AN INVESTIGATION OF SCIENTIFIC AND INDIGENOUS WEATHER FORECASTING FOR IMPROVED DECISION-MAKING BY FARMERS

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AN INVESTIGATION OF SCIENTIFIC AND INDIGENOUS WEATHER FORECASTING FOR IMPROVED DECISION-MAKING BY FARMERS

by

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PREFACE

The research obtained in this thesis was completed while based in the Discipline of Geography, School of Agriculture, Earth and Environmental Science, University of KwaZulu-Natal, Pietermaritzburg Campus, South Africa.

The content of this work has not been submitted in any form to any other university and, except where the work of others is acknowledged in the text, the results reported are due to investigations by the candidate.

....

Signed: Professor Paramu Mafongoya (Supervisor)

DECLARATION

I, Myuri Rishona Basdew, declare that:

i. The research reported in this thesis, except where otherwise stated or acknowledged, is my original work;
ii. The thesis has not been submitted in full or in part for any degree for any examination at any other university;
iii. This dissertation does not contain other individuals' data, pictures, graphs or other information unless specifically acknowledged as being sourced from other persons;
iv. This dissertation does not contain other individuals' writing unless specifically acknowledged as being sourced from other researchers. Where other written sources have been quoted then:
    a. Their words have been rephrased but the general information attributed to them has been referenced;
    b. Where their exact words have been used, their words have been placed inside quotation marks, and correctly referenced;
v. This dissertation does not contain text, graphics or tables copied and pasted from the internet, unless specifically acknowledged, and the sources being detailed in the dissertation and in the reference sections.

....

Myuri Rishona Basdew Date

As research supervisor I agree to submission of this text for examination

....

Professor Paramu Mafongoya (Supervisor) Date

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LIST OF ACRONYMS

IPCC	International Panel on Climate Change
SANBI	South African National Biodiversity Institute
TEK	Traditional Ecological Knowledge
UMDM	uMgungunglovu District Municipality
WHO	World Health Organisation

CHAPTER 1: INTRODUCTION

1.1. Rationale of the Study

A change in climate has had a significant impact on crop production for subsistence farmers. It has changed seasonal cycles which have existed for centuries and has negatively altered crop yields. It has directly affected the livelihoods and food security of farmers, their families and their surrounding communities. Farmers have relied on indigenous knowledge to guide their decision-making for generations. Climate predictions are necessary in rural farming communities as they require guidance in terms of farm planning and management. Due to a lack of external and scientific assistance and guidance in terms of weather forecasting, indigenous knowledge is now becoming difficult to predict and implement. Many African countries are already facing food insecurity and often have their vulnerable situation aggravated by the effects and unpredictability of climate change (Elia et al., 2014). Seventy percent of sub-Saharan Africa relies heavily on rain-fed small-scale or subsistence farming as means of food security (Elia et al., 2014). Climate change has altered seasonal characteristics and patterns making it harder for farmers to adapt to the rapid and drastic changes in climate and weather. According to Ingram (2014) indigenous knowledge is the source of originality and resilience and will assist in adapting to climate change.

By integrating the seasonal scientific forecasting methods and knowledge of local communities and that of science, farmers will have a holistic approach to decision making. This could assist farmers in adapting to the effects and variability of climate change as well as to effectively better their livelihoods.

1.2. Conceptual Framework

According to the World Health Organisation (WHO) (WHO, 2015) food security exists "when all people at all times have access to sufficient, safe, nutritious food to maintain a healthy and active lifestyle". It is based on the four dimensions of food security, that being availability, access, use and stability (Barrett, 2010; De Muro, 2011). Access and stability are essential aspects. Access refers to having physical, financial and social needs. In rural communities this is especially important as the farmers have minimal access to economic and physical resources which hampers their ability to adapt to climate change and secure sufficient amounts of food. Sub-Saharan Africa, compared to other regions across the world, maintains a high prevalence of malnourishment. With reference to the 2014 State of Food Insecurity in the World, Africa has made little progress towards achieving international targets. On the contrary, the prevalence of malnourishment and hunger has decreased by 9.5% in the past 20 years. This is primarily due to increased commitment and effort from the government. The World Food Summit highlights that stability is required in order for the remainder three dimensions of food security to exist (De Muro, 2011). Stability includes attempting to mitigate the consequences of climate change as this is a way of creating stability in food security. Food security is therefore a major concern in Africa and is indisputably and directly linked to agriculture and the state of the environment.

Considering the advancements and current progresses regarding technology, different crop varieties, irrigation systems and multiple greenhouse technologies, the yield of crops is greatly dependent on climate and weather (Parry, 1999). Climate change has over the past decades worsened the state of food security globally (Vermuelen et al., 2012). Many countries have implemented different food systems to regulate and keep the amount of food constant. Many households have opted to have vegetable gardens due the unpredictability of crop yields and the unavailability of certain products on the market. Food shortages have also altered the economic and financial markets. A decrease in certain fruit and vegetables automatically cause the price to peak. Farmers are finding it increasingly difficult to produce crops at the yields they did 10 years ago. More effort and capital is put into maintaining crops and adapting to the effects of climate change but the crops continue to decrease in yields. Rural communities are hard hit as their livelihoods are dominated by small-scale farming or subsistence farming. These communities have minimal resources like land, water, technology and capital with which they need to maintain crop production.

Climate change is therefore a very complex problem and has affected people globally at many different scales. There is much uncertainty when dealing with climate change therefore solutions need to be well adapted to the situation and problem (Ingram, 2014). The effects are often felt in the form of floods, droughts, extreme temperatures, seasonal delays or unpredictable and ‘out-of-the-ordinary’ seasonal characteristics. Over decades local farmers used indigenous knowledge which was passed on from one generation to another to dictate when crops were to be planted or crops harvested. People looked for signs in nature and the environment and these signs were indicative of natural events to come. Rituals were done and much emphasis is and was placed on a 'godly being', to whom much respect was given. Locals had a great spiritual attachment to nature and this often lead to appreciation for indigenous knowledge (Kolawole, 2014). Communities and the farmers lived in harmony with the environment. A person believed what was taken from nature was to be returned. Therefore a symbiotic relationship existed for many years.

Climate change has therefore altered seasonal sequences of events and made predicting environmental events and waiting for signs from nature difficult. Seasons have become unpredictable thereby altering when crops are planted and harvested. Climate change has left local farmers with little time to adapt and seek effective alternate sources of knowledge. The effect of natural disasters like floods and drought are hard to deal with considering that much capital may be needed to restore the land. Often farms are situated alongside rivers to access easily available water, theses farms are the worst hit by floods and instances like this could cause millions of rand's in crop loss. The Lushoto district in Tanzania has been affected by floods, drought and increased and unpredictable rainfall (Mahoo et al., 2015). It has all negatively affected the areas of food security and agriculture. The farms of Lushoto lack diversity and innovative farming methods. This may be due to high poverty rates as more than 50 % of the population lives below the poverty line (Mahoo et al., 2015). Consequently, places like Lushoto are constantly vulnerable and require increased services, resources and aid with which they can maintain farming as their main economic activity and source of food. Due to lacking resources farmers are forced to lower their crop yields (Moeletsi et al., 2013). These farmers are highly disadvantaged because they rarely have access to technology and resources, which is why for so many decades they relied so heavily on indigenous knowledge to guide their livelihood practices.

Indigenous knowledge has been used as a tool to deal with natural disasters, conserve and protect the surrounding environment (Mahoo et al., 2015). It uses variables in the environment that are easily observable and noticeable. Considering this, much of indigenous knowledge is learned from the wisdom of the elderly generation's within a community and family. It is inclusive of information and practices regarding farming and also medicinal home remedies. It is also based on "expert judgement, insight and intuition"

(Goddard et al., 2010). Indigenous knowledge is not well documented yet it is widely used. According to the study undertaken in Lushoto, 83% of the community reported utilising indigenous knowledge in their daily practices to assist them in planning their agricultural activities (Mahoo et al., 2015). A separate study in the Maluga and Chibelela districts of Tanzania showed that farmers rely more on indigenous knowledge and place more trust in it than they do on seasonal scientific climate forecasts (Elia et al., 2014). Indigenous knowledge may use trustable indicators like the presence of animals and birds, insects, trees and flowering plants and astronomy. Also used is wind direction and stones (Elia et al., 2014). Kolawole (et al., 2014) states that indigenous knowledge is inexpensive. It needs no formal education, qualification or training in order to understand and apply it as it has been taught over generations. Conversely, the method of indigenous knowledge is haphazard and unorganised due to no formal methods of representing the information. Forty six percent of the 592 households surveyed in the Ngamiland district in Botswana agreed with this (Kolawole et al., 2014), highlighting that indigenous knowledge is frequently used because it requires no form of capital to transfer or utilise information. It does not require expensive tools, technology or equipment and has been effective for farmers as they rely on a more qualitative idea of weather forecasts in order to make decisions. Weather forecasts in the form of numerical reports are of no use to local farmers. They need to grasp quantities and times. Such information can be gathered from nature once one has learned the signs and indicators to be vigilant of in nature. Locals of Botswana therefore consider local methods and means as always being precise and suitable enough to inform the best decisions (Kolawole et al., 2014). Accounting for all the positive characteristics of indigenous knowledge one set back is that much indigenous knowledge is also lost between generations (Mahoo et al., 2015). It is found that age plays a significant role in the accuracy or indigenous knowledge predictions regarding climate change. Many elderly farmers possess a higher degree of indigenous knowledge compared to younger farmers (Elia et al., 2014). The elderly people of the communities therefore remain the main custodians of indigenous knowledge (Mahoo et al., 2015).

Scientific knowledge includes the forecasting of climate change and weather using specialised equipment, technology and manpower. It is expensive and results obtained still need to be interpreted in order for use by the lay man. In order to collect and interpret climate and weather data a qualification and training is needed. According to Kolawole (2014) 25% of households believed that scientific knowledge cannot be trusted as it is unreliable and always fails. This may be due to almost a quarter of the households finding scientific knowledge hard to interpret understand and predict. One of the main issues with scientific knowledge is the means by which it is presented and communicated to local people (Goddard et al., 2010). By increasing the effectiveness of communication the applicability, interpretation and implementation of the presented knowledge becomes easier for the end users of it. Additionally, local farmers are convinced that scientific knowledge is hard to work with and draw on adaptation methods for farming. They perceive it to be complicated and tasking as well as time consuming. To some users of scientific knowledge the complicated terminology is difficult to understand and implement (Goddard, 2010). No time and effort is taken to fathom the scientific facts and the information is thus thought to be useless. Many adverse perceptions and connotations can be decreased by differently presenting the data collected. Scientific language often utilises complicated words and terminologies which are usually difficult to understand. Scientific data can be translated into the native language of the locals and represented using pictures, diagrams and simple but meaningful sentences. Scientific knowledge interpretation needs to keep in mind the time frame within which indigenous knowledge operates and that scientific knowledge needs to also be qualitative in order for rural communities to implement the scientific suggestions. Goddard (2010) states that scientific forecasts interpret data using environmental indicators which are familiar to the locals. Scientific knowledge therefore needs to be tailored to the needs of the local communities (Goddard, 2010).

Integration of indigenous and scientific knowledge needs to occur in order for effective decision making about climate change and its adaptation methods (Kolawole et al., 2014). Farmers and scientist need to properly understand their respective responsibilities. In doing so, a common understanding can be developed between locals and scientists which enhances effective communication to improve knowledge, data collection and documentation (Kolawole et al., 2014). Increased interaction and communication between the two parties will over time allow for the negative perception of scientific information by the locals to deteriorate. Increased media strategies need to be implemented along with workshops, focus groups, lectures and training for the rural communities involved.

Information can be distributed at schools, community-based organisations, places of worship, NGO's as well as at local shops in the district (Mahoo et al., 2015). Both parties need to understand that they are working towards the common goal of increasing food security, decreasing the effect of climate change and bettering the livelihoods of the community. Empowerment of farmers regarding climate change adaptation and mitigation strategies would better develop their resilience to food security.

1.3. Hypothesis

a) Rural agricultural communities are affected by climate change.
b) Indigenous knowledge and practices are preferred over scientific knowledge and methods.
c) Integrating indigenous and scientific knowledge and weather forecasting can assist subsistence farmers adapt to climate change and make better informed decisions.

1.4. Objectives

a) Determine farmers' perceptions on climate change.
b) Assess the strengths and weaknesses of scientific and indigenous weather forecasting.
c) Evaluate the advantages and disadvantages of integrating scientific and indigenous weather forecasting for improved decision making.

1.5. Thesis Outline

This thesis is written in paper format in which each chapter is a separate paper.

Chapter1

Provides an overview of the thesis, highlighting the purpose and importance of the study. It indicates the main aims and why this research is necessary.

Chapter 2

Underlines the current literature surrounding climate change and its impact on rural communities. It also sheds light on the advantages and disadvantages of indigenous and scientific knowledge used by rural farmers.

Chapter 3

Unpacks farmers' perceptions on climate change. It determines the climate information needed for productive farming to occur.

Chapter 4

Assesses the strengths and weaknesses of indigenous and scientific knowledge. It identifies the indigenous knowledge indicators which are used on a daily basis to inform decision-making. Also, the gaps in scientific information dissemination are highlighted and the issues of integrating the two spheres of knowledge are discussed.

Chapter 5

Amalgamates the findings of the research while highlighting the niches which may exist for future research.

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CHAPTER 2: Literature Review

The integrative role of indigenous and scientific knowledge in climate change mitigation and adaptation regarding rural agriculture

2.1. Introduction

Over the past few decades climate change effects have been overwhelming (Berrang-Ford, 2011). This has triggered researchers interests to investigate the ability of environments to adapt to climate change has prompted mitigation and adaptation tools, methods and interventions to assist farming communities. The effect of climate change on agriculture is of utmost importance due to increasing populations and the demand for food. Statistical projections predict that global cereal and livestock production may need to increase by 60% and 100% respectively in the next 34 years (Thornton et al, 2011).

Agricultural communities have used indigenous knowledge as a means of adaptation for generations and this knowledge is still passed down to current generations (IFAD, 2016; Tella, 2007). Indigenous knowledge has assisted in terms of temperature and rainfall predictions using the natural indicators of natural fauna and fauna (Gomez-Baggethun, 2013; Sraku-Lartey, 2014). A major disadvantage is that indigenous knowledge is not effectively communicated and documented which hinders the awareness and.

Scientific knowledge which is used globally to adapt to the effects of climate change is often not widely used by rural farmers who lack resources, finances and education (Zuma-Netshiukhwi, 2013). Scientific seasonal forecast information is trustworthy and highly accepted as it is based on factual evidence and has no emotive basis. It is well documented which promotes its dissemination and understanding.

This review discusses and highlights current indigenous and scientific forecasts literature as well as shed light on the current adaptation and mitigation projects which are undergo. Integrating the two different types of information allows for increased benefits by researchers' and local rural farmers. It would assist in decision-making and increased agricultural yields if properly combined.

2.2. Climate change in rural agricultural communities

The global population by 2050 is expected to be in the order of 9.19billion (Thornton et al, 2011). Of the 9.19billion, 2.4 are predicted to be clustered in South Asia and sub-Saharan Africa (Lipper et al, 2014). According to the International Panel on Climate Change (IPCC), mentioned in Singh (2014), climate change accounts for anthropogenic alterations to weather and climate systems (Smith et al, 2007). It has resulted in the earth's atmosphere being hotter over the past few years, with regularly rising temperatures (Singh, 2014). The increasing temperatures contribute to climate variability and cause inconsistent weather which is difficult to predict (Singh, 2014). Greenhouse gas emissions were proposed to increase by 95% for sub-Saharan Africa, North Africa and the Middle East from 1990 to 2020 (Smith et al, 2007). For the past 1.5centuaries greenhouse gases have caused the earth to warm by approximately 0.8^{o}C (Singh, 2014). The combination of increased anthropogenic induced emissions, increasing populations and increased temperatures due to climate change has caused food insecurity. Thornton et al (2011) indicates that southern Africa is in a state of unremitting poverty and food insecurity. Climate change will worsen the state of vulnerable developing countries if temperatures increase by a mere 4^{o}C (Singh, 2014). The effect will cause increasing occurrences of storms, droughts and floods.

South Africa has for 44 district municipalities, 226 local municipalities and 8 metropolitan municipalities (The Local Government Handbook South Africa, 2015). According to the South African National Biodiversity Institute (SANBI) (SANBI, 2014) state that there has been an increase in dry spells as well as decreased rainfall in South Africa. According to Hitayezu (2014), KwaZulu-Natal (KZN) is unlike all South Africa's other provinces in that its state of vulnerability exceeds others (Hitayezu, 2014; SANBI, 2014). The uMgungundlovu District Municipality (UMDM) accounts for an area of 9.513km^2 and lies in the province of KZN which has 7 local municipalities. Approximately 10-15% of the UMDM practices agriculture, forestry and fishing (The Local Government Handbook South Africa, 2015). SANBI (2014) statistics highlight that 40% of land cover in the UMDM is utilised for agriculture while SANBI (2014) mention that access to land for agricultural purposes is insufficient and limited.

