# Integration of indigenous knowledge systems in sustaining water security for cattle in resource-limited communities

**By**

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## Declaration

I Kamva Getyengana, declare that this thesis is my original work and has not been submitted in any University. The research reported in this thesis has been conducted under the supervision of Prof. M. Chimonyo. All data, pictures, graphs used in this thesis has been fully acknowledged.

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**General abstract**

The broad objective of the study was to assess the integration of indigenous knowledge systems in sustaining water security for cattle production in resource-limited communities. Cattle production in resource-limited communities contributes enormously to their everyday livelihoods however it is threatened by frequent occurrence of drought. A total of eight key informant interviews constituting of indigenous knowledge custodians between ages of >60 years old were conducted in Musina, Vhembe District Municipality, Limpopo and eight key informant interviews with indigenous knowledge custodians between ages of >60 years old were conducted in Umhlabuyalingana, Umkhanyakude District Municipality, KwaZulu-Natal, South Africa. Four focus group discussions with adult males and females, age >25 years and youth males and females, age =<25 years old. A total of 284 structured questionnaires were administered in two local municipalities of Limpopo and KwaZulu-Natal. In Umhlabuyalingana interviews listed the rejection of indigenous knowledge as a contributing factor to water security challenges. Water shortages forced cattle to travel long distances to water sources. Water security challenges cause weight loss, low productivity and mortalities. The integration of IKS into conventional methods was suggested in Umhlabuyalingana by elderly farmers unlike in Musina to assist curb water insecurity. Integration of indigenous knowledge systems (IKS) and conventional knowledge (CK) was encouraged in Umhlabuyalingana (11 %) as compared to Musina (1 %). Musina farmers preferred CK (25 %) over IKS. The odds of youth ($P < 0.05$) being open to the idea of integration of IKS and CK was seven times more than the adults. The association between cattle ownership and the use of IKS in Umhlabuyalingana differed ($P < 0.01$), farmers (35 %) that owned cattle used IKS more than farmers who owned cattle in Musina (18 %). Male farmers from

Umhlabuyalingana (55 %) preferred to feed natural pastures during drought periods unlike farmers from Musina who preferred using commercial feeds and crop residues.

Therefore, a study was conducted to assess the effect of using different cow-calf management systems on time budgets during droughts in Domboni village, Vhembe District, Musina. Four non-descript lactating cows from each management practice were used. Extensive managed cows spent 2.2 hours/day more ($P < 0.05$) walking to water points as compared to semi-extensive managed cows (0.7 ± 0.15 hours/day) during drought periods. Semi-extensive cows spent 3.4 hours/day more time feeding ($P < 0.05$) compared to extensive managed cows (47 ± 3.53 %). In conclusions drought poses as a threat to cattle and the lack of IKS use. Indigenous knowledge still has hope to upsurge and the youth is showing interest. The use of natural and crop residue for feed increases the possibilities of integrating IKS and CK. The semi-extensive management practices were viable for the cows as they travelled less and spent more time eating while extensive managed cows invested their time walking to water points and feeding points.

**Keywords**: Distance, weight loss, low productivity, mortalities, youth, extensive, semi-extensive, feeding.

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# Chapter 1: General introduction

## 1.1 Introduction

### 1.1.1 Background

Globally the consumption for cattle is increasing with the increasing population. This increase, however, puts pressure on natural resources, especially water. Livestock in Sub- Saharan Africa accounts for 40 % of income generated from agriculture (Staal *et al*., 2009). In Africa, approximately one billion people rely on cattle for food security especially in resource-limited households (Matemilola, 2017). Cattle's responsible for producing one third of the worlds' protein that humans consume (Layman, 2018). For example, cattle production in South Africa accounts for 25 to 30 % of the annual agricultural produce in the form of milk, meat, and live animals (Faku and Hebinck, 2013). Cattle in resource-limited communities are considered to be the most valuable cattle asset. They are kept for subsistence purposes, as a reflection of social status and aid in household food security through the provision of protein.

In 2015/2016, KwaZulu-Natal, Eastern Cape, Limpopo Province and Free State in South Africa severely experienced an agricultural drought which left many communal households vulnerable (Muyambo *et al*., 2017). This led to increased numbers of cattle mortalities due to dehydration and feed shortages. Cattle were subjected to water shortages resulting in increased competition for water resources. Poor management practices of cattle production during droughts periods also contributed to cattle mortalities as it has a negative effect on the behavioural response of the animal. Change in behaviour is a fast and positive indicator of an animal's welfare condition. Behavioural responses can be used to determine whether the animal is experiencing stress, as changes in behavioural patterns are frequently reported when experiencing adverse conditions (Mkwanazi *et al*., 2016). These conditions include water restrictions, low feed intake, high temperatures etc. Cattle cannot adapt to water restriction and feed intake greatly decreases if water is restricted (Wakchaure *et al*., 2015). As a result of management changes due to drought, the time budget of cattle becomes altered under different management methods practiced.

Water requirements for cattle range from 14 to 40 kg/day, depending on season, body weight and activities performed. Therefore, water availability and access is essential to cattle. Thus, cattle should be considered when formulating water security policies and goal. Water security plays an essential role in food production (crops, livestock) by promoting household food security especially in resource-limited households.

Water security is the availability of an acceptable quantity and quality of water for health, livelihoods and ecosystems, coupled with an acceptable level of water-related risks to people, environments and economies (Grey and Sadoff, 2007). Most resource-limited communities remain water insecure due to extreme weather conditions such as floods, drought and poor governance. Although the government contributes to ensuring water security for South Africa, these communities remain neglected when it comes to having access to adequate and clean safe water supply. It therefore becomes their responsibility to develop ways of ensuring and sustaining water security for cattle through water resource management methods. The use of indigenous knowledge systems (IKS) so far has proven to be a sustainable and appropriate solution for resource-limited household that lack municipal water resources and that are exposed to impacts of droughts.

Indigenous knowledge systems provide local communities with daily problem-solving strategies. Indigenous knowledge systems are sometimes the only solution and asset that communal households are familiar with and have control over. Indigenous knowledge systems provide prospective methods that can be integrated effectively in water conservation and management. Methods that can provide ways of improving and enriching current water systems and have been proven viable during droughts (Muyambo *et al.,* 2017). Indigenous knowledge systems evolves within the community and is passed on from one generation to another. Conventional knowledge systems (CKS) of which constitutes of ideas, theories and concepts that are "immutable mobiles" is another type of a "modern" knowledge system used by farmers (Badugela, 2019). It uses conventional technology developed by researchers to solve problems however it does not provide long-lasting solutions especially to Africa's natural resources. Therefore, relying on conventional knowledge systems for water management alone is not enough to ensure sustainable water resources to resource-limited communities.

In Zimbabwe, for example, the use of IKS proved to be useful in reducing flood impacts. In Zimbabwe IKS is used to promote processes of disaster prevention, preparedness, cost-effectiveness and sustainable ways to adapt (Risiro *et al*., 2012). In the Limpopo province households faced with water shortages end up spending their income on buying water (Louis and Mathew, 2020) because IKS methods for ensuring water security are no longer practiced. The water bought is not enough to maintain both humans and cattle as cattle consume more water as compared to humans and water would be costly. Cattle requires large amount of water to perform their functions such as transportation, agricultural traction and for food production. Households that lack IKS suffer the most as they rely on conventional knowledge system that afterwards fail them. Having to buy water for cattle could rather be expensive and IKS methods are cost effective. Furthermore conventional methods for risk management are not easily accessible to everyone during times of droughts and floods especially for resource-limited communities (Risiro *et al*., 2012). Hence, the need to investigate the possible IKS that can be integrated with CKS to ensure water security for cattle production in resource-limited communities, to provide options during water scarcity.

## 1.2 Justification

Livestock are a key resource and help in maintaining the livelihoods of households especially in resource-limited communities. However, in the selected study areas the dominant livestock production is cattle. Droughts and water scarcity are threatening cattle production in Musina and Umhlabuyalingana. The study is interested in comparing how resource-limited communities coped during droughts through the use of IKS as compared to the current CKS used. Indigenous knowledge systems have the potential to reduce water insecurities through their methods of water management as studies report resource-limited communities coped under drought situations compared to now (Rukema and Simelane, 2013). Hence, there is need to determine how IKS can be integrated with conventional knowledge water security systems into water policies so they work together to ensure water security in resource-limited communities. During the 2015/16 drought occurrence the use of IKS proved to be viable in mitigating the drought impacts (Muyambo *et al*., 2017). It is important to explore how the use of IKS during natural disasters has been utilized to sustain cattle production and how it has ensured that water requirements for cattle are maintained.

It is crucial and advisable to encourage agricultural extension services to work hand-in-hand with custodians of IKS in achieving water security and cattle production. Households that are vulnerable to water insecurities should be empowered on alternative ways of ensuring water security. The government needs to understand the water security situation of communal households so as to map a way forward that actively involve the participation of the resource-poor. It should benefit researchers by enlightening them on the importance of IKS to rural communities and by so doing IKS can be documented for future purposes. It should assist scientists and extension officers involved in development projects. Although IKS rely on knowledge embedded in people and is unique to a specific locality and given culture it should assist those who lacks the knowledge such as the youth.

### 1.3 Objectives

The broad objective of the study was to assess the integration of indigenous knowledge systems in sustaining water security for cattle production in resource-limited communities during droughts. The specific objectives were to:

1. Compare the causes and effects of water security challenges on cattle production in resource-limited communities of Limpopo and KwaZulu-Natal during droughts
2. Assess the perceptions of integrating indigenous and conventional knowledge systems to ensure sustainable water security for cattle during droughts
3. Evaluate the effect of different management systems used for cow-calf production on time budgets during droughts: a case of Domboni village, Vhembe District

### 1.4 Hypothesis

a. The causes and effect of water security challenges on cattle production in resource-limited communities of Limpopo and KwaZulu-Natal during droughts are not the same;
b. indigenous knowledge and conventional knowledge systems can be integrated to ensure sustainable water security for cattle during droughts; and
c. effect of different management systems on cow-calf production have no effect on the time budgets during droughts.

### 1.5 References


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# Chapter 2: Literature review

## 2.1 Background

This section examines existing literature that pertains to water security, IKS and cattle production in relation to water balance. A review examined the contribution of IKS in sustaining water security and ensuring water security for cattle.

## 2.2 Water security

Water security is considered a multi-facet concept with widely differing interpretations (Srinivasan *et al*., 2017). Water security is the sustainable use and protection of water resources, safeguarding access to functions and services for humans and the environment, and protection against water-related hazards (flood and drought) (GWP, 2000). On the other hand, Gelark *et al*. (2018) describes water security as a concept that accounts for sustainable availability of adequate quantities and qualities of water for buoyant societies and ecosystems in the face of uncertain global change. However, in South Africa there is an urgent need to protect water security as it is a water scarce country.

Bakker (2012) indicated that attaining water security is a challenge to the environment, economic and social wellbeing. This is especially so in some parts of South Africa that were affected by drought disaster and are now faced with water shortages. Gelark *et al*. (2018) also highlighted that management and use of water can have a significant impact on social welfare and economic activity. Further, the latest water crises in Cape Town, South Africa have been associated to improper water management. Gelark *et al*. (2018) indicated that between water and a society there exist a symbiotic relationship. Water quantity-quality and associated societal facets have an influence in implementation and effectiveness of securing water for societal needs globally (Gunda *et al*., 2019).

In South Africa, however, the major contributing causes of water insecurities are drought, floods and poor water governance with drought being the leading factor. The occurrence of drought in South Africa is increasing in both frequency and severity, resulting in serious economic and social losses and exacerbating the vulnerabilities of the region (Tirado *et al*., 2015). The agricultural sector is immensely affected by occurrence of drought. Furthermore, the agricultural sector plays a crucial role in contributing to the economy but lately its contribution is declining, falling from a contribution of 4.2 % to GDP in 1996 to only 2,3 % in 2015 (Ndlovu, 2016). In South Africa agriculture is important particularly in resource-poor areas as it brings about employment, contributes in subsistence farming and food security. Part of the reason for the decline are droughts.

Although rural-to-urban migration is escalating, South Africa's rural population is still on the third of the total population (Ndlovu, 2016). In 2014 to 2016, the Southern African Development Community (SADC) region was immensely exposed to an intense drought. In 2015/16 during the rainy season the situation was intensified by one of the strongest El Nino Southern Oscillation (ENSO) episodes (SADC, 2016). Among the 15 southern African countries affected by drought was South Africa. The effects of drought were severely felt in northern KwaZulu-Natal, east half of Free State, north eastern Mpumalanga and the North West provinces (Swemmer *et al*., 2018).

The extremities of the 2015/16 drought resulted in 643 000 cattle deaths due to lack of pasture and water (De Waal and Vogel, 2016). Although this value does not include cattle in rural communities. Swemmer *et al*. (2018) argued that the mere reason for cattle numbers to be problematic is due to the fact that extension officers do not always record the cattle numbers accurately and the fact that cattle owners no longer make use of dip tanks which made it easier for cattle numbers to be recorded. The Department of Agriculture, Limpopo Province reported extensive losses and cattle mortality as high as 33 % in the Giyani District. In KwaZulu-Natal higher mortality rates of 43 % for cattle following water shortage relations.

### 2.3 Indigenous knowledge system (IKS)

Knowledge is the information, understanding and skills that somebody gains through education or experience. The term IK indicate a type of knowledge that has emerged from within the community and is advanced to subsequent generations in a specific geographic area (Chaudhry, 2011). Badugela (2019) defines IKS as local knowledge obtained from interaction between people and their environment and is a trait of all cultures. It is passed on from one generation to the next generation and the knowledge emerges from long experimentation and observation of the environment.

Indigenous knowledge system represent the most treasured heritage and ethics of any community. IKS is kept in people's memories and activities, it is conveyed through stories, songs, folklore, proverbs, dances, cultural values, beliefs, rituals, community laws, agricultural practices, plant species and animal breeds (Dlamini, 2017). Thus, IKS assist in basic provision for daily problem-solving strategies for local communities (Buthelezi and Hughes, 2014). Indigenous knowledge systems are perceived to have limited its contribution to development and is considered inferior to "universal" scientific knowledge (Risiro *et al*., 2013; Buthelezi and Hughes, 2014). Western knowledge systems are preferred over IKS. Consequently, due to this attitude IKS has emerged to being neglected in favour of modern knowledge systems which has resulted from the functions of colonialism (Nursey-Bray *et al*., 2020).

### 2.3.1 Colonialism and Indigenous knowledge system

Colonialism has had an impact on South African communities' including apartheid. Buthelezi and Hughes (2014) argued that despite the fact that South Africa has had democracy for two decades there is still much to be done to rectify the impact that colonialism and apartheid had on the IKS of rural communities. As South Africa was colonised by Europeans the focus of the identity and IKS of the people i.e. land which is viewed as the well-being, identity and the existence of indigenous people was taken away (Van Wyk, 2016). Rural households share a symbiotic relationship with their land. The relationship that communities have with their land emerges as they become settled in on a particular place. As a result, the ancestral languages were also harmed by the process of colonialism. The imposition of the dominant language policy in school, media, government affairs and other public context were the main cause (Howitt *et al*., 2012).

Furthermore, the colonial and research in Africa, particularly in South Africa did not devote to the development of indigenous African theory building (Kaya and Seleti, 2014). In accordance Buthelezi and Hughes (2014) aver that the system that was used to introduce formal education was biased towards IKS as the education system did not recognise the existence of diverse epistemologies. Eventually, IKS was disregarded by some people in favour of modern knowledge systems, and this has had an influence on the sustainability of IKS. Although the IKS is still embedded within individual's intellects it is losing its relevance because it is not documented

### 2.3.2 Indigenous versus conventional knowledge systems

The modern knowledge and science have contributed a predominant role in the developmental efforts in the South, contrary, IKS has been characterized as inefficient, old-fashioned and not scientific (Badugela, 2019). Van Wyk (2016) elucidated that scientific knowledge constitutes of ideas, theories and concepts that are "immutable mobiles" and thus this knowledge is considered to be transferable, mobile and not limited to a singular locale as contrary to local knowledge. As such, IKS is, at times, viewed as being unable to organise valid bodies of knowledge for science promotion, as their way of thinking is considered intuitive (and not analytical), their truth and logic are equivalent to local conditions and culture (Gaillard and Mercer, 2013).

The incompetence of scientific methodologies predominantly in rural areas has often been seen to be as a result of the exclusion of peoples IKS (Hughes and Buthelezi, 2014). Conversely, science cherished its resilience in development discourse over IKS because of its perceived 'substance' (Nursery-Bray *et al*., 2020), and that IKS does not possess yet. Development has relied exclusively on one knowledge system, namely, the conventional knowledge system. The predominance of this knowledge system has imposed the marginalization and disqualification of non-Western knowledge systems. When the two paradigms (i.e. indigenous and western knowledge) are integrated for use in environmental and developmental activities then there result potential difficulties (Gaillard and Mercer, 2013). Although there exist attractions in a relevant dialogue between western science and IKS in actually sense tension still prevails. Gaillard and Mercer (2013) suggested that despite the existing challenges between indigenous and scientific knowledge systems, there should be novel mechanisms that serve to integrate these two systems for mutual benefit. This integration can provide ways on how to protect water security for the country and can prevent mostly water security challenges faced by resource-limited communities.

### 2.4 Water security challenges facing rural communities

In most rural areas, domestic water is a production input, in garden irrigation, cattle water, brewing and brick-making (Ncube *et al*., 2018). Interestingly, water insecurity can, moreover, impact directly and indirectly a wider household production and income earning opportunities. Shortages in water impact severely cattle as they have to walk long distances in search of alternative water sources (Mdletshe *et al*., 2018; Musemwa *et al*., 2012). Water use and demand by cattle is greatly influenced by factors such as seasonality, water quality variation, and distance to sources (Mdletshe *et al*., 2018). The use of IKS, however, has kept daily operations intact under the above factors. Drought is not the only challenge that rural areas and farmers are faced with but also they are sometimes affected by floods. Although in a study by Mavhura *et al*. (2013) it was discovered that the use of IKS had an important role in mitigating impacts of floods. The employment of IKS is mostly applicable to poor and rural communities that have high illiteracy levels and are unable to access information (Muyambo *et al*., 2017). Therefore, indigenous agricultural knowledge provides a means of dealing with such challenging situations.

