in cattle

The presence of cysticerci in the muscles of cattle is not associated with clinical signs (Urquhart *et al*., 1989). Cysticerci are usually located in the muscles of cattle, although they can also be found in other parts of the body (Wanzala *et al*., 2005). The lesions, which appear as small vesicles 6-8mm in size are embedded in the muscles, muscular fat, or intramuscular connective tissue (Shah-Fisher & Ralph, 1989). These are known as cysticerci. Some muscles are infected more than others. The presence of *C.bovis* is recognized in cuts of the thigh muscles, heart (shown in Plate 2.1), masseter muscles, tongue and diaphragm (FAO, 2005; Wanzala *et al*., 2005).

These sites can be statistically ranked in the following order of decreasing importance:

- myocardium,
- tongue,
- masseters,
- shoulder muscles,
- neck muscles and
- intercostal muscles.

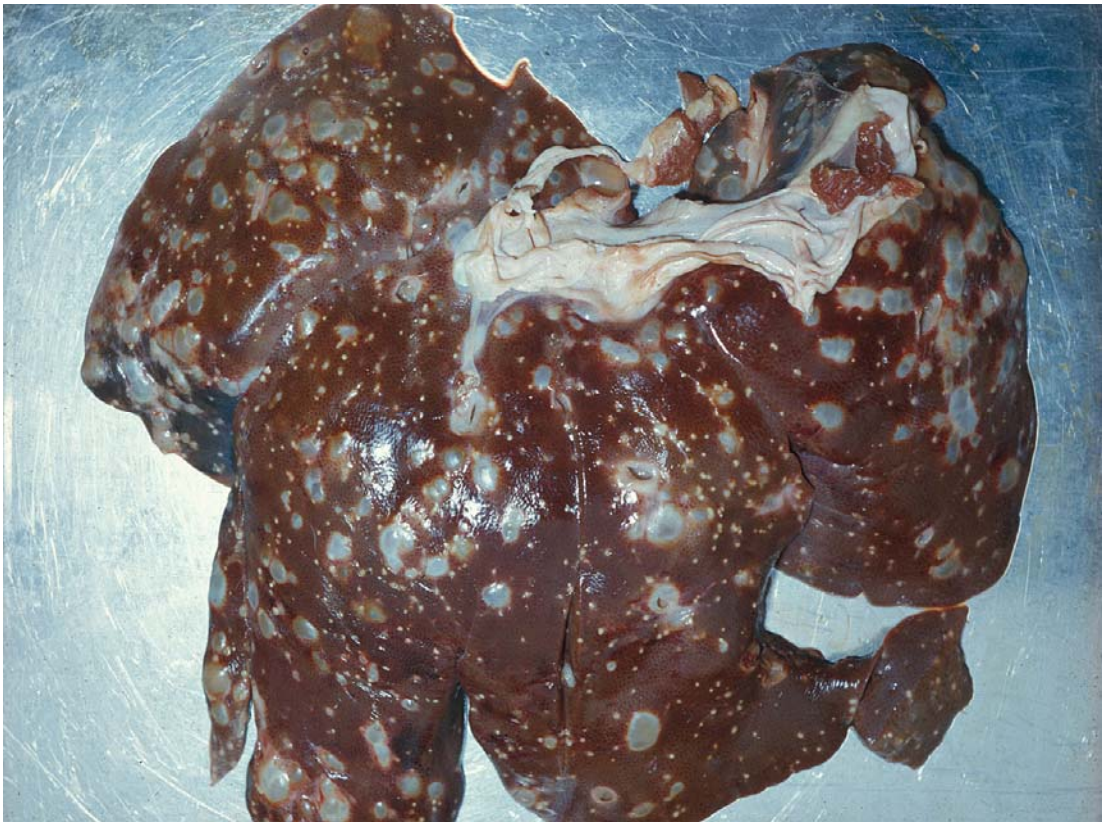


Plate 2.1: Cysticercosis in liver muscle of cattle

Source: University of Pretoria

During post mortem examination of carcasses at meat inspection, invariably the masseter muscle, tongue, heart and triceps muscle are incised and examined as well as the intercostal muscles and diaphragm (FAO, 2005).

The cuts are made at inspection are a compromise between detection of cysticerci and the preservation of the economic value of the carcass; carcasses containing inspection is inevitable a compromise between detection of cysticerci and the preservation of the economic value of the carcass; carcasses containing less than 20 surfaces affected are conditionally passed and frozen. If one or more cysticerci are found on the majority of surfaces (at least 20 surfaces) the carcass are condemned (Meat Safety Act, 2000). The decision to detain or condemn carcasses and organs is based on Table 2.1. Hence the disease has a high economic significance (FAO, 2005).

Table 2.1: Primary meat inspection of cysticercosis

Area bilaterally	No. of surfaces	No. of incisions
M. triceps brachii	12	6
Masseters muscles	8	4
Pterygoid muscles	4	2
Diaphragm	8	4
Heart muscles	6 (4)	2
2 halves of carcass	2	
Total	**38**	**18**

Source: Meat Safety Act 40, 2000

2.1.4 Symptoms and signs of *T.saginata* in people

While tapeworm infestation by *T.saginata* in humans is not usually fatal, the parasite competes with its human host for food. In Africa, where malnutrition can be a real problem in people, this can increase the effects of food deprivation, leading to malaise and even death (C M E McCrindle, Faculty of Veterinary Science, pers. comm., 2005). This is particularly true for Namibia, as under-nutrition remains widespread and a substantial proportion of people suffer from some form of deficiency. According to the Ministry of Agriculture Water and Rural Development (2002), nationally some 28% of the children have been found stunted, nine percent wasted and 26% underweight.

2.1.5 Control

Giesecke (1997) has reported that the incidence and intensity of *C.bovis* depends mainly on:

- the infection pressure (i.e. number of exposures in one area during a given period) on uninfected cattle,
- level of immunity in the cattle exposed to infection,
- slaughtering of existing cattle, and
- replacement of the slaughtered infected cattle with uninfected cattle.

According to Hunter (1994), a number of measures are employed in the control of cysticercosis. Firstly, during meat inspection, strict measures are taken at abattoirs to screen for cysticercus larvae in beef. Meat inspection, which is the most important public health control measure, identifies only a minor fraction of heavily infected animals, and also only when it is too late to avoid losses (Wanzala *et al*., 2002; 2003; 2005). Hunter (1994) described food treatment as the second method. Meat, which is lightly infested with cysterci, may be made safe by cooking at 100°C for 2.5 hours. Also freezing at -10°C for 10 days or pickling at -10°C for 21 days is recommended for meat treatment measures (Du Preez, 1997). Thirdly, the regular deworming of people will prevent the excretion of eggs and so prevent infestation of cattle (Hunter, 1994). This is particularly important in the case of farm workers involved in cattle management, especially in feedlots and other intensive systems. It is possible to remove the adult tapeworm by use of highly effective drugs, for example, praziquantel (Flisser, Gauci *et al.,* 2004a). *T.saginata* can be treated with oral medication, usually as a single dose of the drug niclosamide (Stanford University, 2005; Nginyi *et al*., 2002).

The importance of food borne parasitic zoonoses remains high in many regions of the world. Although control efforts have been exerted for quite some time, overall progress has not been satisfactory, even in many well developed countries. An important drawback in control programmes for parasites such as *Trichinella*, *Toxoplasma* and *Taenia* has been the absence of rapid, accurate and sensitive diagnostic tests for these meat borne parasites (Gamble and Murrell, 1999).

The entire carcass can be condemned without the possibility of reclamation if it is heavily infested. An animal is commonly considered heavily infected if lesions are discovered in two of the usual inspection sites including the masseter, muscles, tongue, oesophagus, heart, and diaphragm (FAO, 2005). Current meat inspection methods are not sophisticated enough to identify all infected

carcasses. This makes eradication difficult as infected cattle populations remain undetected (Harrison, 2005). Consequently, use of meat inspection records will tend to underestimate incidence (Onyango-Abuje *et al*., 1996). Furthermore, post-mortem detection does not avert the financial losses resulting from downgrading or total condemnation (Onyango-Abuje *et al*., 1996).

Sedentary human populations should be educated to use latrines. In a nomadic environment, where there is constant association with animals and no sanitary facilities, it is not possible to prevent *T.saginata* from spreading eggs on the pastures. Control of the infection by treatment of tapeworm carriers on the farms and personal hygiene including the use of latrines are likely to reduce transmission (Dorny *et al.,* 2002). Eggs containing the oncosphere can remain viable for between 16 days in untreated sewage, to 159 days on pastures (Stanford University, 2005).

In agricultural systems the use of human sludge as a fertilizer should be confined to cultivated fields on which cattle will not graze for at least two years. In developing countries the same measures are necessary, but are not always economically feasible (NOLIDEP, 2000). At present the most useful step would be to educate communities in both sanitary and culinary hygiene (Hunter, 1994).

2.1.6 Slaughter and examination for *T.saginata* in beef

The total dissection method is used as a gold standard to indicate the absence or presence of bovine cysticercosis infection in cattle (Wanzala *et al*., 2003). Routine post-mortem examination of a carcass should be carried out as soon as possible after the completion of dressing for the detection of cysticercosis so that meat that is not fit for human consumption is not passed as food (Meat Safety Act, 2000). According to FAO (2005) positive identification of *C.bovis* during post-mortem examination shows:

- Small white lesions (cysticerci) in muscle or organs tissue, 2 – 3weeks after infection
- Clear transparent bladders 5 × 10 mm (infective cysticerci) in tissues or organs 12 – 15 weeks after infection
- Opaque and pearl like lesions in muscle tissue/organs, 15 weeks or longer after infection.
- Degeneration, caseation and calcification of lesions 12 months or more after infection

Post mortem and meat inspection procedures have been designed to detect lesions produced by the disease after slaughter. This was done as part of the use of organoleptic tests of meat, such as the use of touch (palpation) and sight (inspection and observation) (FAO, 2005). Carcass and viscera of heavily infested animals are condemned and those with light infestations should be treated either by boiling or freezing (FAO, 2005).

Where the infestation is not excessive, the carcass and organs may be passed on condition that it undergoes treatment as stated below. According to section 22 of the Meat Safety Act (2000), carcasses and organs must be treated by freezing:

- As sides in a freezer with air temperature at -18 °C for 72 hours; or
- As sides in a freezer with air temperature at -10 °C for 10 days; and
- After deboning the core temperature of the meat inside the container must be below -6 °C before it can be released by the registered inspector.

Visible cysts must be removed from the meat of a carcass that is conditionally passed and treated as described above. Carcasses and organs introduced for freezing must be kept by the abattoir for at least six months, and must be available for inspection purposes according to South African legislation, which is also adopted in Namibia.

The Hazard Analysis Critical Control Point (HACCP)-Based Inspection Model was introduced into the food industry in 1971, to ensure that there would be effective control of the quality of processed foods (FAO/WHO, 2002). It is a common sense approach to food safety that minimizes risks but does not provide zero risks. However, it is recommended that this concept also be applied to Meat Inspection and Meat Hygiene, to make sure that meat and meat products are safe and wholesome for human consumption (FAO-WHO, 2002).

HACCP and other similar auditing systems are being introduced widely in developed countries and also for the export sectors in some developing countries, including Namibia. Their primary aim is to reduce the risk of contamination with meat borne pathogens such as Salmonella and *E. coli*. The development and implementation of HACCP systems are costly and require skills, training and organization (FAO-WHO, 2002).

2.2 Veterinary extension and risk communication

Risk communication through veterinary extension is important in control of cysticercosis (FAO, 2005). The aim of risk communication is to identify and impose priorities and take appropriate actions to minimise risks. Sender, Message, Channel, Receiver and Effect (S-M-C-R-E) is a useful model of communication in extension (Fig 2.2) (Bembridge, 1991). The model depicts how messages are passed from researcher or extension worker to farmers. The extension organization and the extension officer are normally the senders of information derived from agricultural research to farmers and families (Bembridge, 1991). Risk communication strategies in the case of zoonotic diseases, can be designed, using the same methods.

Risk communication is the process by which information and opinions regarding hazards and risks are gathered from potentially affected and interested parties during a risk analysis, and by which the results of the risk assessment and

proposed risk management measures are communicated to the decision-makers and interested parties in the importing and exporting countries (MacDiarmid & Pharo, 2003). This process is multidimensional and iterative and should ideally begin at the start of the risk analysis process and continue throughout.

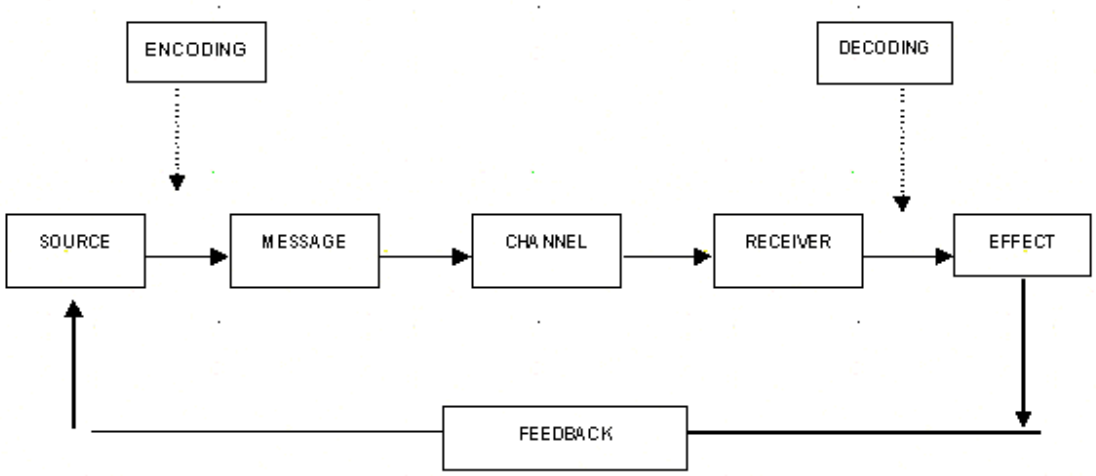


Fig 2.2: The SMCRE-model of communication
Source: Virtual Center, 2005

In 1997, the Namibian government adopted the Farming Systems Research and Extension Approach (FSRE) through the Directorate of Extension and Engineering Services (DEES) within the Ministry of Agriculture, Water and Rural Development (MAWRD). Ever since, an understanding has gradually evolved with MAWRD grappling with the best way to implement it within the Namibian physical, social and institutional environment (National FSRE Support Unit (NFSRESU), 2004). According to the National Agricultural Support Services Programme, FSRE Teams and Units were created, FSRE projects were implemented and many training courses have been held in FSRE courses and related areas (e.g. in Participatory Rural Appraisal (PRA), facilitation skills, and Participatory Farmer Training Development). This is in line with the *"decentralisation bringing the government to the people"* of the FSRE Units and a general move to use the FSRE approach as the methodology for implementing extension work programmes (NASSP, 2003).

FSRE as an effective tool requires linkages between research and extension (Dlamini, 1994) similar to the SMCRE model. These should be both formal and informal, exist at the top and also at the field level. Effective linkages can improve the efficiency of research programs as farmers and extension contribute their knowledge and other inputs. Considerably important issues include:

- How can resources be used more efficiently?
- How can resources be made available?