In sub-Saharan Africa approximately 45% of the population is undernourished (Fischer, 2002). What exacerbates the situation is that most of sub-Saharan Africa is underprivileged and disadvantages in terms of resources, capital and manpower. The impact of climate change on sub-Saharan Africa is therefore much worse due to the current level of vulnerability. As per the World Summit on Sustainable Development paper by Fischer (2002), increased amounts of carbon dioxide (CO_2) in the atmosphere will promote photosynthesis and thereby develop water-use efficiency and increase agricultural yields. Environmentally, climate change will affect and impact:

- the occurrence of pests and diseases,
- rainfall distribution and water storage,
- the adaptation of crops to extreme weather events,
- the growth of weeds (Fischer, 2002).

The above factors also affect agricultural crop yields. Fischer (2002) also highlights that there are multiple factors which act as constraints to high yield. In South Africa the major issues faced by rain-fed crops are that the region is too dry, too steep and soils are infertile (Fischer, 2002). In a paper by Turpie (2014), temperatures from 1960-2003 have increased by 0.13^{o}C per decade. By 2020 increases of 1.2^{o}C are expected. Each thirty years thereafter, figures are predicted to double. Rainfall is also calculated to decrease "by 5.4% in 2020, 6.3% in 2050 and 9.5% in 2080" (Turpie, 2014). An increase in temperature by 2.5-5^{o}C in Africa would cause losses of approximately R317 billion to agriculture. The expected losses for South Africa are predicted to be a mere 3% of agricultural yields (Turpie, 2014). Considering that the impacts and effects of climate change are felt the most by the poor developing countries of sub-Saharan Africa, adaptation measures can still be implemented once researchers and funders understand the perceptions of farmers regarding climate change.

Raymond (2013) highlighted that social barriers play a significant role in the ability of a community or household to adapt to the effects of climate change. Raymond (2013) suggests that social barriers are represented by the views of a community in terms of the acceptability of information. Often traditional communities are not inclined to believe the information put forward through science. Consequently, there is much distrust, scepticism regarding scientific information. Many locals are still sceptical about the occurrence of climate change and are uncertain that such a phenomenon exists (Raymond, 2013). The paper also mentions that local government and extension officers can play a pivotal role in changing the perceptions of communities regarding climate change. The opinions and views of different councillors within an area could cause their groups of supporters to believe certain facts about climate change. Raymond (2013) showed that citizens question the different forms of knowledge regarding climate change. Certain scientist feel that local communities are not adapting to climate change and grasping the concept of it as science detaches it from the traditional setting within which the locals livelihoods exist (Raymond, 2013). Furthermore, rural farmers lack the resources, education and capital to adapt and understand climate change and its effects now and in the future. Raymond (2013) suggests that alternate means of communication needs to be created in order for message and information to be disseminated.

According to Maddison (2007), farmers perceive climate change to include hotter temperatures, less rainfall and shorter periods of rainfall. Farmers' perceptions of climate change are also dependent on their age and therefore their experience. It was found that farmers with more experience claimed that there has definitely been an increase in temperatures and are adamant that a change is occurring (Maddison, 2007). What is noteworthy from Maddison (2007) on Ghana and Niger is that neighbouring households have the same perception of climate change. Neighbouring farmers believed in the same information regarding temperatures and rainfall. Data collected in the Gauteng province of South Africa mentioned that farmers identified the decline in rainfall but did not note a trend in the rainfall (Maddison, 2007). Perceptions of farmers towards human-induced climate change were recorded by Raymond (2013) in South Australia. Many farmers accepted the idea of human-induced climate change but thought that the climate change models are unreliable and that scientists cause unnecessary alarm. Local farmers were concerned about climate change and understood that temperatures cannot increase. Other farmers were unsure about human-induced climate change highlighting that the earth is cooling instead of heating and that fauna and flora are able to adapt to the changing climate. Data collected in the Free State in South Africa identified perceptions of climate change and climate variability in a rural farming community (Gandure, 2013). Farmers identified unexpected rains and that when rains did occur that they were destructive. Also, precipitation was in conjunction with strong winds. The seasons were perceived to be much drier, accounting for insufficient rainfall. Temperatures and seasons were thought to be more extreme with warmer summers and colder winters.

In a communication by Gbetibouo (2009), agricultural change and adaptation is a complex relationship between farmers and the environment within which they are in. Also noted is those farmers' perceptions about climate change effect the adaptation methods utilised as well as inform decision-making. For example, if a rural farmer has always relied on indigenous knowledge to adapt to climate then he/she may consider scientific means of adaptation difficult and ineffective. Gbetibouo (2009), make a note of the fact that if rural farmers were to gradually learn about the risks, challenges and advantages of climate then adaptation will be easier. The best way for farmers to adapt to climate change is to learn adaptation methods by physically doing it themselves, copy the methods of farmers who have already adapted and are currently minimising the effects of climate change and by being trained (Gbetibouo, 2009). In a paper by Cooper et al., (2008) multiple coping strategies are used as adaptation tools by farmers in West Africa. Farmers practice intercropping, low density planting, plot fragmentation and crop diversification as means of coping before the approaching season. Throughout the season crops are replanted keeping in mind the mature varieties, different crops are planted and moved between different land types. After the season grazing lands for livestock is sustained. Kiem (2013) emphasises that adaptation methods need to account for the socio-economics of rural farmers and their economies. Adaptation also needs to include farmers' perceptions and responses to climate change and assess their willingness to adapt to changing weather and climate. Information needs to be gathered by working with the farmers' of the communities and understanding their needs and livelihoods.

Deressa et al., (2013) undertook a study in the Nile basin of Ethiopia during 2004-2005. Results indicated that farmers observed increasing temperatures and decreasing rainfall over the past 20 years but did have adaptation methods implemented. Adaptation methods included planting trees, soil conservation, planting different crop varieties, irrigation and planting either earlier or later in the season. Approximately 42% of the respondents within 1000 households had no means of adaptation. Some reasons for this were a lack of finances, labour, information and land (Deressa et al., 2013). Adhikari (2015) makes note of the adaptation measures implemented by East African farmers. Farmers alter their planting dates as well as crop varieties. Alternatively, farmers switch to more resilient and diverse crops. Vermeulen et al., (2010) mentions that “adaptation can occur at multiple levels, from changed agricultural practices (e.g., staggering the crop calendar), to varietal change, to substitution of diversification, to moving out of crop farming, livestock rearing or aquaculture altogether”. Gbetibouo (2009) reiterates the above findings regarding adaptation practices. Some adaptation methods which were not mentioned in other literature accounts for farmers changing the amount of land which they cultivate.

Singh (2014) highlights the adaptation options which are to be implemented within the Msunduzi Municipality. The report by Singh (2014) identifies vulnerable sectors within the municipality and develops adaptation and mitigation options to improve the situations and assist in terms of climate change adaptation. Some of the possible options include; increasing the education received regarding agricultural practices, an introduction of alternative farming practices to small-scale and subsistence farmers so that their resilience to climate change is increased, identifying grazing lands and implementing sustainable land-use practices to these lands.

2.3. Indigenous Weather Forecasting

Indigenous knowledge, also referred to as traditional ecological knowledge (TEK) includes information, philosophies and traditions which are created and sustained by local and indigenous people due to their interactions with the environment (Gomez-Baggethun, 2013; Raseroka, 2008). It is knowledge that is collected over generations and is orally communicated (Chikonzo, 2006; IFAD, 2016; Tella, 2007). It is “a knowledge that would hold a life system beyond belief: the balance between culture and spirituality- the land of indigenous peoples” (Terena, 2012). Indigenous knowledge and its practices understand and respect the sanctified lands that local communities live on, the biodiversity of the area, the culture and the physical strength of nature. It is able to adapt to changing environments even in unpredictable climatic conditions and is guided by cultural traditions which are difficult to fathom and scientifically provide evidence (Raseroka, 2008). A sense of spirituality is attached to indigenous knowledge as one is taught from a young age to give thanks and show appreciation for good health, food and the environment to the greater spirits that exist (Terena, 2012; Chikonzo, 2006). The World Intellectual Property Organisation mentioned in Kumar (2014) states that indigenous knowledge is created, stored and transmitted within a traditional setting. It is communicated through stories, legends, mythologies, songs and ceremonies and not through formal education systems or teachings (Chikonzo, 2006; Tella, 2007; Raseroka, 2008). Indigenous knowledge is globally important for many farming communities as it assists in providing age-old solutions to increasing water supplies for irrigation, increasing yields though better drainage and cultivation systems, providing methods to rehabilitate soils and react to flooding and drought (IFAD, 2016; Chikonzo, 2006). Indigenous knowledge is significant as it provides a means of solving daily problems for local communities (Tella, 2007). It is especially crucial for rural communities as it is used to decrease their state of poverty and social exclusion as well as allow the communities to sustain the environments within which their livelihoods are based (Sraku-Lartey, 2014). Indigenous knowledge also has the ability to understand, adapt and buffer against climate change (Gomez-Baggethun; 2013, Tella, 2007). It could also be used as a foundation to better understand environmental conditions from local perspectives and use this information to develop and enhance climate adaptation systems.

Although indigenous knowledge is very useful to rural agricultural communities there are many related disadvantages. As mentioned above, indigenous knowledge does not form part of a formal education system (Tella, 2007; Department of Agriculture, 2008). Consequently, there is minimal education and awareness regarding it and it is not considered as a science. The information is not documented and only those who utilise it are aware of it. Researchers and institutions often lack the resources and skills which are required to gain useful information from local farmers (Sillitoe, 2009; Department of Agriculture, 2008). Local people are also often hesitant to divulge important information as it is considered sacred to their community (Sraku-Lartey, 2014). Highlighted is the fact that if indigenous knowledge is shared the powers it possesses will be lost and ineffective (Tella, 2007). Recording or documenting indigenous is also a tedious task which takes long periods of time. Information which is spiritual or implicit needs to be thoroughly understood so it can be documented. Indigenous knowledge is primarily used by the elderly farmers within a household. Youth are therefore less involved in indigenous knowledge systems as they migrate to cities in search of employment. They often have minimal knowledge of indigenous knowledge systems (Department of Agriculture, 2008; Sillitoe, 2009). Another disadvantage of indigenous knowledge is that it does not belong to one particular person, community or institution (Sillitoe, 2009). Consequently there is inadequate protection of this knowledge which allows for the implementation of Intellectual Property Rights (Tella, 2007, Department of Agriculture, 2008). Other tools exist for protecting indigenous knowledge in South Africa like patents, trademarks, geographical indicators, contractual arrangements and secrecy agreements (Department of Agriculture, 2008).

A case study presented by the IFAD (2016) focused on climate change and adaptation in Ethiopia, South Africa. The case study was based on a cultural group called the Gamo people of Ethiopia. Like the rest of the world, these people were experiencing the negative effects of climate change. These effects included lower crop yields, decreased rainfall and soil moisture as well as the increasing unpredictability of weather systems. The Gamo community began using the effects of climate change as a means of understanding forest destruction and its direct effects on them. The community opted to protect and re-establish the endangered biodiversity and recognise plant and tree phenology as an indicator of soil fertility to assist them in term of agricultural activities. The community then taught and trained their children to conserve and protect the forests and environment around them.

Indigenous knowledge was used in Tanzania, to predict climate and weather (Kijazi *et al*, 2012). Seasonal rainfall, extreme weather and past climatic events were predicted using indigenous indicators. Indicators used included plant phenology as an indicator of rainfall events and the movement of birds, insects and animals. The Mahenge and Ismani communities in Tanzania assessed the accuracy and reliability of indigenous knowledge compared to scientific forecasts. Data showed that indigenous predictions and forecasts corresponded with scientifically collected data. The season was predicted to have above normal rainfall events and scientific statics confirmed this.

2.4. Scientific Weather Forecasting

Scientific weather forecasting has been extremely useful in predicting climate at a global, regional and local scale (Chisadza, 2015). Scientific tools are used to monitor, determine and analyse data regarding rainfall, temperature, light and moisture, with the aim of assisting farmers adapt to climate change. Climate information has diverted from environmental management strategies to reduction strategies (Chisadza, 2015). It is used to build on current knowledge systems that exist. Chisadza (2015) highlight that scientific forecasts depend on the theoretical and epistemological perspectives of the researcher. It is communicated through written lectures and is thoroughly documented. Scientific information is widely accessible and its acceptance is based on universal rules and theories. It is based on factual evidence and experiments. Zuma-Netshiukhwi (2013) highlights that scientific information has many disadvantages especially with regard to its use in rural communities. Scientific weather forecasts are not easily accessible and available to resource-poor agricultural communities. Although scientific information is well documented, this information is not represented in ways that rural farmers can understand, interpret and implement. Local farmers feel that scientific information needs to be downscaled to a level fit for daily use (Zuma-Netshiukhwi, 2013). Vermeulen (2010) mentions that seasonal forecasts can assist farmers months in advance due to it being able to predict the interaction between oceans and the atmosphere. Scientific advancements allow farmers to utilise innovative technology, increase crop yields, maintain soil fertility and nutrient content as well as adapt to the effects of climate change well in advance to decrease the possible damage to crops.

Diversification in agricultural systems is meant to benefit agricultural yields and assist in crop maintenance (Lin, 2011). Different types of diversification can occur like the implementation of improved structural diversity among the different crops. The advantage is decreased pests thriving in one crop while they are also promoted to move onto other nearby crops. The implementation of polycultures allow for multiple crops to co-exist in the same field with different varieties of a particular species (Lin, 2011). This assists in terms of climate change adaptation as studies have shown that more ecologically complex crop systems which also include wild varieties and are spatially diverse are able to cope under stressful climatic conditions. The combined growth of crops and trees has resulted in trees providing shade to the crops and consequently protecting them from increased temperatures and heavy storms. The trees therefore act as a buffer. In developing countries, biotechnology solutions are not frequently used by farmers. This is due to traditional or indigenous varieties of crops producing higher crop yields than genetically modified crops.

Africa and China have in the past few years received the impact of the negative effects of climate change with it impacting on food security, water resources and human health (Rui-li, 2013). China has consequently been active at creating and developing mitigation measures to protect their agriculture. Due to decreased water resources rules and regulations were implemented in order for the sustainable usage of water, with particular reference to agricultural irrigation. Additionally, China, has created crop varieties that are able to cope with increasing temperatures while still being able to produce high yields. The country is currently developing an agricultural water system which will be implemented by 2030 and will include increasing the crops that require less water for growth. In doing so, the amount of crops requiring large quantities of water will be decreased.

2.5. Indigenous and Scientific Knowledge Integration

Climate change is predicted to reduce the output of subsistence farms, increase the susceptibility of crops to decreasing precipitation, amplify food insecurity and decrease the current accessibility to natural resources (SANBI, 2014). SANBI (2013) suggests that adapting to climate change requires solutions on a local level regarding agricultural activities, management and planning. Awareness through education and communication needs to be created regarding agricultural practices and adaptation methods. A method to climate change adaptation on a local level is to integrate the current indigenous knowledge that rural subsistence farmers are accustomed to with scientific weather forecasting. The aim is to combine the richness of both information sources to benefit rural subsistence farmers to adapt to climate change by making better informed agricultural decisions on a daily basis.

The differences between indigenous and scientific knowledge are characteristics that also act as a barrier and hindrance to climate change adaptation. Indigenous knowledge is holistic, orally communicated, based on physical observations and experience over years and has a spiritual background. Scientific knowledge is structured, well documented, communicated through pamphlets and via theories and is based on testable evidence (Tella, 2007; Sraku-Lartey, 2014). As a result, indigenous knowledge is thought to be feeble and shabby (Raymond, 2013). There are economic, technical and institutional barriers that affect communities' adaptation to climate change (Department of Agriculture, 2008). Economic barriers are especially prevalent among rural farmers as they have decreased access to capital or finances. As a result farmers cannot invest in machinery or agricultural solutions like pesticides to assist them. Technical barriers include the effect felt due to soil characteristics or local climate. Institutional barriers include the effect of governance and the implementation of adaptation methods and the creation of climate change awareness. Indigenous knowledge lacks any systematic or procedural consistency (Sillitoe, 2009). Due to this, it is a dynamic system that is constantly changing in accordance to the environment. There can be no final document or one which is cast in stone. As a result, it is difficult to include indigenous knowledge in policies, international systems and practices (Sillitoe, 2009). Formal institutions often develop adaptation reports to assist local and rural farmers but in doing so there is no room for local farmer inputs. Results and information is purely science based and often they do not depict the reality of the farmers and the agricultural community. Local farmers are then made to feel as if their experience and knowledge is of minimal or no use to the researchers'. There is minimal collaboration to assist rural farmers increase crop production and make better informed agricultural decisions. Indigenous knowledge was found to be more accepted by the youth of a community as they would have been educated regarding it in schools and university. Consequently the elderly generations who farmed were sceptical regarding the existence of climate change. They recounted their experiences and previous agricultural management skills as well as rainfall over the decades and were less accepting of the climate change concept (Raymond, 2013; Tella, 2007). Consequently, the communication of indigenous knowledge was made difficult due to having to combine tacit local knowledge and factual scientific knowledge. Reports regarding scientific weather forecasting are thought to be complex and often conflict with each other (Raymond. 2013; Sillitoe, 2009). As a result the unaware and uneducated rural farmers' are sceptical of the information presented. It also creates a sense of fear in them due to the confusion of contradicting facts. Contradicting reports do not make decision-making easier for rural agricultural farmers. Rather, farmers are left more confused than they began and therefore resort to using the indigenous knowledge that they are used to. Scientific forecasts and agricultural management advice is not presented in a manner which will promote its utilisation within a community.