### 2.5 Indigenous knowledge systems and water security interaction

When it comes to managing water resources IKS plays a crucial role. This is explored in literature that the linkage between IKS and water security is incorporated in the traditional knowledge and skills in managing and protection of water sources (Ayeni *et al*., 2014). Further, Mahlangu and Garutsa (2014) showed that rural communities can develop their capacities to achieve sustainable and equitable water management through the IKS related to water security that they possess. Although IKS is not mostly documented, there is a growing recognition of IKS in cost-effective and sustainable development by African governments and international development agencies that reveals the need to explore its importance in drought risk mitigation (Muyambo *et al*., 2017).

Literature is silent about the cattle sector in relation to water security. In most literature on the agricultural sector, irrigation of crops is deemed as the only factor that water security is mainly concerned about (Chew *et al*., 2019; Srinivasan *et al*., 2017; Unver *et al*., 2017; Frone and Frone, 2015). In response, water required for irrigation in South Africa is considered to be significant, representing 60 % of the total water use per sector (Baleta and Pegram, 2014). However, people from rural areas are fond of cattle farming practices because cattle contribute to their livelihoods through income generation, cultural purposes, gender equality and food security. In contrary, the cattle sector is already a major user of natural resources such as land and water (FAO, 2018). Water scarce resources are experiencing an increased pressure and require efficient and effective management to build a sustainable future and therefore the one way this can be achieved is through monitoring water uses i.e. how much water is used, who uses water and where is it used.

### 2.6 Role of water to cattle

Water is an essential but often overlooked nutrient for livestock. Water constitute 98 % of all molecules in the body and is essential for, growth, regulation of body temperature, reproduction, lactation, digestion, lubrication of joints, eyesight and as a cleansing agent (Wakchaure *et al*., 2015; Lardy *et al*., 2008). In addition, water constitute 80 % of the blood, and is essential for functions such as digestion, waste disposal, and the assimilation of nutrient. It is important to ascertain an animal's water requirement which is determined by several factors including rate of weight gain, pregnancy, lactation, activity, type of diet, feed intake and environmental temperature (Wakchaure *et al*., 2015). Knowledge of water requirements of cattle will allow designing cattle watering system. However, this action is difficult to achieve for people in rural communal since their cattle generally have to travel long distances to access water especially during droughts.

Daily water demand of cattle varies remarkably among animal species, i.e. the size and growth stage of the animal constitute a strong influence on daily water intake (Hoeskra, 2017). Although cattle can survive for sixty days without food they can only survive for seven days without water (Lardy *et al.,* 2008) and this shows the significance of ensuring water security in cattle. Limiting water intake can depress the cattle's performance and reduce productivity (Wakchaure *et al*., 2015). There is little literature that fully demonstrate water requirement by beef cattle, however, those documented suggested that water requirement for beef is dependent on whether the animal is lactating, moisture content of feed, and environmental factors such as ambient temperature or relative humidity (Ward and McKague, 2007). Body weight gains of beef cattle also increase when there is adequate water supply.

### 2.6.1 Dehydration in cattle

A shortage of water in the body will result in dehydration. Symptoms of dehydration in animals are not different from those seen in humans, but for animals they are at greater levels of body water depletion (Knowles *et al*., 2014). The most notable clinical signs of dehydration can be spotted by the dryness and wrinkling of the skin which subsides slowly after being picked up into a fold (Knowles *et al*., 2014). One way to assess dehydration in cattle is by pulling the skin over the shoulder and hold for a moment then release and count seconds for the skin to unfold, on a dehydrated animal, the skin will hold for several seconds. Guidelines for estimating dehydration in cattle is shown in table 2.3.

Dehydration is sometimes notable during high temperatures. At higher temperatures ranging from 42°C respirational distress is evident due to forced dryness. In response, the pulse gets very rapid and weak and also irregular (Knowles *et al*., 2014) and it can be deduced that death will arise from depression of the respiratory centre in the brain. The most common cause of dehydration in hot environments is loss of water due to evaporative cooling (Chedid *et al*., 2014). This is because water is immediately lost from the bloodstream and if this water is not restored the blood becomes more viscous, exerting a great load on the heart (Chedid *et al*., 2014).

**Table 2.1: Water requirements for cattle, excluding waste and assuming water is clean and palatable**

| Class of cattle | Requirements (Kg/ animal/ day) |
|---|---|
| Cow | 40 to 50 |
| Bull | 45 to 55 |
| Dairy cow | 5 per litre of milk |
| Yearling | 25 to 40 |
| Calf | 15 to 25 |

Source: Department of Agriculture and Rural Development [Date accessed: 27 June 2019]

## 2.7 Importance of cattle to indigenous communities

In South Africa, cattle production is an important benefactor to food security and clothing, and in provision of many social and economic attributes to the country (Meissner *et al*., 2013). Different cattle species serve for different functions and play very significant roles in economic, social, and cultural stature, they contribute to enhance income and well-being of the farm family (Bettencourt *et al*., 2015).

Indigenous communities are often faced with challenges to make ends meet due to family livelihood expenses (Moyo and Swanepoel, 2010), therefore cattle becomes the solution to such challenges. Cattle aids on food supply, family nutrition, family income, asset savings, soil productivity, livelihood, transport, agricultural traction, agricultural diversification, and sustainable agricultural production, family and community employment, ritual purposes and social status (Moyo and Swanepoel, 2010).

### 2.7.1 Food and nutrition

As stated earlier, cattle is an essential benefactor for food supply of rural and urban areas and aids in family nutrition, by also supplying animal protein (Bettencourt *et al*., 2015). Cattle products contribute almost 30 % of human protein consumption (Mottet *et al*., 2017). In India, the landless, marginal and poor poultry farmers kept an average flock of 7-8 non-descript hardy but low-yielding poultry birds as the source of eggs for household consumption and to meet once-off expenditures (Holding, 2006). In Kenya, Boran cattle which are adapted to harsh climatic conditions are kept for meat and they are also reared by indigenous people in southern Ethiopia as a primary source of milk for self-consumption (Pica-Ciamarra *et al*., 2015).

**Table 2.2: Clinical assessment of dehydration in cows**

| Dehydration (% loss of body weight) | Clinical signs |
|---|---|
| **0-5** | Not detectable |
| **6-7** | Mild enophthalmos |
| | Persistence skinfold (3-5 sec) |
| | Dry mucous |
| **8-9** | Hollow eyes |
| | Persistence skinfold (6-10 sec) |
| | Sticky mucous |
| **10-12** | Deep-set eyes in the orbits |
| | Skinfold indefinite persistence (>15 sec) |
| | Dry mucous |
| | Clearly depression |
| **12-15** | Marked signs of shock |
| | Impeding death |
| | PCV may be increased |

Source (Montana *et al*., 2017)

### 2.7.2 Social functions

The cattle social function equate to the symbolic worth linked to a certain species and the use of animals for the satisfaction of a set of rituals and social obligation of families and communities. Cattle are used in conducting traditional rituals, ceremonies and festivities and also as sacrifices for ancestral appeasing, and also for bride wealth (Bettencourt *et al*., 2015). Cattle raises the social status of owners and is claimed to accord to gender balance by affording women and children the chance to own cattle (Waters and Letty, 2010). In indigenous communities owning a large number of cattle denote wealth status.

### 2.7.3 Contribution to crop production

Cattle production is closely associated with crop production (Bettencourt *et al*., 2015). The contribution of cattle to crop production through provision of draught power and manure cannot be undermined (Smith *et al*., 2013). For example, animal manure is said to improve soil fertility, soil structure and increase water holding capacity (Bettencourt *et al*., 2015). Both draught animal power and manure are environmentally friendly enhancing energy and nutrient cycling.

## 2.8 Cattle management during droughts

During droughts communal farmers who have low income suffer as they are unable to practice conventional management methods of managing livestock. Poor communal farmers rely on the IKS methods such as allowing the cattle to search for feed and water on their own. While, middle class communal farmers are able to herd cattle to farms to feed on residuals and provide water. During droughts the vegetation becomes sparse and this subject the cattle to walk for long hours in search of edible feed (Pearce *et al*., 2018 and Hogan and Phillips, 2016). Contrary, in countries that are sub-humid during dry spells farmer prefer to walk their cattle to water points (Matope *et al*., 2020). In countries such as Vietnam and Zambia they have boreholes erected for cattle and this prevents cattle search for water during droughts (Funder *et al*., 2012). This means that South African municipalities should invest in boreholes for communal farmers as they become viable during droughts and cattle can search only for feed. The erection of communal boreholes for cattle makes it possible for IKS and CK to be infused to sustain water security challenges.

### 2.9 Integration of indigenous knowledge systems and conventional knowledge systems

Indigenous knowledge system have be infuriated by scientists in order to popularise the use of conventional knowledge systems (DeWalt, 2017). As a result conventional knowledge systems have been a to-go for communities. Although studies have compared how the two systems can be integrated, there is lack of including the communities perceptions on merging these systems. The revival of IKS would encourage communities to appreciate their IKS while complementing it with CKS in water security. However, further research is required on how the feelings and attitudes of communities are towards the development of integrating IKS and CKS to improve water security for livestock. Integration of IKS and CKS have not been yet developed hence the study seeks to pave a way forward.

Figure 2.1 is a related idea of a conceptual framework for integrating IKS and CK for risk disaster reduction. The framework closely illustrate how IKS and CK can come together to achieve water security.

### 2.10 Summary

Water security is an on-going issue that is mainly affected by climatic changes. Although rural communities suffer the most, it is up to them to find solutions on adapting to such issues. The use of IKS so far has played a major role in mitigating some of these water insecurity issues. However, it does not contribute much in sustaining water balance in cattle hence, the increasing mortality and decreasing GDP. This is evident on the number of mortalities of cattle reported both in Limpopo Province and in north of KwaZulu-Natal. The integration of IKS into conventional knowledge system can be furtherly explored in sustaining water security for humans and in maintaining water balance in cattle.

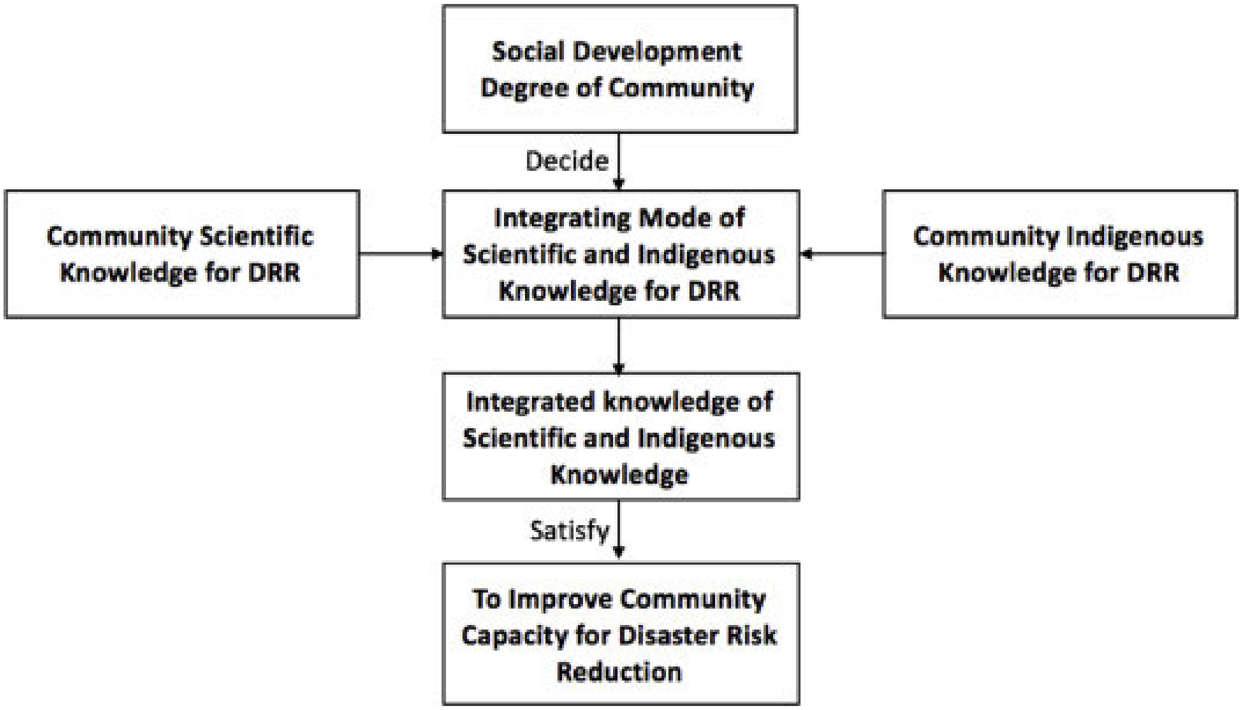


**Figure 2.1. Framework of integration of IKS and CK for disaster risk reduction (Wang *et al*., 2019).**

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## Chapter 3: Causes and effects of water security challenges on cattle production in resource-limited communities of Limpopo and KwaZulu-Natal during droughts


### Abstract

Water shortages hinder livelihoods and wellbeing of resource-limited communities. The objective of the study was to examine the causes and effects of water security challenges affecting cattle production in resource-limited communities of Limpopo and KwaZulu-Natal, South Africa. Eight key informant interviews for males and females who are 60 years old and above were conducted in both Musina, Vhembe District Municipality, Limpopo and Umhlabuyalingana, Umkhanyakude District Municipality, KwaZulu-Natal, South Africa. Four focus group discussions with adult males and females, over 25 years and youth males and females, who are 25 years old and older. Water availability was the major water security challenge faced by cattle from Musina as compared to cattle from Umhlabuyalingana. Both municipalities are prone to frequent droughts. In Umhlabuyalingana interviews listed the rejection of IKS as a contributing factor to water security challenges. The water security challenges affected cattle as they have to travel long distances to water sources. The distance to the water source was 15 km longer for cattle from Musina than for cattle from Umhlabuyalingana which was less than 1 km. Water security challenges affected the weight loss of livestock, the low productivity and caused mortalities. The re-establishment of indigenous methods of securing water was suggested in Umhlabuyalingana to assist during droughts while in Musina modification of conventional methods was considered to be more sustainable. Therefore, further research is needed to investigate the potential of using IKS to sustain water security in resource-limited communities.



**Key words**: Water availability, drought, indigenous knowledge systems, conventional methods

### 3.1 Background

South Africa is a water-scarce country (Sershen *et al*., 2016). Water plays an important role in the livelihoods of livestock farmers. Cattle are integral to livelihoods of resource-limited communities. Cattle contributes in food and nutrition, income, provision of draught power and during socio-cultural ceremonies (FAO, 2012). During water shortages the value of cattle is reduced due to weight loss from insufficient water intake. When the water requirements are not met, productivity of the cattle is reduced (Wakchaure *et al*., 2015). Cattle, for example, require 50 litres of water per day (Lardy *et al*., 2008). It is, therefore, important to consider cattle when developing water security strategies as they are pivotal in the livelihoods of the resource-poor.

Cattle need water to keep hydrated, maintain body functions, hygiene, building and irrigation. Lack of water supply infrastructure exposes cattle to traveling long distance to streams which are drying up due to climate change and results to competition for water resources. Long distances also expose cattle to theft. The increased competition for water resources among cattle results in resource-limited communities farmers facing more water security challenges as marginalized areas are neglected by government. And resource-limited communities are often dependent on the government for basic water services (Mothetha *et al*., 2013).

Water security is defined as "the reliable availability of an acceptable quantity and quality of water for health, livelihoods, ecosystems and production" (Grey and Sadoffs, 2007). Resource-limited communities face the most challenges attaining water supply for cattle during dry spells and, therefore, water security should be a goal pursued by governments and its users. In Limpopo province, for example, 27 % of the households are water insecure (Sershen *et al*., 2016). Limpopo and KwaZulu-Natal are dominated by rural areas and water accessibility is a challenge. The two provinces including the Eastern Cape are also known for their attachment to the IKS methods which were used to mitigate droughts impacts in the Eastern Cape during 20150-2016 (Muyambo *et al*., 2017).

Water unavailability in resource-limited communities remain a major challenge to ensuring water security, however, the causes and effects due to water insecurities towards cattle are misunderstood. Cattle forms part of life for farmers from rural areas and therefore are also affected by water insecurities. Although some farmers have managed the challenges through using IKS to ensure water for livestock, some farmers remain affected during droughts. Indigenous knowledge systems is the long existing knowledge and practices that evolves within a particular community and environment to solve day-to-day challenges (Chisanga *et al*., 2017).

In addition, the outbreak of Covid-19 which required the use of water to minimize the spread of the virus, exposed the country's water situation. Under the Covid-19 pandemic protocols herders were affected as herding of cattle was restricted. This meant cattle often herded to water points were affected. Lastly the use of IK medicines was highly employed during the pandemic to reduce effects of Covid-19. Due to unknown information on how the virus works the poor farmers are likely to get affected in the future and implicating cattle production.

It is important to determine water security challenges in resource-limited communities as cattle are adversely affected and are often neglected during water shortages. Through these challenges it would also be possible to establish the cause of water insecurities and the effects they have on livestock. Again, water security challenges differ with communities, sex, age and farming status quo as cattle farming involves families in rural areas. Farmers share different views when it comes to how cattle are affected during droughts and what the causes could be as management practices often differ. The objective of the study was to compare causes and effects of water security challenges facing cattle in resource-limited communities of Limpopo and KwaZulu-Natal provinces. Understanding such challenges and the factors affecting them assist in developing solutions that may be utilized by local communities, municipalities and governments. Hence, the objective of the study was to examine the causes and effects of water security challenges on cattle production from resource-limited communities during droughts. It was hypothesized that water security challenges facing cattle are not the same between Limpopo and KwaZulu-Natal communities and are not affected by gender, community, or age.

## 3.2 Materials and methods

### 3.2.1 Ethical clearance consideration

Permission to interview participants was obtained from the Humanities and Social Science Ethics Committee (Reference No. HSSREC/00000932/2020) of University of KwaZulu-Natal. Upon interview, a consent form to ensure participants confidential information was disclosed was provided, and in the process of being uncomfortable they may stop the interview.