In the past, extension services were handled in isolation from research, or absent in most communal communities. As a consequence, most research findings were not adopted by farmers, primarily because they were isolated from the process and farmers were only spoon-fed with these new innovations. Therefore, the FSRE approach is aimed at bridging the gap between researchers, extension services and farmers. This is achieved by undertaking the research in collaboration with the farmer and extension worker on the farmers' field (NFSRESU, 2004).

2.3 Cattle Marketing in North Central Namibia

Marketing of livestock and livestock products is mainly through formal and informal markets. The Meat Corporation of Namibia (MeatCo) dominates formal marketing while informal markets are found in communal areas. MeatCo is a statutory body that plays a vital role in the beef industry and it is through MeatCo that farmers can access both the domestic and foreign markets, principally EU markets. MeatCo has made considerable progress with processing and marketing of the products of the meat industry and the value-added situation so achieved is making a major impact on the general economy of the industry (Rawlinson, 1994).

There are however, limitations as far as marketing of livestock products outside the Northern Communal Areas (NCAs). These limits are largely enforced through

the quarantine system: the veterinary cordon fence or infamous red line and the quarantine farms (Mendelson *et al*., 2000). Three quarantine farms have been created in the NCAs (Fig 2.3). Cattle sold to MeatCo (the organisation responsible for farmers in the NCA and other areas north of the red line) must spend three weeks (21 days) on those farms before being slaughtered and before the meat can be exported. This might seem like a reasonable solution, but transporting animals to and from the quarantine farms incurs costs that cattle-owners must bear. In the NCAs, the marketing infrastructure is less developed and access to markets remains a major constraint. Marketing opportunity is consequently through “under the tree” butcheries or informal slaughter for burials or other ceremonies.

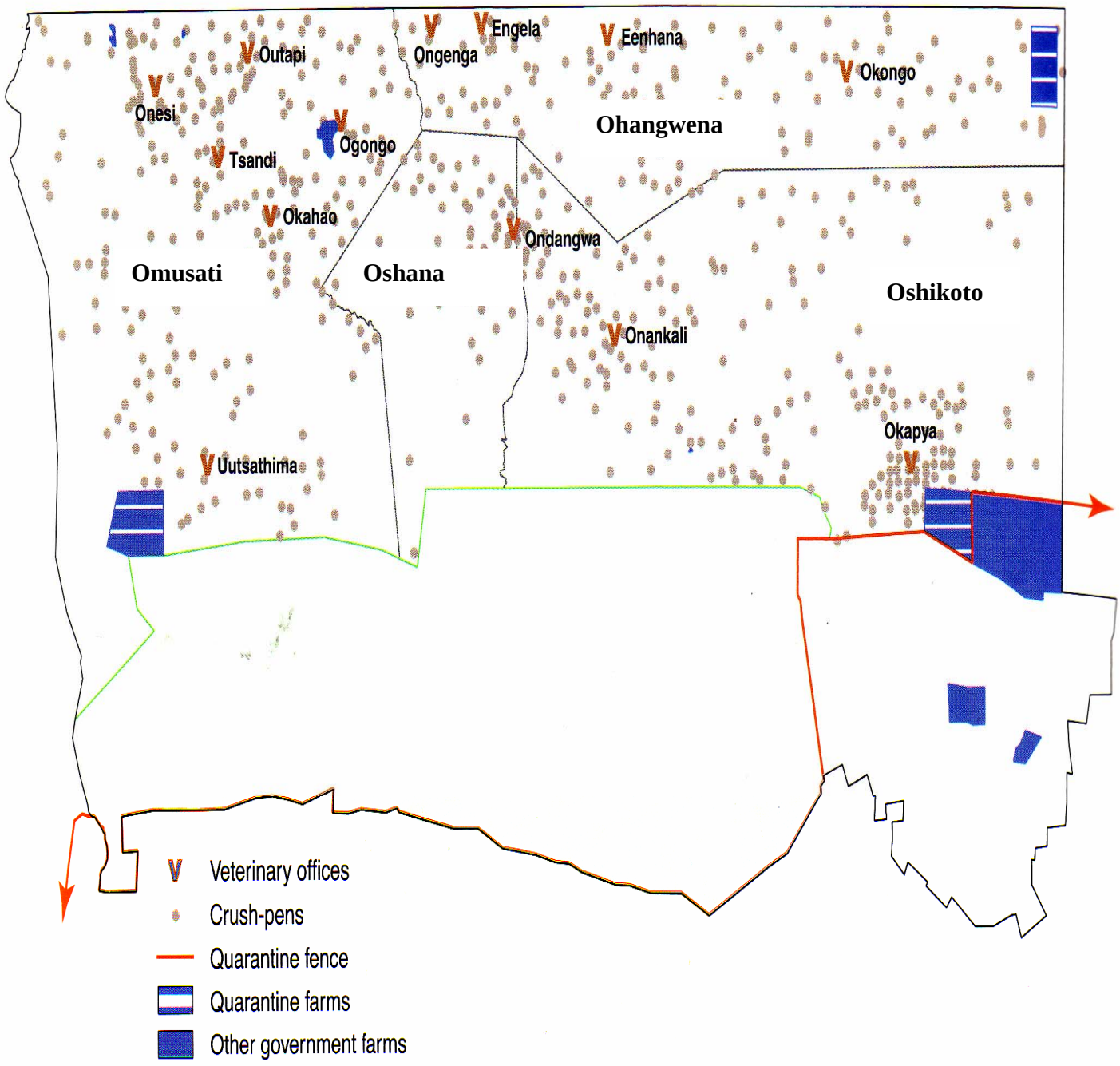


Fig 2.3: Veterinary District Offices and Quarantine farms
Source: Mendelson, et al, 2000

CHAPTER 3

MATERIALS AND METHODS

3.1 Model system and justification of the model

3.1.1 Study area

The study area comprised of Omusati, Ohangwena, Oshana and Oshikoto Regions in North Central Namibia (Fig 3.1). It borders the Kunene North Region to the west, on the Okavango Region to the east, on the Etosha National Game Park and on the commercial farms of Tsumeb to the south, and on Angola to the north (Franco-Namibia Rural Development Project (FNRDP), 1993). Major town centres include Tsumeb and Ondangwa in Oshikoto, Oshakati and Ongwediva in Oshana, Outapi and Ruacana in Omusati, and Oshikango, Eenhana and Ohangwena in Ohangwena Region.

The area is semi-arid with extremely variable and unreliable precipitation (Department of Fisheries and Water (DFW), 1990) with an average annual rainfall of 200 to 500 mm (FNRDP, 1993). Seasonally, the area receives flooding water down an inland delta of drainage channels that reaches from the north to the Etosha Pan, which are linked to the Cuvelai river system in Angola. The countryside and landscape is generally flat, monotonous and dotted with traditional settlements. Mopane, Marula and Wild Fig trees turn up occasionally between the fields and the kraals, and one can also find Makalani palm trees. Found within this plain are gentle undulations with local depressions known as “oshanas”.

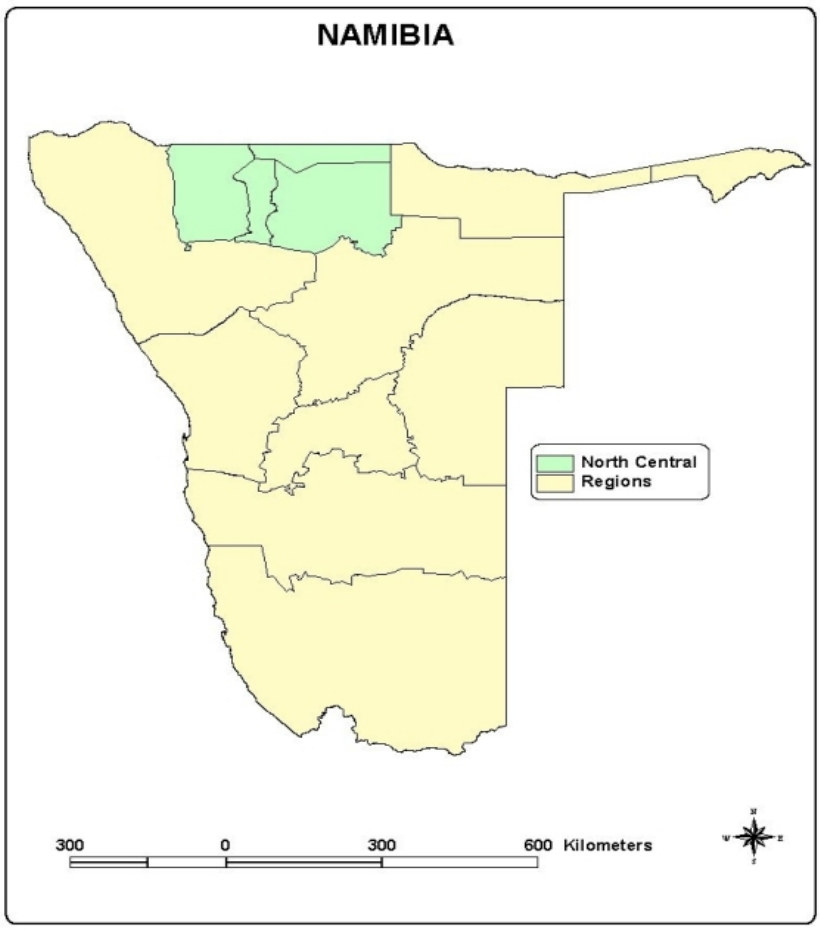


Fig 3.1: A map of Namibia showing the location of North Central Namibia

Source: Tsumis Agricultural College, 2005

This area was selected because of pre-existing information regarding the incidence of the disease (Table 3.1) and the willingness of the farmers and the local abattoir to cooperate in the study.

Table 3.1: Incidence of *C.bovis* at MeatCo Oshakati Abattoir (2005/06/01)

Year	Cattle slaughtered per year	Measly detentions per year	Incidence (%) of measly slaughtered cattle
2000	12 204	973	8
2001	7 888	713	9
2002	10 561	798	8
2003	4 411	347	8
2004	5 309	401	8
Total	**40 373**	**3232**	**8**

Source: MeatCo Oshakati Abattoir records 01 June 2005

3.1.2 Study population

a. Ethnicity and people

According to the 2001 Population and Housing Census of the National Planning Commission (Table 3.2), North Central Namibia has 780 149 inhabitants comprising of 54% women and 46% men, which corresponds to 43% of the total Namibian population of 1 830 330 (NPC, 2003).

Table 3.2: Estimated no of people in each of the four Regions of the study area in 2001

Region	Total Population	Females	Males
Ohangwena	228 384	124 828 (55%)	103 556 (45%)
Omusati	228 842	126 368 (55%)	102 473 (45%)
Oshana	161 916	87 958 (54%)	73 957 (46%)
Oshikoto	161 007	84 620 (53%)	76 387 (47%)
Total	780 149*	423 774 (54%)	356 373 (46%)

Source: NPC, 2003

**This total represents 43% of the total population in Namibia*

Almost half of the entire population live here on just 6% of the Namibian territory. The inhabitants of in the study area are mostly resource-poor subsistence farmers and grow mainly millet intercropped with vegetables while keeping cattle and goats. Owambo ethnicity prevails in the Region, which is subdivided into

seven groups: Ndonga, Ngandjera, Mbalantu, Kwanyama, Kwambi Kwaludhi, and Kolonkadhi (FNRDP, 1993).

b. Livestock

Agriculture in Northern Namibia is extensive and based on natural pasture and indigenous breeds of livestock. According to Undi (2003) livestock production plays a dominant role in the agricultural farming system and within the sector as a whole. Beef production in both communal and commercial agriculture contributes approximately 9% of the Gross National Product (GNP). According to the DVS national census of year 2002, cattle and goats are the dominant livestock species in the communal areas, constituting 66% (1.6 million) and 73% (1.4 million) respectively of Namibia's total population of these animals.

Table 3.3: Estimated populations of cattle in the study area, 1998

Region	No. of cattle
Ohangwena	130 000
Omusati	218 000
Oshana	39 000
Oshikoto	193 000
Total	580 000

Source: Mendelson, et al, 2000

Sheep are relatively scarce (350 000) constituting only 15% of the national flock. The rest of the domestic species in the communal areas are of low economic importance, because of their paucity and/or their low per unit economic value. These include indigenous free ranging poultry estimated at 507 017, donkeys (288 219), horses (14 322) and pigs (40 688) (NASSP, 2003). Cattle populations are shown in Table 3.3.

c. Farming Systems

The Namibian agricultural sector is divided into a communal farming sub-sector, where farmers operate on land operated under a communal tenure system, and a commercial farming sub-sector where farmers operate on freehold title deed land (Ministry of Agriculture, Water and Rural Development, 1995). Communal areas occupy approximately 48% of the total agricultural area (Strydom & Museler, 1999). Agriculture in the Northern Communal Areas (NCAs) consists of a mainly non-income generating production system, as well as very limited cash exchange of local produce. Farmers in these areas are mainly engaged in subsistence, rain-fed cropping and extensive livestock production, characterised by low levels of productivity, high variability of output from one year to the next and a high degree of poverty, household food-insecurity and malnutrition (Ministry of Agriculture, Water and Rural Development, 1995). Much of the agricultural work at household level is customarily handled by women. For communal farmers within the study area, livestock represent the means by which households survive drought periods through slaughter and/or sale of animals (Africa Institutional Management Services, 2002). They are also viewed as a symbol of prestige and are required for ceremonies such as weddings, funerals and dowry (Rawlinson, 1994).

3.2 Experimental design

The experimental work was carried out in seven phases:

- A retrospective survey of the presence of cysticercosis in cattle from Oshakati Abattoir records of 2004.
- A prospective survey of carcasses passing through the Oshakati abattoir over a 12 month period during 2005.
- Trace back of positive carcasses to producers of the abattoir.
- Structured interviews (n=95) with producers (n=105).
- Expert opinion survey: veterinary personnel (n=10).

- Development and evaluation of extension materials to match the extension needs of the target population.

The first two phases overlapped, as retrospective and prospective data collection occurred simultaneously.

3.3 Experimental procedure

A study was undertaken to investigate the incidence of visible cysts in slaughtered cattle carcasses at Oshakati Meatco abattoir in north-central Namibia, as identified during primary meat inspection or post mortem inspection (Meat Safety Act, 2000). Examination of abattoir records was preceded, from January to December 2005, by participation in routine sanitary inspection activities in the abattoir. Thereafter, all inspection records of bovine carcasses slaughtered 2000 – 2004 were examined. Incidence rates were calculated as the proportion of carcasses with cysts compatible with *C.bovis* out of the total cases examined during the given period of study.

Trace-back was done on positive carcasses to indicate the areas in which taeniasis of the human population was most likely to be high. As described Dargatz and Hill (1996) this was in essence a purposive selection of producers of positive beef carcasses, with the aim of discovering variables that contributed to the lack of control of *C.bovis* in the cattle. According to the data collected from MeatCo Oshakati abattoir, 105 producers or farmers were identified from the four Regions. Of the 105 identified, only 95 of were willing to participate in the study. Structured interviews Cameron, (1999) and Thrusfield, (2005) were constructed and both closed and open ended questions were formulated in the respondents' home language.