In order to effectively combine indigenous and scientific knowledge, indigenous information needs to be properly unpacked (Sraku-Lartey, 2014; Raymond, 2013). Indigenous knowledge requires that the users of the information understand its characteristics and uses. Researchers and users of indigenous knowledge need to create a sense of organisation and structure is it is to be used advantageously. Local farmers need to understand the role they play in knowledge transfer and storage and that they act as a keystone species to the existence of the knowledge. Information and communication technologies can assist in the capture, storage, dissemination and promotion of indigenous knowledge. Technologies can also promote the integration of such knowledge and create a platform for agricultural benefits (Sraku-Lartey, 2014). This platform will allow different stakeholders to engage in decision-making. Local farmers will be more inclined to use different adaptation methods and advice is they are included in the decision-making process (Raymond, 2010; Sillitoe, 2009). The integration process needs to be flexible in order for the dynamic nature of indigenous knowledge to be taken into account. It needs to, at a later stage be open to changes in perceptions, methodologies and changes within the environment (Raymond, 2010).

2.6. Conclusion

Scientific and indigenous seasonal forecast could assist rural farmers adapt to climate change. In doing so different methods of integration and communication need to be applied at a local scale for any change to occur and for any crop yields to increase. By improving the communication between researchers and local farmers a knowledge rich method of climate change adaptation can be created. Researchers and farmers need to find a common ground on which to share knowledge and researchers need to create a space for spiritual and tacit information acceptance. Means of documenting indigenous knowledge will enable information transfer between generations, the storage of valuable information and the utilisation of it on a daily basis.

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CHAPTER 3: Rural Farmers' Perceptions on Climate Change

Abstract

Rural subsistence farmers are faced with challenges on a daily basis regarding agriculture and climate change. This study was conducted in the rural community of Swayimane, uMshwathi Municipality, KwaZulu-Natal. The main objectives of the study were to determine farmers' perceptions on climate change, the effect of climate change and climate variability on crop yields. The research accounted for 100 questionnaires administered to the subsistence farmers of the community. Three focus group discussions and 10 key informant interviews were conducted with small groups of individuals. Results showed that there has been a decrease in rainfall and increase in temperatures. Farmers linked an increase in pests and disease to climate change. Majority of the farmers mentioned drought being an extreme weather event which occurred within the past 10 years. Farmers require climate information on rainfall as it directly affects crop yields. The research concluded that farmers' require seasonal climate information relating to rainfall in order to effectively adapt to climate variability and change.

Key words: subsistence farms, climate variability and information

3.1. Introduction

According to Alexandratos (2009), the world by 2050 could flourish, with decreasing levels of poverty and increasing levels of food security. Alternatively it could deteriorate, with increasing levels of food insecurity, decreased food security. This would indicate a world in which climate change has altered agricultural yields therefore resulting in a "world poorer than today". Climate change is therefore inherently and directly linked to the food security of the world. Climate change is considered to be the effect of greenhouse gases concentrating in the earth's atmosphere over the past 200 years due to anthropogenic activities (Department of Agriculture, Forestry and Fisheries, 2015). Developing nations practicing agriculture as a source of income will be the most vulnerable as their current state of poverty, poor education and lack of infrastructure and development will impede the possibility of seeking other sources of income (Kgakatsi et al., 2007). Adapting to climate change on a local level is therefore crucial to ensure livelihood sustainability (SANBI, 2015). Methods of adaptation need to be area-specific to guarantee optimum crop yields. Rural communities of developing and underdeveloped countries require research attention as they lack the appropriate resources necessary to adapt to climate change. There is little infiltration of scientific information or methods of adaptation into these communities. Rural communities use indigenous methods which they are familiar with. Adaptation strategies therefore need to be tailored to individual communities using and unpacking the skills and knowledge that communities already possess with regard to agriculture.

Nhemachena (2014) found that farmers in the Hwange district of Zimbabwe perceived climate change precisely on a day-to-day basis but were inaccurate regarding monthly predictions. Farmers attributed decreasing crop yields to a decrease in rain and therefore considered drought as a major climate change event. Other changes included variations of rainfall, inconsistent lengths of seasons and increasing temperatures (Nhemachena, 2014; Moyo et al., 2012). South African farmers perceive climate change to include a decrease in rainfall and an increase in pests and diseases (SANBI, 2014). Moyo et al., (2012) highlights that farmers' perceptions are based on the experiences they have had while practicing agriculture. Additionally, farmers' perceptions are primarily determined by a decline in crop yields. Inconsistencies in data were evident as farmers' of the same district noted different changes as well as different scales of change over time (Moyo et al., 2012). Another factor mentioned which affects farmers' perception of climate change is the effect of certain periods in a season on their agricultural productivity. For example, if the effect of one particular summer about 5 years ago was devastating in terms of decreased crop yields and drastically lower rainfall then the perception of climate change will be the characteristic of that summer. The effects of that particular summer will stand out against the rest and this will constitute to the farmers perception of climate change.

3.2. Materials and Methods

3.2.1. Study Area

The research was undertaken within the uMgungundlovu District Municipality in the uMshwathi Municipality which lies north-east of Pietermaritzburg. The uMshwathi Municipality (29.4878^{o}S, 30.3303^{o}E) consists of urban towns like Wartburg, New Hanover, Dalton and Cool Air. The rural communities account for Thokozani, Ozwathini, Swayimane and Mpolweni. Swayimane accounts for 32km^2 (SANBI, 2014) land area and was the focus of the study as it is the largest of the four rural communities. The region received approximately 500-800mm/annum of rainfall (SANBI, 2014). The population in the uMshwathi Municipality sits at 106 374 citizens. This population has decreased over time due to many males seeking employment in the neighbouring towns. Farming is the main economic activity for about 9329 agricultural households. Sixty two percent of the population is within the 15-64 age group whilst elderly citizens of 65 years and above account for a 5.2% of the population.

3.2.2. Data Collection and Analysis

One hundred questionnaires were randomly administered to the households practicing agriculture in the Swayimane community. The research also required that participants be between the ages of 20-100 to ensure that they had a good understanding of the area, its local traditions and history regarding farming. The questionnaires consisted of multiple open-ended and close-ended structured questions. The questionnaires were used for the quantitative data collection.

Qualitative data was obtained during focus group discussions and key informant discussions. The focus group participants formed 3 groups. Each group consisted of 8 females and 7 males. Key Informant participants included local business owners, extension officers, community leaders, nurses, teachers and principals as well as local stakeholders. Statistical Package for Social Science 24 (SPSS) was used to analyse data. Content analysis was used to identify themes and concepts.

3.3. Results

3.3.1. Socio-economic characteristics of the respondents

Sixty seven respondents were female (Figure 3.1). The males of the households are the breadwinners and therefore unavailable due to employment in neighbouring towns. This resulted in 33% of the respondents being male. Consequently, there is a significant difference in the percentage of males to females.

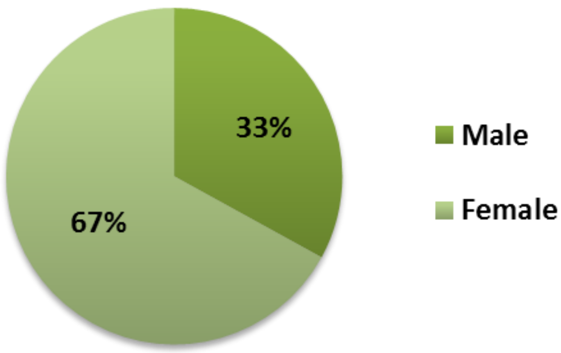

Figure 3.1 Percentage of male to female respondents

Majority of the respondents were between the ages of 41-60 and 61-80, accounting for 45% and 29% respectively (Figure 3.2). Twenty five percent of the respondents were between the age group of 20-40 years old.

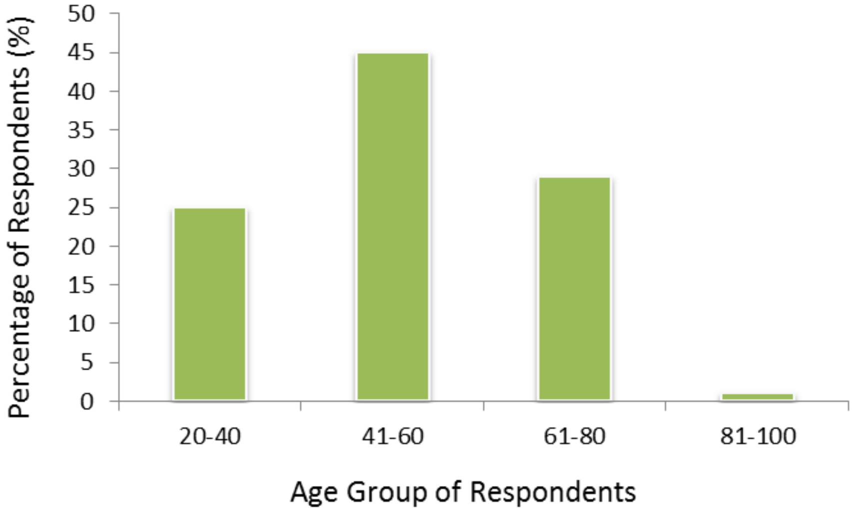

Figure 3.2 Age Distribution of Respondents

Results show that 33% of the respondents were females between the age group of 41-60 (Figure 3.3). Twenty four percent of the males were evenly distributed between the 20-40 and 41-80 age groups. One fifth of the respondents were females in the 61-80 age groups.

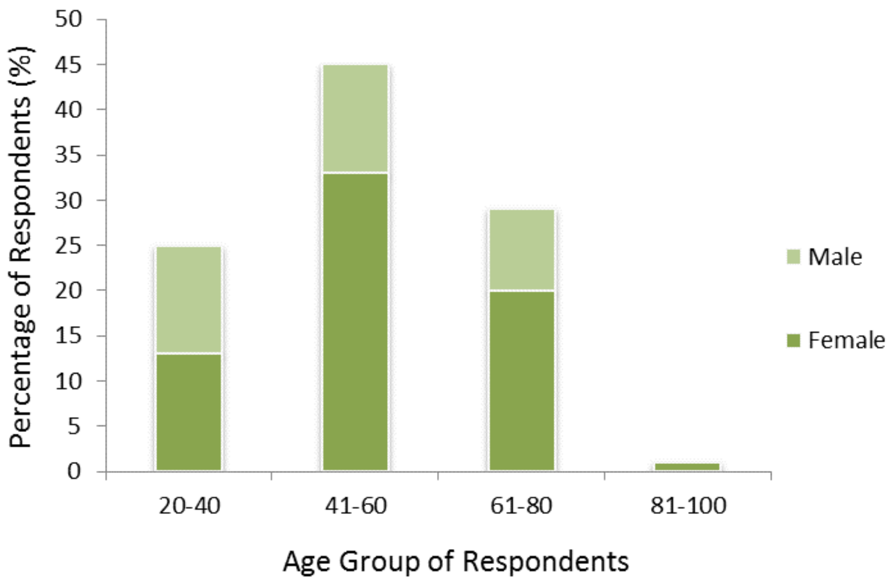

Figure 3.3 Percentages of Male and Female respondents per Age Group

All crops planted were for subsistence use. Maize was grown by 88% of the respondents while beans were the only legume grown by 59% of the respondents (Figure 3.4). About 56% of the respondents grow sweet potato and 51% were growing amadumbes (taro). Although the community of Swayimane is known for the high annual yields of sugarcane, 84% of the respondents did not produce sugarcane. Fifty percent did not grow potatoes.. Thirty seven percent of the respondents grow fruits like avocados and vegetables like spinach, chillies, herbs, onions, red pepper and spinach.

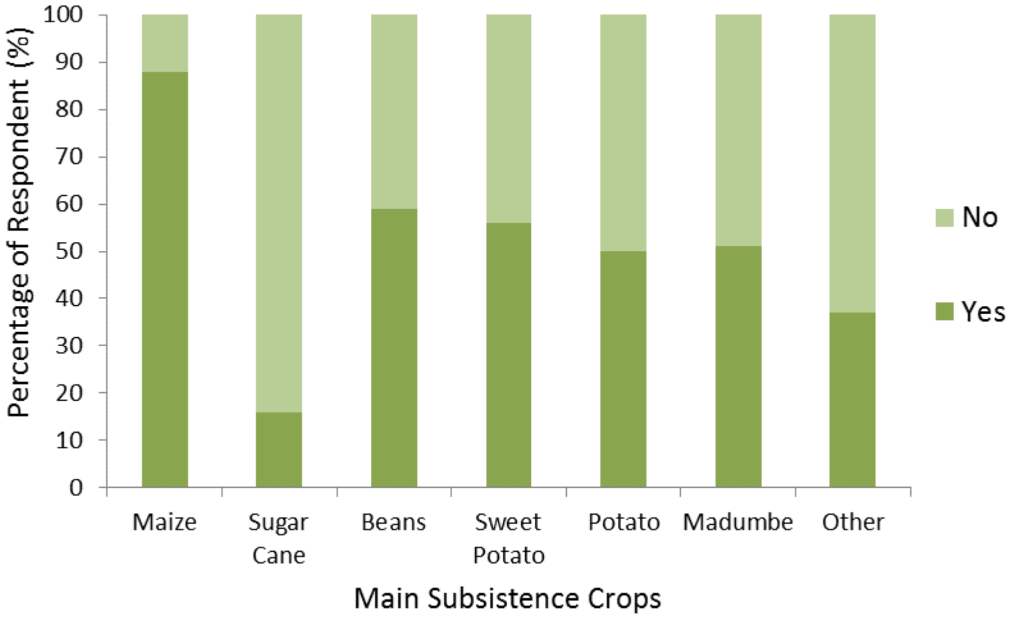

Figure 3.4 Main subsistence crops planted by the respondents

3.3.2. Farmers Perceptions on Climate Change over the past 10 years

The data presented in Table 3.1 encapsulates respondents' opinions on the effects of climate change on their farming regimens. Forty eight percent of the target population stated drought to have an effect on agriculture. Twenty percent and 12% of the respondents confirmed that decreased farming yields and erosion respectively, have been the results of climate change. Twelve percent of the respondents highlighted other effects of climate change on farming like heavy storms, inconsistent weather, flooding and inconsistent growth of crops. Two percent of the respondents felt that due to climate change their current methods of farming needed to be altered in order to suit the changing weather patterns. Six percent of the respondents stated that agriculture had not been affected by climate change.

Table 3.1 Effects of Climate change on Agriculture

Effects of Climate Change on Agriculture	Percentage (%) of Respondents
Escalating drought	48
Decreased crop yields	20
Exacerbated erosion	12
Damaging storms	7
Agriculture has been unaffected	6
Inconsistent weather	3
Farming methods need to be altered	2
Flooding	1
Inconsistent growth of crops	1

Results in Table 3.2 show that 39% of the respondents are of the opinion that the non-agricultural environment has been unaffected by climate change. The non-agricultural environment accounts for all land which is not farmed on. Approximately one- fifth of the respondents emphasised a decrease in the grazing pastures for their cattle. Furthermore, 20% indicated that heavy storms were due to climate change.

Table 3.2 Effects of Climate Change on the non-Agricultural environment

Effects of Climate Change on the non-Agriculture Environment	Percentage (%) of Respondents
Non-agricultural environment has been unaffected	39
Decreased grazing pastures for livestock	22
Damaging storms	20
Decreased levels of water in dams and rivers	12
Increase in different species of grass	1
Total	**100**

3.3.3. Climate information and variability

The research indicated that extremely high temperatures were observed by 30% of the respondents (Figure 3.5). Over the past 10 years there have been increases in pests like caterpillars and aphids well as random thunderstorms that included hail. This accounted for 19% and 14% respectively, ($P \leq 0.05$) . Other indicators of climate variability mentioned included decreased rainfall, drought, strong winds, inconsistent weather and low temperatures. The remaining 1% of the target population mentioned that there has been no climate variability.