### 3.2.2 Study sites

The study was conducted in UMkhanyakude and Vhembe district municipalities at two different provinces (KwaZulu-Natal and Limpopo Province), South Africa. The study was conducted at the local communities of Umhlabuyalingana Local Municipality (27°1'S 32°44'E), located in the north-eastern part of KwaZulu-Natal. Umhlabuyalingana is generally rural constituting of informal settlements and is divided into four traditional council areas (Tembe, Mashabane, Mabaso and Zikhali). The municipality holds a population of 172 077 with an average of five people per household (Community survey, 2016). The type of natural vegetation is the Maputo coastal thicket. The soils are mainly sandy. It has an average annual rainfall of 963 mm (Mathews, 2007). The maximum and minimum temperature ranges from 18°C to 26.3°C.

Musina Local Municipality (22° 22’ 0” S, 29° 45’ 0” E lies in Vhembe District Municipality Limpopo Province, South Africa). The municipality holds a population of 132 009 with an average of five people per household (StatsSA, 2016). The bushveld comprising of low-shrubs and thorny trees is prevalent in the municipality. The soil is mostly sandy. Musina receives an annual rainfall of 246 mm, with most rainfall occurring mainly during mid-summer (SA Explorer, 2017). It receives no rainfall in June and the highest of 55 mm in January. The average temperatures for Musina range from 23.9°C in July to 32.1°C in January. The region is coldest during July when temperatures drop to 7.6°C on average (SA Explorer, 2017). Figure 1 and 2 show the locations of the two study sites.

#### 3.2.3 Study design and participant selection

Three communities in Umhlabuyalingana and two communities in Musina were visited. Through the assistance of cattle extension officers, permission to commence with interviews was granted by the chiefs of each community. A purposive sampling method was used to identify participants. The key informant interviews were comprised of both genders above the ages of 60 years old including the chiefs who own livestock. While the focus group discussions (FGD) comprised of both genders and were grouped according to gender and age. The adult group who are above 25 years old and the youth group who are 25 years old and below who had cattle in their homesteads. The sampling technique used was used to focus on the gender, age, cattle ownership and water security challenges faced by each farmer including provinces.

#### 3.2.4 Data collection

Data were collected using direct observations, key informant interviews, focus group discussions (FGDs).

### 3.2.5 Key informant interviews

Interviews were used to access information from cattle owners and custodians of IKS. The custodians of IKS were selected to give thorough insight on deeper causes of water security challenges in a cultural perspective and bring about solutions as they did in the past. Interviews were conducted in vernacular, that is, isiZulu in Umhlabuyalingana Municipality and Tshivenda in Musina Municipality. Information gathered was mainly on the water security challenges faced livestock, demographics, and the causes. The participants were referred by the cattle association official as well as the tribal chiefs. Tape-recorders were used to capture the interviews to reduce errors during transcribing and note-writing was done as a back-up during interviews. Data gathered was translated into English then transcribed and thereafter thematic analysis was done. Eight interviews in each municipality were conducted. Each interview took an average of an hour. The participants in Musina included three tribal chiefs, one female traditional healer, two male cattle farmers and three female cattle owners. In Umhlabuyalingana the interviews included two tribal chiefs, two traditional healers male and female, a cattle farmer and three IK custodians who once owned cattle.

### 3.2.6 Focus group discussions

Four focus group discussions in each province were used to gather information on the water security challenges. The FGD were divided into adult women and adult males over the age of 35 years, youth girls and youth boys below the age of 35 years. Since water security challenges differ between communities, sex and age the purpose of the FGD was to gather information if farmers share common views as from the interviews based on sex and age on water security challenges facing livestock. The FGDs were conducted in vernacular languages. Each focus group comprised of between 8 and 15 participants. The focus group for adults was comprised of cattle owners to capture data on water security challenges for livestock. Semi-structured guides were used in FGDs, to give room for probing and for the participants to express their knowledge, attitudes and perceptions on water security challenges affecting livestock. The guide covered water situation, water source reliability, and gender issues. After, translation and transcribing, thematic analysis was done. Each FGD took between 30 minutes and one hour.

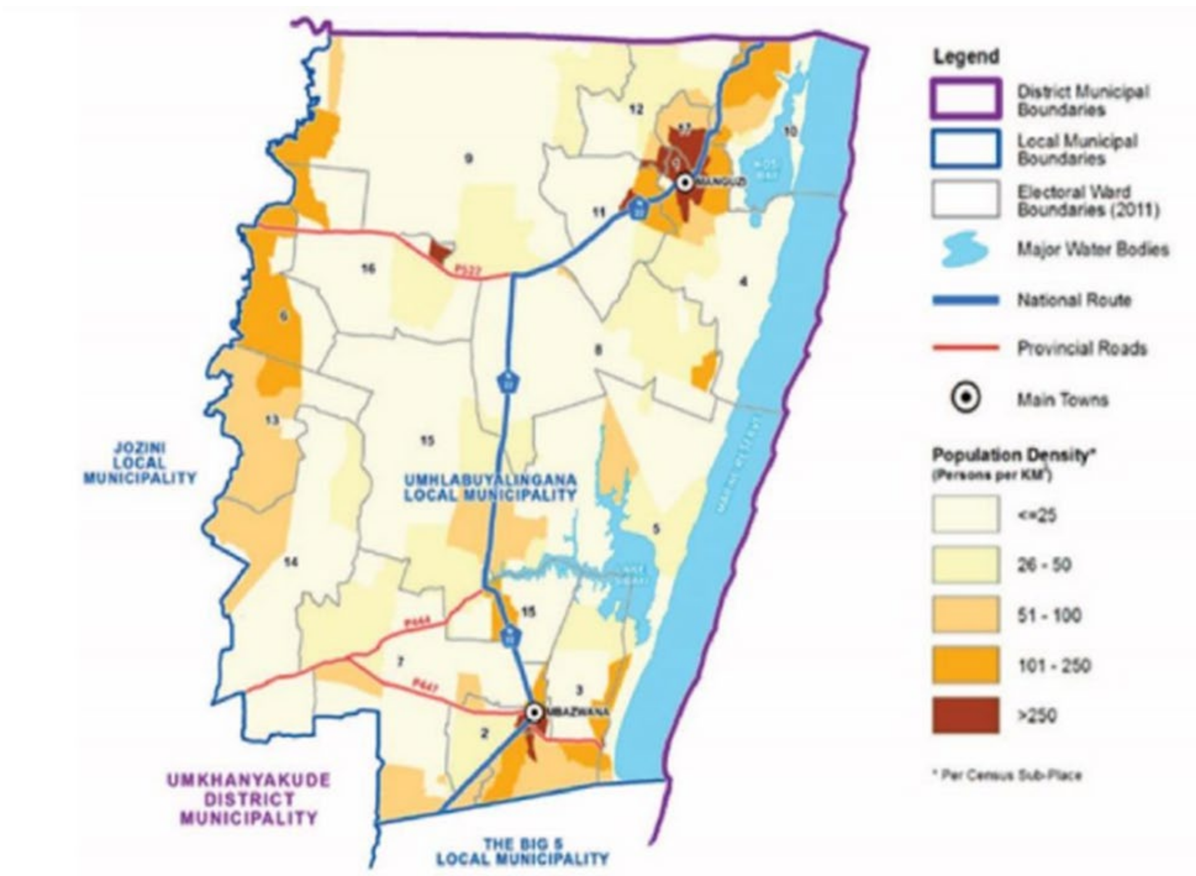


**Figure 3.1: Map showing the geographic position of Umhlabuyalingana Local Municipality (Umhlabuyalingana Local Municipality, 2017)**

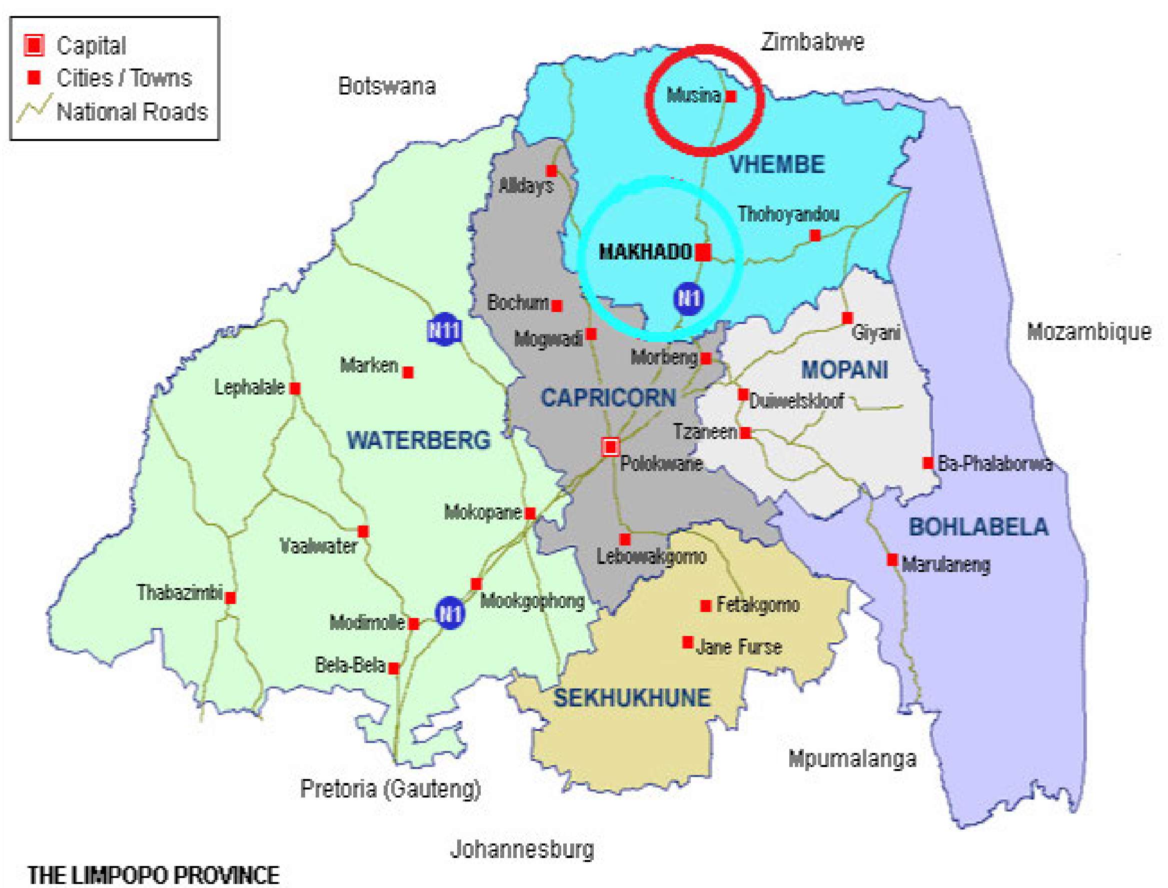


**Figure 3.2: Districts municipalities of Limpopo, South Africa (Makhado Municipality, 2005)**

## 3.3 Results

### 3.3.1 Water sources used by humans and livestock

Interviews and focus group discussions from Kwa-Sonto, Umhlabuyalingana revealed that cattle relied from the river and stream for drinking. The stream was reported not to dry up and the distance to the water source was less than 1 km. The boys and girls FGDs indicated similar results. Although, the women's FGDs from Ndlondlweni, Umhlabuyalingana pointed out that farmers with boreholes and taps where not facing similar challenges as farmers without boreholes. Cattle of farmers with boreholes shared the same water source while neighbours had to ask for water for their cattle since their dams are dry. Similarly, interviews from Musina indicated that farmers with boreholes their cattle had no water access challenges unlike farmers without boreholes. The farmers relied from the Nwanedi River to access water for livestock. Through direct observations, the distance to the river is 15 km. The girls FGD from Musina highlighted that sometimes water from the communal borehole is shared with livestock. The boys FGD from Musina reported that when water is unavailable from the borehole farmers have to buy for goats and cattle are left to drink from the river. In Musina, the interviews and discussions indicated that cattle used to have a separate borehole and it has been broken for over a year. The borehole was for all communal cattle use.

### 3.3.2 Causes of water insecurities

#### 3.3.2.1 Lack of municipal support

An elderly interviewee from Umhlabuyalingana pointed out that water security challenges faced by farmers were due to lack of municipal support. The men and women's FGDs from Umhlabuyalingana blamed the government for neglecting cattle during water allocation infrastructures and not providing water for cattle during water shortages. The youth FGDs did not mention any grievances towards municipality. Similarly, interviews and focus discussion from

Musina highlighted incompetence of the municipality. During the boys and girls discussions it was established that it takes 2-5 years for government to address farmers' issues. The women's FDG from Musina indicated that the broken borehole was reported to the municipality over a year, however, it has not been fixed. Cattle now relies from the Nwanedi River.

#### 3.3.2.2 Lack of rainfall

Interviews from Umhlabuyalingana reported the main cause for challenges hindering water security sustainability was the prevalence of drought due to lack of rainfall. The youth boys discussions concurred with the above reports as they pointed out water used to be accumulated during rainfall however now it has not rained. An elderly traditional healer and cattle associate added that the availability of water changed due to drought which started in 2014 to 2019. It has not rained since April 2019 up until September 2019. "*It been a while, the drought started 2014, its five years now. There is no rainfall*" – Elderly male farmer, Umhlabuyalingana. The adult women FGD from Umhlabuyalingana furtherly reported drought was the reason for lack of water and dry dams. Similarly, the adult male's focus group discussion claimed that dams are suffering due to drought and water is now too deep underground.

Correspondingly, interviews from Musina coincided with reports from Umhlabuyalingana on the cause of water security challenges. A livestock associate indicated that the lack of rain causes drought which later affects water availability. It was established from the interviews and youth boys and girls discussions that Musina experiences both short long term drought and it is currently experiencing both. Similarly, to Umhlabuyalingana, the boys FGDs from Musina highlighted that it's been the fifth year experiencing drought. The livestock associate further pointed out that the current drought started in May 2019 up until October 2019 and is ongoing.

### 3.3.2.3 Lack of IKS use

Different views on causes of challenges hindering water security were explored from interviews in Umhlabuyalingana. A livestock associate and traditional healer pointed out that lack of respect for ancestors and abandoning traditional customs was the reason for drought. Two elderly farmers concurred with the above statement highlighting that chiefs are no longer playing their part on practicing rainmaking ceremonies which always ensured water security for ecosystems. It was noted from the discussions that other causes of drought were not known such as lack of IKS. It was established that the groups had no knowledge about IKS for ensuring water security. Similarly, group discussions from Musina were unaware of other related water security challenges except lack of rain. However, one chief from Musina indicated that since IKS for water security were neglected, water has been scarce. Although another chief from Musina was aware of the IKS used, did not believe in them.

The interviews from Umhlabuyalingana revealed that during the olden days, chiefs and men would go to the mountains to perform rainmaking ceremony and it would rain. The rivers would be full and cattle would have access to water easily. An elderly female farmer who lost all her cattle further highlighted that even sangomas who are responsible to convey messages from ancestors about drought were not passing the messages. The drought is caused by the wrath of ancestors. Only the girls from Umhlabuyalingana FGD were familiar with some of the IKS practiced to ensure water security for cattle such as digging a hole next to were water flowed and cattleman drink. The adult FGDs and boys FGDs did not know any IKS. Correspondingly, adult group discussions from Musina lacked IKS used during drought. Although, boys and girls group discussions had knowledge on IKS used during droughts believed they are time consuming. The boys' group discussion also revealed that different beliefs affect the way we see IKS. A chief from Musina gave insight on the challenges which resulted in IKS being neglected. *"During summer* *no one is allowed to touch the marula fruit until someone from the royal brews it for rain making ceremony, but now we cannot control how people use their fruit trees which makes it hard to make the ceremony as it won't be effective*"- Chief, Domboni village, Musina.

### 3.3.3 Effects of water insecurity challenges on livestock

#### 3.3.3.1 Dry rangelands

During transect walks it was observed that there was sparse vegetation in parts of Musina villages for cattle to feed. An interview with a livestock associate from Musina reported that the prevalence of drought was putting a strain on the cattle as the land is dry. The boys FGDs further indicated the effect of drought enforces them to herd cattle such as cattle to the mountains as nearby rangelands are dry. The girl FGDs revealed that girls were not involved in cattle herding like boys. It was observed from the adult discussions of Musina that drought had in impact on the cattle as dry land forces cattle to change grazing points and have to search for near water points. Although, in Umhlabuyalingana interviews highlighted that cattle are not faced with water challenges, it was reported that during droughts cattle change the grazing habits to browse in forests. Forests, unlike grasses are rarely affected by droughts. Similarly, the boys FDGs from Musina reported that during drought they pick leaves from mountain forest to feed the weak cattle at home. The youth’s group discussions from Umhlabuyalingana were vague on cattle management during drought. The adult male group discussions indicated that cattle relied on the grass for feed and the lack of rainfall hinders the growth of the grass. The women group discussions concurred with the males discussions as it was also discussed that currently cattle are not released from household as grasses are dry. Correspondingly, a chief from Musina pointed out that during the old days farmers used to cultivate and cattle would rely on the residues. However, the prevalence of drought and lack of using IKS is affecting cattle and cultivation.

#### 3.3.3.2 Competition at water source

A livestock associate from Umhlabuyalingana who owned a private tap indicated that there was no competition between farmers and cattle for water. Although, it was reported that neighbouring cattle during drought use the same stream *Umnandawo* for water accessibility.

Interviews with farmers without private taps differed as they reported competition between farmers and cattle at the water source. The group discussions also reported competitions at the water source between farmers, cattle and other neighbouring farmers. In Musina competition for water was only reported by the chief who owned a borehole. The chief reported the borehole is shared with cattle and with other village farmers. The girls' group discussion from Musina also reported there was competition at the communal borehole when water is available cattle drink from leaks and it distracts other water users. The youth boys group discussion did not report competition at the water source. The women group discussions from Musina pointed out that since cattle use the Nwanedi River there was no competition at the communal water source. Although, goats have water bought for them, cattle need to travel to the river.