3.4 Interviews

Simpson & Wright (1988) defined a structured interview as a structured procedure with scientific purpose, by means of which the respondent, through a series of questions, is induced to give verbal information. Structured interviews were conducted with identified producers of Oshakati Abattoir using validated questionnaires.

Interviews with a sample of 95 farmers, (94 males and 1 female) in all the Regions were carried out using a set of questionnaires (Appendix A). The questionnaires had provision for numerical data and comments concerning changes, constraints and suggestions for improving dissemination of information and extension services in the target areas.

Respondents chosen were preferably the heads of their respective households, defined as the person who has the highest authority about most decisions concerning all individual members within one household (Conklin, 2004). In their absence any adult member present at the homestead was interviewed.

Household data, including type of construction, sanitary facilities and number of inhabitants, as well as demographic details on socioeconomic level, employment in agriculture, age, gender and level of education were recorded. The market value of the cattle and socioeconomic effects of poor prices also featured in the questionnaire. The level of knowledge of respondents about human taeniasis and bovine cysticercosis and their opinion about the risk and epidemiology of the disease was recorded. Informal slaughter for home consumption also featured in the questionnaire.

A questionnaire was also designed to aid in the development of appropriate extension materials for Namibia (Appendix B). State veterinarians and Chief

Animal Health Technicians (CAHTs) (n=10) serving in the study area were the respondents chosen for the structured interviewees.

3.5 Observation and analysis

Observations were recorded using photographs and on printed questionnaires. The information was entered into Microsoft Excel ® and Epi Info 3.3.2 (Freeware) software programmes for statistical and epidemiological analysis with a stated confidence of 0.95 and error of 0.05. Results were displayed in pie charts, histograms, charts and tables (Chapter 4).

3.6 Development and evaluation of extension materials

The information gathered was used to evaluate available extension materials to promote community awareness of the taeniasis/cysticercosis syndrome and how to prevent and treat the disease in humans and cattle. The extension materials were designed and evaluated in consultation with the Division of Veterinary Public Health of the Directorate of Veterinary Services (DVS).

3.6.1 Expert opinion study

The veterinary personnel (5 veterinarians and 5 CAHT) were selected for their knowledge of the target community and asked to rank different concepts. and visual materials to be used for extension and risk communication about control of *C.bovis*. They were also asked to rank different methods of extension so as to optimise the impact on the target audience.

CHAPTER 4

RESULTS AND DISCUSSIONS

The first part of this chapter focuses on the incidence of cysticercosis by describing the incidence as recorded at Oshakati Abattoir, and compares the incidence in the study area to that recorded for the rest of Northern Namibia including commercial areas. The consecutive subsections analyze the information obtained from structured interviews by Region. Demographic characteristics, education levels, animal production and marketing patterns as well as knowledge about *C.bovis* are presented. It is of essence to note that reliability of statistical information on households is based on the assumption that the information was conscientiously, accurately and reasonably provided by the respondents.

The results will be presented and discussed under the following headings:

- Incidence of cysticercosis.
- Demographic characteristics of respondents.
- Primary employment of respondents.
- Cattle production systems investigated.
- Cattle acquisition and marketing chain information.
- Meat inspection.
- Evaluation of the level of knowledge on *C.bovis*.
- Veterinary extension and risk communication.

4.1 Incidence of cysticercosis

Data obtained from the records of the 2004 and 2005 abattoir slaughtering season, yielded the findings presented in Fig 4.1 below. The high rate of cysticercosis infestation in the study area is consistent with observations made elsewhere in poor countries (Giesecke, 1997). The highest (12%) and the lowest

(3%) incidence of *C.bovis* were found with animals from Oshikoto Region in 2005 and 2004 respectively. Incidence of *C.bovis* in animals from Ohangwena and Omusati Regions during 2005 decreased as compared to the 2004 slaughtering, except for the 7% recorded with Oshana Region animals in both seasons. In comparison with the overall incidence of cysticercosis in the study area over 2004 and 2005 (Fig 4.1), no decrease in incidence was recorded for Oshana and Oshikoto Regions. Moreover it can be seen that the Region most at risk was Oshikoto Region, where an increase of 6% was observed.

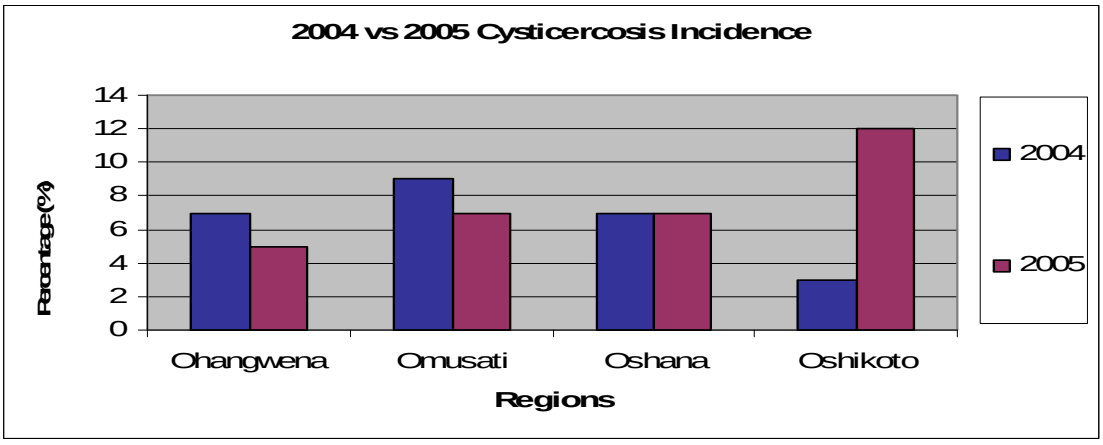


Fig 4.1: Comparison of cysticercosis incidence in 2004 and 2005 at Oshakati Abattoir

During the 2005 preliminary sanitary inspection, the abattoir slaughtered 2832 heads of cattle (Table 4.1), which represents 0,5% of the estimated total large-stock in North Central Namibia. About 7% (n=205) of slaughtered animals were positive for C.*bovis* (Table 4.1).

Compared to the incidence of 0,3% (n=243) at the abattoir in Windhoek servicing commercial farmers (Table 4.1), the mean incidence (7%) of *C.bovis* at Meatco Oshakati Abattoir is of great concern. Schneider (1994) reported that the mean incidence at all abattoirs in Namibia in 1992 was in the Region of 2%. The incidence of *C.bovis* is similarly lower (5%) for both predominantly livestock producing areas other than North Central Namibia, such as the Kunene Region, as well as commercial farms, (Table 4.1).

Giesecke (1997) reported that only about 50 to 55% of carcasses infected with cysticercosis are identifiable, even in abattoirs employing the most stringent meat inspection techniques, such as Oshakati and Windhoek abattoirs. Since even the best post-mortem abattoir examination can succeed in identifying only a fraction of positive cases, it would appear credible to assume that the incidence of cysticercosis infection could be as much as two times higher than that found in both the Oshakati and Windhoek MeatCo Abattoir records. Based on this assumption, the study yields a relatively high incidence of 14% in 2005. The incidence of *C.bovis* was found to be >10 times higher with the antigen detection ELISA than by classical meat inspection (Dorny *et al*., 2002). So the actual incidence may be higher still.

Table 4.1: Incidence of bovine cysticercosis in the four main sources of beef cattle slaughtered during January – December 2005

Source of Beef cattle	Cattle slaughtered	Cattle infected	Incidence of infection
Kavango	719	39	5%
Kunene	2944	159	5%
Study area	2832	205	7%
Others[1]	590	32	5%
Total Oshakati	7085	435	6%
Total Windhoek	71388	243	0,3%

Source: Meatco Oshakati and Windhoek Abattoir records 10 January 2006

[1]*Commercial farms in Outjo, Grootfontein and Tsumkwe districts*

Poor sanitary measures and close cohabitation of humans and farm animals appear to be responsible for increased incidences of cysticercosis in the study area. Table 4.2 shows that the majority of the respondents do not own proper sanitary facilities, i.e. pit latrines or waterborne toilets, except for Oshana Region where 91% of the respondents have indicated ownership of waterborne toilets. According to Herenda *et al*., (1994) cattle become infected while grazing, by the ingestion of soil and vegetation contaminated with proglottids or ova of

T.saginata from human faeces. Detailed records of the incidence of *C. bovis* in beef cattle slaughtered at the Oshakati Abattoir are shown in Appendix C.

Table 4.2: Distribution of sanitary facilities in percentage (%) per Region in the study area

Region	Pit Latrines	Waterborne toilet	Neither
Ohangwena	29	12	9
Omusati	17	8	65
Oshana	0	91	9
Oshikoto	26	13	61
Total (Average)	18	31	50

From the overall analysis of the Oshakati abattoir records shown in Table 4.1, 3% of the infected carcasses were condemned. Fig 4.2 indicates the distribution of condemned carcasses among the four main sources of beef cattle in the study area.

Although the Oshikoto Region had the highest incidence of positive carcasses, none of the carcasses were condemned in 2005. This indicates a lower number of cysts in carcasses (see earlier Section 2.1.5 p. 12-13) (FAO, 2005). Instead, results show the highest condemnation was in the Omusati Region (Fig 4.2), a factor possibly related to the low level of sanitary facilities (Table 4.2) coupled with high rural population density and limited grazing capacity for cattle in Omusati Region.

Despite the frequent movement of animals across the Namibian-Angolan border, Ohangwena Region has a low incidence and no carcasses condemned. Access to and ownership of grazing land in Ohangwena was reported by the NPC (2006), as being on average, 24% higher than all the other Regions. In Ohangwena Region, the incidence of positive carcasses was lower. The lower level of positive carcasses is perhaps due to very low numbers of animals (130) sold to the abattoir yearly, optimal natural grazing and lower population densities as compared to the other Regions.

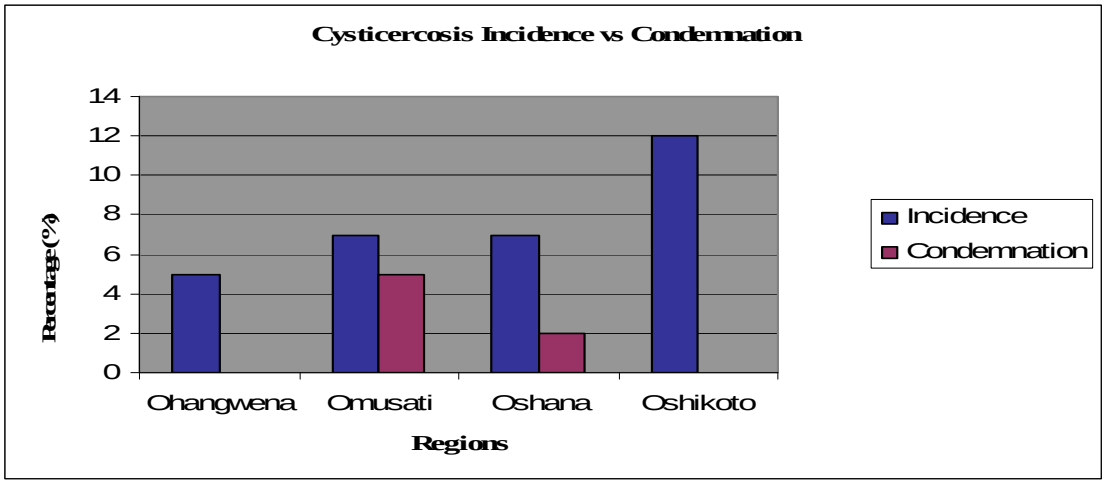


Fig 4.2: Comparison incidence infection vs condemnation

Sanitary inspection techniques employed at Oshakati MeatCo Abattoir were seen to be consistent with the established international standards as described by Herenda *et al*., (1994). General observations made during the study period revealed that MeatCo conducted its business so as to comply strictly with the Meat Safety Act 40 of 2000, as quoted below:

"*To provide for measures to promote meat safety and the safety of animal products; to establish and maintain essential national standards in respect of abattoirs; to regulate the importation and exportation of meat; to establish meat safety schemes; and to provide matters connected therewith.*"

4.2 Demographic characteristics of respondents

The purpose of this section is to provide a descriptive summary of some demographic and social characteristics of the sampled population (Fig 4.3, 4.4, 4.5, and Table 4.3, 4.4, 4.5).

4.2.1 Household composition of respondents

For this study, a household was defined as a group of people (household members) who live together most of the year (more than six months) and share income and agricultural production between its individual members. Knowledge about the number of members in an individual household is important, because household size affect its capacity to improve and address other social needs e.g. construction of toilets that could aid in reduction of the incidence of *C.bovis.*

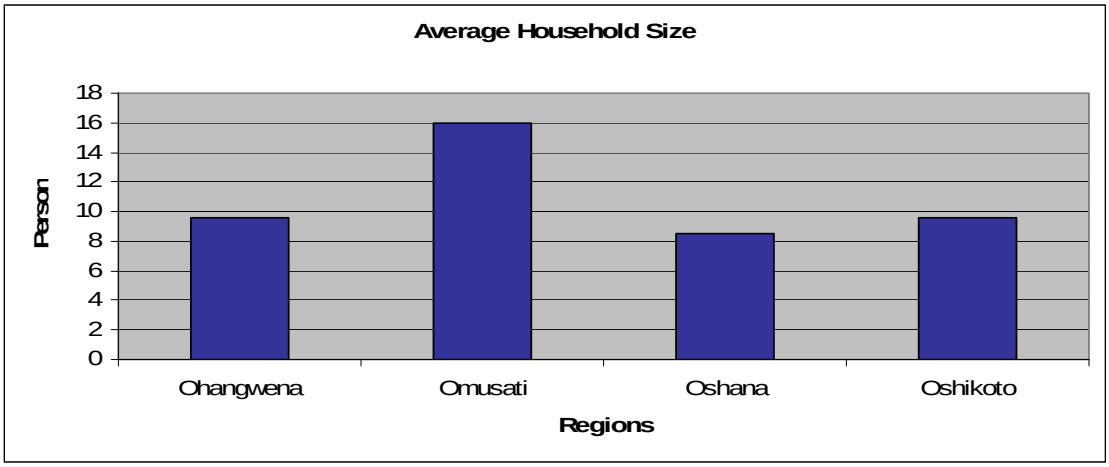


Fig 4.3: Average household size per Region

During the study it was found that a typical household in the four Regions has an average household size of 11 people, with an overall range between two and thirty household members (Fig 4.3). The number of members per household varied from an average of 8,5 persons in Oshana, 9,6 in Oshikoto, 16 in Omusati and 9,6 in Ohangwena Region (Fig 4.3). These findings are in line with national statistics (NPC, 2003).

The portion of households with 10 and more members was substantially higher in Omusati Region, and found to be lowest in the Oshana Region (Table 4.3).

Table 4.3: Proportions of household members (>10) per Region

Region	Percentage
Ohangwena	42
Omusati	83
Oshana	27
Oshikoto	43

From these statistics, it is clear that the number of dependants is relatively higher in these Regions than the national average of 5,1 persons per household in Namibia (NPC, 2003). This may be due to the high numbers of orphans as well as grandchildren whose parents have migrated to the towns for work, and who are supporting the children through sending money to their parents (remittances).