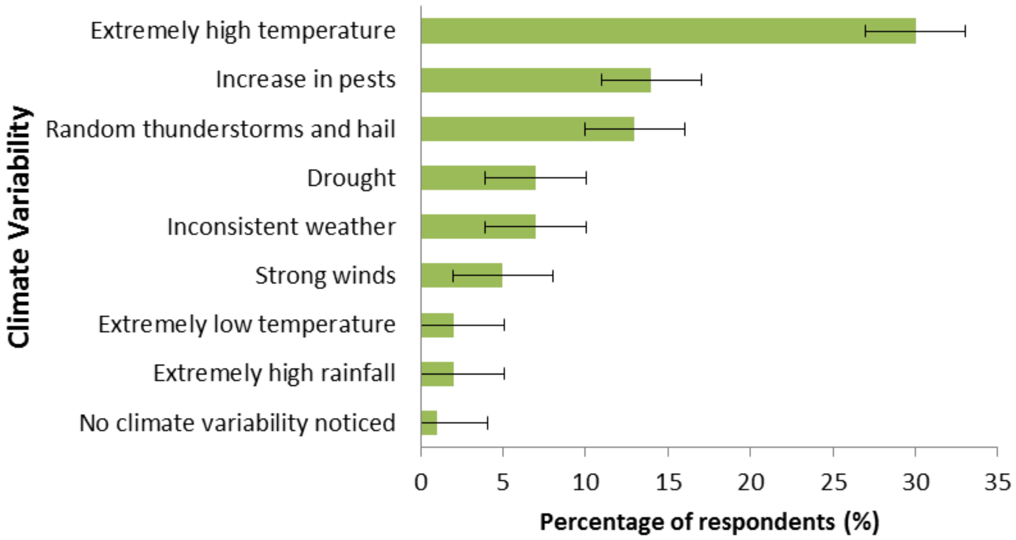

Figure 3.5 Climate variability experienced by the respondents with regard to extreme weather conditions

Fifty nine percent of the respondents need a combination of different climate information for farming to occur (Figure 3.6; $P \leq 0.05$). Data shows that 49% and 42% respectively, prefer knowledge regarding the maximum and minimum temperatures in order to make decisions for productive farming. Thirty six percent and 34% respectively needed information regarding the state of the season, specifically relating to the amount of rainfall and minimum temperatures. Total rainfall in the month and the total number of days with rain was required by 13% of the respondents, respectively. Information regarding the total number of days in a season with rain, total rainfall in a month and total number of days with rain in a month are not needed by majority of the respondents.

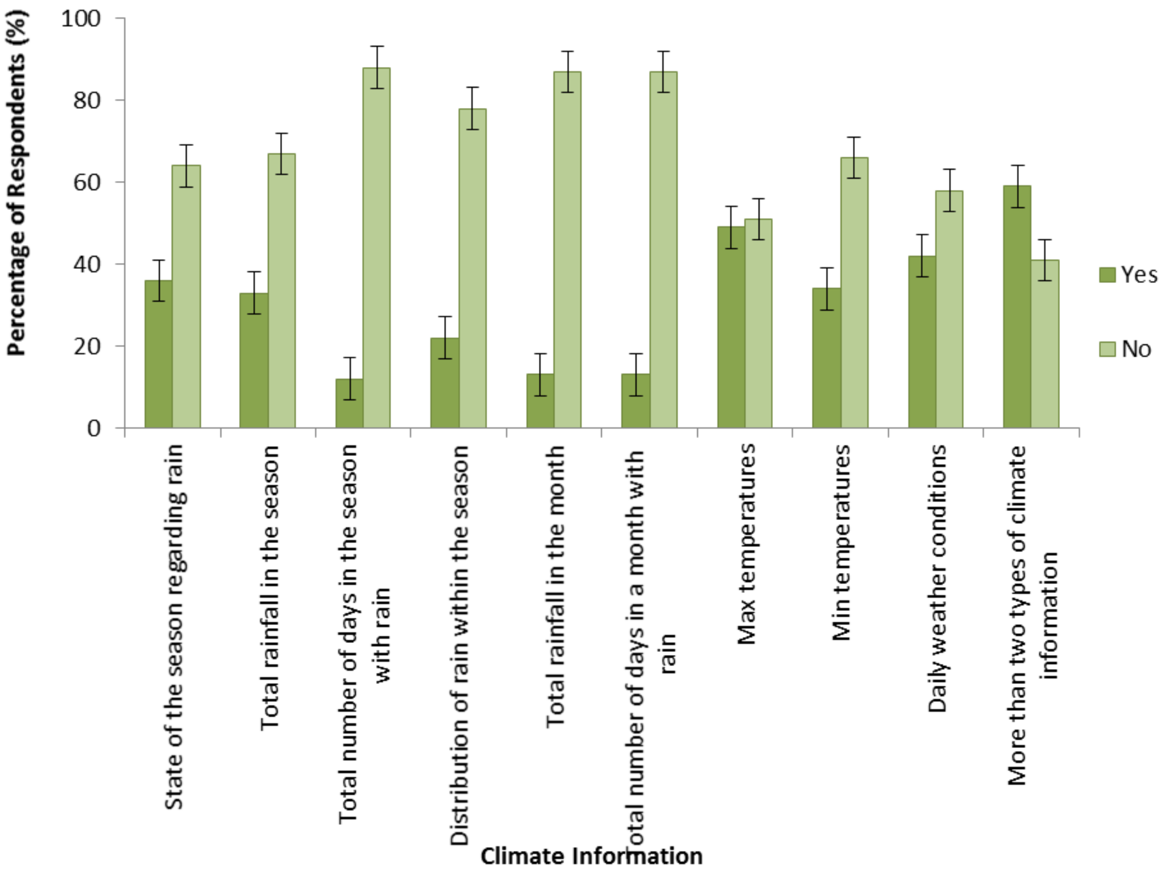

Figure 3.6 Climate information required by the respondents

The most essential climate information required was the state of the season regarding rainfall, accounting for 33% (Figure 3.7). Total rainfall in the season was also needed by 28% of the respondents. Thirteen percent required information regarding the distribution of rain within the season. Twenty five percent of the respondents mentioned climate information which was less important for farming. Typical factors included total rainfall in the month, maximum and minimum temperatures, daily weather conditions, total number of days in the season with rain and total number of days in a month with rain.

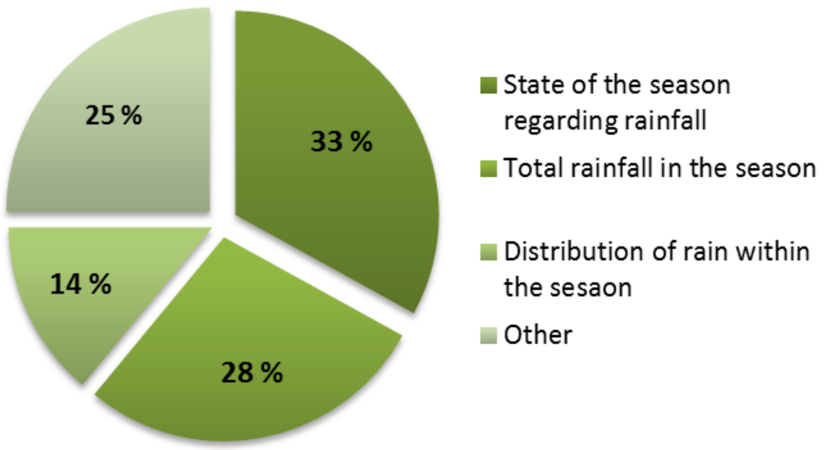

Figure 3.7 Most essential climate information needed by the respondents for productive farming

3.4. Discussion

The findings revealed that a majority of the target population, comprising 67% of the Swayimane community were females within the age group of 41-60 years old. In Nigeria, women accounted for 60% - 80% of the agricultural labour force (Ogunlela, 2009). Such findings bear true for subsistence farmers in Africa (Seletei, 2014). Thirty eight percent of the rural households in the uMshwathi Municipality are female headed (StatsSA, 2011). Data collection revealed these women farm until a very old age, that is until they are physically unable to do so, due to sickness and old age. Farming is therefore a method of coping in poor financial times, with minimal resources and education. According to Gladwin et al., (2001) multiple livelihood strategies are necessary for female farmers to cope. Female farmers need to combine agricultural and non-agricultural activities to earn an income and in order to adapt to the effects of climate change and poor financial situations. In Eastern Zambia non-agricultural activities include sewing, making pots, being traditional healers, selling fruits and vegetables as well as buns (Gladwin et al, 2001). Female farmers also need to be equipped with the right tools and resources in order to productively farm. In Bangladesh female farmers were equipped with new and improved varieties of vegetables via women's groups to assist those who had relatively small portions of farming land

(Quisumbing, 2010). These women were able to adopt the new varieties and utilise them even on small plots of agricultural land. In doing so, the female farmers were developing their skills and knowledge regarding small-scale farming. Within the Swayimane community information regarding sugar cane is transferred during regular meetings with the South African Sugar Association (SASA). During these meetings the cost-effectiveness, growth stages, water consumption and economic benefits of different varieties of sugar cane are explained to the farmers. There are no agricultural groups, women's groups or extension services which could aid the transfer of information regarding fruits and vegetables among female farmers. Consequently female farmers repeatedly use the varieties which they are used to.

The women of the household provide a sustainable livelihood for the family by practicing agriculture. Additionally, the women of Swayimane are the caregivers to their grandchildren while the youth work in the neighbouring urban town of Wartburg. The age group 20-40 accounts for 13% of the females respondents. Considering this, many females do not continue to tertiary education therefore prioritise household duties and farming, such is the case for the 13% of female respondents (Seleti, 2014). They are also meant to bear children and further the lineage of the family. Males of the community only account for approximately one third of the respondents. This is due to rural-urban migration. Employment is sought in Wartburg and surrounding towns. Often the women are left to head the households for months while the men work in the towns and during this time women have no source of income.

Swayimane consists of subsistence farmers as well as small-scale farmers growing sugarcane. The area receives a substantial amount of rainfall which accommodates multiple hectares of sugarcane per family. Considering this, only 16% of the respondents accounted for sugarcane as their main subsistence crop. Other crops which were cultivated included beans, sweet potato and taro. This is due to the nutritional value of the crops and the ease with which they grow. Considering this, only half of the target population grew potatoes. Also, preference was allotted to sweet potato over potatoes because it is a more wholesome food. It has more nutritional value than most cereals and contains 12 essential vitamins and minerals (Department of Agriculture, Forestry & Fisheries, 2013). Sweet potatoes and potatoes are high in starch and have minimal micronutrients and are therefore frequently cultivated (Modi, 2006). It contains antioxidants, anti-inflammatory properties, has the ability to regulate blood sugar levels and is antibacterial (The George Mateljan Foundation, 2016). Fruits such as avocado, pear and orange were also grown.

In developing countries like South Africa, maize is considered as a staple diet for approximately 200 million people (Du Plessis, 2003). In Swayimane, maize was the main subsistence crop for 88% of the respondents. It cultivated due to its high nutritional value. The maize kernel consists of carbohydrates, fats, minerals and proteins. Maize requires 450-600mm of water per season coupled with warm daily temperatures no less than 23^{o}C (Du Plessis, 2003). One hundred and twenty to 140 days is the frost free time frame which is required for effective growth at all stages of the maize plant (Du Plessis, 2003). Due to the farming community identifying higher temperatures and drought as an effect of climate change the maize crops are seldom affected by frost damage. The farmers noted less cold winters therefore there is minimal chance of frost damage. Seeds from the current crops were used for the next, therefore allowing for a constant supply of maize which secures the supply of food for the next season.

According to SANBI (2014) the short-term droughts which the community currently faces will considerably affect crop production. The current study revealed that drought was highlighted by 48% of the respondents. Decreased farming yields are due to a decrease in irrigation resources which respondents considered that to be a crucial effect of climate change. Erosion is also an effect of climate change. This links to the lack of rainfall which would hold down the topsoil of agricultural land. Seven percent of the respondents noted heavy storms as an effect of climate change. Heavy storms would increase erosion and flooding in the area. The result will be damaged crops and poorer soils due to erosion.

A small portion of farmers (Table 3.1) feel that agriculture has been unaffected by climate change. Many households employ water tanks to collect water which assists in times of decreasing rainfall. Considering that this is a means of water harvesting, an intensification of this practice will ensure that farmers have a sufficient supply of water even through very dry summers and during winters with minimal rainfall. In doing so, farmers will be able to maintain the fertility of their soil as well as experience less erosion (Muzari, 2012). Thirty nine percent of the respondents were of the opinion that the areas of the community which are not agricultural land are unaffected by climate change. One percent accounted for an increase in the different species of grass, possibly due to weeds and alien species overtaking the growth of indigenous grasses. Heavy storms were also highlighted as having an effect on the non-agricultural environment.

According to 30% of the respondents, extremely high temperatures had been noticed over the past 10 years. This was due to the higher than normal temperatures experienced during times of drought. Farmers' have noticed an increase in pests as an effect of climate change and climate variability. There have been instances of sudden thunder storms and hail, followed by strong winds. Respondents noted that the random or sudden changes in weather made it difficult to take precautionary measures. The inconsistency in weather has over time also altered the time frames within which each season generally occurred. As a result, planting and harvesting times have changed. Consequently the Swayimane farmers are often forced to alternate crops to better suit the season. The farmers who sell a portion of their produce are unable to do so because the crops are not ready soon enough. The changing climate therefore makes it harder and more complicated for farmers to predict (Morton, 2007). In doing so, farmers become more vulnerable to the effects of a changing climate and are unable to adapt fast enough. The resilience of these farmers therefore needs to be found in the ability of a family to work together on a farm and utilise the manpower and labour they have, tend towards subsistence farm diversification such that there not seasons are left with no source of food and the transfer of indigenous knowledge between communities and families (Morton, 2007).

A combination of two or more different types of seasonal climate information is necessary for productive farming to occur. Climate information needed on a daily basis include maximum temperatures and daily weather conditions. With this, farmers can plan when to plant. Regarding rain, the state of the season is important as it will guide the following season practices. For example, the farmers of Swayimane expect rain to occur during the latter part of August. If rains occur then, planting needs to go ahead. If there is little or no rain then farmers wait until there is sufficient rainfall. September will therefore be set aside to harvest crops planted in August. Climate change has now altered these times. Therefore most essential information required for productive farming is the state of the season regarding rainfall, total rainfall in the season and the distribution of rain within the season. If farmers are equipped with knowledge regarding these three major factors, they will be able to better plan agricultural practices and adapt to climate change.

3.5. Conclusion

The study highlighted that farmers' perceptions about climate change are correlated to the amounts of rainfall and daily temperatures. This is a determinant of either flooding or droughts. Subsistence farm livelihoods revolve around the availability of irrigation resources or rainfall. Without one or both, crop production drastically decreases and constitutes to food insecurity and malnutrition. With increasing temperatures, farmers' struggle to sustain yields as dams and river levels has decreased severely. Adaptation practices are paramount in order to enhance the farmers' livelihoods and decrease the effect of climate change and variability.

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CHAPTER 4: An Assessment of the Strengths and Weaknesses of Indigenous and Scientific Knowledge

Abstract

Indigenous knowledge has for generations assisted rural subsistence farming communities adapt to climate change and make daily decisions regarding agriculture. This study was conducted in the rural community of Swayimane, uMshwathi Municipality, KwaZulu-Natal. The main objectives of the study were to determine the indigenous indicators used by rural farmers, identify the means through which seasonal climate information is disseminated and assess the strengths and weaknesses of indigenous and scientific knowledge. The other objective of the research was to evaluate the integration of indigenous and scientific weather forecasting. The research used 100 questionnaires which were administered to the subsistence farmers of the community. Focus group discussions and key informant interviews were conducted with small groups of individuals. Results showed that majority of the indigenous indicators related to rainfall and seasonal predictions. Also, seasonal scientific climate information was mainly disseminated via television and radio. Local farmers highlighted that indigenous knowledge was essential in predicting seasonal changes and rainfall and scientific knowledge was not trusted. Scientific information was thought to be too technical and difficult to comprehend. Research concluded that subsistence farmers were open to the integration of scientific and indigenous weather forecasting. They highlighted that it would improve decision making concerning their agricultural activities.

Key words: information dissemination, integration, climate change

4.1. Introduction

The South African National Biodiversity Institute (SANBI) explains that climate change will have an effect on agriculture even if greenhouse gas emissions are to decrease SANBI (2013). The effect will be felt by commercial and subsistence farmers throughout the country. Food security would be the main concern due to the increasing temperatures and decreasing crop yields (Jiri et al., 2015). Adapting to climate change is crucial for sustainability and progress especially during unpredictable weather. Kniveton et al., (2014) mentions that minimal research is conducted regarding the combination of indigenous and scientific knowledge to adapt to climate change. Combining both would benefit communities in a manner which science cannot do single-handedly.

Graaff et al., (2009) highlights the significance of indigenous knowledge stating that it has been a survival mechanism for ages. Indigenous knowledge was for a long time replaced with the modern findings of science. Indigenous knowledge wisdom and credibility was lost. As generations past, escalating attention and value is being placed on indigenous knowledge around the world with the hope that it can assist in providing solutions to global concerns (Graaff et al., 2009). Indigenous knowledge can be roughly defined as "the knowledge that an indigenous (local) community accumulates over generations of living in a particular environment" (Graaff et al., 2009). Indigenous knowledge can be used as a tool to adapt to the changes in daily climates and weather. Considering this, indigenous knowledge is holistic and requires different methods of dissemination as it is required by rural communities.

Indigenous knowledge is stored in the minds of the elderly farmers and residents of the communities within which they are used. The information is not physically written down or documented (Sraku-Lartey, 2014). Indigenous knowledge has different channels within which information is transferred and shared. Some include; storytelling among children and elders; the gathering of social, religious or agricultural groups; the collection of records in the forms of paintings, pictures or carvings and direct observation of the environment (Mundy, 1991).