#### 3.3.3.3 Long distance travelled

In Umhlabuyalingana interviews reported that during water scarcity, an alternative river called Mwelandlovu is used for livestock. The river is an hour away when walking. The river Mwelandlovu is also where some farmers keep their cattle to be near to the water source to avoid walking every day. The youth's group discussions highlighted the stream *Umnandawo* in which the distance differed with where one house is situated. Some reported cattle walked less than 1 km. While in Musina unlike goats, cattle mostly are subjected to walking 15 km to the nearest river Nwanedi as the borehole is unable to sustain both farmers, goats and cattle. The interviews further indicated that the distance travelled by cattle to the river result in them being weak and have low birth rate. The boys' group discussion from Musina also revealed that during water shortages they need to herd cattle to the hills to get water. The hills are 1 hour away. The boys FGD from Musina indicated that cattle that are weak to walk, boys have to go to the hills and fetch water and forages for cattle. The adults' group discussions reported the distance to Nwanedi River. There are also farmers in Musina who keep their cattle near the

Nwanedi River to prevent them from traveling long distance every day and are supplemented and browse on nearby trees.

In Umhlabuyalingana, distance to water source differed between communities for livestock. In KwaSonto, cattle share a nearby stream with household users, while in Ndlondlweni, adult female FGD's revealed that cattle was not released from premises and relied from neighbours' borehole for water supply as rivers are dry. Ndlondlweni had no available water sources other than private boreholes one installs themselves. Although in Musina some farmers have boreholes, cattle are still required to travel for feed and return to get access to water as those cattle do not go towards Nwanedi River for browsing/grazing and water access.

"*We walk for an hour to fetch water on top of the hill, fhahani… Besides on top of the hill and wells we get water from Nwanedi river*"- Youth male from FGD, Musina.

#### 3.3.3.4 Low cattle productivity

During the adult male FDG it was highlighted that water shortages have a negative impact on cattle productivity in Umhlabuyalingana. Milk yield is reduced for calves and farmers no longer milk their cows. Drought has also affected the prolificacy rate of cows due to mortalities and low body water. In Musina, cattle are left on the mountains to feed as there is sparse pastures and come back to drink from boreholes after two or three days in households with boreholes. While farmers without boreholes let their cattle wonder around in search of feed and water which subject cattle to theft. It was reported that when cattle are on the mountain, they get stuck in-between rocks and die if the farmers does not check on them. Goats are provided with water by farmers. When cattle are weak to travel that's when youth males go to mountains to fetch feed.

"*We go to the bushes and get leaves to feed them*" – Youth male from FGD, Musina.

A livestock associate reported that 27 cattle died and was left with only 9 which are not producing at the rate they used to before drought of 2015/16. While similar results were reported in Musina whereby cows die strangely, and farmers suspect it could be because of drought.

##### 3.3.3.5 Body weight loss

An elderly farmer from Umhlabuyalingana reported that even when cattle survive drought it ends losing weight and be less energetic. The group discussion were vague on weight loss of livestock. In Musina only the boys group discussions highlighted the weight loss of cattle during water shortages.

##### 3.3.3.6 Cattle mortalities

Cattle mortalities were reported in both municipalities caused by water shortages. In Umhlabuyalingana interviews did not report cattle mortalities caused by water shortages but mortalities are due to lack of vegetation caused by drought. Although an elderly farmer in Umhlabuyalingana blamed the mortalities to angered ancestors. While in Musina the interviews revealed that cattle mortalities were caused by lack of adequate water supply. The girls' group discussions reported that cattle during droughts tend to eat soil and dies. The discussions further pointed out that since cattle are dying, it is evidence there is an ongoing drought. The boys' group discussion indicated that cattle are dying because of water shortages and high temperatures. A livestock associate officer further clarified that when cattle die during water shortages the grass ingested becomes dry and the stool of cattle is also dried up.

### 3.3.4 Methods of ensuring sustainable water security

It was established from the elderly interviews from Umhlabuyalingana that the re-establishment of IKS would cease the current drought situation. While the adult male group discussions reported that installation of windmills would solve the water security challenges faced by livestock. *"…and it is convenient to use windmills because they use wind to pump water and when the tank is full the water will immediately fall to the ground and the cattle's can drink that water"* – Adult male, Umhlabuyalingana. The adult women group discussions suggested a communal borehole for cattle to have access to water. Both the adult group discussions revealed that the water needed to ensure sustainable water security was deep underground. The youth group discussions from Umhlabuyalingana suggested reliable private taps to eliminate competing with cattle for water. Similarly, the girls' group discussions in Musina suggested a separate borehole for cattle to drink. Both in interviews and focus group discussions the use of IKS to sustain water security was discouraged in Musina. The adult group discussions reported that some people may not like the idea of using IKS and the girls' focus group discussion claimed IKS are time consuming. Nevertheless, it was noted that the boys' group discussions revealed they were keen on the idea of re-establishing IKS use. "*I believe in the rituals because my grandmother told me that it works"*– Youth male FGD, Musina. Although some were reluctant on the use of IKS as they claimed they are Christians.

### 3.4 Discussion

The major water security challenge stressed in the study was the unavailability of water for livestock. Water forms part of livelihoods and therefore it is essential for water to be available and easily accessible to livestock. In rural communities it is common that cattle use the river, streams and dams to access water which is the indigenous way to provide water unlike the conventional ways of erecting boreholes for livestock. The aforesaid concurs with findings from Umhlabuyalingana which had farmers mostly practicing indigenous ways of providing water to livestock. The findings from Umhlabuyalingana that cattle had access to *Umnandawo* stream which never dries up is in accordance with water security mandate. Contrary, the findings from the women's FGD in Umhlabuyalingana and interviews from Musina coincided with reports from a study by Funder *et al* (2012). Wealthy farmers who practiced conventional ways that owned boreholes were not facing similar challenges like the rest of farmers without boreholes (Funder *et al*., 2012). The results from girls FGD in Musina that communal borehole is shared with cattle could mean that cattle get water from the ground through leaks. The broken cattle borehole in Musina could be due to poor maintenance from both government and community members. The above statement proves that conventional systems are not reliable hence the need for IKS intervention. The observations from Musina that water is bought for goats shows the implication of how water insecure farmers are in that community. It shows how poor accessibility to water is and goes against water security mandate. Water security is multi-faceted and relates to access and provision of adequate quality and quantity of water for cattle (Soyaphi, 2017; Srinivasan *et al*., 2017).

Lack of municipal support for water services is an impeding challenge countrywide. The findings of lack of municipal support was also reported by Virk *et al*. (2019) and Mothetha *et al*. (2013). The findings that youth showed no grievances towards the government was expected. The youth still lack awareness of basic water services and stakeholders responsible. The observation of the broken communal borehole in Musina is evidence of incompetence in the government for cattle as the borehole was reported over a year.

One of the major causes for water to dry up are extreme high temperatures. Water evaporation is catalyzed under high temperature conditions. The lack of rainfall, however, has led to drought prevalence. Prolonged drought affects natural water sources as they dry up. In the village of Ndlondlweni in Umhlabuyalingana respondents complained they no longer have a river as it dried up. Farmers have no other alternatives but to spend money and buy water from neighbours. These villages have been under drought since 2014. The drought does not only affect water availability, but it affects grazing pastures for cattle.

Findings from Umhlabuyalingana revealed that water insecurities were due to drought and is as a result from angry ancestors. Results reported that people no longer believe in African traditional ways hence the occurrence of drought. This confirms the findings by Rukema and Simelane (2013) where people of Msinga claimed that the behavior of people in letting go of their cultures and practicing foreign ways has resulted in ancestors forsaking the community. The result that youth of Umhlabuyalingana was unfamiliar with IKS was expected. The results suggest that the youth lacks IKS as conventional methods are dominantly used. The latter includes findings from youth group discussions of Musina. The findings that the chief also did not believe in IKS could be due to clash of beliefs. The foreign religion has affected the way African culture is viewed. The African culture is associated with witchcraft and sin which goes against other religions. Although there many other underlying factors relating to how African culture is views besides religion.

Rainmaking rituals have always been practiced in many parts of Africa. These rituals have kept many Africans water secured. Similar results were reported by Rukema and Simelane (2013), that when a drought was predicted traditional healers had to go up the mountains to appease the ancestors.

The land has become dry such that cattle are required to be taken to be placed where there is feed. In Musina cattle rely on bushes for feed. The leaves from the bushes however, are being used up and they are dry, this subjects their cattle into walking long distances under hot extreme temperatures in search for feed. Hot extreme temperature can affect the productivity of cattle as more energy is required for walking. During extreme temperatures water is lost through respiration in cattle. The findings that drought affects grass more than forest in Umhlabuyalingana suggest that grass become overgrazed during droughts and forest become a substitute range. The observation that youth from Umhlabuyalingana was naïve about cattle management during water shortages was unexpected since the youth is often responsible for assisting adults in herding livestock.

During water shortages cattle must travel long distances in search for water, this have a negative effect on the cattle's productivity. The above concurs with the observed results from Musina were cattle must walk for 15km to the nearest river and decreased prolificacy. Cattle invest most of their energy and time walking to water points instead of feeding. The findings that in both municipalities cattle are kept near the water source could be to avoid the long distance traveled and maximize productivity, although results from Umhlabuyalingana differs in that cattle productivity has since decreased after drought. When cattle walk for long distance water is lost through respiration, this results in the body having to use more energy for maintaining water balance as well as heat stress. Cattle become weak during water shortages, especially those from household that do not have water sources in the yard. Some die along the way due to water imbalances. Installation of well-maintained water troughs and boreholes for cattle would mean the energy used in walking is conserved for reproduction and will ensure water security for livestock. Therefore, government should provide skillful personnel to conduct trainings on how to maintain such water sources to the community.

The findings from Umhlabuyalingana that the productivity rate is decreased were expected since water plays significant role in reproduction. When feed and water intake are reduced the oestrus cycle process is prolonged (Reddy and Rao, 2014). Cows from resource-limited community calve once in 2 years unlike commercial cows. The libido of bulls is also reduced during water restrictions (Reddy and Rao, 2014). Again, when cattle are too thin their energy levels and reproduction is decreased hence the results noted from Musina. The milk yield decreases, and the milk is reserved for the calf only. Muli (2000) argued that continuous availability of water increased milk yield than when given water once. Therefore, the lack of drinking water troughs for cattle and water insecurities reduces cattle productivity.

Parameters of productivity include weight gain, milk yield and reproduction (Wakchaure *et al*., 2015). Water is a source of nutrient to cattle. When cattle are subjected to water shortages, feed intake is reduced (Chedid *et al*., 2014). Weight loss is accelerated during water restriction periods (Baumgard *et al*., 2012). When cattle are thin profit is low reducing their marketability.

Prolonged water restriction results in death of cattle as goat are drought resistant (Mpendulo *et al*, 2017). The finding on mortalities in Umhlabuyalingana for cattle could be due to dehydration during the severe drought of 2015/16. Although the same cannot be said about Musina as no post-mortem tests were conducted. Cattle can live for up to six days without water but for sixty days without food (Wakchaure *et al*., 2015) and the 2015/16 drought was rather harsh on cattle especial from rural communities (Muyambo *et al*., 2017). It becomes the farmers' responsibility to provide water for cattle of which water access is an issue to farmers as well. During water shortages there is high competition among cattle for resources. In Musina the land is also dry and the distance to the nearest water source is very far resulting in cattle losing weight. During the dry season cattle lose weight and may die in two months (Descheemaeker *et al*., 2018).

The re-establishment of IKS to ensure sustainable water security for cattleman prove to be challenging due to clash of beliefs. The findings from Umhlabuyalingana that IKS use needs to be re-establish will need to be further investigated to get other farmers perceptions. The installation of windmills and boreholes describes the way the society is trapped into conventional methods. It also suggest the vast lack of IKS as conventional methods continue to fail, the youth still have hope because they are unfamiliar with IKS strategies and IKS as a whole.

### 3.5 Conclusions

In conclusion water security challenges were not too different between provinces however differed with sex and age. In both municipalities water availability was a major challenge. Drought was the main cause of the water securities. The drought was because of lack of rain and the use of IKS to secure water for livestock. The women FGD from Umhlabuyalingana had no water source for their cattle while an elderly male interviewed highlighted there was a water source for cattle that does not dry up. In Musina, although cattle had a borehole it was non-functional. The youth boys and girls were unaware of lack of municipal support while the adult indicated lack of municipal support. Further research is needed on the re-establishment of IKS use to ensure sustainable water security for cattle as suggested by the custodians of IKS. Hence, the need to investigate farmers perception on the integration of IKS and CK to ensure water security for cattle production.

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# Chapter 4: Integration of indigenous and conventional knowledge systems to ensure sustainable water security for cattle during droughts


## Abstract

The use of indigenous knowledge to mitigate natural disasters have prompted the need of integration of indigenous and conventional knowledge system to ensure water security. The use of IKS directly benefits farmers and cattle as water security becomes safeguarded. The objective of the study was to assess perceptions on integrating indigenous and conventional knowledge in ensuring water security for cattle. A total of 284 structured questionnaires and 8 focus group discussions (FGD) were used to collect data in two local municipalities of Limpopo and KwaZulu-Natal. The research tools were used to capture perceptions on integrating indigenous and conventional knowledge systems. There was a significant association between cattle ownership and the IKS use in Umhlabuyalingana. Farmers (35 %) that owned cattle used IKS more than farmers who owned cattle in Musina (18 %). Integration of IKS and CK was encouraged in Umhlabuyalingana (11 %) as compared to Musina (1 %). Musina farmers preferred CK (25 %) over IKS. Female farmers (46 %) in Musina preferred the use of rituals to prevent water insecurity and to cope during water scarcity while no female farmer from Umhlabuyalingana used rituals. The odds of youth ($P < 0.05$) being open to the idea of integration of IKS and CK was seven times more than the adults. Traditional healers ($P < 0.05$) showed a positive attitude towards integration of IKS and CK as the odds were eight times more than unemployed people. The perceptions of age, education status, and employment status and cattle ownership were the most common factors that influenced integrating IKS and CKS.



**Keywords**: Natural disasters, ritual, youth, traditional healers, cattle ownership.

### 4.1 Background

Indigenous knowledge systems (IKS) refers to long existing knowledge and practices that evolves within a particular community and environment to solve day-to-day challenges (Chisanga *et al*., 2017). Other sources define IKS as to what the local people do for survival, having evolved through trial and error, however, proven beyond doubt to cope with change (Vilakazi *et al*., 2019). Indigenous knowledge systems are usually passed from one generation to the next generation through songs, storytelling, and training (Basdew *et al*., 2017). Indigenous knowledge systems are often received from the elderly, traditional healers, and diviners (Mkwanazi *et al*., 2020).

Indigenous knowledge systems have been used by farmers in decision-making during natural disasters to prepare and cope (Howitt *et al*., 2012). During the 2015/2016 drought that left farmers vulnerable and with minimal government support, farmers had to rely on their IKS to cope. Hence, the elderly remain convinced on IKS being a viable option to sustain water security for livestock.

Indigenous methods used for water security include rainmaking ceremonies (Ombati, 2017) which are now underutilized because people have adopted CK. During periods of difficulty such as droughts, however, such methods are often rekindled. Although IKS are practiced in ensuring water security, they differ geographically within Provinces, communities and are influenced by culture, religion, gender, and age. It is important to consider the different cultures for each community when documenting IKS and to find common grounds.

In resource-limited communities, cattle contribute to food security and income generation (Mseleku *et al*., 2020). Cattle for example, have multiple functions such provision of meat, milk, and skin (Mapiye *et al*., 2019). Their contribution, however, depends on the surplus of feed and water (Hoeskra, 2017). Water shortages lead to decreased body condition, milk yield and meat quality (Bettencourt *et al*., 2015). Water is essentially required to regulate body temperature, digestion, metabolism, excretion lubrication and reproduction (Conte *et al*., 2018). The drought impact and failure of conventional knowledge systems exposes cattle to the above dynamics.

Conventional knowledge (CK) on the other hand, is based on experimentation, and immutable mobiles (DeWalt, 2017). Conventional knowledge often requires external inputs from skilled technicians, and it is usually not environmentally friendly whereas IKS are developed within the community and in close contact with the environment. Indigenous knowledge systems are fit to specific situation occurring at that moment while CK requires input from researchers to investigate the problem further (Gaillard and Mercer, 2013). Conventional methods are aimed at ensuring water security through water resource management systems. Water resource management systems include water source infrastructures, water pricing, information management (World Bank, 2017).

The use of conventional methods alone is, however, not sustainable due to poor infrastructure and lack of resources thereby leaving many resource-limited communities struggling to have access to adequate water. Despite concerted efforts of water provision by Department of Water Affairs, in resource-limited communities cattle remains neglected. In resource-limited areas, only one out of three water pumps are working (Nkuna, 2012) and exclude cattle having access to them. In other communities water sources have never been installed for cattle like borehole found in Musina. Resource-limited communities rely on utilizing locally available water sources such as streams, rivers and lakes. However, these water sources also rely on rainfall to be sustain livestock. The use of IKS directly benefits farmers and cattle as water security becomes safeguarded. Water security is "the availability of an acceptable quantity and quality of water for health, livelihoods, ecosystems and production…" (Grey and Sadoffs, 2007).

There is little available information on integrating IKS and CK to ensuring water security for livestock. Indigenous knowledge systems are marginalized, and the assimilation of western culture has contributed to a situation whereby IKS are diluted and not absorbed to benefits livelihoods (Vilakazi *et al*., 2020). Opportunities of complementing CK with IKS are great (Mkwanazi *et al*., 2020). There is a need to investigate the attitudes and perceptions of farmers on the integration of IKS and CK in water resource management systems to strengthen water security for livestock.

The study helps to pave a way forward for government on how to incorporate IKS to water resource policies through perceptions of using IKS and working with IKS custodians. It will get the feelings of farmers on re-introducing IKS and utilizing it with CK during natural disasters to prepare and cope. It is important to promote the use of IKS through integrating it to existing water resource management systems as cattle are also affected and CK are unreliable (chapter 3) and require skillful technicians unlike IKS. The study seeks to include decision-making about cattle water supply and utilization in water resource services. Through IKS documentation, IKS could be the future for young farmers unfamiliar with it and assist in reviving IKS making it possible for its integration. Provinces such as Limpopo and KwaZulu-Natal surrounded by rural areas are believed they are still attached to their cultural beliefs and use IKS to mitigate drought impacts (Muyambo *et al*., 2017). Since drought is prone to these provinces it of utter interest to investigate and compare the perceptions of re-establishing IKS and integrating IKS with CK to ensure water security for cattle as IKS employment was highlighted in chapter 3.