4.2.2 Gender distribution

The distribution of the respondents by gender was drastically skewed, with 1% of the respondents being female and 99% being male. This is perhaps due to the fact that livestock trading in the Regions is dominated by males, while females chiefly labour at crop production activities. It has also been reported by Maree & Casey (1993) that women are not interested in large animals like cattle, they are more interested in small animals like goats, sheep and chickens. The target audience for extension would therefore mainly be the adult male cattle-owning segment of the population, although extension on provision of sanitary facilities would have to involve a broader audience including women, children, health officials and decision makers.

4.2.3 Age of respondents

The average age of the interviewed farmers was 56 years, ranging from 22 to 78 years of age, with about 73% of them above 50 years of age (Fig 4.4). This is attributed to the fact that young people are not established in farming or rural enterprises and the older ones take up farming after taking packages at their

urban work-place and then buy cattle as a form of retirement security and investment (Makgatho, 2005).

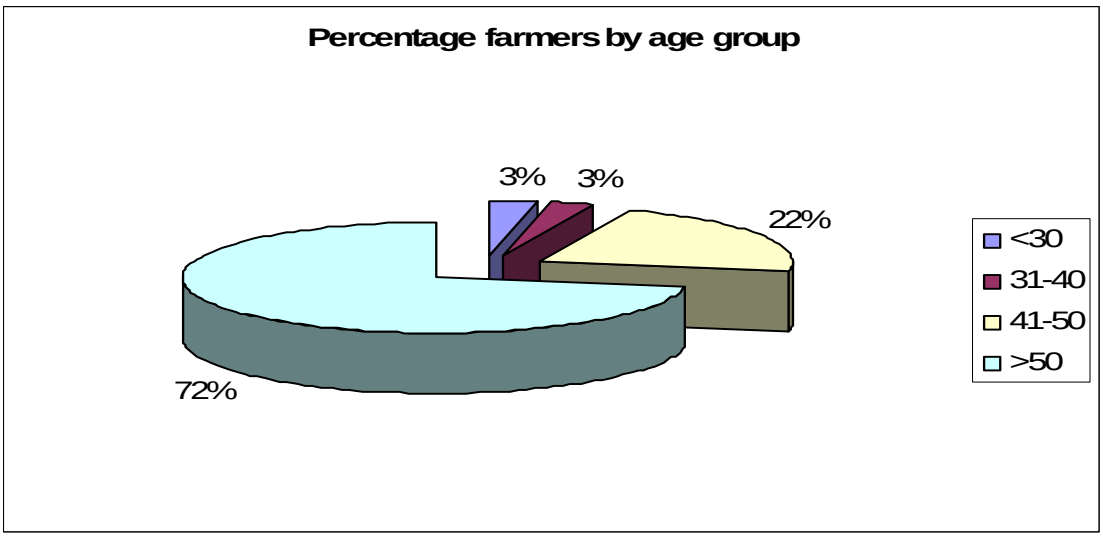


Fig 4.4: Average age categories of farmers in the study area

4.2.4 Educational level

The typical education attainment level of respondents was between primary and secondary school education, representing 33% and 29% respectively. About a quarter of respondents (24%) did not attain any informal education, with only 14% of respondents holding tertiary qualifications (Table 4.4).

Table 4.4: Reported Average Educational level of respondents

Educational level	Percentages
No formal education	24
Primary	33
Secondary	29
Tertiary	14
Total	100

Educated farmers have easier access to resources (e.g. extension and veterinary services), employment (off-farm) and income-generating options (e.g. marketing chain) which translates into better support for their on farm activities and families, and contribute directly to the household basic requirements and other needs.

In all the Regions under study, people from younger age groups reached significantly higher levels of formal education than those from older age groups. The basic educational levels (primary and secondary) reached in Omusati Region were generally higher than those attained in other Regions (Fig 4.5). While holders of tertiary education qualifications, were found most in Ohangwena Region, over 25% of the farmers reported that they had no formal education (Fig 4.5).

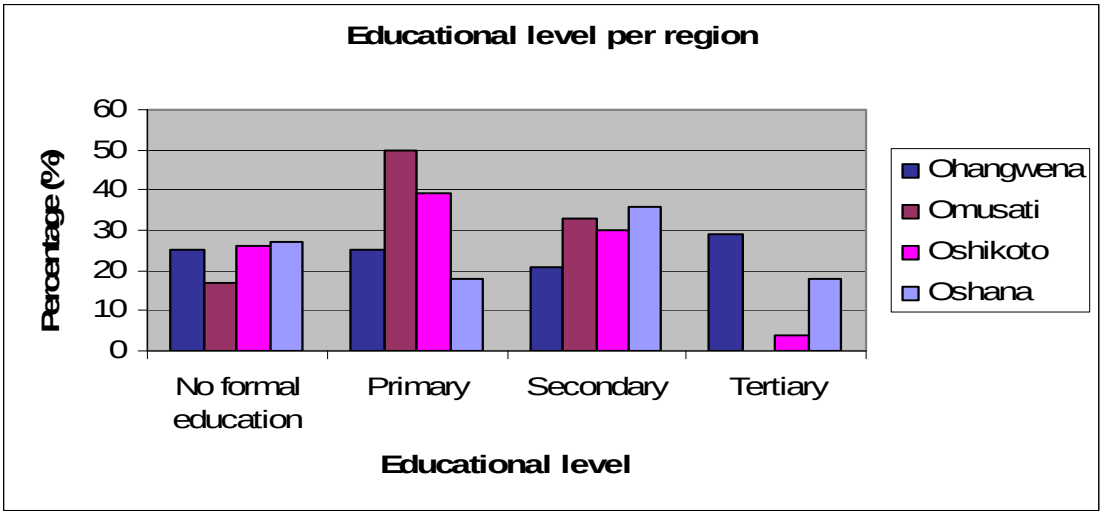


Fig 4.5: Distribution of the educational level of farmers in the study area

4.2.5 Language proficiency

Farmers were asked if they were able to read, write and communicate in their home language, Oshiwambo. Language literacy was measured in terms of ability to read and write. However 7% of respondents were found not to be able to read and write their own language (Table 4.5).

Trading in competitive and commercial environments where English literacy, and Afrikaans to some extent, is a requirement, hinders positive communication and ready access to formal markets by smallholder farmers. Only 20% of respondents indicated an ability to read and write English and Afrikaans (Table 4.5).

Table 4.5: Language literacy levels of respondents in the study area

Language proficiency	Percentage
Oshiwambo	93
Afrikaans	20
English	20

Note: The above percentages for language proficiency will not add-up to 100% because some respondents are proficient in more than one language. Therefore they are counted more than once.

It was also found that none of the interviewed farmers use English as their home language. Comparatively, national statistics show that the level of primary and secondary school education attained by all those aged above 15 years, stands at 42% and 15% respectively (NPC, 2003).

4.3 Primary employment of respondent

The first level of analysis was to determine the major types of income sources. The study findings show that the majority of the respondents : 21%, 83%, 46% and 35% in Ohangwena, Omusati, Oshana and Oshikoto Regions respectively, derived their income from farming (Table 4.6). NPC (2003) during the 2001 Population and Housing Census, also reported that the main household income in the Regions is farming, ranging from 36% of the total inhabitants in Ohangwena to 56% in Oshikoto Region.

Most of the study respondents had more than one source of income, except for the 3% and 9% entirely farming households in Ohangwena and Oshikoto

Regions respectively. This outcome for Ohangwena holds relevancy with national statistics showing that the Region is among the least developed with 99% rural orientation (NPC, 2004). In Oshikoto Region, there are more farmers (17%) depending on state pensions, while for Omusati and Oshana Regions there were no respondents indicating additional income from pensions (Table 4.6). Fishing is an important source of income in the Regions with seasonal water in the form of oshanas (the local word for a Namibian flood plain that has seasonal shallow water) such as Omusati and Oshikoto Regions. Those Regions with no fishing activities were shown to have higher dependence on private/state employment (Table 4.6)

Table 4.6: Percent distribution of respondent's primary employment per Region

Region	None	Farming	Own Business	Mining/ Fishing	Private/ State	Pension
Ohangwena	25	21	17	0	29	8
Omusati	0	83	33	33	8	0
Oshana	0	46	18	0	36	0
Oshikoto	9	35	26	9	17	17

Note: The above percentages will not add-up to 100% because some respondents have more than one source of income. Therefore, they are counted more than once.

4.4 Cattle production systems investigated

Cattle farming is a very important economic activity in the livelihoods of the majority of Namibians. In the absence of a rural banking system, the cattle herd is the family's stock of wealth and a source of milk, draught animal power and manure (Goby, 1997) and is also a type of insurance (FNRDP, 1993). The farmers consider it better to have cattle than material goods. The periodic drought is also a reason for keeping as large a herd as possible and for not selling cattle unless an emergency arises. It is reasoned that the more cattle you have, the greater are your chances of surviving a drought (Goby, 1997).

4.4.1 Reasons for keeping cattle

Fig 4.7 indicates the main reasons why the interviewed farmers in the study area keep cattle. Use of cattle for traditional purposes was outscored by business reasons by 10%, a sign that smallholder farmers are shifting into commercial agricultural production, even although they farm on state-owned land. Efforts to support these emerging farmers to improve are thus important and creating extension models for cysticercosis prevention and control holds relevancy.

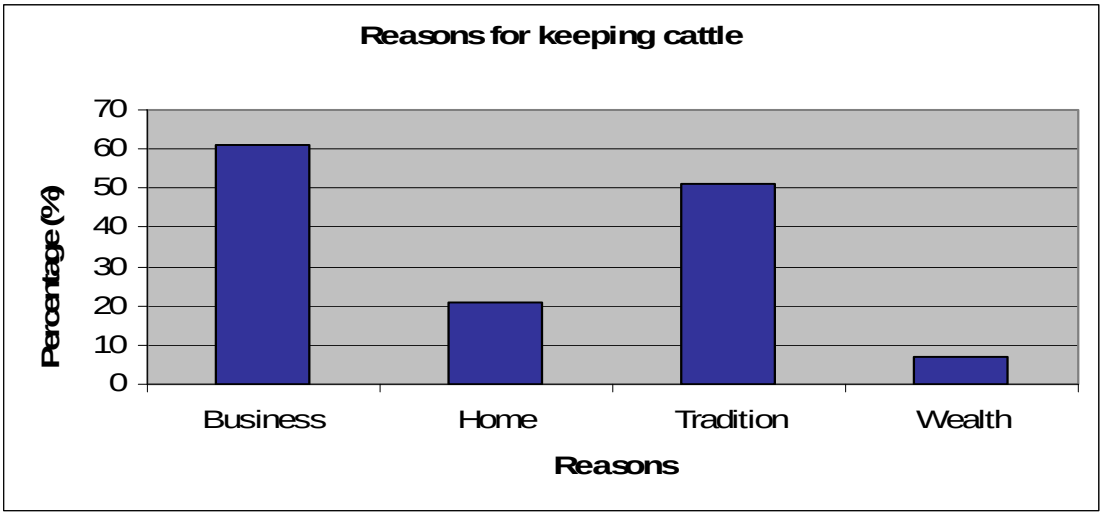


Fig 4.6: Reasons for keeping cattle

4.4.2 Grazing systems of cattle

a. Feeding regime of cattle

A total of 43 million hectares of pasture has been measured in the study area, of which 20% (850 000 ha) are not used, due to lack of water sources (FNRDP, 1993). The study indicates that cattle in the study area are grazed on natural pastures, and that only a few farmers (14%) provide supplementary feeds to their cattle in the form of licks, a practice putting more pressure on limited natural

grazing. Similar observations were made by Kuvare & Mbai (2006) in their paper on the environmental impact of draught animals.

In the study area, the children herd the cattle to the *oshanas* in the wet season and around the dwellings for grazing during the dry season (FNRDP, 1993). The current trend is actually to keep cattle in fenced “cattle posts” (fenced, state owned land where the cattle herders look after animals belonging to several owners) far away from the dwellings, during the major part of the year. During the study, it was recorded that these “cattle posts “ may be as far as 300 km away from where the cattle owners live and cattle are driven there on foot, sometimes only during the dry season, sometimes during the whole year.

b. Grazing areas

Communal farmers do not keep all their animals at one place; some are kept around the homestead, while others are sent to cattle posts, usually on foot. This is to reduce the losses of cattle through drought periods and epidemic diseases (Goby, 1997). In order to overcome grazing shortages in their home area, most cattle owning households move their cattle to remote cattle posts where grazing conditions are better in the dry season. Out of the surveyed sample, 57% have indicated that they keep their animals at one cattle post throughout the year; while 37% keep them at both the cattle post and at home; and the remaining 6% farmers keep their cattle only at the homestead.

4.4.3 Herders of cattle

More than half of the respondents employed herdsmen to look after their animals, perhaps due to the diversified income initiatives and that the majority of male owners are working elsewhere. These herdsmen were also responsible for taking the cattle for vaccination during campaigns and reporting any sick cattle to the owner or the nearest veterinary offices (Table 4.7).

Table 4.7: Herders of cattle

Herders	Percentage of total owners
Owner	17
Labourers	56
Children	4
Wife	1
Family members	27

Note: The above percentages will not add-up to 100% because some respondents have more than one type of herders. Therefore, they are counted more than once.

About 17% looked after their own cattle as they were full-time farmers or were on pension (Table 4.7). Other members of the family, mainly young male relatives, also look after the cattle. The average herd size recorded for was 155 cattle per household, which is practically impossible for one person to look after. This necessitates the employment of labourers or assistance from family members as cattle herders. It is possible, as was suggested by Dorny *et al*., 2002, that this close contact between herders and the herd, in the absence of adequate sanitary facilities at the cattle posts and on the rangeland (see Table 4.2), may be a contributing factor to the high levels of *C.bovis* found in beef carcasses from communal areas (Table 4.1).

4.5 Cattle acquisition and marketing

4.5.1 Acquisition of cattle

Many of the farmers reported that they inherited their initial stock (herd) from their parents. They then increased their herds through acquisition from various sources (Fig 4.7). The study showed that the majority of cattle bought by farmers originated from other communal farms and auction sales, with 56% and 31% respectively. Respondents were able to gain direct access to large quantities of relatively cheap cattle from communal farms in Omusati Region.

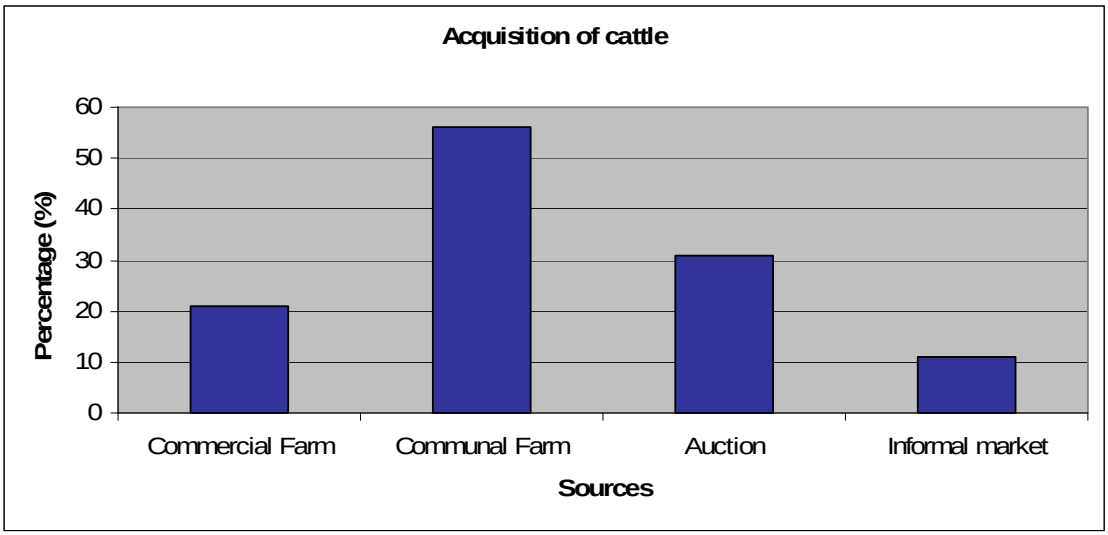


Fig 4.7: Sources for cattle acquisition by farmers in the study area

The Veterinary Cordon Fence to the south of the study area bars the transfer of meat and animals to other parts of the country; this is probably one of the main reasons why farmers do not adopt more commercial management methods for their cattle (FNRDP, 1993).