Indigenous knowledge is an essential component of communities (Sraku-Lartey, 2014). Indigenous knowledge is passed through generations and in this way so is the culture of the community. Over generations, the knowledge has deteriorated as the elders of the family passed on and the youth moved to cities and towns (Elia, 2014). Indigenous knowledge reaches the community members via internal means like small gatherings. There is minimal or no use of technology. Due to there being no external channels like that of mass media, the perceptions and methods carried are thought to be more credible and trusted by the community (Sraku-Lartey, 2014).Furthermore, indigenous knowledge channels are essential to convey messages of change regarding adaptation and changes in agricultural methodology. Indigenous channels are crucial to enable the gathering of information regarding the area, its initiatives or projects and its state of agriculture. By promoting indigenous channels external researchers and funding institutions can gain access to valuable information which can in turn promote development in the community.

Considering the above reasons indigenous knowledge is important, there are many reasons why indigenous knowledge is not always favoured. According to Zuma-Netshiukhwi (2013), indigenous knowledge is based on culture and is different for individual cultures. Many of the indigenous knowledge predictions are daily and seasonal predictions are difficult. Indigenous data does not predict quantities of rainfall but can predict the different times of planting and harvesting. Indigenous knowledge has the notion that scientific information is false and cannot be trusted (Zuma-Netshiukhwi, 2013).

According to Raymond *et al.* (2010), scientific knowledge and information is a formalised process which validates itself using empirical evidence. Such evidence is written and accepted as a set of theories and rules. With reference to Raymond et al., (2016), a decline in water, increasing temperatures and prolonged dry spells will be exacerbated by 1.5^{o}C to 2^{o}C in South Africa. It is through scientific improvements that many of the global issues have been rectified. Science has benefitted crop yields and managed pests and disease effectively. Many rural communities have minimal access to technology. It is therefore not as easily accessible as it is to city-dwelling individuals and commercial farmers to attain information regarding climate change, adaptation or improved farming methods (Zuma-Netshiukhwi, 2013). Scientific weather information is presented in a structured manner with technical terms and figures. To many local farmers it is difficult to understand and interpret therefore making decision-making difficult. The dissemination is scientific weather information is mainly via television and radio (Sraku-Lartey, 2014). Rural communities do not have access to computers and the internet. They do have access to cell phones but often the quality of the device does not allow for a variety of uses. They are mainly used for communication purposes. As a result, scientific knowledge is only transferred within a few minutes on the television or radio. This does not allow for enough detail to be gathered by the farmers. Scientific information therefore requires dissemination methods which will benefit the local farmers.

By integrating indigenous and scientific information rural farmers will have a holistic approach to bettering their agricultural practices. Raymond (2010) unpacks the challenges to integrating knowledge. Highlighted is the fact that if knowledge is not integrated effectively, many interested and affected parties, stakeholders and locals will question the validity and authentication of the outputs (Raymond, 2010). The process, methods and outputs of integration need to be analysed in order for it to best benefit the end users. Scientific information needs to enhance the current indigenous knowledge. In doing so a platform for discussion and deliberation can be created for locals to share and gain access to information.

4.2. Materials and Methods

4.2.1. Study Area

The research was undertaken within the uMgungundlovu District Municipality in the uMshwathi Municipality which lies north-east of Pietermaritzburg. The uMshwathi Municipality consists of urban towns like Wartburg, New Hanover, Dalton and Cool Air. The rural communities account for Thokozani, Ozwathini, Swayimane and Mpolweni. Swayimane accounts for 32km^2 (SANBI, 2014) land area and was the focus of the study as it is the largest of the four rural communities. The region received approximately 500-800mm/annum of rainfall (SANBI, 2014). The population in the uMshwathi Municipality sits at 106 374 citizens. This population has decreased over time due to many males seeking employment in the neighbouring towns. Farming is the main economic activity for about 9329 agricultural households. Sixty two percent of the population is within the 15-64 age group whilst elderly citizens of 65 years and older account for a mere 5.2% of the population.

4.2.2. Data Collection and Analysis

One hundred questionnaires were randomly administered to the households practicing agriculture in the Swayimane community. The research also required that participants be between the ages of 20-100 to ensure that they have a good understanding of the area, farming, its local traditions and history. These questionnaires consisted of multiple open-ended and close-ended structured questions. The questionnaires accounted for the quantitative data collection.

Qualitative data was collected using focus group discussions and key informant discussions. Discussions with each group answered in depth semi-structured questions which enabled triangulation. The focus group participants formed 3 groups of 8 females and 7 males each. Key Informant participants included local business owners, extension officers, community leaders, nurses, teachers and principals as well as local stakeholders. Statistical Package for Social Science 24 (SPSS) was used to analyse data.

4.3. Results

Results show that 33% of the respondents were females between the age group of 41-60 (Figure 4.1). Twenty four percent of the males were evenly distributed between the 20-40 and 41-80 age groups. There were no males of 81-100 years old. One fifth of the respondents were females in the 61-80 age groups.

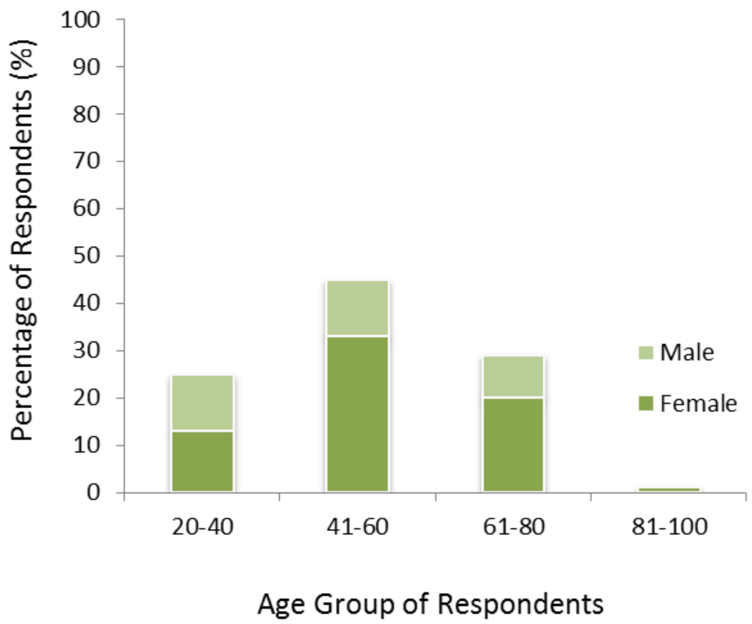

Figure 4.1 Percentage of Male and Female respondents per Age Group

Indigenous knowledge has been used by 73 % of the Swayimane community for as long as they can remember (Figure 4.2). According to 14 % of the residents indigenous knowledge has been used for the past 50 years. Seven percent and 6 % of the respondents noted that indigenous knowledge has been applied for the past 20-30 years and 100 years respectively.

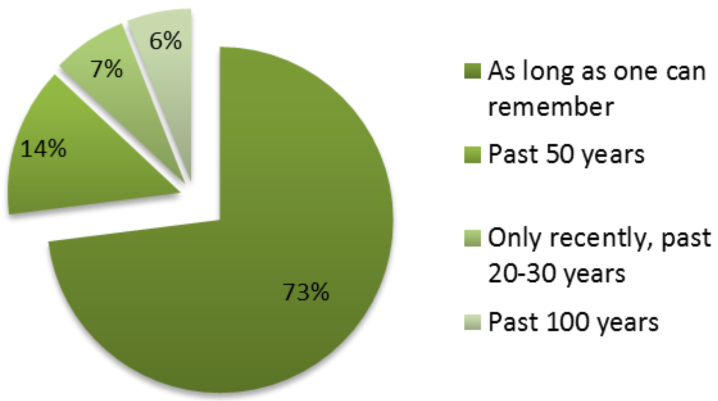

Figure 4.2 Time frames within which indigenous knowledge has been used

Figure 4.3 shows the use of IKS in weather prediction. Data reveals that a significant proportion of the respondents (61%; $P \leq 0.05$) used indigenous knowledge to predict the approaching season while the rest used it to determine planting time, irrigation, pest control decisions, predicting rainfall or never used IKS at all (Figure 4.3).

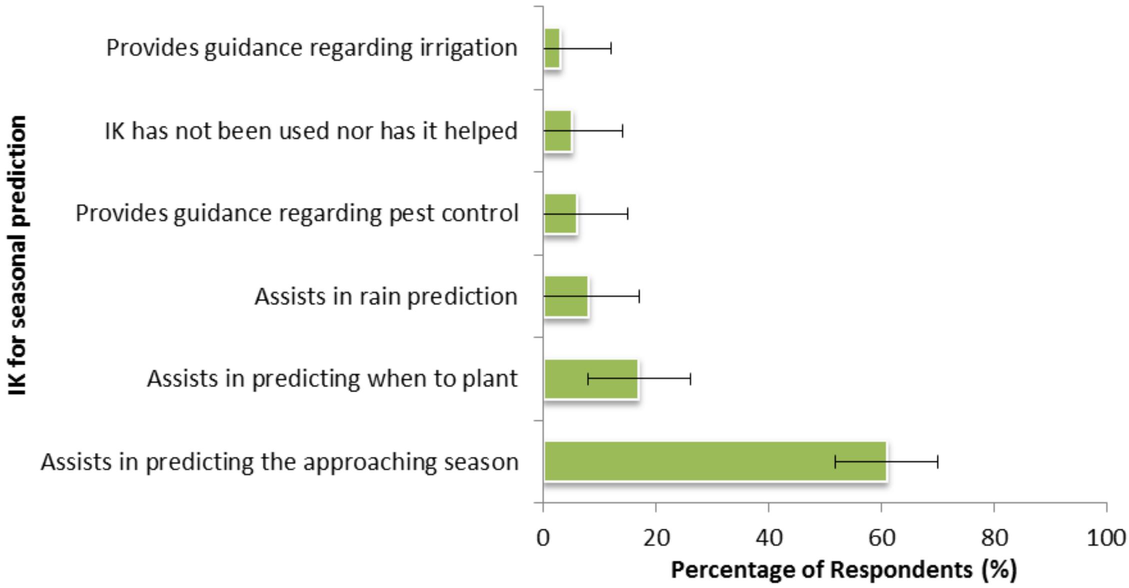

Figure 4.3 The use of indigenous knowledge to predict seasonal quality

About 40% of the respondents have either not used IKS or have used indigenous knowledge regarding rainfall to adapt to climate change (Figure 4.4). Seasonal changes which were identified using traditional knowledge were used by 16 % of the respondents. A mere 8% used indigenous knowledge regarding crop rotation to shed light on their decision-making. These (the 16% and 8%) were significantly lower in number compared to those who used IKS to predict periods of rain or never used IKS at all ($P \leq 0.05$).

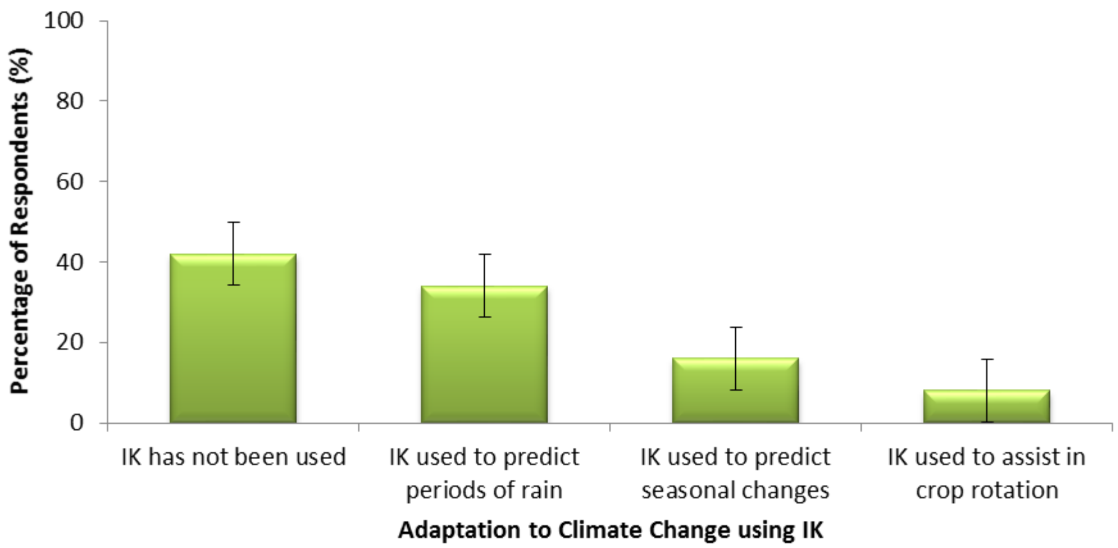

Figure 4.4 The use of indigenous knowledge to adapt to climate change

Data collected regarding the different types of indigenous knowledge indicators used suggests that the most frequently used indicator is the flowering of the peach tree. Sixty two percent of the respondents referred to this indicator (Table 4.1). Thirty five percent of the residents mentioned the observation of the pear tree, Hantela tree and roses blooming. This meant farmers needed to plough the land. Twenty nine percent and 14 % referred to the use of birds as an indicator, the *Phezkomhkono* and *Insingiza* bird respectively. Fifteen percent accounted for different species of birds appearing to signify the end of winter. The arrival of winter was indicated by leaves turning brown and falling to the ground, 26 %. Dark clouds mentioned by 12 % of the residents meant rain was to come within the next few hours. An increase in insects and butterflies highlighted by 11 % of the respondents meant the onset of spring. Nine percent of the residents each pointed out thunder storms and dew or mist as an indicator. Three percent of the respondents stated that thunder storms were signified by frogs. Very few respondents identified the evident of worms in the soil as an indicator.

Table 4.1 Indigenous knowledge indicators and its significance

	Indigenous Knowledge Indicators	**Percentage of Respondents (%)**		**Significance of Indicator**
		Yes	**No**	
1	Peach (*Prunus persica)* tree flowering	62	38	Approaching of summer. Time to plant
2	Flowers blooming: Pear (*Pryus communis)* , Roses (*Rosa Damascena*), Hantela tree	35	65	Time to plough
3	Calling of PhezuKomkhono *(Cuculus solitaries)*	29	71	Time to plant regardless of the season
4	Discolouration and falling of leaves	26	74	Onset of winter
5	Grass grows fast grass very green	23	77	Season of summer

6	First rain in August	21	79	Approaching of summer. Time to plant
7	Long days short nights	15	85	Season of summer
8	Different species of birds	15	85	Season of spring and end of winter
9	Calling of Insingiza bird (*Bucorvus leadbeateri)*	14	86	Onset of rain
10	Dark clouds gathering together	12	88	Onset of rain
11	Increase in insect species and butterflies	11	89	Conclusion of winter and onset of spring
12	Half moon facing east and full moon	10	90	No rain to come
13	Dew and mist	9	91	A lack of morning dew signifies rain. Crops will not grow properly
14	Thunder storms	9	91	Approaching of summer
15	Increase in pests	5	95	More rainfall is to come
16	Worms in soil	4	96	Season of summer and excessive rain
17	Frogs	3	97	Onset of thunder storms

Indigenous knowledge has been useful in understanding the effects of climate change to 45 % of the Swayimane farmers (Figure 4.5). Thirty six percent expressed it as being moderately useful while 19 % found it to be ineffective.

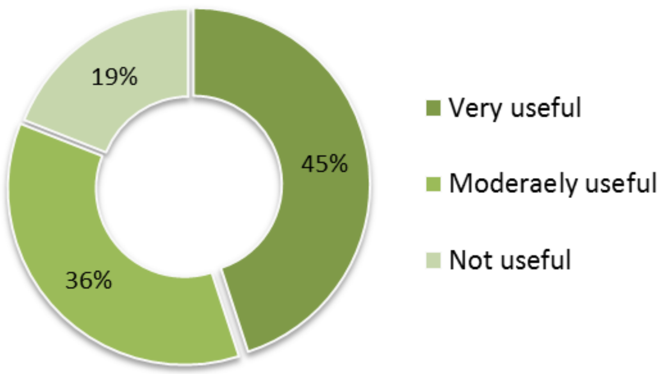

Figure 4.5 The usefulness of indigenous knowledge to understand the effects of climate change

Forty five of the respondents stated that indigenous knowledge is useful as it guides all their agricultural practices (Figure 4.6; $P \leq 0.05$).). Contrary to this, 3% of the residents said that it does not assist or guide their agricultural practices. As expected, a significant 28% of the respondents regard IKS as unreliable ($P \leq 0.05$). Adding to this was 16% who explained that indigenous knowledge is not always accurate. Indigenous knowledge has become less useful as climate change has altered the timing of season. This was highlighted by 4% of the respondents. Two percent noted that indigenous knowledge is useful because it does not require technological information. Another 2% said the usefulness lied in its ability to assist in the prediction of rain.