The objective of the study was to investigate farmer perceptions on integration of IKS and CK in ensuring water security in communities of Musina, Limpopo and Umhlabuyalingana, KwaZulu-Natal. It was hypothesized that perceptions of integrating IKS and CK are the same for ensuring water security across different communities.

## 4.2 Materials and methods

### 4.2.1 Study site

*Study site described in chapter 3.2.1*

### 4.2.2 Household selection and data collection

The study sites were selected based on their frequent experiences of water challenges for cattle with assistance of local leadership and Department of Agriculture and Rural Development. A purposive sample technique was used to select participants. The villages from each district municipality were identified based on ownership of cattle, lack of access to perennial water supplies, faced with extreme water shortages. Four communities that participated in the study were Ndlondlweni, Mseleni, KwaMabasa and KwaSonto in Umhlabuyalingana Local Municipality. Domboni and Malale represented the two communities from Musina Local Municipality visited. In each community, scheduled meetings with chiefs and local headmen were arranged to gain access to communities. The data were collected between August and October 2019.

### 4.2.3 Questionnaire administration

A total of 154 households in Umhlabuyalingana and 130 in Musina were randomly selected to participate in the study. The selection of households was based on willingness of farmers to participate in the study. Data collection was carried out with the assistance of trained enumerators which were identified by local community leaders to ensure that farmers are comfortable to co-operate during the study. The questionnaires were presented in the vernacular language, IsiZulu in Umhlabuyalingana and Tshivenda in Musina.

The questionnaire captured household socio-economic information, mitigation and adaptation strategies used to ensure cattle water security, perceptions on integrating IKS and CK. Respondents below the age of 40 years were classified as young adults, middle-aged adults as those between 40 and 59 and old adults were above 60 years (Wen-Bing Horng *et al*., 2001).

Professionals were those that had knowledge based contemporary occupations with skills that were acquired from formal training or education (Evettes, 2003).

### 4.2.4 Statistical analyses

Data were analysed using SAS (2019). The PROC FREQ procedure of SAS was used to compute the association between demographics and perceptions on the use of IKS. An ordinal logistic regression was done using PROC LOGISTIC to predict the odds ratios of the likelihood of integrating IKS and CK methods to ensuring water security. The results were interpreted for age, gender, level of education (educated and uneducated), occupation, cattle ownership, and site. The model used was:

$$\text{Ln}\,[P/1\text{-}P] = \beta_0 + \beta_1X_1 + \beta_2X_2 + \beta_3X_3 + \ldots\beta_tX_t + \varepsilon$$

Where: P is the probability of group integrating IKS and CK;

[P/1−P] is the odds of the group integrating indigenous knowledge and conventional knowledge systems;

$\beta_0$ is the intercept;

$\beta_1\ldots\beta t$ are the regression coefficients of predictors;

$X_1\ldots X_t$ are the predictor variables;

$\varepsilon$ is the random residual error

When computed for each predictor ($\beta1\ldots\beta t$), the odds ratio for group integrating IKS and CK.

## 4.3 Results

### 4.3.1 Demographic factors affecting use of indigenous knowledge systems

Table 4.1 shows the association between household demographics of respondents the use of IKS. There was a significant association ($P < 0.05$) between socio-economic characteristics and IKS use. Male farmers from Umhlabuyalingana (31 %) over 60 years old preferred IKS use more ($P < 0.05$) than male farmers (22 %) in Musina. Whilst 33 % of female farmers from Musina below 40 years preferred the use of IKS more to ensure water security than female farmers from Umhlabuyalingana (8 %). The association between farmers who favoured the use IKS and attended secondary education differed ($P < 0.05$) in Musina while it was 19 % in Umhlabuyalingana and 23 % of farmers in Umhlabuyalingana who favoured IKS use did not have formal educational training. The use of IKS was considered more by unemployed farmers in Umhlabuyalingana ($P < 0.05$) while in Musina it was prevalent amongst professionals (31 %). There association between cattle ownership and the use of IKS in Umhlabuyalingana differed ($P < 0.01$), farmers (35 %) that owned cattle used IKS more than farmers who owned cattle in Musina (18 %).

**Table 4.1: Association between household demographics of respondents the use of indigenous knowledge systems**

| Factors | Categories | Umhlabuyalingana | Musina | Significance |
|---|---|---|---|---|
| Gender | Male | 31 | 22 | ** |
| | Female | 15 | 32 | |
| Age group | ≤ 25 – 40 | 8 | 33 | ** |
| | 41-59 | 8 | 11 | |
| | ≥ 60 | 30 | 11 | |
| Education level | Uneducated | 23 | 11 | ** |
| | Primary | 4 | 15 | |
| | ≥Secondary | 19 | 28 | |
| Occupation | Professional | 7 | 31 | ** |
| | Traditional healer | 4 | 6 | |
| | Unemployed | 36 | 16 | |
| cattle ownership | ***Cattle*** | | | ** |
| | Yes | 35 | 18 | |
| | No | 9 | 37 | |
| | *Goats* | | | * |
| | Yes | 15 | 31 | |
| | No | 30 | 25 | |
| | ***Chickens*** | | | NS |
| | Yes | 13 | 22 | |
| | No | 32 | 33 | |
| Site | | 56 | 44 | NS |

* P<0.05; ** P<0.01; NS- Not significant (P>0.05)

### 4.3.2 Indigenous knowledge systems used to ensure water security

The association between gender and use of bio-indicators in Musina differed ($P < 0.05$), females (47 %) aged below 40 years (48 %) used bio-indicators to predict droughts as compared to females (5 %) from Umhlabuyalingana. There was a significant association ($P < 0.05$) between gender and the use of astrology to predict natural disasters in Umhlabuyalingana, male farmers (26 %) used astrology for predicting natural disasters than male farmers from Musina (19 %). In Musina female farmers (46 %) preferred the use of astrology to predict natural disasters than female farmers (9 %) from Umhlabuyalingana. There was an association between education level ($P < 0.05$) and use of astrology, farmers who attended secondary education in Musina (31 %) preferred astrology more than farmers in Umhlabuyalingana (22 %).

The association between age, gender, and transhumance (Table 4.3) during water scarcity differed ($P < 0.01$), female farmers from Musina (35 %) below 40 years old preferred transhumance more than female farmers (13 %) in Umhlabuyalingana of the same age. Male farmers from Umhlabuyalingana (33 %) over the age of 60 years old preferred transhumance as compared to male farmers in Musina (19 %) during water scarcity. There was a significant association between gender ($P < 0.05$), education level ($P < 0.01$) and use of rituals to cope during water scarcity in Musina. Female farmers (46 %) below 40 years old preferred the use of rituals to prevent water insecurity and cope during water scarcity while no female farmer from Umhlabuyalingana used rituals.

**Table 4.2: Associations between demographic information of farmers and indigenous predictive strategies used to ensure water security**

| Factor | Category | Bio-indicator | | | Astrology | | | Weather trends | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Umhlabuyalingana | Musina | Significance | Umhlabuyalingana | Musina | Significance | Umhlabuyalingana | Musina | Significance |
| Gender | Male | 16 | 31 | * | 26 | 19 | ** | 52 | 11 | NS |
| | Female | 5 | 47 | | 9 | 46 | | 22 | 15 | |
| Age group | ≤25 – 40 | 7 | 48 | ** | 10 | 40 | NS | 11 | 11 | NS |
| | 41 – 59 | 5 | 23 | | 10 | 12 | | 15 | 7 | |
| | ≥60 | 9 | 8 | | 14 | 14 | | 48 | 9 | |
| Educational level | No formal education | 8 | 13 | NS | 12 | 14 | * | 43 | 7 | * |
| | Primary | 3 | 30 | | 0 | 21 | | 0 | 4 | |
| | ≥Secondary | 11 | 36 | | 22 | 31 | | 30 | 15 | |
| Occupation | Professional | 1 | 22 | NS | 3 | 7 | NS | 0 | 4 | * |
| | Traditional | 0 | 6 | | 5 | 9 | | 4 | 4 | |
| | Unemployed | 21 | 50 | | 26 | 50 | | 70 | 17 | |
| Period of Stay | | | | | | | | | | |

* P<0.05; ** P<0.01; NS- Not significant (P>0.05)

**Table 4.3: Association between demographic factors and indigenous coping strategies during droughts**

| Factor | Category | **Coping strategies** | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Transhumance | | | Rituals | | | Taboos | | | Cultural prohibitions | | |
| | | Umhlabuyalingana | Musina | Significance | Umhlabuyalingana | Musina | Significance | Umhlabuyalingana | Musina | Significance | Umhlabuyalingana | Musina | Significance |
| Gender | Male | 33 | 19 | ** | 14 | 40 | * | 41 | 18 | NS | 47 | 6 | NS |
| | Female | 13 | 35 | | 0 | 46 | | 18 | 23 | | 24 | 23 | |
| Age group | ≤25 – 40 | 12 | 30 | ** | 0 | 61 | ** | 31 | 19 | NS | 19 | 18 | NS |
| | 41 – 59 | 11 | 12 | | 3 | 18 | | 13 | 13 | | 13 | 6 | |
| | ≥60 | 23 | 12 | | 11 | 8 | | 19 | 7 | | 44 | 0 | |
| Educational level | No formal education | 19 | 11 | ** | 14 | 22 | ** | 18 | 0 | NS | 29 | 6 | NS |
| | Primary | 2 | 21 | | 0 | 11 | | 0 | 6 | | 18 | 12 | |
| | ≥Secondary | 24 | 23 | | 0 | 53 | | 41 | 35 | | 24 | 11 | |
| Occupation | Professional | 2 | 10 | ** | 0 | 19 | NS | 13 | 6 | NS | 6 | 6 | NS |
| | Traditional healers | 2 | 4 | | 3 | 18 | | 12 | 0 | | 0 | 0 | |
| | Unemployed | 44 | 38 | | 11 | 57 | | 37 | 32 | | 65 | 24 | |

* $P<0.05$; ** $P<0.01$; NS- Not significant ($P>0.05$)

### 4.3.3 Feed management during water shortages for livestock

Table 4.4 illustrate the association between demographic information and perception on feed used during water scarcity. The association between gender and commercial feeds differed (P < 0.05) in Musina, female farmers (53 %) preferred to use commercial feeds as compared to female and male farmers in Umhlabuyalingana (7 and 11 %, respectively). There was a significant association (P < 0.05) between income and use of natural pastures in Umhlabuyalingana compared to Musina. Male farmers from Umhlabuyalingana (55 %) who earn between R 800 – R 1500 (24 %) preferred to feed natural pastures unlike farmers from Musina who relied on commercial feeds.

### 4.3.4 Integrating IKS and CK to ensure water security

The odds ratio estimates of integrating IKS and CK are shown in Table 4.5. The probability of adult farmers (P < 0.05) in Umhlabuyalingana preferring the idea of integration of IKS and CK was 7. 35 times greater than youth farmers. Whilst in Musina adults farmers were 1.148 less likely to promote the integration of IKS and CK than youth farmers (P > 0.05). The probability of educated (P < 0.05) farmers to support the integration of IKS and CK was 4. 325 times greater than uneducated farmers in Musina. The likelihood of farmers who are traditional healers considering integration of IKS and CK (P < 0.05) to ensure water security was 8 times greater than unemployed farmers in Umhlabuyalingana and 3. 259 times greater in Musina (P > 0.05). The probability of farmers who did not own cattle and who did not prefer integration of IKS and CK to ensure water security was 16. 871 greater in Umhlabuyalingana (P <0.05). In Musina farmers who did not own cattle were 3. 473 times likely not to support integration of IKS and CK (P < 0.05).

**Table 4.4: Association between gender, age group and type of feed system preferred during water scarcity**

| Factor | Category | Commercial feed | | | Natural pastures | | | Crop residues | | | Natural pastures and commercial feed | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Umhlabuyalingana | Musina | Significance | Umhlabuyalingana | Musina | Significance | Umhlabuyalingana | Musina | Significance | Umhlabuyalingana | Musina | Significance |
| Gender | Male | 11 | 29 | * | 55 | 10 | ** | 55 | 2 | NS | 34 | 23 | NS |
| | Female | 7 | 53 | | 12 | 23 | | 36 | 7 | | 26 | 17 | |
| Age group | ≤25 – 40 | 6 | 51 | NS | 23 | 18 | NS | 17 | 4 | * | 3 | 17 | ** |
| | 41 – 59 | 4 | 14 | | 19 | 9 | | 15 | 4 | | 12 | 20 | |
| | ≥60 | 8 | 17 | | 25 | 6 | | 60 | 0 | | 46 | 3 | |
| Income | < R 800 | 1 | 16 | NS | 14 | 11 | * | 4 | 6 | ** | 0 | 11 | * |
| | R 800 – 1500 | 8 | 29 | | 24 | 10 | | 70 | 0 | | 6 | 17 | |
| | R 1501 – 3000 | 2 | 17 | | 12 | 12 | | 15 | 2 | | 20 | 9 | |
| | >R 3001 | 7 | 20 | | 17 | 1 | | 2 | 0 | | 34 | 3 | |

*- Significant at P<0.05; **- Significant at P<0.01; NS- Not significant (P>0.05)

**Table 4.5: Odds ratio estimates, lower and upper confidence interval (CI) of integrating IKS and CK of ensuring water security**

| Predictor | Umhlabuyalingana | | | | Musina | | | |
|---|---|---|---|---|---|---|---|---|
| | **Odds ratio** | **Lower CI** | **Upper CI** | **P-value** | **Odds ratio** | **Lower CI** | **Upper CI** | **P-value** |
| Gender (Female vs Male) | 1.239 | 0.411 | 3.741 | NS | 2.161 | 0.806 | 5.791 | NS |
| Age (Adult vs Young) | 0.136 | 0.035 | 0.522 | * | 1.148 | 0.472 | 2.789 | NS |
| Education status (Educated vs Uneducated) | 0.513 | 0.130 | 2.025 | NS | 4.325 | 1.268 | 14.752 | * |
| Employment status (Employed vs Unemployed) | 2.530 | 0.531 | 12.060 | NS | 1.572 | 0.430 | 5.751 | NS |
| (Traditional healer vs Unemployed) | 8.098 | 1.362 | 48.133 | * | 3.259 | 0.573 | 18.529 | NS |
| Cattle ownership (No vs Yes) | 16.871 | 2.752 | 103.415 | * | 3.473 | 1.104 | 10.923 | * |

NS not significant; * significant ($P < 0.05$)

### 4.4 Discussion

The use of IKS during water shortages ensures water availability for livestock. The practices to bring about rain automatically refills streams and dams used by livestock. The integration of IKS and CK provides less pressure use on CK as they may be affected by overuse and burden of sustaining many users. Cattle will be water-secure regardless when CK systems fail. Elderly men unlike women are more devoted to their indigenous methods as it brings them closer to their spirituality. This could explain why elderly male farmers in Umhlabuyalingana used IKS more to ensure water security. Integration of IKS and CK may be difficult to initiate properly.

The findings that female farmers in Musina used IKS more than male farmers was unexpected, because women are responsible for household duties (Rukema and Simelane, 2014) than herding livestock. The observed association between education and use of IKS was unexpected, education often influence peoples attitude towards IKS practices. The Western educational system regard IKS as being inferior as compared to CK (Mkwanazi *et al*., 2020; Hughes and Buthelezi, 2014). It also influences the way cattle become managed under drought situations resulting in them suffering as farmers tend to not have alternatives on ensuring water security. Western education highly promotes western technologies.

The observed association between cattle ownership and IKS use in Umhlabuyalingana was expected because cattle farming forms part of resource-limited communities livelihoods and water scarcity puts pressure on owners and livestock. This means that cattle owners who use IKS must ensure water security for both humans and livestock. Another explanation could be that conventional water systems do not include cattle needs hence farmers rely on IKS to ensure water. Cattle are valued cattle and hence farmers find it mandatory to ensure water availability. The observed association between gender and use of bio-indicators in Musina, where female farmers used bio-indicator could be influenced by the involvement of women in cattle farming and therefore, they are able to predict natural disasters through livestock. Animal behaviour are used to predict natural disasters such as drought (Rukema and Simelane, 2013). Since, female farmers can use IKS its integration with CK would be easy to implement.

Farmers who failed to prepare for drought occurrences were linked to challenges encountered with being unable to predict droughts (Matope *et al*., 2020; Mavhura *et al.,* 2015). Common prediction strategies should be documented to assist farmers without IKS and needs to be explored. The findings that age and gender were associated with the practice of transhumance suggest that young female farmers in Musina prefer transhumance to avoid traveling and herding cattle to distant water points during water shortages. Farmers from sub-humid environment often prefer to walk their cattle long distances in search for water (Matope *et al*., 2020) unlike farmers from Musina. Similarly, in Zimbabwe, farmers prefer to walk their cattle during dry seasons to water points (Chakoma *et al.*, 2016). Again, it could be that middle-aged female farmers have household responsibilities and therefore, are unable to search water for cattle during water shortages. The observed associations between gender and transhumance in Umhlabuyalingana were expected, since men are often more involved in cattle decision-making as they are household heads (Fakade, 2016). The cattle's well-being is often the men responsibility in most African cultures and women are considered fit for household responsibilities.

Male farmers should include female farmers in decision-making to curb the gap between their farming roles as female farmers end-up being helpless during water scarcity (Gumede *et al*., 2013). The findings that there was an association between age group and practicing rituals in Musina was unexpected, youth is oblivious when it comes to performing rituals. The results show the enthusiasm that the youth farmers has towards using IKS as compared to adults farmers. The observed findings on association between education and rituals was unexpected in Musina, since education has the power to change people's perception on using IKS. Indigenous knowledge systems are often used by farmers with low educational training and rituals are the epicentre of IKS to secure water such as in rain making ceremonies (Mkwanazi *et al*., 2020). Integration of IKS and CK would mean frequent use of rituals. Guidelines to perform such rituals through documentation as the interest of using IKS is growing in young farmers should be prioritized.