4.5.2 Number of cattle acquired by respondents

On average only 77 cattle per farmer (ranging from one to a thousand cattle per farmer) were found to have been bought through the formal market during 2004/2005. The rest of the cattle acquired were bought through the informal market, inherited, bartered or obtained through lobola.

4.5.3 Cattle Marketing

Informal marketing of cattle between the northern Regions of Namibia (Fig 4.8) is indicated by the large numbers of informal butcheries that have sprung up in the outlying suburbs of certain towns.

These informal butcheries mostly consist of a slaughtering-floor which is only equipped with a tripod and hooks from where the farmers sell the meat themselves (Plate D.3). Carcasses are carved up by a butcher on request.

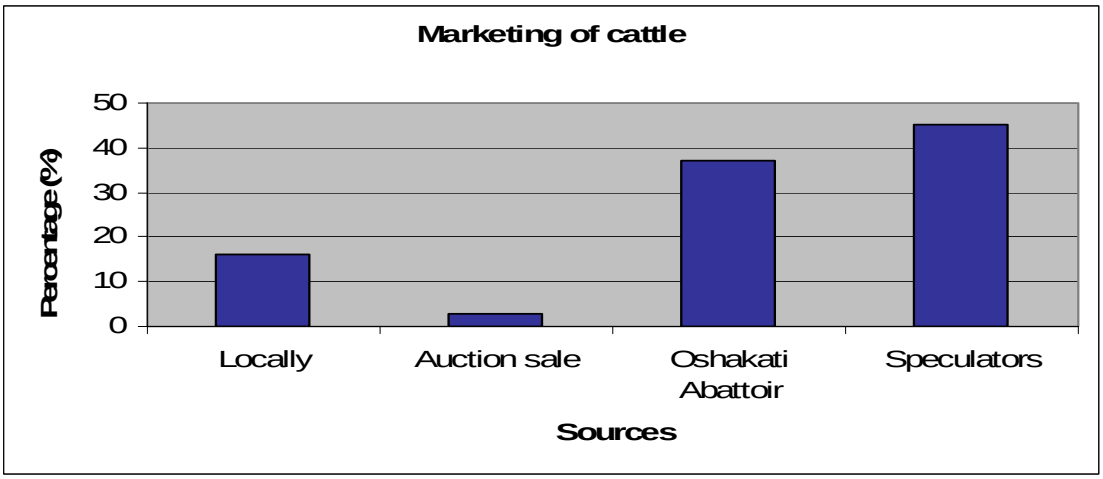


Fig 4.8: Marketing of cattle

Marketing outlets for cattle were grouped into local (informal sales), auction sales, MeatCo Abattoir and private individuals (mainly speculators). Of these the most common were local markets and speculators. It is important to note that market was also dependent on the motive for sale. For instance, households selling to meet expenses stemming from an emergency did not have much choice in terms of customer and price. They sold the animals to the most readily available customer at the offer price.

Even although the interviewed farmers are producers for the Oshakati Abattoir; the survey indicates that the majority of farmers prefer to sell their cattle to speculators (45%) and to a lesser extend to the local butchers (16%), (Fig 4.8).

This is because of the relatively high costs they incur for transporting animals to and from the quarantine farms, resulting in lower profits. It is also suggested that another underlying cause seems to be the fact that producers in the study area

tend to want to sell animals that are older, while MeatCo wants to buy younger animals (NOLIDEP, 2000).

Cash flow may also be a reason for the preference for local sales and speculators. However, Goby (1997) noted that traditionally animals are only sold when the household has a need for a large amount of cash. The biggest advantage of informal sales, as perceived by respondents, was that they pay better prices and leave room for negotiation. This is probably because the sellers do not have to pay for transport to the abattoir or slaughter fees and the sales do not always attract tax. This agrees with Rawlinson, (1994), who has indicated that high transport costs are a major constraint to formalisation of the livestock marketing chain in Namibia.

4.5.4 Number of cattle sold by respondents

During the year 2004/2005, the average number cattle sold per respondent were 41 (range 2-150) head of cattle. Other than the local (informal sales), the major share of cattle sold, as shown in Fig 4.8, went to the MeatCo Oshakati Abattoir (37%) and speculators (45%). Both of these have various options for further cattle marketing channels (Plate 4.1).

NOLIDEP (2000) established that the cost of access is a major determinant for the decisions on whether to market into the informal chain, or through the formal meat marketing system. Cattle are being slaughtered and sold in the urban areas through the many bush-butcheries (Goby, 1997). NOLIDEP (2000) reports that, in reality, there is an informal marketing chain that has become adapted to its environment over many years, and that has been impacted upon the MeatCo operations in this area (the formal marketing chain).

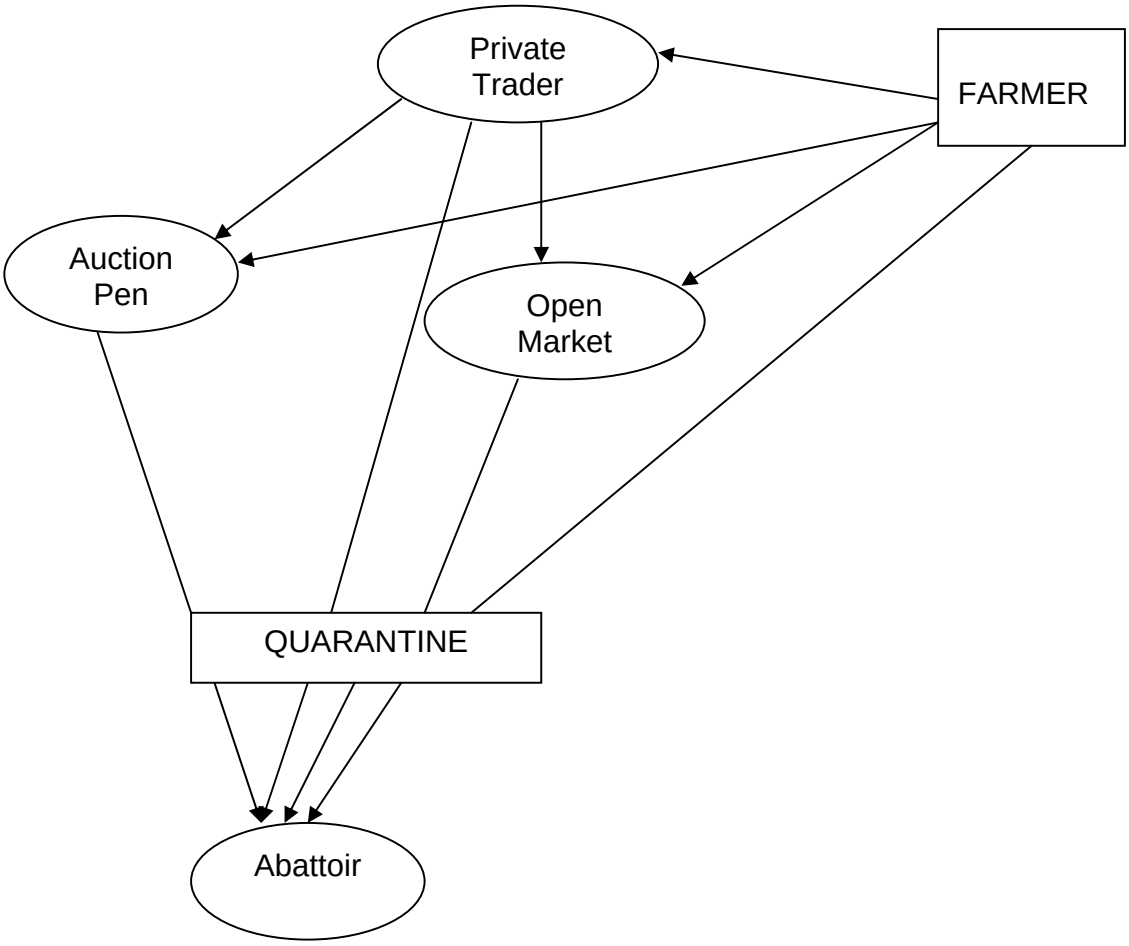


Plate 4.1: Cattle commercial marketing routes to the abattoir

Updated after Hendrikx, 2000

4.6 Meat inspection

The aim of meat inspection is to provide safe and wholesome meat for human consumption (Herenda *et al*., 1994) and the *onus* of achieving this objective lies with the DVS, as represented by state veterinarians and veterinary health inspectors at the abattoir. Respondents were asked if they knew the reasons why meat inspections were carried out and whether they considered them to be of any importance. The answers and perceptions, as well as observations on meat

inspections in the different abattoirs, are given in more detail in the following sub-sections.

4.6.1 Constraints to meat inspection

There are two abattoirs (Omusati and Oshana Regions respectively) managed by the local authorities for informal market meat provision in Oshakati and Outapi respectively. Several constraints have been identified as reasons for meat inspection not to take place in rural abattoirs (Table 4.8).

Table 4.8: Constraints of meat inspection in rural abattoirs

Constraints	Percentage (%)
Lack of knowledge	39
No access to meat inspection	33
Too far from the abattoir	6
Not important	6
Below standard	9

Lack of knowledge and no access to meat inspection were reported as main constraints by 39% and 33% farmers respectively. Some respondents (6%) have indicated that the abattoir is too far from their respective farms, while a few feel it is not important to carry out meat inspection (Table 4.8). The actual slaughtering of animals is done in unhygienic circumstances in the informal slaughtering house or “bush abattoirs” included in the investigation. This is an issue that does not present easy solutions, but nevertheless one that will need to be given the required attention, since they are a potential source of infection for those consuming the meat.

4.6.2 Respondents knowledge about meat inspection

All of the respondents from Oshana Region were knowledgeable about meat inspection and why it should be carried out, while respondents from Ohangwena and Oshikoto Regions recorded a knowledge level 46% and 35% respectively (Table 4.9).

Table 4.9: Knowledge of farmers about meat inspection

Region	Yes (%)	No (%)
Ohangwena	46	54
Omusati	76	25
Oshana	100	0
Oshikoto	35	65

The high level of knowledge about meat inspection, recorded for Oshana, could be related to the urban orientation of the Region, in particular, the fact that the two major towns, Oshakati and Ongwediva, have a better standard of living and strategic town management.

4.7 Evaluation of knowledge about cysticercosis

Farmers were asked whether they were able to define the word “cysticercosis” and explain how cysticercosis spread and how it could be controlled or prevented.

4.7.1 The meaning of cysticercosis

The question about the meaning of the word “cysticercosis” was given both in English and the vernacular. It was found that the majority of the respondents did not know what the word “cysticercosis” means (Table 4.10). Farmers in Oshikoto Region had the lowest level of knowledge of the word (3%). This is a possible cause for the high incidence of *C bovis* (12%) in cattle from this Region (Fig 4.1).

Table 4.10: Knowledge of respondents on what cysticercosis means

Region	Know what "cysticercosis" means (%)	
	Yes	No
Ohangwena	17	83
Omusati	41	58
Oshana	36	64
Oshikoto	4	96
Total (Average)	25	75

4.7.2 Signs of the disease in people and cattle

The respondents were not aware that cysticercosis can also infect people and how people get infected, and how the disease is diagnosed in both cattle and people. This explains the absence of meat inspection procedures at informal abattoirs and at household level.

The study shows that 25% know that cysticercosis is a zoonotic disease, but cannot identify the signs in sick people. Those (25%) that could recognise meat infected with cysticercosis, mentioned the muscles, tongue and heart as the sites where they had seen the cysts.

Through informal discussions, it was noted that they were aware about worms in human faeces but had not made a link to the presence of cysts in the meat.

4.7.3 Transmission and control measures

If farmers were aware of the consequences thereof, they would probably always enforce the implementation of the rules governing food safety during home slaughter and at informal slaughter-houses/butcheries. The study revealed that 74% and 71% of the respondents in the study area were not conversant with the control measures against cysticercosis. Training workshops or farmers' day visits would be required to remedy the farmer's lack of knowledge on cysticercosis. It

will be necessary to break the cycle of ignorance linked to infection of humans and animals. All of the respondents (100%) have indicated their interest in acquiring more information on the subject.

Control of this parasite is by the treatment of human tapeworm carriers and hygienic and effective faeces disposal is well described (Schneider, 1994). This is well known among veterinary staff in Namibia. Animal and human health is a major concern of the DVS throughout Namibia and they play an important role in risk communication, through veterinary extension and communication, of the potential and existing hazards of zoonotic diseases (NOLIDEP, 2000).

4.8 Veterinary Extension and Risk Communication

4.8.1 Sources of information on cysticercosis

There are substantial a *priori* reasons to believe that the availability of timely and accurate information could play a key role in decreasing the incidence of *C.bovis* in the study area. It was found that 99% of the respondents interviewed during the study wanted more information on cysticercosis. Related to information, some respondents seem to have misconceptions about the spread and control of cysticercosis. Some respondents felt that Regional Veterinary Services are responsible for the vaccination and general health of livestock. While the study has shown that MeatCo generally informs producers about the incidence of cysticercosis in their cattle, it is clear that the success of these efforts differs from farmer to farmer. There is also little evidence that this information is targeted at those groups of livestock owners who are more likely to sell animals to other cattle markets.

The study has identified the various stakeholders or sources that could play a role in dissemination of information about cysticercosis as:

- MeatCo Oshakati Abattoir

- State Veterinarians and Animal Health Technicians (AHTs)
- Extension materials and workshops
- Community Based Organisations and farmer associations
- Local authorities and Regional governments

The most important components in the prevention of cysticercosis are: education about sanitation, the widespread use of latrines and proper fencing of grazing areas. However, grazing land in rural areas is regarded as communal land that does not belong to the inhabitants but to the state. It is necessary to educate the communities about the spread and control measures of cysticercosis. All available means of health education must be used by veterinary, extension and environmental health officers at the Ministry of Health, at the level of Local Authorities and medical staff, especially in the communities and at primary health-care facilities. Control of infection by treatment of tapeworm carriers on the farms and personal hygiene, including the use of latrines, are likely to reduce the transmission.

It this respect it is important to look at the information needs for the various participants in the market. There are a number of avenues, such as radio and leaflets that could be better used to ensure that livestock owners are aware of preventive and control measures against cysticercosis. About 93% of the respondents have indicated access to communication tools such as television, radio, newspaper and newsletter. Due consideration should also be given to the role that community based organisations and Local / Regional authorities can play in information dissemination, and not only extension generated and distributed by agricultural service agents.