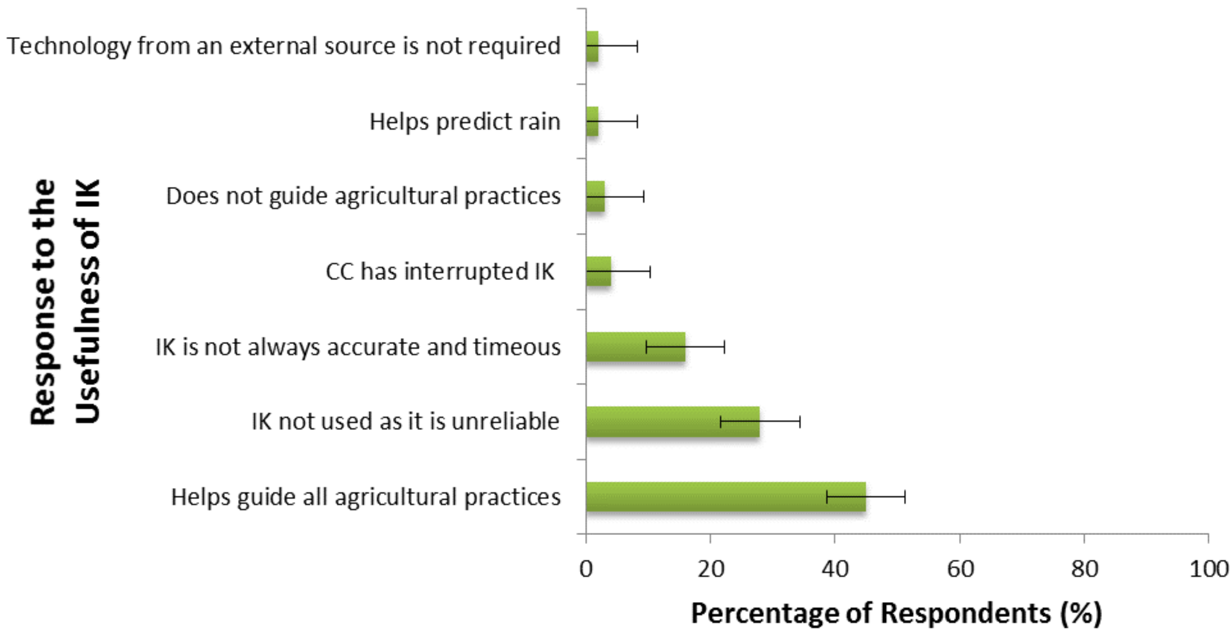

Figure 4.6 The means by which indigenous knowledge is used to understand the effects of climate change

Indigenous knowledge has a function with regards to crops and livestock. Twenty one percent of the respondents did not answer (Figure 4.7). Seventy seven respondents noted that it had a significant role to play ($P \leq 0.05$). It was significant as it assisted them regarding their crops, 58% and their livestock, 21% ($P \leq 0.05$). Three percent noted that the role was insignificant.

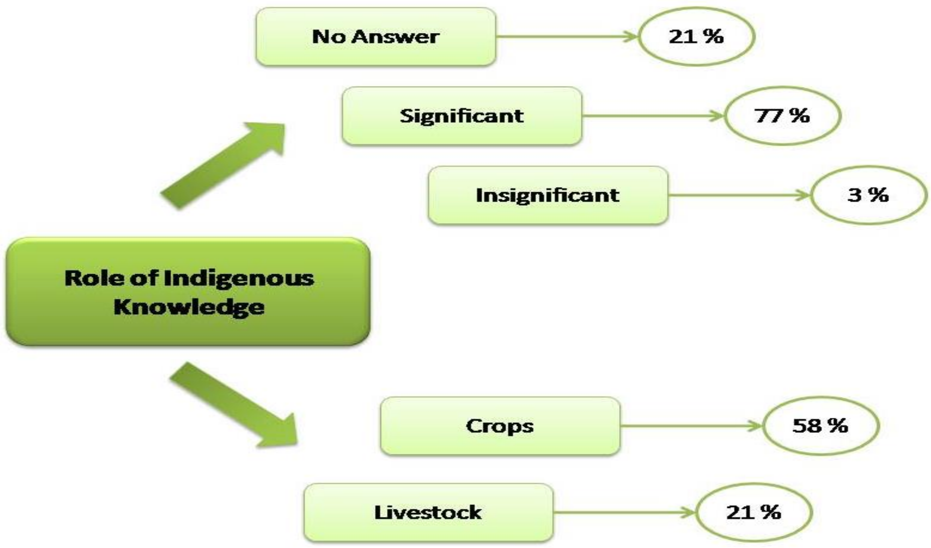

Figure 4.7 The role of indigenous knowledge regarding crops and livestock

Respondents were asked if indigenous knowledge confirmed the findings of scientific knowledge and information. Seventy six per said that the two spheres do correlate while 12% did not (Figure 4.8;$P \leq 0.05$). Six percent mentioned that they correlate intermittently. A small percent mentioned that it is unreliable and cannot be trusted when compared to indigenous knowledge.

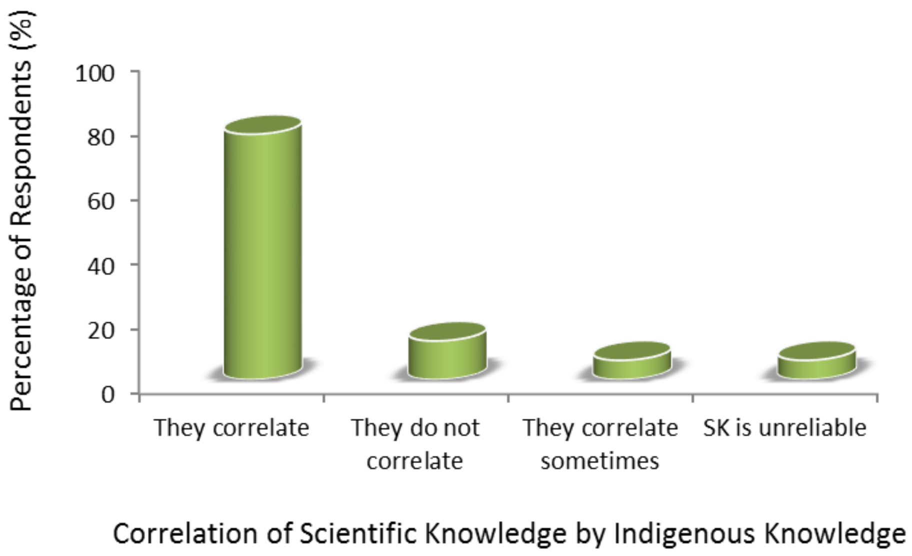

Figure 4.8 Link between scientific and indigenous knowledge

Eighty eight respondents received seasonal climate forecasts while 12% did not (Figure 4.9). The answer referred to any type and means of receiving information.

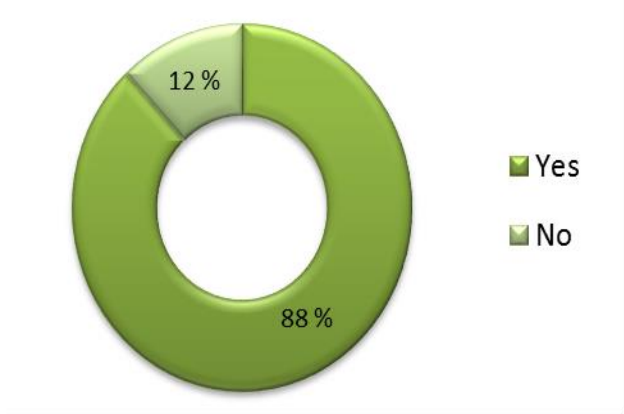

Figure 4.9 Number of respondents who receive seasonal climate information

Responses regarding whether residents received or did not receive certain climate information was recorded. Eighty four percent relied on the daily weather conditions which were aired during the daily news on television (Figure 4.10; $P \leq 0.05$). Seventy one percent relied on climate information from the news on the radio. Forty six percent of the respondents relied on word of mouth to communicate climatic conditions and information. The least used climate dissemination means were extension services, short message systems and the internet. Only 7% made use of the internet via their cell phones.

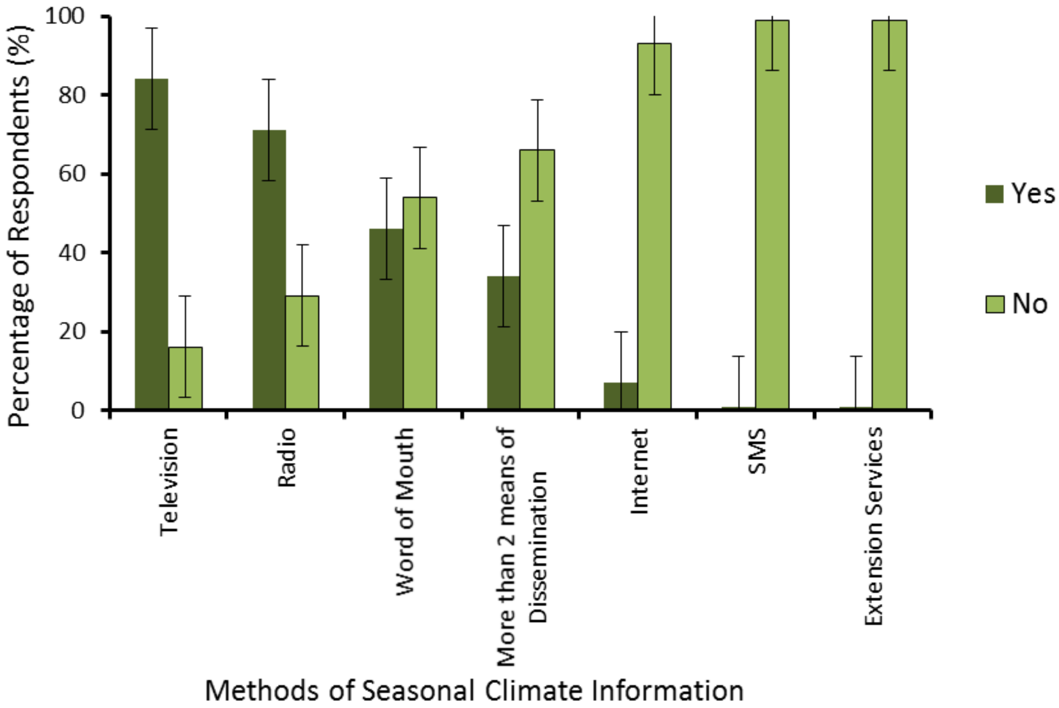

Figure 4.10 The main means by which seasonal climate information is disseminated

Farmers were asked about their perceptions regarding the means of climate information (Figure 4.10). Twenty seven percent of the respondents said that radio and television were more trustable than any other means of climate dissemination (Figure 4.11). Twenty two percent relied on radio and television to provide information about rainfall. Thirteen percent note that all information they receive is essential and 1% said mentioned that only scientific information is important. Eighteen percent of the target population chose to ignore the question while 7% said that no scientific climate forecasts are used.

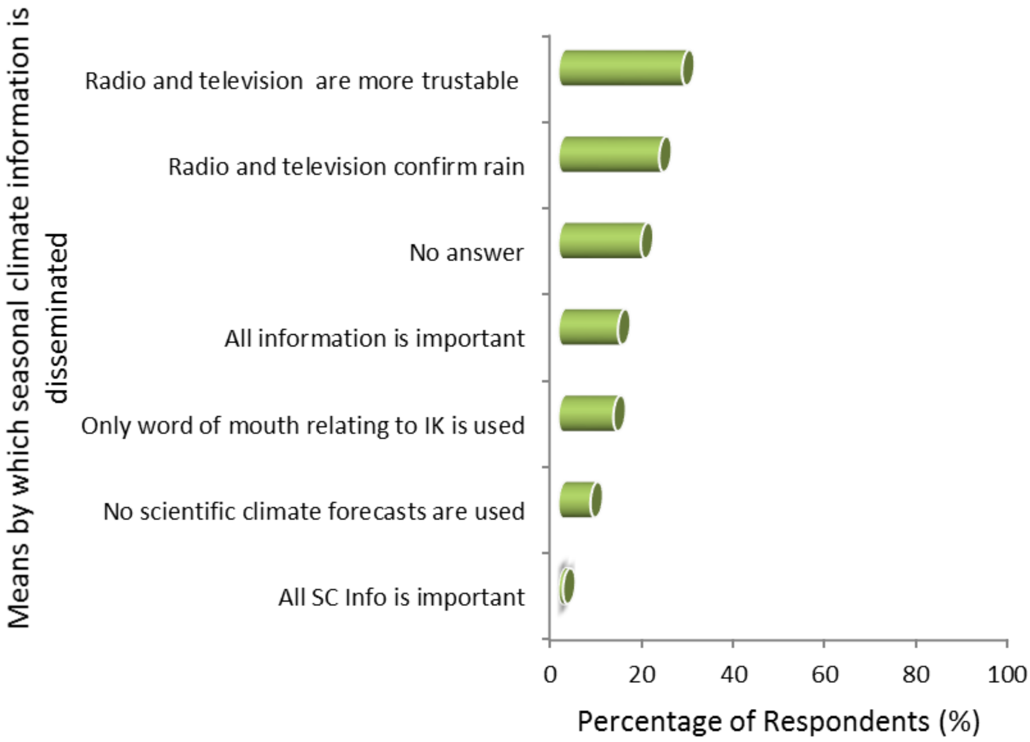

Figure 4.11 Means by which seasonal climate information is disseminated

Excluding climate change there are external factors which affect farm level decision-making. According to 32% of the respondents their crops are destroyed by animals (Figure 4.12; $P \leq 0.05$). Crops are trampled by neighbouring cattle and goats and eaten by monkeys. Twenty percent of the farmers said that there is a lack of finance to aid farming. Nineteen percent noted that pests and disease affect decisions about what to farm and when ($P \leq 0.05$). Minimal government support was noted by 7% of the target population to affect decision-making. Soil fertility and a lack of agricultural education were highlighted by 6 and 4 people respectively. Nine percent of the respondents mentioned that there were no external factors affecting their decision-making.

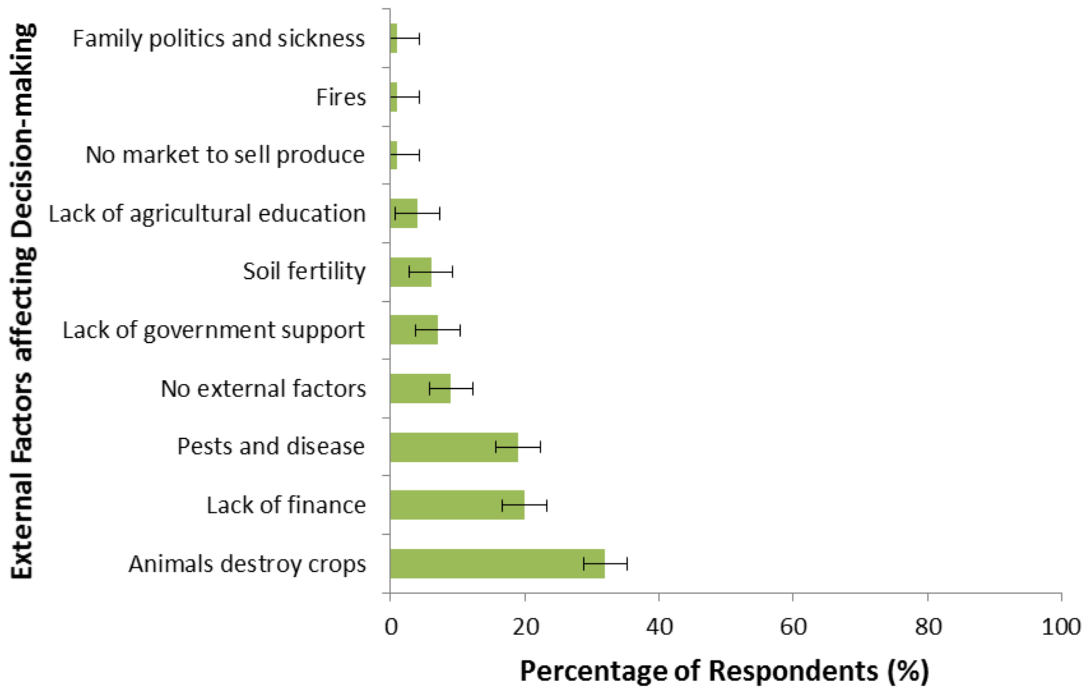

Figure 4.12 External factors which affect and influence farm level planning, decision making and information

Indigenous knowledge has worked for generations according to 71% of the respondent farmers (Table 4.2). Another advantage is that it accurately predicts seasonal changes for 41% of the respondents. Thirty three people noted that in can be used to determine changes in the climate and weather far in advance. The remainder of the target group stated that it was advantageous in that it did not require money or electricity. Considering the advantages 37% of residents believed that the climate predictions are not dependable and guaranteed. Indigenous knowledge cannot assist in terms of climate change adaptation, pest control and soil fertility. Seventeen percent of the farmers said that it cannot predict seasonal rainfall therefore contributing to the inaccuracy.