The findings that there was no association between demographics, use of taboos and cultural prohibitions could imply that farmers are not familiar with taboos and cultural prohibitions used in the community since IKS is less practiced. The observed association between site and IKS being convenient in both Musina and Umhlabuyalingana suggests the ease of accessibility of IKS over CK in both sites. This also implies that although IKS use differs geographically, it is still used for its convenience. Indigenous knowledge systems can be easily modified to suit the changing environmental changes unlike CK which is immobile (DeWalt, 2017). The idea of integrating IKS and CK would mean including IKS custodians during CK development to better understand what works for the community. Extension officers would have to encourage the use of IKS amongst communities because of its convenience when CK fails. The observed association between site and CK being cost-effective in Musina was contradictory since IKS are normally perceived as being convenient and cost-effective (Ndwandwe, 2013). The results could be propelled by long term dependency on CK since IKS are now less used. The positive attitude towards use of IKS in Umhlabuyalingana shows a promising ability for the integration of the two knowledge systems to ensure water security for livestock.

The findings that age group influenced integration of IKS and CK in Umhlabuyalingana by adults shows the entitlement of IK ownership to its custodians, The results could be because adult farmers are familiar with both IKS and CK and therefore integrating the two would be easy than for youth farmers who are mostly exposed to CK. Failures of CK methods are ascribed to the elimination of IKS in resource-limited communities (Hughes and Buthelezi,

2014) and therefore integrating the two systems could have potential benefits on sustainability. This could also allow IKS to be revived and be passed on to future young farmers.

The observations that younger farmers are in favour of IKS and CK integration were unexpected in Musina, because youth have adapted to conventional technologies such as getting water from taps, they have little to no knowledge on the use of IKS to ensure water security. The younger generation is growing in an environment where rituals are less and no longer practiced. Younger farmers of Musina, are however, showing interest to know the IKS unlike youth farmer from Umhlabuyalingana. In a study by Rukema and Simelane (2013) it was revealed that the youth when being taught IKS they are doubtful and to IKS custodians it discourages them as they also did not ask questions of why. The unexpected high probability of educated farmers in Musina to encourage integration of IKS and CK could be due to that some educated people undermine IKS. People with high level of education earn substantial income and are able to replace broken infrastructure easily (Mutibvu *et al*., 2012) and perceive IKS as backwards.

Many of spiritual practices by traditional healer are done where there is flowing water (Bernard, 2003), therefore during droughts they become affected hence the observed probability of traditional healers preferring the integration of IKS and CK. Again, some of the medicine prepared require to be diluted with water and having to go to the river each time to mix herbs is difficult and conventional taps have become useful. Often when drought is predicted a message is conveyed to the traditional healers and then they send the message to the elders and chiefs' place to perform a ritual (Dlamini, 2017). Most religious Christian believing people have moved away from IKS practices this has led to traditional healers fearing to pass messages from ancestors to perform IKS rainmaking rituals to ensure water as they are perceived as witches and sinners.

The associations between gender and feed in Musina were evident that lack of rainfall results in farmers having to rely on commercial feeds due to unavailability of forage. The supply of fodder from extension officers paves a way for female farmers not to only rely on natural pastures but also get the chance to feed commercial feeds during dry seasons. The findings that gender and the use of natural pastures had an association in Umhlabuyalingana resonates with Fakade (2016). Erratic rainfall lead to dry land resulting in pastures drying.

### 4.5 Conclusions

Integration of IKS and CK was less encouraged in both the municipalities. Integration of IKS and CK was however, highly encouraged in Umhlabuyalingana as compared to Musina as being convenient. The youth of Musina showed an interest in the integration of IKS and CK unlike the youth from Umhlabuyalingana. The educated farmers from Musina also preferred the integration of IK and CK. In Umhlabuyalingana male farmers preferred using IKS as compared to male farmers of Musina, while in Musina female farmers preferred using IKS to ensure water security as compared to female farmers from Umhlabuyalingana. Lack of IKS seems to be hindering the integration of IKS and CK. Due to poor documentation of IKS strategies to ensure water security sustainability and lack of interest from some youth it becomes difficult to normalize it. Further research is needed on how different management systems under IKS and CK practiced during droughts affect the welfare and behaviour of lactating cows. Lactating cows are responsible for increasing the herd and producing milk and therefore their behavior during droughts needs to be understood. Hence, the need to investigate the effect theses management systems have on time budgets of cows as farmers prefer CK over IKS.

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# Chapter 5: Effect of different management systems used for cow-calf production on time budgets during droughts: a case of Domboni village, Vhembe District

## Abstract

Cattle forms part of livelihoods in resource-limited communities of Sub-Saharan Africa. The use of indigenous extensive managed methods during droughts to manage cows in resource-limited communities is increasingly becoming popular. The objective of the current study was to compare time budgets of cows kept under the extensive managed and conventional herding systems during drought. Four non-descript lactating cows from each management practice were used. The cows were monitored for each management system using trained enumerators during the dry season. Extensivel managed cows spent 2.2 hours/day more time ($P < 0.05$) walking as compared to semi-extensive managed cows (0.7 ± 0.15 hours/day). Extensive managed cows travelled 18.6 min/h longer ($P < 0.05$) in between feeding than semi-extensive managed cows (17 ± 6.80 %) that walked for 2.45 min/hr. Semi-extensive managed cows spent 3.4 hours/day more time feeding ($P < 0.05$) compared to extensive managed cows (47 ± 3.53 %). It was concluded that under drought conditions, extensive managed cows spent more time walking to the water source and to rangelands than semi-extensive managed cows. Although, indigenous management methods were more convenient for poor farmers, semi-extensive management practices are most viable during drought periods

**Key words**: Time spent walking, feeding and standing, extensive managed, semi-extensive managed, herding.

### 5.1 Background

Over one billion of the world population, mostly from Africa, rely on cattle for food security (Matemilola, 2017; Ickowicz *et al*., 2012). Cattle forms part of livelihoods in resource-limited communities of Sub-Saharan Africa. Sub-Saharan Africa is severely affected by climatic conditions such as droughts and limited resources which also affect cattle directly. Unlike goats which are drought-tolerant (Mpendulo *et al*., 2017), cattle are highly susceptible to water and forage shortages, yet they are highly popular and highly valued in communal production systems. Cattle are highly valued over goats and sheep because of their great benefits. They are kept for provision of draught power, cultural ceremonies, status quo, and income investment and for nutritional benefits. Cows, for example, are mostly kept to multiply the herd and produce milk. During the calving season, cows require increased amounts of water and forages. During droughts, resource-limited farmers struggle to provide high input resources for cows and, thus, practice extensive management farming. Under extensive farming cows rely on natural pastures and require less labour effort. Extensive management is dominant in resource-limited communal farmers during droughts, however, few farmers practice semi-extensive management of late. Semi-extensive management is the integration of extensive and intensive management. In Musina (Chapter 3) the use of semi-extensive farming management was highly preferred as compared to Umhlabuyalingana which used extensive farming management. The disadvantage of extensive management during drought period is that cows travel long distance in search for feed and water while in semi-extensive management cows can be controlled in a camp.

In the case of Musina, extensively managed cows were allowed to search for feed while semi-extensive managed cows were allowed to graze on crop residues on a farm. The extensively managed cows needed to search for water points and semi-extensively managed cows used the river for water access while they browse again near the water point. Therefore, the time cows travel to and from pastures is twice the amount of time taken by the rest of the herd per day for extensive cows. Therefore, frequent occurrence of droughts decreases milk yield, calving rates and performance and, consequently, reduce herd sizes. Few farmers are able to install water sources for cows to get water while the rest rely on rivers and cows have to travel long distances to access water and natural pastures. There is need to determine time budgets in cows kept under different management systems.

Limpopo, Eastern Cape and KwaZulu-Natal provinces were severely affected by the 2015/2016 drought. Farmers had to rely on the use of IKS water management practices to mitigating the impacts of droughts and therefore IKS was a viable option during droughts (Iloka, 2016; Muyambo *et al*., 2016). Indigenous knowledge sysmtems indicate a type of knowledge that has emerged from within the community and is advanced to subsequent generations in a specific geographic area (Chaudhry, 2011). Thus, IKS us would be a viable tool under extensive management. While semi-intensive management system involves the use of advance technology such as boreholes, controlled grazing/browsing in camps and also allowing free movement.

Time budgets of cows under these two management practices on the time budget of cows needs to be understood by livestock officials to ensure the development of sustainable strategies to manage cows during droughts. Time budgeting is the time spent on feeding, walking and standing (Dodzi and Muchenje, 2012). Determining time budgets should convince farmers, government and non-for-profit agencies on challenges that cattle face and design appropriate mitigation strategies to reduce loss of cattle productivity. The objective of the study was, therefore, to investigate the effect of different management practices on the time budgets of cows during droughts in resource-limited communities. It has been hypothesised that time budgets for extensive and semi-extensive managed cows differ.

## 5.2 Materials and methods

### 5.2.1 Description of study site

The study was conducted in Musina Local Municipality (22° 22’ 0” S, 29° 45’ 0” E), in Vhembe District Municipality Limpopo province, South Africa. The study sites where chosen based on water security challenges, frequency of drought occurrences, availability of livestock, and how cattle is managed during droughts. The municipality consists mainly of commercial farms. The municipality holds a human population of 132 000 with an average of five people per household (StatsSA, 2016). The type of vegetation found in the municipality is the bushveld comprising of low-shrub and thorny trees. The type of soil found here is mostly sandy.

Musina receives an annual rainfall of 246 mm, with most rainfall occurring mainly during mid-summer (SA Explorer, 2017). It receives the lowest rainfall of 0mm in June and the highest of 55 mm in January. The average temperatures for Musina range from 23.9°C in July to 32.1°C in January. The region is the coldest during July when the mercury drops to 7.6°C on average (SA Explorer, 2017). Common agricultural practices in the district include commercial field crops, vegetables and extensive rearing of livestock.

### 5.2.2 Experimental procedure and management of cows

Eight non-descript cows from two herds were selected and divided into two groups in a completely randomized design. The cows used included cows and their calves. The two groups selected were either extensively or semi-extensively managed. The cows mostly browsed from bushes in the mountains and return after two days for water. When it rains the cows stay longer and drink water stored in rocks at the mountains. The cows mostly fed on the Marla leaves. These cows were classified as extensive managed cows as no labour was required and were not herded. The second group of cows had access to the river and grazed on grass and crop residual at the farm and were categorised as semi-extensive managed cows as they were herded. These cows would also browse on trees near the river. The river was 400 m from the farm and these cows were penned every day. All the cows used in the study had calved within three weeks.

The cows were released from 0800 h and penned at 1600 h. The experimental cows were marked with different colour sprays (Supona aerosol®) for easy identification. The cows were allowed to walk with the rest of the herd. Each cow was considered a replicate. The cows were penned overnight.

#### 5.2.3 Description of experimental cows

The cows were mixed breeds as they are bought from auctions. The ages of the cows ranged from five to 10 years. Extensively managed cows were penned daily during dry season unlike the rest of the herd since they return for calves to suckle until calves are able to browse. Semi-extensive manged cows were penned daily to prevent from theft and wild animals. Semi-extensive managed cows that were used had calved three times. The cows used to calve once a year before the impacts of droughts, however, since the drought the calving rate has decreased to calving once in two years underweight calves. In both management systems, calves were weaned naturally. The body condition score (BCS) of extensive managed cows was 2 and 3 while semi-extensive managed cows had a BCS of 3 (Table 5.1).

#### 5.2.4 Data collection

The cows were monitored from time of release from the pen. Observations were done at about 100 m from the herd to limit stress and distractions to cows. Each cow had an individual observer assigned to it. Data were collected over three days from 0800 h to 1100 h.

Behavioural activities observed in the study were based on the Ethogram given in Table 5.2. Data on time budgets for walking, feeding and standing behaviour of cows were collected using direct observations (Chizzotti *et al*., 2015). A stopwatch was used to time and record the duration sessions. Sessions were described as the average duration spent on each activity by cows before changing to another activity. Frequency was the total number of times the cows performed each behavioural activity from the time they leave the pen until they come back for overnight penning. The cows were continuously monitored to assess time budgets under the different management systems.

### 5.2.5 Body condition scoring

Body condition score (BCS) of the cows in the herd were recorded (Table 5.3). The BCS were determined to assess the time scheduling of cows and compare the effectiveness of each management. Visual assessment of BCS was done using a five-point scale (Fakade, 2016). Body condition score was done by one person throughout the duration of the study to prevent possible inter-observer discrepancies.

**Table 5.1: Description of management practices for cows**

| | Extensive | Semi-extensive |
|---|---|---|
| N | 4 | 4 |
| Distance to water source from rangeland | >4 km | <4km |
| Time taken to water source | > 3 hours | < 5 minutes |
| Rangeland | Natural pastures | Crop residues |
| Water source used | River | River |

**Table 5.2: Ethogram of behavioural activities used in the study**

| Activity | Description of behaviours |
|---|---|
| Walking | Movement of the cow without engaging in any activity such as drinking and feeding |
| Drinking | Muzzle touches the water |
| Feeding | Biting the feed and stopped when it pauses longer than 30s without biting |
| Standing | Standing idle without movement of limbs |

**Table 5.3: Body condition scoring sheet used**

| Body condition score | Description |
|---|---|
| 1 | Severely emaciated |
| 2 | Very thin |
| 3 | Moderate |
| 4 | Fat |
| 5 | Over fat |

**Source**: Fakade (2016)

### 5.2.6 Equations

Total time budgets $= \frac{\sum Time\ scheduling}{240(total\ observational\ time)} \times 100\ \%$;

Hourly time sessions $= \frac{\sum time\ scheduling\ per\ hour}{60} \times 100\ \%$;

Total distance walked (km) = Total time spent walking per day × Average walking speed of a dairy cow (3.4 km/h).

### 5.2.7 Statistical analyses

The mean proportion (%) of time spent on each activity was analyzed using the generalized linear model procedures of SAS (2009) to determine the time scheduling (walking, feeding and standing behaviour) for cows. The time budgets were analyzed in hours then presented in mean proportions.

The model used was;

$Y_{ijk} = \mu_i + W_j + T_k + (W \times T)_{jk} + \varepsilon i_{jk}$

Where:

$Y_{ijk}$ – time spent on each activity (walking, feeding and other activities)

$\mu_i$ - overall mean,

$W_j$ – effect of management system (j = extensive managed and semi-extensive managed),

$T_k$ – effect of time of day (k = 9, 10, 11),

$(W \times T)_{jk}$ - interaction of management system and time of day,

$\varepsilon ij$ –residual error.

## 5.3 Results

### 5.3.1 Time spent on behavioural activities

Table 5.4 shows the proportion of the mean total time spent and the hourly sessions on each activity of cows. Differences were observed on the total time spent walking by extensive managed cows (53 ± 3.8 %) as they walked 2.24 hours/day longer than cows that are semi-extensive managed (17 ± 3.8 %) (Table 5.4). Extensive managed cows traveled 18.6 min/h longer ($P < 0.05$) per hour (39 ± 6.80 %) before changing to another activity than semi-extensive managed cows (17 ± 6.80 %) that walked 2.45 min/h (Table 5.4). Extensive managed cows travelled longer ($P < 0.05$) from rangelands to the water source than semi-extensive managed cows. Total time spent feeding was significantly longer ($P < 0.05$) for semi-extensive managed cows as they spent 3.37 hours/day more time feeding (71 ± 3.5 %) compared to extensive managed cows (47 ± 3.5 %) (Table 5.4).

### 5.3.2 Relationship between time spent walking and time spent feeding in different management systems

The mean proportion for the effect of different management systems on time budget is illustrated in Figure 5.1. There was a significant effect ($P < 0.01$) of management systems on time budget of cows (i.e. time spent walking and feeding). The extensive management practices had an inverse effect on time spent walking and time spent feeding of cows (Figure 5.1) compared to semi-extensive management systems ($P > 0.05$). Under the extensive management system cows walked longer (53 %) and spent less time feeding (47 %).

### 5.3.3 Interaction between management systems and time of day on time spent walking

There was a significant interaction ($P < 0.05$) between management systems and time of day on time spent walking. Extensive managed cows travelled longer in between feeding during 0900 h

**Table 5.4: Time budget (%) of activities by free-ranging and semi-extensive managed cows (mean ± SE)**

| Time budget | Extensive managed cows | | Semi-extensive managed cows | | SE | Significance |
|---|---|---|---|---|---|---|
| *Walking* | (%) | Time (h) | (%) | Time (h) | (%) | |
| Total time walking (h/day) | $53^a$ | 2.24 ± 0.13 | $17^b$ | 0.67 ± 0.15 | 3.84 | * |
| Walking sessions (m/h) | $39^a$ | 18.58 ± 1.94 | $17^b$ | 2.45 ± 1.57 | 6.80 | * |
| Frequency for walking | 14 | 7.75 ± 0.95 | 13 | 17.0 ± 1.15 | 1.37 | NS |
| *Feeding* | | | | | | |
| Total time feeding (h/day) | $47^b$ | 4.59 ± 0.11 | $71^a$ | 3.37 ± 0.18 | 3.53 | * |
| Feeding sessions (m/h) | 59 | 29.13 ± 4.46 | 70 | 11.28 ± 3.49 | 6.18 | NS |
| Frequency for feeding | 14 | 7.50 ± 0.86 | 15 | 19.0 ± 2.0 | 1.24 | NS |
| *Standing* | | | | | | |
| Total time standing (h/day) | 0 | 0.75 ± 0.09 | 12 | 1.07 ± 0.72 | 2.95 | NS |
| Standing sessions (m/h) | $2^b$ | 5.87 ± 2.68 | $12^a$ | 7.80 ± 2.94 | 2.13 | * |
| Frequency for standing | 0 | - | 6 | 8.0 ± 1.53 | 1.08 | NS |

$^{a,b}$ Values across rows with different superscripts differ.