4.8.2 Veterinary Services

In Namibia, the DVS falls under the Department of Agriculture in the Ministry of Agriculture, Water and Forestry (MAWF), and functions in terms of the Animal Disease and Parasites Act, 1956 and the regulations promulgated in terms of the Act published on 4th October 1953 (Rawlinson, 1994). The directorate therefore promotes a healthy and productive national herd with the goal of uplifting the living standards of all the inhabitants of Namibia. The personnel are responsible for disease surveillance, monitoring stock numbers and stock movements. Each AHT works within a specific area, and inspects animals on a regular basis. They are all trained to recognise the major scheduled diseases and control compulsory vaccination of animals in their areas.

Table 4.11: Veterinary Services visits to communities / farmers as rated by respondents

Frequency	Percentage (%)
Weekly	4
Monthly	2
Quarterly	11
Yearly	21
Not at all	60
Only on request	2
Total	**100**

According to the veterinary personnel interviewed, AHTs are expected to undertake four visits per community over one calendar year, but due to mileage state limitations and budgetary constraints this does not happen in most cases (Table 4.11). This is probably linked to the poor performance of the AHTs in their communities. Table 4.11 indicates the opinion of the farmers about the frequency of visits made to the communities by veterinary staff.

Efforts to improve the situation have been focussed towards farmer empowerment initiatives which should be encouraged. Recently, about 500

animal health kits were distributed to Community Health Animal Workers (CAHW) in North Central Namibia through the Productivity Upliftment Micro-Projects programme (Kuvare and Mbai, 2006). Respondents (n=57) have reported that CAHW are inactive and in some areas their existent is unknown (Table 4.11).

4.9 Developing appropriate materials for Namibia

After the questionnaires were statistically evaluated, a participatory strategy was followed to assess the way forward. Due to the lack of knowledge of the farmers about cysticercosis, it was decided to develop extension materials on the control of cysticercosis. It was found that 99% of farmers were in favour of learning how to control and prevent the spread of cysticercosis.

All veterinary personnel interviewed (n=10) indicated that no extension materials are available. However, it was found that the "Basic Veterinary Manual for Communal Livestock Farmers of Namibia" contains extension information on *C.bovis*. Although primarily developed "*as a supplement to the wide knowledge a communal farmer has on animal health aspects in the absence of a veterinarian or an AHT*", the major drawback is that the manual is developed in English, a language hardly read by communal farmers. In addition it is very comprehensive and technical with few understandable messages for prevention and control by rural farmers.

Possible extension pictures and information, obtained from the Onderstepoort Veterinary Institute , Onderstepoort, Gauteng, RSA (Appendix B) were shown to state veterinarians to rate their appropriateness and adoption for use in North Central Namibia. Extension materials are described in Table 4.12 below. Evaluation was done by the veterinary staff of the Veterinary Public Health Division of the DVS at the MAWF.

Table 4.12: Description of extension material used (copies included in Appendix B)

Code	Description
A	The life cycle of the beef tapeworm
B	Measles in muscle of cattle
C	Measles in heart muscle of cattle
D	Only buy meat that has undergone meat inspection
E	Families must be treated for tapeworms
F	Never buy meat from informal butchers
G	Keep your animals in fenced pastures
H	Cook meat well/provide proper ventilated toilets

Results show that samples D and E were ranked as best suited to Namibia or most preferred and useful, rated as the best with a score of 44 and 64 respectively (Fig 4.9).

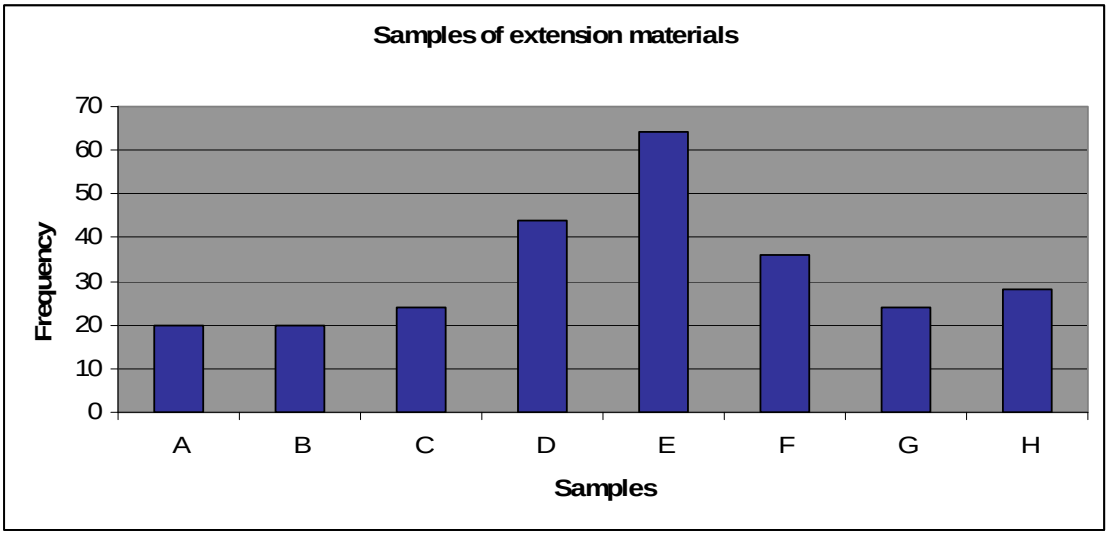


Fig 4.9: Ratings of samples by veterinary personnel (n=10) under DVS at MAWF

It was also suggested by the experts (n=10) and based on the findings about literacy of the respondents, that the material to be developed should be available in Oshiwambo, Otjiherero and English for use in North Central Namibia.

CHAPTER 5

CONCLUSIONS AND RECOMMENDATIONS

5.1 Summary of conclusions

It was concluded from slaughter record of MeatCo, Oshakati Abattoir in 2004 and 2005 that the incidence of *C.bovis* in carcasses from Oshikoto Region in the study area was unacceptably high in comparison with those received from commercial farmers in Outjo, Grootfontein and Tsumkwe.

Structured interviews with cattle owners (n=95) from North Central Namibia where the cattle originated showed that there was a very low comprehension of *C.bovis* as a zoonotic disease and a very low level of sanitation. The farming systems in the Region were also characterised by close contact between humans (both family members and herdsmen) and cattle. The majority of the farmers were male and had a low level of literacy, the language spoken was Oshiwambo.

Existing extension materials and constraints to risk communication by veterinary and agricultural staff were examined. It was found that *C.bovis* was not prioritised and that a majority of time was spent on vaccination and control of notifiable animal diseases such as Contagious Bovine Pleuropneumonia, Anthrax and Foot and Mouth Disease. Budgetary restrictions on transport compromised routine extension visits on prevention or control of other diseases.

5.1.1 Incidence of cysticercosis

The study has shown that there is a high incidence of *C.bovis* in cattle originating from communal farming communities in the study area. The highest (12%) and lowest (5%) rate of cysticercosis infestation in the study area was found in cattle from Oshikoto and Ohangwena Regions respectively over the 2005 season (Fig

4.1). Even though cattle originating from Oshikoto Region had the highest level of carcasses positive for cysticercosis, no carcasses were condemned (Fig 4.2).

Poverty resulting in an inability to secure dependable sanitary facilities is probably largely responsible for the favourable conditions created for cysticercosis and taeniasis transmission within these communities. It was shown in Table 4.2 that there was a link between lack of sanitation and high levels of *C.bovis* in cattle from the same district.

When bovine carcasses are rejected at the abattoir there is a financial loss to the farmers. Meat products from the communities where the cattle have a high likelihood of being infested with *C.bovis*, will not have access to the more lucrative markets with more stringent requirements.

5.1.2 Cattle Production

The grazing systems in North Central Namibia differ from those in Kunene North. Owners of small herds keep their animal near to the homesteads throughout the year, while large owners practice a rudimentary form of transhumance. Some large owners also use *ekoves* (the local name for a fenced grazing reserve) around the homesteads or at cattle posts. Sales (business) and cultural traditions were identified by respondents as the main reasons for keeping cattle (Fig 4.5). It is concluded that these farming systems, where cattle are herded close to people's homes and at cattle posts where the herders sleep very near to the cattle for security reasons, probably increase the risk of cattle consuming soil or herbage containing ova of *T.saginata* originating from human carriers.

5.1.3 Cattle Marketing

The informal marketing chains in North Central Namibia seem to be well adapted to its environment, and serve as a safety net for many poor farmers whose

margins of survival are thin. Cattle are bought from a variety of places, with speculators going from around from village to village, enquiring about what is available, and negotiating prices. Cattle are slaughtered at home or informal butcheries. These informal chains are not subjected to meat inspection.

Customers also prefer to buy meat at informal markets rather than inspected meat from MeatCo, because the meat is cheaper. Some consumers are aware of the health risks when buying meat from the informal markets. Because Meatco either condemns or treats lightly infected carcasses, the life cycle of cysticercosis is broken.

All the above findings indicate that there is a high risk to the uninformed consumer from un-inspected, untreated *C.bovis* positive beef. The cycle is perpetuated through their ignorance.

5.1.4 Meat inspection

In communal areas, in particular small abattoirs, meat inspectors often lack the necessary information and guidelines to assess the sanitary status of carcasses, meat and organs from slaughter animals (Table 4.6). It is evident, most cysticercosis-infected carcasses are passed untreated for human consumption and that the population is at risk when eating undercooked meat. Control of the infection by treatment of tapeworm carriers on the farms, as well as personal hygiene, will be most effective.

5.1.5 Farmers knowledge on cysticercosis

It was noted that the knowledge of farmers about cysticercosis was very low (Table 4.10). They did not recognise the term. Informal interviews showed that although farmers were aware of worms in humans, they did not seem to be able to differentiate between tapeworms or any other kind of worms. They could

identify cysticercosis in cattle but did not associate this with any diseases of either humans or cattle.

There was a feeling of anger about carcasses being condemned, as they did not understand why this was happening, even although MeatCo confirmed that pamphlets on cysticercosis were being supplied to farmers. However the pamphlets were in English and mostly words in rather than pictures, so it is unlikely that they would be understood.

From the farmer's side there was a great willingness to learn and it is suggested that veterinary extension on cysticercosis in the Regions most affected would have a significant impact in preventing the disease. The farmers need to be educated.

5.1.6 Veterinary services and communication

The main short-coming of extension services is that it is difficult to reach the majority of communal farmers, especially the poorer farmers who are predominantly women (Table 4.11).

Difficult access to information is a factor that affects the remote farm-based households. They have no contact with extension centers and have no radios: or other forms of educational media.

This lack of information will negatively affect the livelihoods of the rural people. Similarly, the lack of information on marketing products and technologies will impact negatively on productive activity and diversification.

It is therefore equally important for the key stakeholders to continue to play their role in information dissemination and awareness creation on cysticercosis.

5.2 Recommendations

The ways to control *C.bovis* have been known for centuries and are even described in texts from Ancient Egypt (Bruschi *et al*., 2006). Control measures are preventing human defecation on pasture where cattle graze, treatment of affected humans and condemnation of cattle carcasses that are heavily infested. It was confirmed that these control measures were not in place in the areas most affected.

The study was not undertaken to investigate the epidemiology or control of *C.bovis*, but to investigate why, despite this knowledge, the incidence of positive carcasses is rising in Namibia, which is a country with a good veterinary and public health infrastructure. In essence – what are the constraints preventing control and how can they be addressed.

While the Veterinary Services are dealing with most of the endemic contagious diseases through vaccination campaigns, there is a gap regarding prevention and treatment of the diseases which are not of national importance. With regard to a disease such as cysticercosis, which has both human health and economic consequences, it is felt that it would be better to actually target areas where there is a problem and improve the situation in that area. Oshikoto Region is such an area and a concentrated campaign to inform both the farmers and the community would probably result in significant economic gains for the farmers.

Coordination efforts between Veterinary and Extension Services could play an important role in North Central Namibia livestock development, encouraging best practices in animal husbandry and range management. In theory, livestock extension messages could also be supplied by agricultural extension officers and technicians, where veterinary technicians are absent. In practice we found little evidence of this, as the agricultural extension service is concentrated on crop production and little on livestock issues. However, there appears to be no sound

knowledge of animal husbandry and only a few farmers are aware of the possible ways to deal with heath problems challenging their herd and very little about cysticercosis prevention and control. Given that local authorities are tasked to manage town hygiene, there is a dire need for the respective Town Councils to coordinate their meat inspection and hygiene services with the Regional State Veterinarian.

Finally, extension material can be produced, based on the findings of this study, which is directly targeted at the age group of people and the area most affected. It is suggested that funding be made available, to produce the training material in both English and Oshiwambo. This can be used for an extension campaign to assist in the control of *C.bovis*.

It is therefore recommended:

- That a specific effort be made to inform stakeholders within the industry and the state of the rising trend in the incidence of *C.bovis*, so that it can be put on the agenda and addressed.
- To motivate for more communication between veterinary and agricultural staff so that efforts can be combined and coordinated to present an extension campaign to control this disease.
- That the public health department of the Ministry of Health be informed so that they can also participate in risk communication on *C.bovis*.
- That MeatCo staff be made aware of the lack of understanding of *C.bovis* by the majority of the farmers, especially rural farmers as well as the need to condemn highly infested carcasses. Both the farmers and speculators need to be targeted. Their level of education, language, gender, culture, interests and socio-economic level must be taken into consideration.
- That funding should be found for the printing of extension material in the vernacular language, based on the findings of this study, for use by extension staff and also MeatCo.