Table 4.2 Advantages and disadvantages of Indigenous Knowledge

Indigenous Knowledge	Percentage of Respondents (%)	
Advantages	**Yes**	**No**
Its worked for generations	71	29
Precisely predicts seasonal changes	41	59
Can predict what will happen in advance	33	67
Doesn't need electricity	17	83
Doesn't need money	18	82
Disadvantages	**Yes**	**No**
Predictions not guaranteed reliable	37	63
Doesn't assist in terms of climate change adaptation methods	23	77
Cannot predict soil fertility, pests and disease that are in the soil	24	76
Cannot predict seasonal rainfall	17	83

Data collected revealed that 54% of the target population accounted for scientific knowledge being more realistic and reliable (Table 4.3). Scientific knowledge was is advantageous because it can be accessed at any time and is easy to use (31%) as well as it being accurate and easy to understand (38%). Scientific knowledge provides details regarding pest control via chemical solutions and this is mentioned by 16% of the respondents. Another 16% benefitted from scientific knowledge providing details about planting and harvesting. Fifteen percent of the farmers added that it promote different methods of planting. The disadvantages highlighted include that scientific knowledge requires electricity (18%) and money (16%) and is not always accessible (16%). Scientific knowledge often uses a logical systematic style of writing which is considered by locals (13%) to be too technical and difficult to understand. Ten individuals said that chemical and other scientific innovations make crops unnatural and therefore genetically modified. Four farmers mentioned that they would prefer the scientific knowledge which they received via the television and radio provided more market related information. Fourteen percent of the

Swayimane community believed that scientific knowledge is unreliable and cannot be trusted or used on a daily basis.

Table 4.3 Advantages and disadvantages of Scientific Knowledge

Scientific Knowledge	Percentage of Respondents (%)	
Advantages	**Yes**	**No**
More reliable realistic	54	46
Daily weather info is accurate easy to understand	38	62
Accessible anytime ease of use	31	69
Info can be researched in advance	17	83
Provides chemical solutions pest control	16	84
Provides precise details about planting harvesting	16	84
Promotes different methods of planting	15	85
Disadvantages	**Yes**	**No**
Requires electricity	18	82
Not always accessible	16	84
Requires money	16	84
Unreliable	14	86
Technical language barrier inhibits comprehension	13	87
Crops are genetically modified and unnatural	10	90
More details required about the markets what affects farming	4	96

Figure 3.12 below states that 55% of the farmers believe that indigenous knowledge is more reliable than scientific knowledge (Figure 4.13). Twelve percent noted that it is reliable while 21% were indifferent and unresponsive about the correlation or relationship that the two aspects had. Seven percent and 5% respectively stated that indigenous knowledge is moderately reliable and not reliable compared to scientific knowledge.

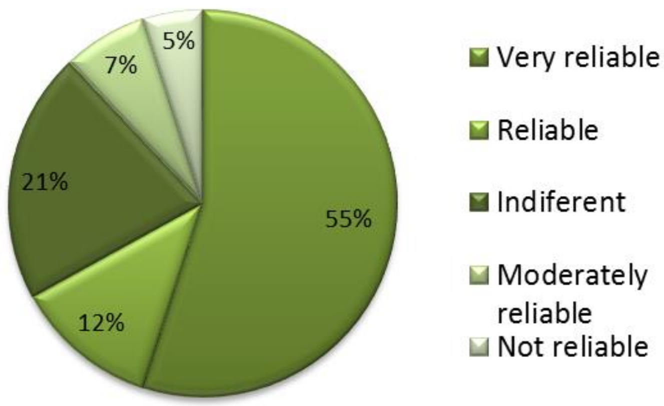

Figure 4.13 The reliability of indigenous knowledge compared to scientific knowledge

Questionnaires inquired about the advantages of combining indigenous and scientific knowledge in terms of weather forecasting to better assist decision-making. Data revealed that 38% of the residents assured that it would improve all agricultural practices (Figure 4.14). Thirty three percent said they will benefit as integrated solutions for farming would decrease their current farming issues. Thirty percent highlighted that adding scientific knowledge to their current indigenous knowledge would increase crop yields. Creative and innovative methods of pest control and disease management were stated by 27% of the farmers. One quarter of the residents highlighted that it would, in general, assist agricultural decision-making.

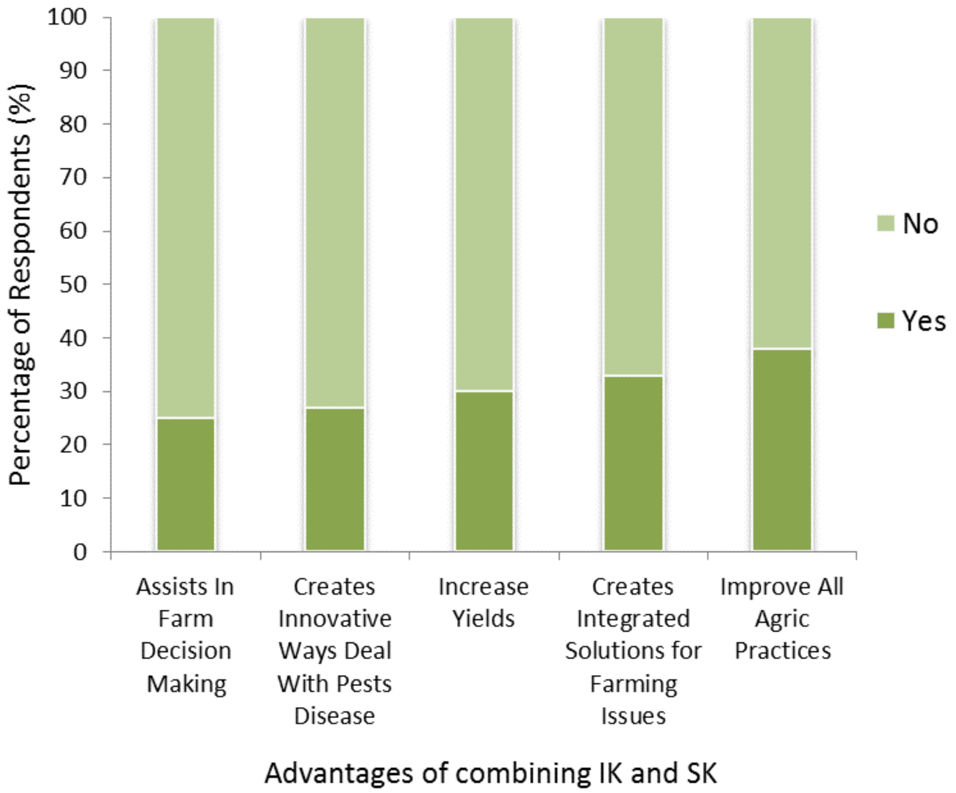

Figure 4.14 The advantages of combining indigenous and scientific knowledge

4.4. Discussion

4.4.1. Predictions

Sixty one percent of the respondents mentioned that indigenous knowledge assists in predicting the approaching season while 16% highlighted that it is used to predict seasonal changes in terms of climate change. Thirty four percent of the questioned residents stated that indigenous knowledge is used to predict rain in order to adapt to climate change while 17% mentioned that it is used to predict rain as a means of foretelling the seasonal changes. According to the respondents, seasonal change is the general characteristic of the season and is compared each year. Climate change accounts for the daily and weekly changes which exist over a short period of time. This change is used to predict daily agricultural practices while seasonal predictions are used to assist farm level planning decisions. Data revealed that 3% of the respondents used indigenous knowledge in terms of the guidance it provides regarding irrigation. According to Sraku-Lartey (2014) indigenous knowledge is also used as a means of coping and adapting to climate change using traditional methods of water conservation and irrigation. Many of the local farmers in Swayimane save water in buckets and drums during rains. Water is later used during times of minimal rainfall to irrigate crops and maintain soil fertility. It is of interest to note that 61% of the residents used indigenous knowledge to predict the seasons and its quality but 42% noted that it is not used with regard to climate change adaptation.

4.4.2. Adaptation

Majority of the Swayimane subsistence farmers do not have adaptive measures in place to react to the effects of climate change. These farmers are aware of the use of indigenous knowledge for a number of generations. Seventy three percent of the respondents stated that indigenous knowledge has been used for as long as they can remember, considering that the mainstream respondents fell between the ages of 41-80. Of the 100 respondents, the majority of 67 were female. This has confirmed United Nations Food and Agricultural Organisation's (FAO) (2016) findings that females account for a large percent of the agricultural sector in developing countries, accounting for roughly 43%. Women are also unable to act on seasonal climate information as well as information regarding rainfall and drought due to lacking resources (FAO, 2016). This may be the reason why there is minimal climate change adaptation methods implemented by the Swayimane farmers. Additionally, women have limited resources, technology and man-power to effectively adapt to climate change yet they are the main subsistence farmers in rural parts of South Africa (FAO, 2016; Seleti, 2014).

4.4.3. Indigenous Knowledge Indicators

Climate change according to the Reyes-Garcia (2016) is primarily depicted by changes in precipitation as well as changes in the quantities of different water bodies. This was found to be accurate regarding the Swayimane community of farmers. For example local people easily observe changes in levels of their surrounding dams and rivers. Data collected revealed that the appearance of dark clouds which have gathered together signifies a storm or rain to come within the next few hours. This correlates with findings from Zuma-Netshiukhwi (2013). A means of adapting would be to secure roof tops and implement rain-water harvesting systems to ensure that the most water is saved and the least damage is caused (Zuma- Netshiukhwi, 2013). Respondents also indentified that the appearance of worms in the soil signifies excessive rain and that it is the season of summer. Also, increases in pests like worms mean that more rainfall is to come. Kijazi et al., (2012) mentioned that the appearance of worms, mainly army worms signified an abundance of precipitation in the season to come which confirms observations by the Swayimane farmers. Contrary to this, the study conducted by Zuma-Netshiukhwi (2013) highlighted that the evidence of worms, notably army worms means that the community needs to prepare for a dry season to come. The Swayimane community was unaware regarding the species of worms which they saw. They did not have specific names for the different worms as they do for the birds. For example, the *Insingizi* bird, commonly known as the Southern Ground-hornbill is used as an indicator of rain to come by 14% of the respondents. A half moon which faces the east means that there is no rain to come. Zuma-Netshiukhwi (2013) states that different moon phase, like a downward crescent shape indicates rainfall within the next three days while a moon with a halo represents good rains to come. Nine farmers mentioned that no mist in the morning means that there will be rain but crops will not grow properly. Frogs are used as an indicator of thunderstorms for the local community.

4.4.4. Seasonal Predictions and Agricultural Decision-making

Respondents were questioned regarding the indigenous indicators which were used to predict seasonal changes. According to 26% of the respondents, winter is signified by the discolouration of leaves from green to brown. At this stage leaves also fall off the trees. With reference to Zuma-Netshiukhwi (2013), these observations are characteristic of winter during the month of June. The conclusion of winter is identified by an increase bird and insect species. Additionally it means that Spring is in close proximity. At this stage, that is the end of July, the local farmers have already ploughed the land and have planted their relevant crops. The expectation is that it will rain in the weeks to come such that germination is enhanced. Farmers anxiously await the first rains in August. This is mentioned by approximately one fifth of the respondents. After the first rains the soil is saturated and more planting can go on. During the warmer months farmers' seek indicators like frogs as they indicate thunder storms. Thunder storms are also indicative of summer months. It is noted that during the summer months, grass grows much faster and there is an increase in pests. Sixty two percent of the local farmers highlighted that the flowering of the peach tree meant that summer was approaching and there for it was time to plant. Planting times were indicated by the calling of the *Phezukomkhono* bird which is commonly known as the Red-chested cuckoo, by 29% of the respondents. It signified that planting had to begin regardless of the season in which the bird called and arrived.

4.4.5. Usefulness of Indigenous Knowledge

According to Nhemachena et al., (2014) the International Panel on Climate Change (IPCC) can decrease crop yields by half in the next four years. Considering that South Africa is a developing third world country the vulnerability of communities drastically increases. As a result indigenous knowledge is used as a means of maintaining crop yields and predicting seasonal changes. Forty five percent of the Swayimane farmers stated that indigenous knowledge is very useful in understanding the effects of climate change. Thirty six percent said that it is moderately useful. Indigenous knowledge has been used to guide agricultural practices, predict rainfall and seasonal changes. It is essential to note that due to climate change the local farmers are unable to effectively predict seasonal changes as it has altered the natural cycles of season. Indigenous knowledge is more informative in terms of its application regarding crops than livestock. Considering this, all of the respondents were owners of subsistence farms. In households where there were livestock, it accounted for a maximum of 2 cows and many goats. As a result the livestock did not require much management. Households also possessed chickens and roosters. They were kept in order to produce eggs for the families. No indigenous knowledge was mentioned or documented with regard to livestock management, pest control or diseases.

4.4.6. Climatic Information for Crop Production

Due to indigenous knowledge being crucial to the yields of crops, certain information is required on a daily base. Eighty eight respondents received seasonal climate information from the television and radio. A large percentage relied on word-of-mouth to communicate daily conditions or seasonal changes. Considering that Swayimane is a rural community the farmers lack resources. Some homes do not have a television or access to the internet but frequently listen to the radio. Respondents believe that the radio and television is very trustable and confirm when it will rain. This therefore allows the farmers to effectively plan ploughing, planting and harvesting times. The extension officers do not convey climate information to the farmers due to minimal means of communication. External and privately owned research companies who have running projects in the community provide workshops to the farmers. Unfortunately, the workshops are not useful to all the subsistence farmers as they often pertain to sugar cane. Respondents therefore highlighted that there is a lack of governmental support and that they are not well educated regarding the crops they grow. The farmers also mentioned that crop yields are decreased as animals destroy crops. There is an increase in pests and disease which the local farmers are unable to curb and control because such detail and information has not been transferred through generations. A few respondents mentioned that there are no markets at which to sell their excess produce. Additionally, because the residents farm until a very old age, many have deteriorating health. Over the years, as the youth move to the cities in search of employment the elderly males and females are left to farm with little or no assistance. This requires them to work in their fields for hours at a time and often in unbearable conditions with the little tools and resources they own.

4.4.7. Advantages of Indigenous and Scientific Knowledge

According to the International Fund for Agricultural Development (IFAD) (2016) indigenous people of the world have been using local indigenous knowledge to adapt to the changing environments for millennia. Indigenous knowledge has therefore been a priceless tool for climate change adaptation. Sraku-Lartey (2014) highlights that indigenous knowledge methods and ideologies are unique. It differs greatly from scientific knowledge which is primarily utilised by commercial farmers. The distinctions lie in the manner in which the two spheres of information are approached, communicated, taught and explained (Sraku-Lartey, 2014).

The community of Swayimane emphasized that indigenous knowledge has been used for generations (Table 4.4). It was verbally taught to the next farming generation of the family or household. It was therefore highly trusted and thought to be reliable as its source was reliable. As a result it was used more often than scientific knowledge or scientific weather forecasts were used. The local farmers are able to effectively predict the seasons and changes occurring within that season. They do so by identifying indicators in nature. For example, the Peach tree flowering and the first rains in August signify the proximity of summer. As a result, farmers are able to identify these indicators much in advance due to generations of using the same indigenous knowledge. They then make arrangements regarding the well-being of their crops or livestock based on the weather they will be expecting. The use of indigenous knowledge does not require money or electricity. Rural communities, like Swayimane therefore benefit from this. The locals feel that this is especially important as indigenous knowledge is not hampered by any external forces. Indigenous knowledge communication and applications are largely unaffected by the challenges faced by scientific forms of knowledge.

Scientific knowledge is rarely used by the Swayimane farmers even though it may be advantageous to them and their crops. According to Sraku-Lartey (2014) scientific knowledge consists of compartmentalised information which is well documented and taught via lectures or lessons in a systematic manner. It is devoid of emotion and social attachment and is based on factual information. According to the data collected by the local farmers, scientific knowledge is more reliable and realistic (Table 4.4). Also, daily weather information is accurate and easy to understand. Scientific weather information is communicated through radios and television and highlights the daily maximum and minimum temperatures. Locals also rely of the percentage of rain which is expected. For the small portion of farmers who have access to the internet and technological devices, scientific information can be easily accessed. Due to the innovative and advanced nature of scientific methods and applications it assists local farmers by providing chemical solutions to pest control. Indigenous knowledge does not provide assistance regarding pest control for the farmers of Swayimane. Information is provided with precision and detail. It highlights the different and most effective methods of planting and harvesting.

4.4.8. Disadvantages of Indigenous and Scientific Knowledge

According to Elia (2014) indigenous knowledge has over the past few years become less predictable and reliable. This is reiterated by the data collected in Swayimane. Local farmers highlighted that predictions are much less reliable than before. Predictions are not guaranteed to be true and deliver the expected results. Indigenous knowledge does not provide solutions to adapt to climate change. It does not provide sustainable measures and methods they could use on a daily basis. Contrary to many of the local farmers being able to use indigenous knowledge to predict seasonal changes and rainfall activities during the season, other locals felt that indigenous knowledge cannot predict seasonal rainfall. The result is that they are unable to effectively adapt to climate change and make educated decisions regarding agriculture. Indigenous knowledge is also unable to determine or predict soil related issues. Soil fertility cannot be determined by the Swayimane farmers and pests and disease cannot be identified. All these factors result in increased reliability on scientific knowledge. Considering this, scientific knowledge has disadvantages which affect its utilisation by rural farmers. Scientific knowledge required money and electricity to be used. Without finances and access to electricity the accessibility of scientific knowledge is drastically reduced. Scientific knowledge is also communicated in a systematic manner. Elia (2014) indicates that scientific information is presented using theories and evidence to validate information. Consequently scientific information is considered by the local farmers as being too technical and therefore cannot be effectively understood. Farmers are also of the opinion that if chemicals are used in terms of pest control and disease then crops are unnatural. This also prevents them from trying scientific control methods. A few local farmers mentioned that scientific knowledge needs to provide information regarding external farming markets and the factors that affect the markets. This will enable them to make better informed decisions regarding their crops.