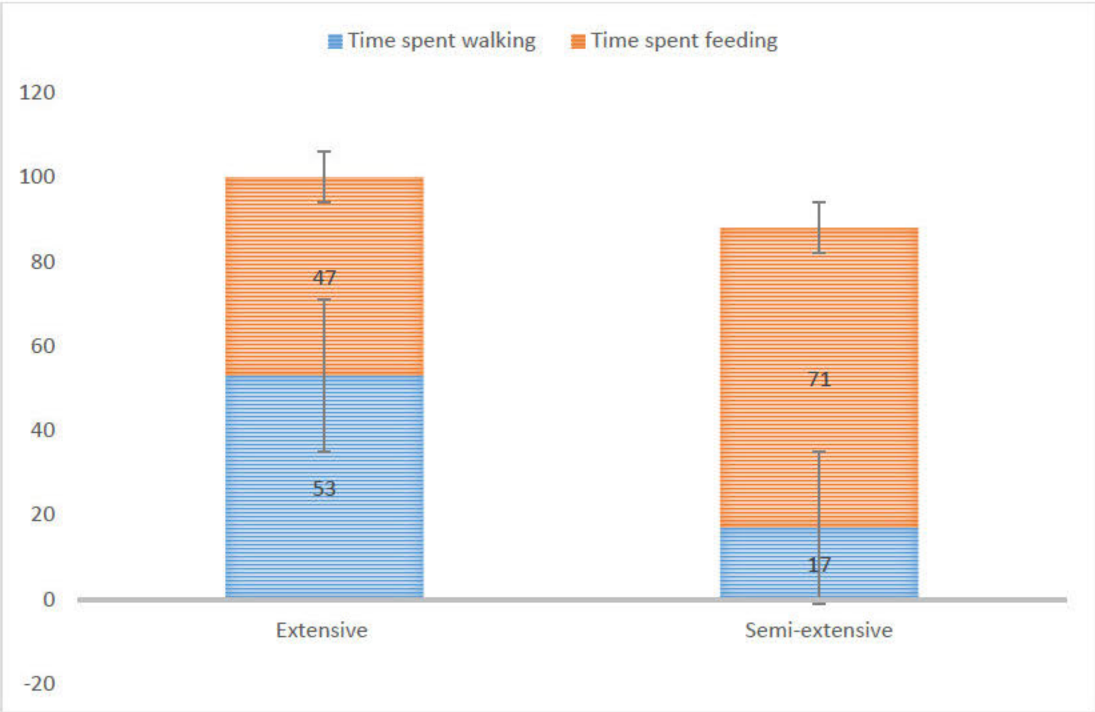
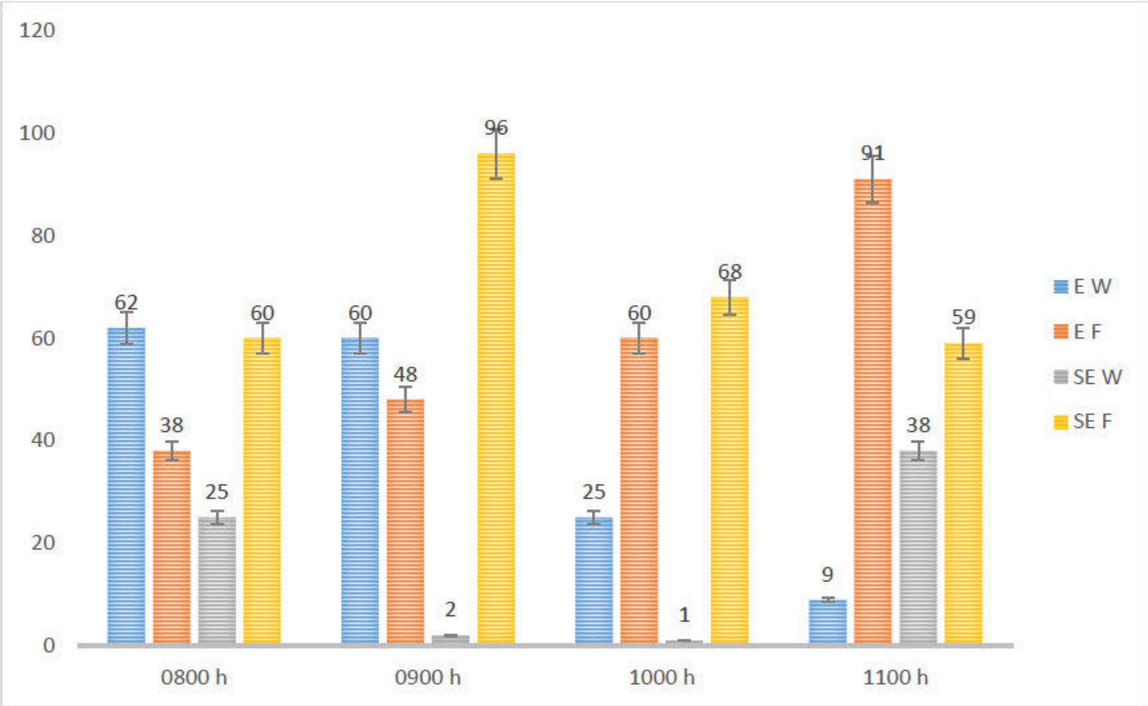
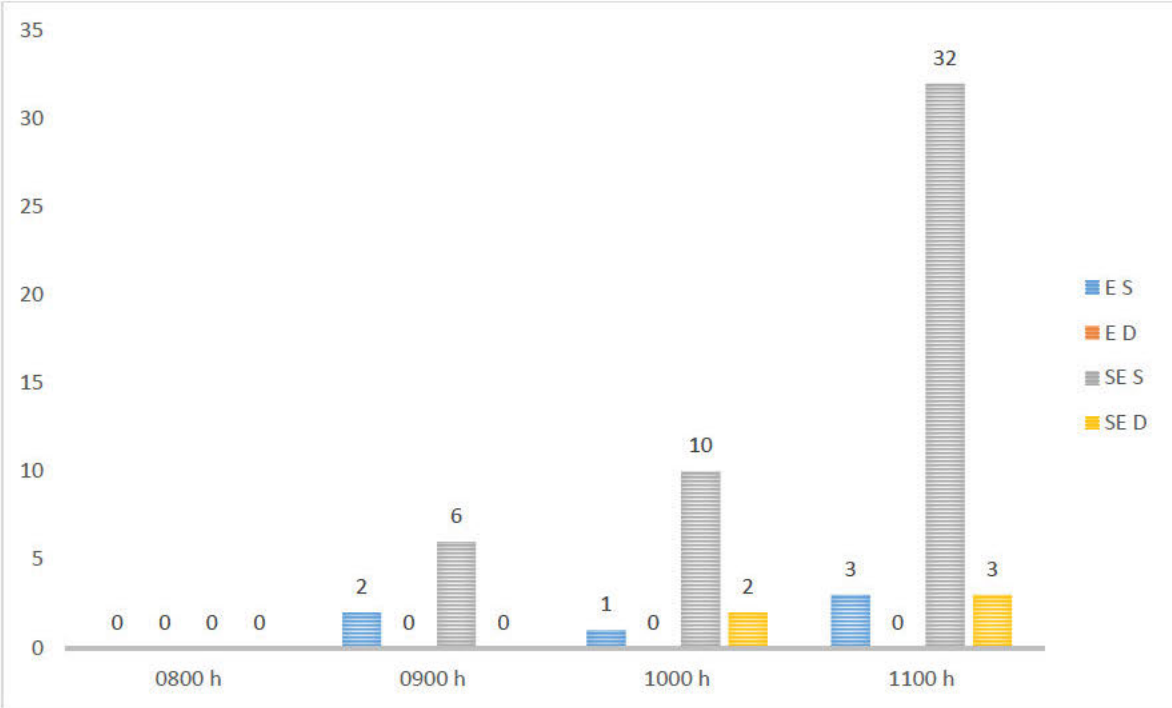



**Figure 5.1: Mean proportions of time spent walking and time spent feeding in different management systems**




Abbreviations: Extensive walking (EW)- Extensive feeding (EF)- Semi-extensive walking (SEW)- Semi-extensive feeding (SEF)- Extensive standing (ES)- Extensive drinking (ED)- Semi-extensive standing (SES)- Semi-extensive drinking (SED).

**Figure 5.2: Interactions between management systems and time of day on time spent walking and feeding.**




Abbreviations: Extensive walking (EW)- Extensive feeding (EF)- Semi-extensive walking (SEW)- Semi-extensive feeding (SEF)- Extensive standing (ES)- Extensive drinking (ED)- Semi-extensive standing (SES)- Semi-extensive drinking (SED).

**Figure 5.3: Interactions between management systems and time of day on time spent on other activities (standing and drinking).**

(60 %) while semi-extensive managed cows spent only 2 % of their time walking (Figure 5.2 A) in between feeds. However, walking time for semi-extensive managed cows (38 %) increased ($P < 0.05$) from 1100 h as they towards the water source as compared to extensive managed cows (9 %) which had access to water in the morning before time of release from pens.

#### 5.3.4 Interaction between management systems and time of day on time spent feeding

There was a significant interaction between management systems and time of day on time spent feeding ($P < 0.05$). During 0900 h semi-extensive managed cows spent 58 min/h (96 ± 12.35 %) feeding than walking while extensive managed cows spent 29 min/hr (48 ± 12.35 %) feeding before changing to another activity (Figure 5.2 B). Conversely, from 1100 h the time spent feeding increased ($P < 0.05$) for extensive managed cows (91 ± 12.4 %) with decreased walking time as compared to semi-extensive managed cows (59 ± 12.35 %).

Differences were observed between management systems and time of day spent on standing ($P < 0.05$). Semi-extensive managed cows spent time standing during 1100 h when at the water source than extensive managed cows.

### 5.4 Discussion

The frequent occurrence of droughts results in many changes and adaptations to manage cows due to farmers being unprepared. In chapter four it was discovered that some farmers practice IKS feeding strategies such as extensive management practices over integrated IKS and CK strategies which is semi-intensive managements. It was discussed that cows unlike the rest of the herd is adversely impacted under extensive management systems. The time budgets of cows get implicated during drought spells and the behaviour of cows changes.

The findings that time spent walking for extensive managed cows was more than that of semi-extensive managed cows was expected. This is because of the long distance extensive managed cows need to travel from natural pastures to the water source (Mdletshe *et al*., 2018) as compared to the 5 minutes distance that semi-extensive managed cows travel. Long distance is often a disadvantage under the IKS management practices during droughts as compared to herding. The observations that walking sessions for extensive managed cows was more is due to the long distance in-between feeds and the water source. Another reason could be due to sparse vegetation during feeding unlike semi-extensive managed cows where feed is near the river (Reeves *et al*., 2019). Similar findings were observed by Phillips (2002) where it is claimed movement of cows is encouraged by severity of resource restriction. Malan *et al*. (2018) stressed that when water source is closer to the farm cows limit the walking time and cows drink continuously unlike extensive managed cows from the current study. This means the practice of CK management during droughts has the potential to curb long distance travelled.

The observation that semi-extensive managed cows spent more time feeding suggests that the time spent walking is invested in feeding unlike extensive managed cows. The short time spent from the pen and water source to natural pastures allows the semi-extensive managed cows to spent most of their time feeding (Malan *et al*., 2018). However, the use of IKS such as rainmaking rituals could ensure natural pastures are abundant as extensive managed cows travel due to sparse dry land. The rain would ensure poor farmers cultivate and therefore cows can rely on both crop residues and natural pastures. This would give farmers an advantage to integrate IKS and CK and practice semi-intensive management system to manage cows during possible droughts.

The finding that there was an interaction between extensive managed cows and time spent walking the second hour was anticipated. The fields are far from the river and vegetation is far apart until they reach the fields unlike semi-extensive managed cows which are closer to the fields hence less time is used for walking. And, semi-extensive managed cows are where feed is ad-libitum. Contrary, the findings that the interaction between hourly walking sessions of semi-extensive managed cows and time spent walking increased from 1100 h is because cows are semi-extensive managed towards the water source at this time while extensive managed cows only have access to the borehole early in the morning before walking to the fields. Although, extensive managed cows had access to the water source after three days, Ali *et al*. (2015) describes that the maximum time cows can be water restricted should not be more than three days.

The observation that there was an interaction between semi-extensive managed cows and time spent feeding in the second hour could be due to the fact that feeding fields are closer to the kraal, unlike extensive managed cows that need to spend the first three hours walking to rangelands. The same could be said for the second hour where semi-extensive managed cows spent most of their time feeding. The findings that there was an interaction between hourly times spent feeding and extensive managed cows that increased from 1100 h was expected. The findings suggest the vegetation is abundant from that point although far from the water source. On the contrary, Ishiwata *et al*. (2008) reported that feeding time for free ranged cows decreased with pasture availability. A closer water source enables cows to get enough time to feed than spend all the energy searching for feed. This is evident on the semi-extensive managed cows as they were closer to the river. The semi-extensive managed cows spent less time walking to the water source and less time walking to feed. This will also allow the cows to conserve production energy from feed.

### 5.5 Conclusions

Semi-extensive managed cows spent more time feeding near the water source while extensive managed cows spent enormous time walking to the water source from fields. It can therefore be concluded that there were differences in type of management used by farmers during droughts. Extensive managed cows invested time walking between rangeland and water source while semi-extensive managed cows walked less and spent more time foraging. However, semi-extensive managed cows require enormous inputs and labour. Hence, CK managements system as stand-alone are difficult to implement. The enthusiasm of integrating IKS and CK would therefore benefit both farmers and cows. Indigenous knowledge management systems such as feeding natural pastures are freely accessible to cattle although affected by droughts and distance. Therefore, the integration of

IKS use to ensure water security and CK management systems have the potential to reduce drought impacts on cows.

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# Chapter 6: General discussion, conclusions and recommendations

## 6.1 Background

Cattle farming is the epicentre of livelihoods in resource-limited communities and is equally affected during droughts. The increasing drought invasion has caused strain in natural resources and resulted in resource-limited communities finding ways to cope with natural disasters. The use of IKS in water management during droughts to cope with water shortages in other parts of the country was significant (Muyambo *et al*., 2017). The integration of IKS and conventional knowledge (CK) systems to ensure and sustain water security for cattle as CK methods continue to be unreliable during droughts in resource-limited communities has not been explored. Understanding the causes and effects caused by droughts in cattle can better assist in implementing an IKS and CK system that can be used to prepare and cope during droughts. There are many underlying factors contributing to the causes and effect of droughts which tend to also affect how cattle is managed in the process.

The causes and effect of water security challenges were investigated in Chapter 3. Key informant interviews and focus group discussions were conducted to get the in-depth of causes and effects of water security challenges hindering cow-calf unit production increasing. Water unavailability was the major issue facing cattle in both study areas assessed. Lack of municipal support was reported in both Musina and Umhlabuyalingana as the leading cause to sustaining water security for livestock. This is due to broken infrastructure that the municipality take years to fix. In Musina a cattle borehole was reported to have been broken for one year and has never been fixed though it has been reported severally. In Umhlabuyalingana there was lack of infrastructure for livestock. Indigenous water sources such as streams and rivers were the only water points used in Umhlabuyalingana as compared to Musina where some farmers shared the borehole with their livestock. Lack of rainfall was reported in both study areas as the second contributing factor to drought causes. The lack of rainfall is due to climatic change that causes fluctuations in precipitation and due to most farmers being unable to predict the weather trends, this has led to farmers failing to prepare for droughts and cattle suffer as a result. The interviews further revealed that discontinued use of IKS was another reason for droughts experienced by farmers and livestock. Indigenous knowledge systems have in the past been used to predict oncoming natural disasters and this assisted in preparing for such disasters (Muyambo *et al*., 2017). The superseded use of IKS such as rainmaking rituals which is the centre for ensuring water security through IKS was listed as an effective method. The use of IKS has been discouraged due to differences in beliefs and lack of enthusiasm from the youth as reported in the interviews.

The effects of droughts on cattle discussed included dry rangelands. Due to droughts, the land is dry and the grass is scarce for cattle as most farmers practice IKS methods of feeding such as natural pastures. Browsing was common among the cows as bushes were abundant than grass which was only available in cultivated farms. It becomes difficult for farmers to cultivate for cattle to feed on crop residues after harvest as some farmers rely on conventional methods of feeding to avoid long distances travelled by livestock. In Musina it was reported that during droughts cattle travel 15km to the nearest water source which is Nwanedi River while in Umhlabuyalingana cattle travelled for 3 km to the nearest water source. The results suggests that cattle need to invest most energy in walking which could be used for maximising productivity. Contrary, farmers from Zimbabwe preferred for their cattle to travel long distances to water sources (Muyambo *et al*., 2017). The lack of water has led to competition for water resources in Umhlabuyalingana as it was reported that neighbouring villages tend to use the same water stream as boreholes are an expense to install for both farmers and livestock. In Musina it was reported that cattle often drink water from licking boreholes used by people. The findings displays the severity of drought on livestock. Competition for resources lead to cattle lacking adequate water supply and therefore affecting the productivity. In Umhlabuyalingana it was discussed that cows produce less milk and the calving rate has decrease due to droughts while similar results were revealed in Musina. In Umhlabuyalingana, interviews revealed that during IKS practices era water was abundant and cattle did not suffer. While in Musina installation of boreholes for cattle was encouraged over IKS for livestock.

The perception of integrating IKS and CK to ensure sustainable water security for cattle production during droughts was investigated in Chapter 4. Male farmers from Umhlabuyalingana (31 %) over 60 years old preferred IKS use more ($P < 0.05$) than male farmers (22 %) in Musina. The findings exposes the possession of IKS among elders and implies dominant use of IKS in parts of KwaZulu Natal surrounded by rural communities. Whilst 33 % of female farmers from Musina below 40 years preferred the use of IKS more to ensure water security than female farmers from Umhlabuyalingana (8 %). The observed results were unexpected as females are not involved in IKS practices for ensuring water security such as rainmaking ceremonies. The findings concurs with Chapter 3 that men were responsible for ensuring water security through rainmaking rituals performed on mountains and women were not allowed (Rumeka and Simelane., 2017). There association between cattle ownership and the use of IKS in Umhlabuyalingana differed ($P < 0.01$), farmers (35 %) that owned cattle preferred IKS more than farmers who owned cattle in Musina (18 %). The findings could be due to the fact that cattle in Umhlabuyalingana uses streams while cattle in Musina rely on both the river and boreholes. The results further exposes the dependency of Musina farmers on conventional systems over IKS.