CHAPTER 6

REFERENCES

1. Africa Institutional Management Services (AIMS) 2002 *Training of Farmers in Livestock Management and Marketing*. Manual for a Workshop held November/ December 2002 at Ogongo Agricultural College, Namibia

2. Bembridge T J 1991 *The practice of Agricultural Extension. A Training manual*. Klem-Lloyd Lithographers (Pty) Ltd. South Africa

3. Bruschi F, Masetti M, Locci M T, Ciranni R and Fornaciari G 2006 Cysticercosis in an Egyptian Mummy of the late Ptolemaic period. *American Journal of Tropical Medicine and Hygiene,* 74: 598 – 599

4. Cameron A R 1999 *Survey Toolbox – A Practical Manual and Software Package for Active Surveillance of Livestock Diseases in Developing* Countries. ACAIR Monograph. Australian Centre for International Agricultural Research. Australia

5. Carlos E, Armando N and William A 2003 ***Taenia solium*** *cysticercosis/taeniosis: potential linkage with FAO activities; FAO support possibilities*, Animal Production and Health Division, Animal Health Service FAO, Rome, Italy

6. Center for Disease Control and Prevention 2005 URL: http://www.dpd.cdc.gov/dpdx (Accessed: 2005/05/05)

7. Conklin Jr A R 2004 *Field Sampling Principles and Practices in Environment Analysis*. Marcel Dekker, USA

8. Cripps P J 2000 Veterinary education, zoonoses and public health: a personnel perspective. *Acta Tropica,* 76(1): 77-80

9. Dargatz D A and Hill G W 1996 Analysis of survey data. *Preventive Veterinary Medicine,* 28(4): 225-237

10. Department of Fisheries and Water (DFW) 1990 Preliminary Feasibility Study of Irrigation in Owambo. *Report Number 15/4/1-CD1. Government of the Republic of Namibia, Windhoek*

11. Dlamini S M 1994 A Report on 3rd SAAAFSR-E Conference. *Government of the Republic of Namibia, Windhoek*

12. Dorny P, Phiri I, Gabriel S, Speybroeck N, and Vercruysse J 2002 A sero-epidemiological study of bovine cysticercosis in Zambia. *Veterinary Parasitology,* 104 (3): 211-215

13. Dorny P, Vercammen F, Brandt J, Vasteenkiste W, Berkvens D and Geerts S 2000 Sero-epidemiological study of *Taenia saginata* cysticercosis in Belgian cattle. *Veterinary Parasitology*, 88 (1-2): 43 – 49

14. Du Preez J 1997 Zoonoses 3 – Man and Pork and beef measles. *Farmers Weekly:* March 7, 1997:16-19

15. Flisser A, Gauci C G, Zoli A, Martinez-Ocana J, Garza-Rodriquez A, Dominquez-Alpaizar J L, *et al*; 2004a Induction of Protection against Porcine cysticercosis by vaccination with Recombinant Oncosphere Antigens. *American Society of Microbiology*, 72 (9): 5292 – 5297

16. Flisser A, Viniegra A, Aquilar-Vega L, Garza-Rodriquez A, Maravilla P and Avilla G 2004b Portrait of Human Tapeworms. American Society of Parasitologists. *Journal of .Parasitology*., 90(4): 914-916

17. Food and Agriculture Organization (FAO) 2005 *Risk management and food safety - FAO Food and Nutrition Paper 65*. URL: http://www.fao.org/ (Accessed 2005/06/29)

18. Food and Agriculture Organization (FAO) and World Health Organization (WHO) 2002 *The HACCP-Based Inspection Models Project (A New Public Health in the United States Slaughter Industry).* FAO/WHO Global Forum of Food Safety Regulators held on 28-30 January 2002, in Marrakech, Morocco

19. Franco-Namibian Rural Development Project (FNRDP) 1993 *Analysis of farming systems in the Regions of Omusati, Oshana, Ohangwena and Oshikoto*. Ministry of Agriculture, Water and Rural development, July 1993

20. Gamble H R and Murrell K D 1999 Detection of parasites in food. *Journal of Parasitology*, 117: 97-111

21. Giesecke W H 1997 Incidence and economic implications of taeniasis/cysticercosis in South Africa. *Proceedings of a Workshop held at the Onderstepoort Veterinary Institute, Onderstepoort, South Africa*, August 18-19 1997, pp 19-70

22. Goby L 1997 *Animal Healthcare Community Agents – Lessons from the tests in North Central Namibia*. Northern Namibia Rural Development Project – Ongwediva, Namibia

23. Harrison L J S 2005 Epidemiology and control of *Taenia saginata* cysticercosis. URL: http://www.vet.edu.ac.uk/ctvm/

24. Hendrikx P 2000 *Support Mission on Epidemiological Surveillance of priority animal diseases*. Mission Report, April 4-13, 2000. North Central Regions-Namibia

25. Herenda D, Chambers P G, Ettriqui A, Seneviratna P and da Silva T J P 1994 *Manual on meat inspection for developing countries*. FAO Animal Production and Health Paper 119, Rome, Italy

26. Hunter A 1994 *The Tropical Agriculturalist*. Animal Health Volume 2. The Macmillan Press Limited, London and Basingstoke, UK

27. Kuvare U S K and Mbai S 2006 *External Evaluation of Draught Animal Power and Acceleration (DAPAP) and Productivity Upliftment Micro-Projects (PUMP)*. Final Report, June 2006, Windhoek, Namibia

28. Matt A 1989 Cestode. URL:http://www.members.aol.com/fedprac/cestode/ (Accessed 2005/03/07)

29. MacDiarmid S C and Pharo H J 2003 Risk analysis: assessment, management and communication. *Office International des Epizooties (OIE), Science and Technical Review,* 22 (2): 397 – 408

30. Makgatho C N, McCrindle C M E and Owen J H 2005. Participatory rural appraisal to investigate constraints in reporting cattle mortalities in the Odi district of North West Province, South Africa. *Journal of the South African Veterinary Association*, 76 (4): 209-213

31. Maree C and Casey N H (Eds) 1993 *Livestock Production Systems – Principles and Practice*. Agri-Development Foundation, P.O.Box 11309, Brooklyn, Gauteng, South Africa: 69-88

32. McCrindle C M E 2005 Personal communication

33. Meat Safety Act, 2000 (Act No. 40 of 2000) of South Africa. Red Meat Regulation, 1072: 1-53

34. Mendelson J, Obeid S and Roberts C *2000* *A profile of North-Central Namibia*. Gamsberg Macmillan Publishers, Windhoek, Namibia

35. Michael L 1997 *Cestoda*. Onderstepoort Veterinary Institute. ARC, Pretoria, South Africa

36. Ministry of Agriculture, Water and Rural Development 1995 *The National Agricultural Policy of Namibia***.** Ministry of Agriculture, Water and Rural Development, Windhoek, October 1995

37. Ministry of Agriculture, Water and Rural Development 2002 Progress on the World Food Summit Commitment. Country report presented at the World food Summit – 5 years later, Rome June 2002. Published by the Government of the Republic of Namibia

38. National Agricultural Support Services Programme (NASSP) 2003 *Livestock Strategy Review.* Report No. 3/2003. Ministry of Agriculture, Water and Rural Development. May 2003. Windhoek, Namibia

39. National FSRE Support Unit (NFSRESU) 2004 *An assessment of the use of the Farming Systems Research and Extension Approach (FSRE) in the Ministry of Agriculture, Water and Rural Development*. Report (July 2004) of the Ministry of Agriculture, Water and Rural Development and FSRE, Namibia

40. National Planning Commission (NPC) 2003 2001 *Population and Housing Census*. National Report July 2003. Basic Analysis with Highlights. Central Bureau of Statistics, Namibia

41. National Planning Commission (NPC) 2004 *Ohangwena Regional Poverty Profile, Full Report*. Based on Village-level Participatory Assessments in Ohangwena Region, Namibia in October/November 2003. Windhoek, Namibia

42. National Planning Commission (NPC) 2004 Vision 2030. Policy Framework for Long-term National Development Main Document. Namprint, Windhoek, Namibia

43. National Planning Commission (NPC) 2006 *Namibia Household Income and Expenditure Survey 2003/2004*, Preliminary Report. March 2006. Windhoek, Namibia

44. Nginyi J M, Wamae L W, Harrison L J S, Onyango-Abuje J A, Letitiya W, Gatong P, Lumumba P, Omondi G and Odera G 2002 *Pilot evaluation of an integrated control of Taenia saginata infection in human and cattle in Samburu District, Kenya*. Joint TSAP/TVA Conference Proceedings. Kenya, 282 – 289

45. Northern Regions Livestock Development Project (NOLIDEP) 2000 *Livestock Marketing in Northern Communal areas of Namibia*, Full Report. Windhoek, Namibia

46. Onyango-Abuje J A, Nginyi J M, Rugutt M K, Wright S H, Lumumba P, Hughes G, Harrison L J S 1996 Sero-epidemiological survey of *Taenia saginata* cysticercosis in Kenya. *Veterinary Parasitology* 64: 177 – 185

47. Pawlowski Z S 2002 Basic Biology and Transmission. In Singh G and Prabhakar S (eds) *Taenia solium Cysticercosis, from Basic to Clinical Science*. CABI Publishing, USA

48. Rawlinson J 1994 *The meat industry in Namibia*, 1835-1994. Gamsberg Macmillan, Windhoek, Namibia

49. Schmidt-Dumont A M A 1994 *Strategies used in veterinary extension*. Extension Strategies in Namibia Proceedings of the 1994 National Extension Conference, Ministry of Agriculture, water and Rural Development, Directorate of Engineering services, July 1994, pp 47 – 49

50. Schneider H P 1994 *Animal Health and Veterinary Medicine in Namibia*. Agrivet. Windhoek, Namibia

51. Shah-Fisher M and Ralph S R 1989 *Manual of Tropical Veterinary Parasitology*. Cambrian Printers. Aberrystwyth, UK

52. Simpson B H and Wright D F 1988 *The use of Questionnaires to Assess the Importance of Clinical Diseases in Sheep*. Ministry of Agriculture and Fisheries, Private Bag, Palmerston North, New Zealand: 97-105

53. Stanford University 2005 *Taenia saginata* – beef tapeworm. URL: http://www.stanford.edu/class/ (Accessed 2005/02/07)

54. Strydom P J and Museler D L 1999 *The performance of the Namibian beef Industry*. AGRICOLA, Namibia

55. Thrusfield M 2005 *Veterinary Epidemiology*. 3rd ed. Blackwell Science Limited. Oxford, London

56. Tsumis Agricultural College 2005 *A map of Namibia showing the location of North Central Namibia*. URL: http://www.tsumis.com/ (Assessed 2005/02/05)

57. Undi M 2003 *Training Communal Farmers in Namibia: The Role of the University in Rural Development*. University of Namibia, Faculty of Agriculture and Natural Resources, Department of Animal Science. Windhoek, Namibia

58. Urguhart G M, Armour J, Duncan A M and Jennings F M 1989 *Veterinary Parasitology*. Longman Group UK Limited, UK

59. Virtual Center 2005 Training, Extension and Awareness Creation http://www.lead.virtualcenter.org/ (Accessed 2005/02/25)

60. Waltner-Toews D 2004 Veterinary Public Health. URL: http://www.nesh.ca/ (Accessed 2004/11/04)

61. Wanzala W, Onyango-Abuje J A, Kang'ethe E K, Ochanda H and Harrison L J S 2002 Sero-diagnosis of bovine cysticercosis by detecting live Taenia saginata cysts using monoclonal antibody-based antigen – ELISA. *Journal of the South African Veterinary Association*, 73 (4): 201 – 206

62. Wanzala W, Onyango-Abuje J A, Kang'ethe E K, Zessin K H, Kyule N M, Baumann M P O, Ochanda H and Harrison L J S 2003 Analysis of post-mortem diagnosis of bovine cysticercosis in Kenyan cattle. *Online Journal of Veterinary Research*, 7: 1–9

63. Wanzala W, Onyango-Abuje J A, Kang'ethe E K, Zessin K H, Kyule N M, Baumann M P O, Ochanda H and Harrison L J S 2003 Control of Taenia saginata by post-mortem examination of carcasses. *African Health Sciences,* 3(2): 68-76

64. Wanzala W, Onyango-Abuje J A, Kang'ethe E K, Zessin K H, Kyule N M, Ochanda H and Harrison L J S 2005 Distribution of *Taenia saginata* cysts in carcasses and implications for meat inspection. *Online Journal of Veterinary Research*, 9(1): 66-73

65. Witenberg G G 1964 *Cestodiases*. - *In Zoonoses*. Van den Hoeden (Ed). Elsevier Publishing Company. Amsterdam, London, New York. USA :649-707

APPENDIX A: QUESTIONNAIRE FOR FARMERS

Number	

A: BASIC INFORMATION

Name of quarantine camp

Okongo farm	1
Mangeti	2
Oshivelo	3
Omutambomawe	4

V_1 [ ][ ][ ] 1-3

V_2 [ ] 4

Gender

Male	1	Female	2

V_3 [ ][ ] 5-6

Age……Years

V_4 [ ] 7

What language (s) do you speak? (Home language)

Oshiwambo	1
ruKavango	2
English	3
Afrikaans	4
Other	5

Number of persons in household

Person	No		
Adult Male (>18)		V_5	[ ][ ] 8-9
Adult Female (>18)		V_6	[ ][ ] 10-11
Boys		V_7	[ ][ ] 12-13
Girls		V_8	[ ][ ] 14-15
Babies (<2)		V_9	[ ][ ] 16-17

Highest educational level of respondent

1	2	3	4	5	
None	Primary School	Grade 10	Grade 12	Tertiary	V_{10} [ ] 18

Primary employment of respondent

1	2	3	4	5	6	
None	Farming	Own business	Mining / Fishing	Private/ State	Pension	V_{11} [ ] 19

Electricity

1	2	
Yes	No	V_{12} [ ] 20

Waterborne toilet

1	2	
Yes	No	V_{13} [ ] 21

Pit toilet

1	2	
Yes	No	V_{14} [ ] 22

Water

1	2	3	
Reticu-lated	Bore-hole	Surface	V_{15} [ ] 23

B: QUESTIONS

Data on cattle production

1. Main type of cattle farming

Beef	1
Dairy	2
Dual	3

V_{16} [ ] 24

2. Where do you keep your cattle?

1	2	3
Home	Cattle post	Both

V_{17} [ ][ ][ ] 25-27

3. How many animals do you have?.....

V_{18} [ ][ ] 28-29

4. Number of years involved in farming……

V_{19} [ ][ ] 30-31

5. Who looks after your animals?

1	2	3	4	5
Owner	Children	Wife	Family members	Labourers

V_{20} [ ] 32

6. Reasons for keeping cattle?

1	2	3	4
Business	Tradition	Home consumption	Wealth

V_{21} [ ] 33

7. Are they free-ranging / kept extensively?

1	2
Yes	No

V_{22} [ ] 34

8. What do they feed on?

1	2	3
Commercial feed	Pasture	Both

V_{23} [ ] 35

Data on Cattle marketing & use

9. Do you buy cattle

1	2
Yes	No

V_{24} [ ] 36

10. From whom/where do you buy cattle?

Commercial cattle farmer	1
Communal cattle farmer	2
Auction	3
Other cattle market	4
Neighbours	5

V_{25} [ ] 37
V_{26} [ ] 38
V_{27} [ ] 39

11. How many cattle did you in during 2004/2005 year?.....

V_{28} [ ][ ][ ] 40-42

12. Where do you sell your cattle?

Locally	1	V_{29}		43
Auction sale	2	V_{30}		44
Abattoir	3	V_{31}		45
Friends / Neighbour	4	V_{32}		46
Speculators	5	V_{33}		47

13. How many cattle were sold during 2004/2005?

Number		V_{34}		48-49
Average price per head in N$		V_{35}		50-53

14. Do you think the price is fair?

1	2			
Yes	No	V_{36}		54

15. If not, what do you think is the fair price…….. V_{37} 55-58

16. a) Why do you keep animals

Sale	V_{38}		59
Culture	V_{39}		60
Consumption	V_{40}		61
Bartering	V_{41}		62
Other			

b) If other, please specify……

17. How many used for home consumption?…… V_{42} 63

Data on meat inspection

18. Where do you slaughter cattle?

Home	1	V_{43}		64
Informal market	2	V_{44}		65
Abattoir	3	V_{45}		66
Butchery	4	V_{46}		67
Other, please specify……				

19. Any meat inspection carried out?

1	2			
Yes	No	V_{47}		68

20. If no, for what reason

No access to meat inspection	1	V_{48}		69
Too far from the abattoir	2	V_{49}		70
Abattoir condemns cattle	3	V_{50}		71
Lack of knowledge	4			
Not important	5			
Other, please specify……				

21. Do you know why meat inspection should be carried out?

1	2			
Yes	No	V_{51}		72

22. If yes, how informed / get to know

State veterinary services	1	V_{52}		73
Extension services	2	V_{53}		74
MEATCO	3	V_{54}		75
Farmers organization	4			
Other, please specify…….				