4.4.9. Advantages of Knowledge Integration

Climate change has over the generations made it difficult for rural farmers who rely on indigenous knowledge to adapt to the effects of the changing weather and make agricultural related decisions. With reference to local rural farmers in Swayimane, integration of indigenous and scientific knowledge will improve all agricultural practices. Agricultural practices which they are referring to mainly include planting and harvesting. Other practices include the collection and management of rain water. According to Sraku-Lartey (2014) integrating the two spheres will need multiple changes to occur between institutions and government. One needs to understand that indigenous and scientific knowledge are very different in terms of their ideologies and methodologies but can be very beneficial to each other. Information needs to be tied together in a logical and meaningful manner. Institutions need to collaborate with local communities to gather indigenous information and make it easily available and accessible. Local farmers also need to understand that scientific knowledge will develop the knowledge they already possess. The aim is not to discourage and destroy the confidence in indigenous knowledge. Integration will also assist in creating integrated solutions for farming issues. For example, local farmers seek solutions from the newspapers, other local farmers and workshops held by external institutions. Integrating the two spheres of information will enable farmers to use sustainable methods to farm but drawing on what is currently used and what can be added by science. Integration will also create innovative ways of dealing with pests and disease. If issues regarding pests and disease are dealt with effectively, farmers can focus on increasing their yields using scientific methods. Scientific information methods can shed light on soil fertility, water conservation, farming approaches, crop rotation, biological control of pests and the use of pesticides. Furthermore, scientific methods which have been tried and tested can be utilised by the farmers in order to increase yields and make better decisions regarding agricultural management.

Considering that integration is essential for development and climate change adaptation, indigenous knowledge needs to be thoroughly managed. Sraku-Lartey (2014) highlights that indigenous information should be well understood in relation to the community at hand. Additionally, indigenous knowledge needs to be organised according to a structure which will effectively depict the types of information which it emphasises. It needs to identify the role of the indigenous knowledge stakeholders and other groups involved. Indigenous knowledge also needs to be communicated in order for communities to use it. Many rural households in Swayimane have access to televisions and radios and in certain households a cell phone. Referring to Sraku-Lartey (2014) information and communication technologies can be used to improve communication, distribution and transmission information to people and communities who need them the most. Communication technologies comprise of telecommunications like telephones and radio and digital technology like computers and software (Sraku-Lartey, 2014). By utilising different technologies to communicate integrated knowledge, a cost-effective means of dissemination can be created (Sraku-Lartey, 2014). Rural communities can benefit from technologies they already own like cell phones and thereby their accessibility to the internet. The different types of technologies could also enable the storage of indigenous knowledge. In doing so, local youth will have access to this information. By creating a platform for indigenous knowledge, information can be transferred between communities and institutions. Solutions to the problems farmers are facing can be dealt with using innovative combinations of scientific and indigenous knowledge.

4.5. Conclusion

The research emphasised that integrating indigenous and scientific knowledge will enable local farmers adapt to climate change and make better informed decisions. Indigenous knowledge is favoured in the Swayimane community therefore integration requires the inclusion of the people, their traditional knowledge and skills. Scientific knowledge should be presented and communicated to local farmers in a manner which they will understand and easily employ. Farmers need to understand that scientific knowledge is meant to aid their daily agricultural practices and promote them adapting to climate change. Consequently, traditional knowledge needs to be recognised in governments and institutions.

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CHAPTER 5: Conclusions and Recommendations

5.1. Conclusions

The data collected from this study emphasise that rural subsistence farmers are aware of climate change. Although aware, local farmers are unprepared, uneducated and ill-equipped to deal with the physical effects of the changing seasons. The impacts of climate change are mainly experienced and remembered during seasonal changes inclusive of decreasing rainfall and increasing daily temperatures. Extreme weather events include droughts and thunderstorms. Seasons which had devastating and severs impacts on the quality of farmers' crops, the quantity of their yields and directly worsened their livelihoods were remembered as being the effects of climate change. No mitigation methods were implemented if changes in climate or weather are expected.

Information regarding seasonal changes and daily weather was gained by the use of radio and television. Cell phones were also used as well as radios. Access to other forms of technology was minimal. The use of the internet, newspapers, extension officers and word of mouth communication were apparent but not frequent. A factor hampering the use of the above mentioned forms of information dissemination is a lack of household finances or credit. A large percentage of rural farmers are uneducated which decrease the amount of information that is retained and applied subsequent to receiving information via televisions and radios. Due to the technical nature of the scientific information received, local farmers prefer the use of indigenous knowledge and its natural or environmental indicators. Indigenous knowledge is for the most part preferred as it does not require finances or electricity. Consequently, indigenous knowledge is unaffected by factors that affect the availability of finances or electricity. Indigenous knowledge is trustable and seasonal changes can be predicted in advance.

Integrating indigenous knowledge with that of existing scientific information and methods could increase rural subsistence farmers' resilience to climate change. The combination of information can assist all agricultural practices as well as allow farmers to make better informed decisions regarding crop management. Scientific advantages include the use of innovative technology, chemicals for pesticides and disease control, water management implements and methods as well as tried and tested agricultural management solutions.

Integrating scientific seasonal forecasts with indigenous knowledge to predict seasonal changes could assist farmers increase their crop yields. This will increased food security. In doing so, scientific information needs to be received by local farmers regularly regarding daily temperatures and seasonal changes. Such information will be used to adapt to the changing climate and thereby increase crop yields and to sustain livelihoods.

5.3. Future research

Based on the data collection and analysis as well as the desktop literature review of the research, the following recommendations can be made:

1. Data collection should be collected on a long-term basis so we can test the rigour of indigenous indicators and assess the linked adaptive options used by farmers. Upon data collection it is evident that more time is necessary to effectively collect qualitative and quantitative data. One needs to fully understand the background of the subsistence farmers who are the focal points of many agricultural and climate related studies. A limitation of the study was the short time period within which data was collected.

2. Indigenous knowledge is primarily documented in scientific journals or stored in local museums and archives. In doing so, the farmers who require the information the most do not have access to it. Contrary to this, indigenous knowledge is also kept within communities for use by them. Information between farmers and scientists need to be exchanged in order for more value to be attained from each sphere of information. Information must be presented to local farmers in a user-friendly manner that is easy to understand. Consequently, scientists needs to understand the spiritual background and reasoning of indigenous knowledge.

3. Collaboration of indigenous knowledge and scientific knowledge should occur to document the qualitative aspect of weather forecasts. Integration will occur only once local farmers are willing to adapt to change and accept external help. Also, funding from government is essential to promote more means of information

dissemination. By increasing current funding and resources to rural agricultural communities, farmers will stand a better chance of adapting to climate change.

4. Climate change cannot be brought to a standstill but it can be managed. Projects need to be implemented in vulnerable and rural communities. This can educate and train subsistence farmers on an ongoing basis on essential requirements like, water conservation, soil fertility, crop rotation and agricultural management. In doing so, education will encourage awareness, with the aim of assisting the community adapt to climate change.

5. Future research needs to include an integrative model of indigenous and scientific knowledge that can be effectively used by rural farmers and commercial farmers alike, to adapt to the changing climate. The model should include scientific evidence as validation for indigenous indicators in a manner that local farmers can understand. It should include an exchange of knowledge between scientists and local farmers. Issues like climate change, adaptation and mitigation should be the focus of knowledge exchange. In doing so, the different perspectives will promote agricultural education and create a platform for the integration of concepts and ideologies.

6. Research should use indigenous and scientific knowledge as variables to determine the best practicable option for rural farmer in terms of crop yields. It should determine which type of knowledge produces higher yields and increases a household's ability to adapt to climate change and climate variability.

7. The scientific basis of indigenous indicators needs to be determined. Environmental indicators should be cross checked to validate their usage and authentication with regard to the types of weather and activities which are guided by them in terms of science. Indigenous indicators can be mainstreamed into scientific literature to create a robust system for farmers to use.

APPENDICES

APPENDIX 1: Climate Change Perspectives, Indigenous and Scientific Knowledge Questionnaire

University of KwaZulu-Natal – Pietermaritzburg

Questionnaire: Combining Indigenous and Scientific Knowledge

The University of KwaZulu-Natal has undertaken a study to determine the relevance and prevalence of indigenous and scientific knowledge in specific rural communities of Kwa Zulu-Natal, South Africa. The aim is to determine farmers' perspectives on climate change and assess the strength and weaknesses of scientific and indigenous forecasting methods. In doing so, the data collected from the following questionnaire will be analysed and applied to improved seasonal forecasts for farmers. These forecasts will assist farmers in adapting to climate change by way of informing decision-making regarding agricultural practices. The study understands the importance of indigenous knowledge systems and practices to the rural villages of Africa and South Africa as one of the primary sources of seasonal information.

The information that will be collected will assist current government and organisational interventions in providing more effective climate information in more user-friendly ways to the rural agricultural communities. Participation in this research is voluntary and confidentiality is guaranteed. Should you wish to withdraw from the study or decline to answer any questions there will be no negative circumstances. The interview may take approximately 30 minutes to complete. During this time, additional information and responses will be recorded in a note book such that there is minimal loss of data and to ensure that all data is effectively recorded.

Survey Number: ……………………………………………………………………………………………………

Date: ………

Name of Interviewer: ………………………………………………………………………………………………

Location (region, district, village): ……………………………………………………………………………

Name of Respondent (optional): ………………………………………………………………………………

Age: …………………………………………Gender: ……………………………………………………………

Section A

Type of Farm (private, communal): ……………………………………………………………………………………………

Main Crops and Season of Harvest:

	Main Crop	Season/s
1.		
2.		

1. Has agriculture been affected by climate change in the past 10 years?

   YES / NO ,If yes or no, please explain.

   ____

   ____

2. Have there been changes in the non-agricultural environment around the community within the past 10 years?

   YES / NO, If Yes, please explain.

   ____

   ____

3. What has most been affected by climate change? Please tick the appropriate answers.

Factors Affected by Climate Change		
1.	Temperature	
2.	Rainfall	
3.	Pests	
4.	Disease	
5.	Other	

4. What type of climate variability has been noticed over the past 10 years with regard to extreme weather events?

   ____

   ____

5. Relating specifically to agricultural needs, what type of climate information is desired/needed for productive farming to occur? Please tick the appropriate answer.

Climate Information		
1.	State of the season regarding rainfall.	
2.	Total rainfall in the season.	
3.	Total number of days in a season with rain.	
4.	Distribution of rain within the season.	
5.	Total rainfall in the month.	
6.	Total number of days in a month with rain.	
7.	Maximum temperatures.	
8.	Minimum temperatures.	
9.	Daily weather conditions.	

5.1. Which 3 of the above climate information is the most essential and why?

	Most Essential Climate Information	Why is this information important?
1		
2		
3		

Section B

6. How has indigenous knowledge been used to predict seasonal quality?

____

____

7. How has indigenous knowledge been used to adapt to climate change?

____

____

8. How long has indigenous knowledge been used to assist agriculture? Please tick the appropriate answer.

1.	As long as you can remember	
2.	Past 100 years	

3.	Past 50 years	
4.	Only recently, past 20-30 years	

9. What indigenous knowledge
   A. indicators are used for seasonal forecasting,
   B. in which season and
   C. what is the meaning if the indicator?

A. Indicator	**B.Season/s Applicable**	**C. Meaning of Indicator**

10. How useful is indigenous knowledge in understanding the effects of climate change? Please tick the appropriate answer and explain your response below.

1.	Very useful	
2.	Moderately useful	
3.	Not useful	

____

____

11. What is the role of indigenous knowledge in decisions making regarding crops or livestock?

____

____

12. Do indigenous knowledge forecasts confirm scientific forecasts?
    YES / NO.   If YES, what correlations exist?If NO, why not?

____

____

13. State the main constraints regarding the optimal use of:

A. Indigenous Knowledge (Table A)

B. Scientific Knowledge (Table B)

13.1. How can information use be improved to maximise the benefits received by farmers? Please complete Column 3 of Table A and B.

Table A

A.	Indigenous Forecast Information Constraints	Methods of Improving Information Use
1.		
2.		

Table B

A.	Scientific Forecast Information Constraints	Methods of Improving Information Use
1.		
2.		

14. Do you receive seasonal climate information? YES / NO, If Yes, from where?

____

____

15. What are the mains ways which are used to disseminate seasonal information?

Please tick the appropriate answer in the Table below.

A.	Dissemination Methods	
1.	Radio	
2.	SMS	
3.	Television	
4.	Internet	
5.	Extension Services	

6.	Word of Mouth	
7.	Other (please specify)	

16. What are your perceptions about the above mentioned seasonal climate information?

____

____

17. What other factors (excluding climate information) affect and influence farm level planning, decision making and information?

____

____

18. What are the advantages using indigenous indicators?

Please state theses as advantages **(Column A).**

18.1. What are the problems, issues or complications associated with indigenous indicators? Please state these as disadvantages **(Column B).**

Indigenous Knowledge		
	A. Advantages	**B.** Disadvantages
1.		
2.		

19. What are the advantages of using scientific knowledge?

Please state theses as advantages **(Column A).**

19.1. What are the problems, issues or complications associated with scientific knowledge? Please state these as disadvantages **(Column B).**

Scientific Knowledge		
	A. Advantages	B. Disadvantages
1.		
2.		

20. Please rate the reliability of indigenous knowledge compared to scientific knowledge. Please tick the appropriate answer in the Table below.

Very reliable	Reliable	Moderately reliable	Not really reliable	Not reliable at all

21. What are the advantages of using/combining both scientific and indigenous knowledgeto better inform decision-making?

____

____

22. Please state any other issues, concerns or opinions which you feel may be of relevance to the study with respect to indigenous and scientific knowledge as well as seasonal quality prediction.

____

____

For additional information, queries or concerns please contact:

Student: Myuri Basdew   Supervisor: Prof. P. Mafongoya

myuri.basdew@gmail.com / 033 260 5463

Thank you for your time, patience and assistance!

APPENDIX 2: Indigenous and Scientific Knowledge Key Informant Questions

University of KwaZulu-Natal – Pietermaritzburg

Key Informant Interview: Combining Indigenous and Scientific Knowledge

My name is Myuri Basdew from the University of KwaZulu-Natal in Pietermaritzburg. I am currently studying towards a master's degree inclusive of climate change, indigenous and scientific knowledge. I am therefore collecting data by means of key informant discussions. I aim to understand the challenges and advantages of indigenous knowledge and scientific knowledge individually in order to assist farmers' decision making. The information collected will only be used for educational purposes. Participation in this research is voluntary and confidentiality is guaranteed. Should you wish to withdraw from the study discussion there will be no negative circumstances. The discussion may take approximately 30 minutes to complete. Please note that the key informant discussion will be recorded whilst additional notes are transcribed and pictures taken for quality purposes.

1. How has agriculture been affected by climate change in *the* past 10 years?
2. What indigenous knowledge indicators are used for seasonal forecasting, in which season and what is the meaning of each indicator?
3. What are the advantages and disadvantages associated with indigenous knowledge indicators?
4. What the main constraints regarding the optimal use of indigenous knowledge?
5. How can the constraints mentioned regarding indigenous knowledge be altered or improved to better assist decision-making?
6. What are the advantages and disadvantages associated with scientific knowledge?
7. What the main constraints regarding the optimal use of scientific knowledge?
8. How can the constraints mentioned regarding scientific knowledge be altered or improved to better assist decision-making?
9. What are the mains ways which are used to disseminate seasonal information?
10. What are the advantages of using/combining both scientific and indigenous knowledge to better inform decision-making?

APPENDIX 3: Indigenous and Scientific Knowledge Focus Group Questions

University of KwaZulu-Natal – Pietermaritzburg

Focus Group Interview: Combining Indigenous and Scientific Knowledge

My name is Myuri Basdew from the University of KwaZulu-Natal in Pietermaritzburg. I am currently studying towards a master's degree inclusive of climate change, indigenous and scientific knowledge. I am therefore collecting data by means of focus group discussions. I aim to understand the challenges and advantages of indigenous knowledge and scientific knowledge individually in order to assist farmers' decision making. The information collected will only be used for educational purposes. Participation in this research is voluntary and confidentiality is guaranteed. Should you wish to withdraw from the study discussion there will be no negative circumstances. The discussion may take approximately 30 minutes to complete. Please note that the focus group discussion will be recorded whilst additional notes are transcribed and pictures taken for quality purposes.

1.How has agriculture been affected by climate change in *the* past 10 years?

2. What indigenous knowledge indicators are used for seasonal forecasting, in which season and what is the meaning of each indicator?

3. What are the advantages and disadvantages associated with indigenous knowledge indicators?

4. What the main constraints regarding the optimal use of indigenous knowledge?

5. How can the constraints mentioned regarding indigenous knowledge be altered or improved to better assist decision-making?

6. What are the advantages and disadvantages associated with scientific knowledge?

7. What the main constraints regarding the optimal use of scientific knowledge?

8. How can the constraints mentioned regarding scientific knowledge be altered or improved to better assist decision-making?

9. What are the mains ways which are used to disseminate seasonal information?

10. What are the advantages of using/combining both scientific and indigenous knowledge to better inform decision-making?