The association between gender and commercial feeds differed ($P < 0.05$) in Musina, female farmers (53 %) preferred to use commercial feeds as compared to female and male farmers in Umhlabuyalingana (7 and 11 %, respectively). The observed results could be as a result to unsafe environment for females when herding cattle hence commercial feeds are preferred. Commercial feeds are however, convenient for cattle during drought to prevent cattle travelling long distances in search for feed. The findings that natural pastures are preferred more in Umhlabuyalingana implies the severity of drought is not as compared to Musina. This includes the distance travelled to water source by cattle from Umhlabuyalingana which is 3 km and cattle from Musina which travelled over 15 km as discussed in Chapter 4. The integration of IKS and CK in Musina was not be appreciated as compared to Umhlabuyalingana and this could be due to the influence of conventional methods. CK methods are practiced over IKS methods due to droughts. The probability of adult farmers ($P < 0.05$) in Umhlabuyalingana preferring the idea of integration of IKS and CK was 7. 35 times greater than youth farmers. Whilst in Musina adults farmers were 1.148 less likely to promote the integration of IKS and CK than youth farmers ($P > 0.05$).

Chapter 5 assessed the effect of different management systems used for cow-calf production on time budgets during droughts. During droughts farmers are faced with challenges of managing their cattle and the type of management system used has the potential to affect the time budget of cows. Differences ($P < 0.05$) were observed on the total time spent walking by extensive managed cows (53 ± 3.8 %) as they walked 2.24 hours/day longer than cows that are semi-extensive managed and followed CK management system (17 ± 3.8 %). The findings implies that although IKS is convenient it has disadvantages during drought towards cows as most time is spent walking than feeding. However, the integration IKS and CK management such as in semi-extensive management system could create a balance for lactating cows during droughts. Cows could feed on crop residues during calving and lactating periods and be allowed to free-range when the calf has reached three weeks. This would allow the cow to produce enough milk for the calf and eliminate the double distance the cow travels per day for the calf to suckle. Total time spent feeding was significant ($P < 0.05$) for semi-extensive managed cows as they spent 3.37 hours/day more time feeding (71 ± 3.5 %) compared to extensive managed cows (47 ± 3.5 %). The longer time spent walking decreased the time spent feeding for cows and hence the decreased productivity discussed in chapter 3. The energy reserved for milk production is used up during walking and therefore reduced calving rate and milk production.

## 6.2 Conclusions

The lack of municipal support in Umhlabuyalingana and Musina has led to poor farmers perceiving IKS as a viable option to succumb and cope through droughts. The dependency of farmers to conventional methods resulted in IKS being forgotten and undermined hence droughts experienced. The droughts has caused drastic effects on the cattle production as it has led to dry lands especially in Musina. Although the land is dry, IKS managerial practices are still highly considered in Umhlabuyalingana than in Musina. In Musina IKS management practices were prone amongst poor cow farmers. Indigenous knowledge management systems although convenient proved to negatively affect the feeding and walking time of cows when used alone. The cows during drought under IKS managerial practices spent more time walking to natural pastures and little time was spent in feeding while under integrated management systems the cows invested more time feeding and drinking.

## 6.3 Recommendations and further research

The documentation of IKS methods to ensure water security could contribute highly in integration of IKS and CK. Farmers are dependent on CK because they lack IKS guidelines for ensuring water security. The elderly which are IKS custodians should be involved and included in water security systems to incorporated IKS and CK. Furthermore, a system in which IKS is used to bring about rainfall and CK used in managerial practices would is needed. IKS would ensure water availability and therefore allowing farmers to cultivate and practice CK managerial practices. In return, both cows and calves would eradicate the distance and separation encountered under current drought conditions in Musina.

Further research aspect that can be include:

1. How integration of IKS and CK system would be incorporated in water management allocation for livestock.

2. How involvement of young farmers can be encouraged on using IKS for ensuring water security as growing cattle farmers.
3. Assessing how semi-extensive management systems during different seasons affect the BCS of cows and calves.
4. How do we integrate these two systems to mitigate the effect of drought, water scarcity and climate change?"

## 6.4 References

Muyambo, F., Bahta, Y.T. and Jordaan, A.J., 2017. The role of indigenous knowledge in drought risk reduction: A case of communal farmers in South Africa. *Jàmbá: Journal of Disaster Risk Studies*, *9*, p.1-6.

## Appendix 1: Ethical approval to conduct survey

UNIVERSITY OF KWAZULU-NATAL
INYUVESI YAKWAZULU-NATALI

29 May 2020

**Prof Michael Chimonyo (28007)**
**School of Agriculture, Earth & Environmental Sc**
**Pietermaritzburg Campus**

Dear Prof Chimonyo,

**Protocol reference number:** HSSREC/00000932/2020
**Project title:** Utilization of indigenous knowledge in sustaining water security for humans and livestock in resource-limited communities
**Degree:** Staff Research

### Approval Notification – Expedited Application

This letter serves to notify you that your application received on 06 January 2020 in connection with the above, was reviewed by the Humanities and Social Sciences Research Ethics Committee (HSSREC) and the protocol has been granted **FULL APPROVAL**

**Any alteration/s to the approved research protocol i.e. Questionnaire/Interview Schedule, Informed Consent Form, Title of the Project, Location of the Study, Research Approach and Methods must be reviewed and approved through the amendment/modification prior to its implementation. In case you have further queries, please quote the above reference number. PLEASE NOTE: Research data should be securely stored in the discipline/department for a period of 5 years.**

This approval is valid until 01 June 2021.
To ensure uninterrupted approval of this study beyond the approval expiry date, a progress report must be submitted to the Research Office on the appropriate form 2 - 3 months before the expiry date. A close-out report to be submitted when study is finished.

All research conducted during the COVID-19 period must adhere to the national and UKZN guidelines.

HSSREC is registered with the South African National Research Ethics Council (REC-040414-040).

Yours sincerely,

[redacted]

-----------------------------------------------
**Professor Dipane Hlalele (Chair)**

**/ms**

**Humanities & Social Sciences Research Ethics Committee**
**UKZN Research Ethics Office Westville Campus, Govan Mbeki Building**
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**Tel: +27 31 260 8350 / 4557 / 3587**
**Website:** http://research.ukzn.ac.za/Research-Ethics/



## Appendix 2: Key informant interviews

**Enumerator's Name: ………………………… …Village name: ……………………………**

| TIME ALLOCATION (MINS) | **TASK: Utilization of indigenous knowledge in sustaining human and livestock water security** | **Section Covered** |
|---|---|---|
| | **SECTION A: INTRODUCTION** | |
| | **Demographic Information** | |
| | Name, Age, Gender, Occupation, Experience of IKS, | |
| | **SECTION B: CURRENT WATER SECURITY SITUATION** | |
| | **Water Security Situation** | |
| | Water sources, water related problems, gender, water related conflicts, competition of water between livestock and humans | |
| | **Drought situation** | |
| | Frequency of drought, lengths of drought, effect of droughts on drinking water for livestock, When was the last drought? | |
| | **SECTION C: INDIGENOUS KNOWLEDGE USED** | |
| | **Causes of drought (seasonal and prolonged) or floods** | |
| | Taboos, angering ancestors, | |
| | **Signs of upcoming drought or floods (Prediction and anticipation strategies)** | |
| | Bio-indicators, Observing stars, Observing cloud pattern | |
| | **Evasive coping mechanisms** | |

| | | |
|---|---|---|
| | Transhumance, prohibition (taboos) and punishment, rituals | |
| | | |
| | **Perception of use of IKS as compared to conventional methods** | |
| | Contribution of IKS; Effectiveness of IKS, reliability of IKS, Would you recommend IKS practices? | |

**Appendix 3: Focus group discussions**

**Focus group discussion**

| **Groups (n = 10)** | **Description** |
|---|---|
| Youth | Males |
| Youth | Females |
| Adults | Males and females |
| School age | Both boys and girls |
| **TOTAL (N)** | **4** |

| **TIME ALLOCATION (MINS)** | **TASK: Utilization of Indigenous knowledge to ensure sustenance of human and livestock water security** | **Section Covered (tick)** |
|---|---|---|
| | **SECTION A: DEMOGRAPHY** | |
| | Age group; Gender; Education, Experience in IKS and livestock production | |
| | **SECTION B: WATER SECURITY SITUATION** | |
| | **Water sources** | |
| | Water sources are used, why? Reliability of water source | |
| | **Water related problems** | |
| | Seasonal variations, conflicts, queues, water quality, damaged infrastructure, length of problem, | |
| | **Gender issues** | |
| | Who fetches water for livestock? | |
| | **Water quality** | |
| | Is the water from named water sources of good quality?<br>Describe in terms of taste, odor and clarity? Is it salty? Do | |

| | | |
|---|---|---|
| | You purify the water further before drinking? What is used for purification? Who is responsible for purifying the water? Are there any effects of water to human and livestock health? | |
| | **Periods of water insecurity** | |
| | Trends of droughts or floods, when was the last drought experienced? How intense ae the drought? Are they ready for the drought? | |
| | **SECTION C: INTEGRATION AND PERCEPTIONS** | |
| | Do people know knowledge of indigenous methods used? Relevance of indigenous knowledge to the members and why; Are IKS methods effective? Can they recommend the use of IKS and why? Do they prefer using IKS alone or conventional alone or both and why? | |

## Appendix 4: Questionnaire

Date: ______________________ Questionnaire number ☐

Province ______________________ Enumerator name ______________________

District ______________________ Respondents' name ______________________

Municipality ______________________ Village ______________________

**SECTION A: HOUSEHOLD DEMOGRAPHY**

A1. Who is the head of the household? a. Father ☐ b. Mother ☐ c. Children ☐
d. Grandmother ☐ e. Other (Specify) ______________________

A2. What is your marital status?
a. Single ☐ b. Married ☐ c. divorced ☐ d. widowed ☐
e. Separated ☐ f. Other (specify) ______________________

A3. Age group
a. ≤ 25 years ☐ b. 26 – 40 years ☐ c. 41 – 55 years ☐ d. 56 – 70 years ☐
e. > 70 ☐

A4. Gender: a. Male ☐ b. Female ☐

A5. Highest level of education?
a. never attended school ☐ b. Primary level ☐ c. Secondary ☐
d. Tertiary level ☐

A6. Animal husbandry training?
a. Master farmer training ☐ b. Certificate in Agriculture/Veterinary ☐
c. Degree Agriculture/Veterinary ☐ d. None ☐

A7. Occupation
a. Professional ☐ b. Traditional healer ☐
e. Extension Officer ☐ d. Other (specify) ______________________

A8. Sources of income?
a. Crops ☐ b. Livestock ☐ c. Salaries/wages ☐ d. Social grant ☐
e. Other (specify) ______________________

A9. Income?
a. <800 ☐ b. 800-1500 ☐ c. 1501- 3000 ☐ d. 3001- 5000 ☐
e. >5000 ☐

A10. How long have you stayed in this area?
a. <2 years ☐ b. 2- 10 years ☐ c. All my life ☐

A11. Poverty level
e. Very poor ☐ b. Poor ☐ c. Less poor ☐

A12. Household size ☐☐

A13. Livestock composition

Cattle ☐ Goats ☐
Chickens ☐ Sheep ☐

A14. Importance of livestock in the household

a. Cattle : Meat ☐ Milk ☐ Insurance against crop failure ☐
Cash through sells of live animals and their products ☐
Rituals ☐ Show of status ☐

b. Goats : Meat ☐ Milk ☐ Insurance against crop failure ☐
Rituals ☐ Cash through sells ☐

c. Sheep : Meat ☐ Wool ☐ Insurance against crop failure ☐ Cash through sells ☐

d. Chickens: Meat ☐ Eggs ☐ Cash through sells ☐ Pleasure in ownership ☐

**SECTION B: WATER SOURCE AND CHALLENGES**

B1. What water source do you use?

a. River ☐ b. communal tap ☐ c. household tap ☐ d. well ☐

e. borehole ☐ e. Other (specify) ______________

B2. What is the name of the water source you use? ________________________________________

B3. Is the water available throughout the year?

a. Yes ☐ b. No ☐ c. Sometimes ☐

B4. If not, what is your alternative water source during periods of water scarcity?

______________________________________________________________________________________

B5. Is the water source reliable?

a. Yes ☐ b. No ☐

B6. How far is your water source from the homestead?

a. 0- 500m ☐ b. 501- 1000m ☐ c. 1001- 2000m ☐ d. > 2000 m ☐

B7. What do you use the water for?

a. Domestic use (drinking, cooking, bathing, cleaning) ) ☐ b. Crop irrigation ☐

c. Livestock ☐ d. Building ☐

B8 Who fetches water for use in the household?

a. Mother ☐ b. Daughter ☐ c. Father ☐ d. Son ☐

e. Domestic worker ☐ f. Other (specify) _________________

B9. Do you pay for your water?

a. Yes ☐ b. No ☐ c. Sometimes ☐

B10. If Yes, How much do you spend on water (per litre and per week)?

Specify__________________________________________

B11. Is any water stored at home for future use?

a. Yes ☐ b. No ☐ c. Sometimes ☐

B12. Is there any competition between animals and humans at the water source you use?

a. Yes ☐ b. No ☐ c. Sometimes ☐

B13. What is the condition of the conventional water infrastructure you use?

a. Good ☐ b. Rusty ☐ c. Leaking pipes ☐

d. Other (specify) ________________________________________________________________________

B14. Fill in the following table and rank the water security challenges according to the following; (1) most prevalent, (2) moderately prevalent (3) rare

| **Water challenge** | **Rank** |
|---|---|
| **The water is not clean**<br><br>Looks dirty, foul odor , tastes bad | |
| **There is shortage of water for livestock and crops** | |
| **There are conflicts** | |

| | |
|---|---|
| Among households/villages/municipality/livestock | |
| **Community infrastructure is damaged**<br><br>Leaking or blocked pipes, rusty and old | |
| **Water source is far from homesteads** | |
| **Water source is not protected** | |
| | |

**SECTION E: INTEGRATION OF INDIGENOUS AND CONVENTIONAL METHODS**

**Use of indigenous knowledge**

E1. Do you know of any indigenous knowledge method used to ensure water security?

a. Yes ☐ b. No ☐

E2. Are you able to predict droughts?

a. Yes☐ b. No ☐ c. Sometimes ☐

E3. Which predictive methods have you used before?

a. Use of behaviour of animals or animals ☐
Explain: ______

b. Observing the patterns of stars and clouds☐
Explain: ______

Other(specify): ______☐______

E4. To avoid a drought or flood, which method is do you use?

a. Temporarily take your livestock to relatives who live where there is no drought ☐ b. Rituals to appease angering the ancestors ☐ c. Use taboos to conserve water ☐

c. Observe cultural prohibitions to conserve water ☐
Specify

______

______

**Livestock management**

E5. Which method is more convenient as a source of feed during droughts?

a. Commercial feeds ☐ b. Natural pastures and forage ☐ c. Crop residues ☐

d. Natural grazing and Supplementary feeding ☐

E6. Which treatment method is nost convenient for you to treat illnesses? Why?

a. Ethno-veterinary medicines ☐ b. Conventional medicines ☐

b. Both ☐

E7. Do you think ethno-veterinary medicines can work with conventional medicines?

c. Yes ☐ b. No ☐ c. I don't know ☐

E8. Which method of controlling external parasites do you prefer most?

a. Use of ash b. Use phytotherapy ☐ c. Use conventional medicines (dipping)

c. Other (specify) ☐

E9. Do you ever combine the above-mentioned methods?

a. Yes ☐ b. No ☐

E10. Do you receive any assistance from municipalities for supplying water to livestock?

a. Yes ☐ b. No ☐ c. Sometimes ☐

E11. Do you get compensated for livestock mortalities due to water shortages? If so how?

a. Yes ☐ b. No ☐

______________________________________________________________________________

E12. Are the indigenous methods you use to ensure water also used to supply water for livestock?

a. Yes ☐ b. No ☐ c. Sometimes ☐

E13. Can these methods be employed by other livestock owners elsewhere?

a. Yes b. No c. I don't know ☐

E14. How long have you relied on these methods?

a. Over 10 years ☐ b. Less than 10 ☐ c. >20 years ☐

**Perceptions of integrating indigenous knowledge and conventional knowledge**

E15. Are indigenous methods reliable?

a. Yes ☐ b. No ☐ c. Sometimes ☐

E16. Would you recommend indigenous knowledge practices to others? Explain why.

a. Yes ☐ b. No ☐

______________________________________________________________________________

______________________________________________________________________________

E17. Are you able to apply indigenous knowledge together with conventional methods for water security?

a. Yes ☐ b. No ☐ c. Sometimes ☐

E18. Is the water generated from indigenous methods enough to sustain humans and livestock at the same time?

a. Yes ☐ b. No ☐

E19. Do you think indigenous methods of ensuring water security are effective for humans?

a. Yes ☐ b. No ☐

E20. Do you think indigenous methods are effective for ensuring water security for livestock?

a. Yes ☐ b. No ☐

E21. Which one is convenient between indigenous knowledge systems and conventional?

a. Indigenous ☐ b. Conventional ☐ c. Both ☐

E22. Which one is cost effective between indigenous knowledge systems and conventional?

b. Indigenous ☐ b. Conventional ☐ c. Both ☐

E23. Are the indigenous knowledge methods of predicting drought accurate?

a. Yes ☐ b. Sometimes ☐ c. No ☐

E24. Are the indigenous knowledge methods of predicting floods accurate?

a. Yes ☐ b. Sometimes ☐ c. No ☐

E25. Are the methods used for purifying water always reliable?

a. Yes ☐ b. No ☐ c. Sometimes ☐

E26. Can these methods be used by everyone?

a. Yes ☐ b. No ☐ c. Some ☐

E27. Which purifying methods do you prefer using?

a. Boiling ☐ b. Plants ☐ c. Bleach ☐ d. Other (specify)

____________________

E28. Do you think indigenous knowledge methods should be implemented to conventional methods of water resource management?

a. Yes ☐ b. No ☐