Data on measles knowledge

23. Do you know what the word measles means?	1 Yes	2 No	V_{55}		76
Please describe in your own words					

24. Do you know how it is spread?	1 Yes	2 No	V_{56}		77
Please describe in your own words					

25. Can it infect people?	1 Yes	2 No	V_{57}		78
If yes, please describe in your own words					

26. How would you know a person is infected?

Please describe in your own words	V_{58}		79

27. How would you know that beef (cattle meat) is infected?

Please describe in your own words	V_{59}		80

28. Have you ever seen small cysts in the meat that look like white stones?	1 Yes	2 No	V_{60}		81

29. If you have seen them, in what parts of the animal?

Tongue	1	V_{61}		82
Muscles (meat)	2	V_{62}		83
Heart	3	V_{63}		84
Liver	4			
Other (please specify)	5			

30. Do you know how it can be prevented or controlled?	1 Yes	2 No
Please describe in your own words		

V_{64} [ ] 85

31. Have you any other questions or comments on measles?	1 Yes	2 No
Please describe in your own words		

V_{65} [ ] 86

Data on how farmer heard about measles

32. Have you heard about it previously?	1 Yes	2 No

V_{66} [ ] 87

33. If yes, from whom / where?

Animal Health Technician / Extension	1
Abattoir	2
Workshops / Training	3
Books / Extension materials	4
Friends / Neighbours	5
Farmers organization / Community based org	6
Other, please specify…….	

V_{67} [ ] 88
V_{68} [ ] 89
V_{69} [ ] 90

34. Have you ever attended any workshop on measles in the past five years?	1 Yes	2 No

V_{70} [ ] 91

35. If yes, by whom facilitated/sponsored

MEATCO	1
Meat Board of Namibia	2
State Veterinary services	3
Extension services / other public agency	4
Farmers Association / CBO	5
NGO	6

V_{71} [ ] 92
V_{72} [ ] 93
V_{73} [ ] 94

Data on communication

36. Do you require information on measles and meat inspection?

1	2
Yes	No

V_{74} ____ 95

37. Can you read and write?

1	2
Yes	No

V_{75} ____ 96

38. If yes, what language are you most competent?

ruKavango	1
Oshiwambo	2
Afrikaans	3
English	4
Other	5

V_{76} ____ 97

39. Do you have access to communication tools?

1	2
Yes	No

V_{77} ____ 98

40. If yes, which one

TV	1
Radio	2
Newspaper	3
Vet Newsletter	4

V_{78} ____ 99
V_{79} ____ 100

41. How often do AHT visits you / your community?

Weekly	1
Monthly	2
Quarterly	3
Yearly	4
Not at all	5

V_{80} ____ 101

42. If services are insufficient, how often do you recommend?

Weekly	1
Monthly	2
Quarterly	3
Yearly	4
More often than the above	5

V_{81} ____ 102

43. Do you have community based animal health workers?

1	2
Yes	No

V_{82} ____ 103

44. If yes, how do you rate their services?

Excellent	1
Good	2
Satisfactory	3
Very poor	4
Don't know	5

V_{83} ____ 104

APPENDIX B

QUESTIONNAIRE FOR STATE VETS & CAHT

Number

Data on extension materials

1. Have Namibia developed its own extension materials on cysticercosis?

1	2	3
Yes	No	Don't know

V_1 ☐ 1

2. If yes, in which languages?

English	1
Afrikaans	2
Oshiwambo	3
ruKavango	4
Other (please specify)…….	5

V_2 ☐ 2
V_3 ☐ 3
V_4 ☐ 4

3. If no, are you using ext materials from RSA or other countries?

1	2	2
Yes	No	Don't know

V_5 ☐ 5

4. If not, please elaborate

V_6 ☐ 6

Data on communication

5. Does the AHT visit the communities, except during the vaccination campaigns?

1	2
Yes	No

V_7 ☐ 7

6. If yes, how often?

Weekly	1
Monthly	2
Quarterly	3
Yearly	4

V_8 ☐ 8

7. If not, what are the constraints? Please elaborate

V_9 ☐ 9

8. Do you have community based animal health workers (CBAHW)?

1	2
Yes	No

V_{10} ☐ 10

9. If yes, 9.1 What are their duties? 9.2 Which areas have they covered? 9.3 Number of CBAHW?	V_9		9

10. How often do they visit the communities?

Weekly	1	V_{10}	10
Monthly	2		
Quarterly	3		
Yearly	4		
Other……..	5		

Data on developing appropriate extension materials

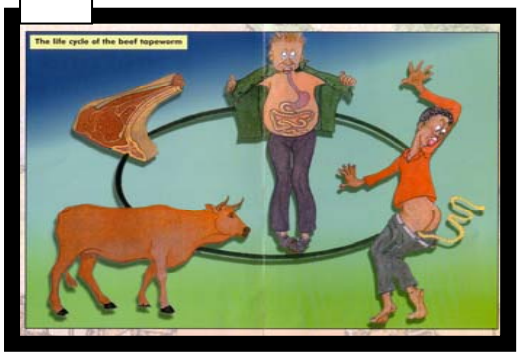
11. The templates on page 3 are extracts from the extension materials of RSA. Please refer to them and rate them accordingly. These will assist in designing appropriate extension materials.

	1 Very Poor	2 Poor	3 Satisfactory	4 Good	5 Excellent			
A	1	2	3	4	5	V_{11}		11
B	1	2	3	4	5	V_{12}		12
C	1	2	3	4	5	V_{13}		13
D	1	2	3	4	5	V_{14}		14
E	1	2	3	4	5	V_{15}		15
F	1	2	4	4	5	V_{16}		16
G	1	2	4	4	5	V_{17}		17
H	1	2	3	4	5	V_{18}		18

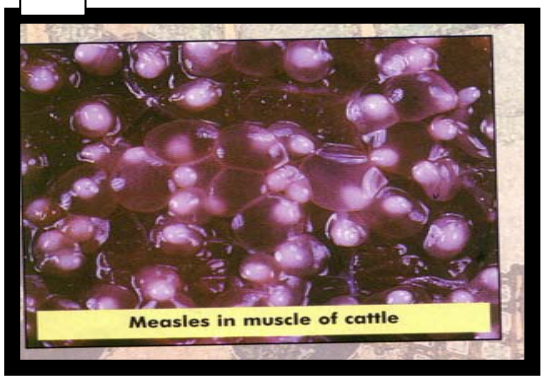
12. In your own opinion, what do you think is the correct format (e.g. posters, pamphlets, etc) for displaying extension materials? Please specify……..	V_{19}		19

Thank you.

A


The life cycle of the beef tapeworm

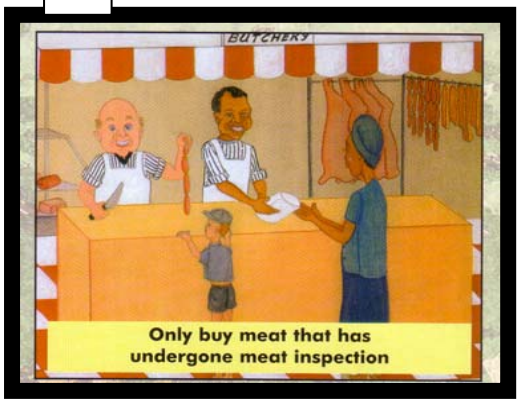
B


Measles in muscle of cattle

C


Measles in heart muscle of cattle

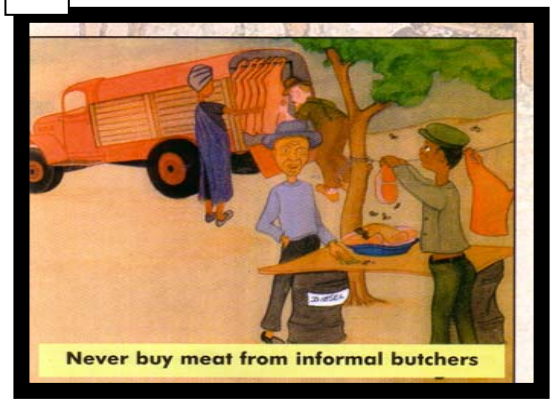
D


BUTCHERY
Only buy meat that has undergone meat inspection

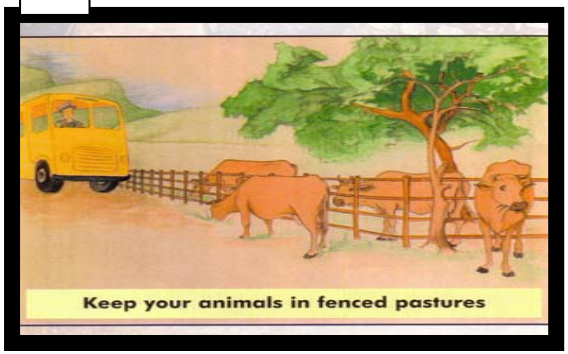
E


CLINIC
Families must be treated for tapeworms

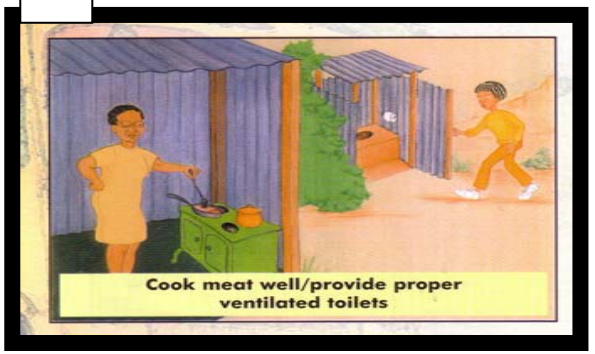
F


Never buy meat from informal butchers

G


Keep your animals in fenced pastures

H


Cook meat well/provide proper ventilated toilets

APPENDIX C: DETAILED RECORDED INCIDENCES

Table: Incidence of cysticercosis in cattle from Ohangwena Region (2005)

Month	Cattle slaughtered	Cattle infected	Prevalence of infection	Condemned carcasses
January[1]				
February[1]				
March[1]				
April	4	0	0	0
May	1	0	0	0
June	3	0	0	0
July	63	4	6.4%	0
Aug	48	3	6.3%	0
September	11	0	0	0
October[1]				
November[1]				
December[1]				
Total	**130**	**7**	**5.4%**	**0**

Source: Meatco Oshakati Abattoir records 10 January 2006

[1]Abattoir closed, slaughtering did not take place (J Nel, Oshakati Abattoir, pers. comm, 2005)

Table: Incidence of cysticercosis in cattle from Omusati Region (2005)

Month	Cattle slaughtered	Cattle infected	Prevalence of infection	Condemned carcasses
January[1]				
February[1]				
March[1]				
April	111	11	9.9%	0
May	158	5	3.2%	0
June	312	21	6.7%	0
July	351	22	6.3%	1
Aug	134	8	6.0%	2
September	112	11	8.8%	1
October[1]				
November[1]				
December[1]				
Total	**1178**	**78**	**6.6%**	**4**

Source: MeatCo Oshakati Abattoir records 10 January 2006

[1]Abattoir closed, slaughtering did not take place

Table: Incidence of cysticercosis in cattle from Oshana Region (2005)

Month	Cattle slaughtered	Cattle infected	Prevalence of infection	Condemned carcasses
January[1]				
February[1]				
March[1]				
April	49	0	0	0
May	131	2	1.2%	0
June	460	36	7.8%	1
July	352	29	8.2%	1
Aug	195	10	5.13%	0
September	77	13	16.8%	0
October[1]				
November[1]				
December[1]				
Total	**1264**	**90**	**7.1%**	**2**

Source: MeatCo Oshakati Abattoir records 10 January 2006

[1]Abattoir closed, slaughtering did not take place

Table: Incidence of cysticercosis in cattle from Oshikoto Region (2005)

Month	Cattle slaughtered	Cattle infected	Prevalence of infection	Condemned carcasses
January[1]				
February[1]				
March[1]				
April[2]				
May[2]				
June[2]				
July	139	12	8.6%	0
Aug[2]				
September	121	18	14.9%	0
October[1]				
November[1]				
December[1]				
Total	**260**	**30**	**11.5%**	**0**

Source: MeatCo Oshakati Abattoir records 10 January 2006

[1]Abattoir closed, slaughtering did not take place

[2] No cattle received from this region

Table: Prevalence of bovine cysticercosis found in cattle slaughtered from North Central Namibia during January – December 2005

Origin of cattle	Cattle slaughtered	Cattle infected	Prevalence of infection
Ohangwena	130	7	5.4%
Omusati	1178	78	6.6%
Oshana	1264	90	7.1%
Oshikoto	260	30	11.5%
Total NCN	**2832**	**205**	**7.2%**

Source: MeatCo Oshakati Abattoir records 10 January 2006

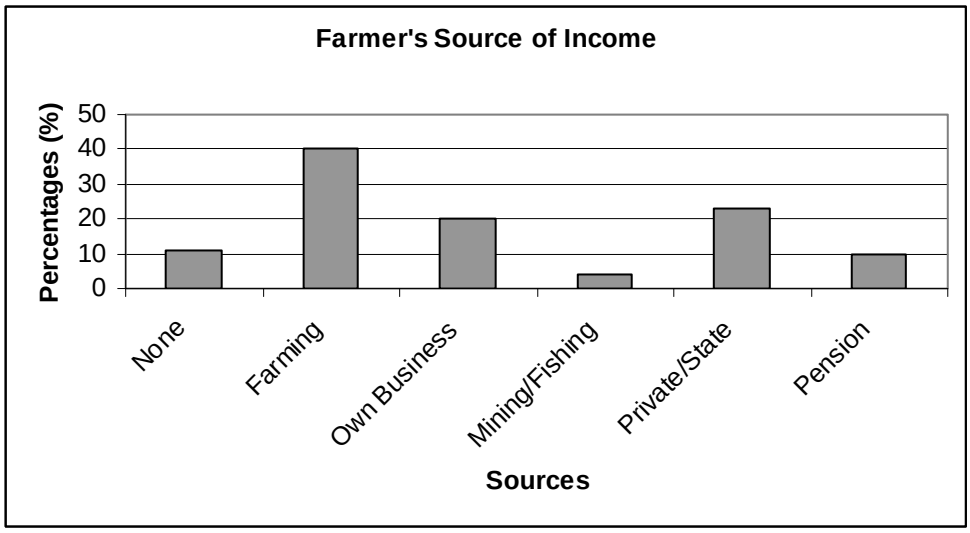


Fig: Sources of Farmers Income in the study area

APPENDIX D: PHOTOGRAPHS OF OBSERVATIONS

Plate D.1 Unhygienic circumstances prevail – informal markets

Plate D.2 Informal markets for beef in Omusati Region

Plate D.3 Informal butcheries / markets – only equipped with a tripod and hooks

Plate D.4 Cattle herded along the road

Plate D.5 An example of a pit latrines found in the study area

APPENDIX E

The pamphlet is originally produced in English, because funding was not available as yet to re-produce the extension materials in the vernacular spoken by farmers in the study area. As soon as funds have been the pamphlet will translated and distributed to all regions in the affected areas.