Research Article

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Integration of indigenous and scientific knowledge in climate adaptation in KwaZulu-Natal, South Africa

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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, South Africa. The main objective of the research was 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. Indigenous knowledge is transmitted by oral tradition, from generation to generation and mainly among the elderly, and, thinly, to the younger generation. Scientific information was thought to be too technical and difficult to comprehend. It can be 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.

Keywords: information dissemination, integration, climate change

1 Introduction

[1] explains that climate change will have an effect on agriculture even if greenhouse gas emissions are to decrease. The effect will be felt by commercial and subsistence farmers throughout developing countries. Food security would be the main concern due to the increasing temperatures and decreasing crop yields [2]. Adapting to climate change is crucial for sustainability and progress especially during unpredictable weather. [3] 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.

[4] highlights the significance of indigenous knowledge stating that it has been a survival mechanism for ages. Indigenous knowledge was for a long time being replaced with the modern findings of science. Indigenous knowledge wisdom and credibility was being 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 [4]. It can also be roughly defined as "the knowledge that an indigenous (local) community accumulates over generations of living in a particular environment" [4]. 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.

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It is stored mainly 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 [5] and 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 [6].

Indigenous knowledge is an essential component of communities [5] which 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 [7]. It 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 [5]. 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 [8], 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 [8].

According to [9], scientific knowledge and information is a formalised process which validates itself using empirical evidence. Such evidence is usually written and accepted as a set of theories and rules. With reference to [9], a decline in water, increasing temperatures and prolonged dry spells will be exacerbated by 1.5°C to 2°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 [8]. 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. As a result, scientific knowledge is only transferred within a few minutes on the television or radio.

By integrating indigenous and scientific information rural farmers will have a holistic approach to bettering their agricultural practices. [9] 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 [9]. 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.

2 Materials and Methods

2.1 Study Area

The research was undertaken within the uMgungundlovu District Municipality in the uMshwathi Municipality which lies north-east of Pietermaritzburg, South Africa. 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 [10] 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 [10]. 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.

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 30-70. This will ensure that they have a good understanding of the area, 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.

3 Results

3.1 Demographic distribution of the respondents

The age distribution of the respondents is shown in Figure 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.

Indigenous knowledge has been used by 73% of the Swayimane community for as long as they can remember. 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.

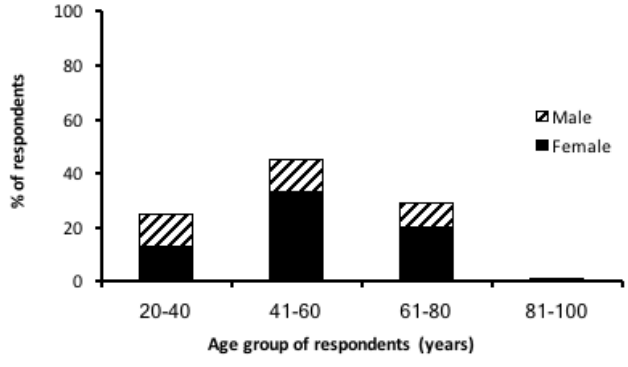


Figure 1: Percentage of Male and Female respondents per Age Group

3.2 Use of Indigenous Knowledge Systems (IKS) in weather prediction

Figure 2 shows the use of IKS in weather prediction. Data reveals that a significant proportion of the respondents (61%; P £ 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 2).

3.3 Use of IKS in climate adaptation

About 40% of the respondents have either not used IKS at all, or have used indigenous knowledge regarding rainfall only, to adapt to climate change (Figure 3). 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 £ 0.05).

3.4 IKS predictors used by the local farmers

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 1).

3.5 Usefulness of IKS

General results indicated that indigenous knowledge has been useful in understanding the effects of climate change to 45% of the Swayimane farmers. Thirty six percent expressed it as being moderately useful while 19% found it to be ineffective.

In terms of usefulness in guiding agricultural practices, 45% of the respondents stated that indigenous knowledge is useful as it guides all their agricultural practices (Figure 4; P £ 0.05). As expected, due to infusion of modern science and climate change, a significant 28% of the respondents regard IKS as unreliable (P £ 0.05).

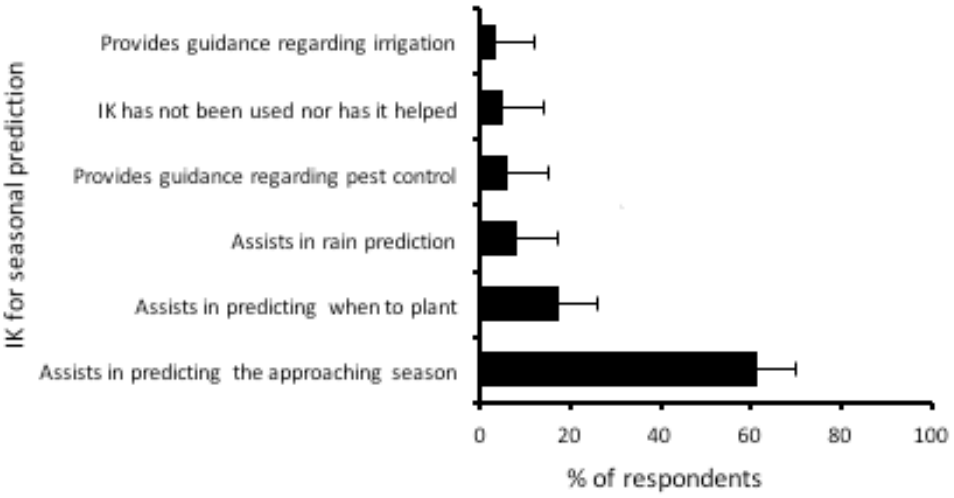


Figure 2: The use of indigenous knowledge to predict seasonal quality

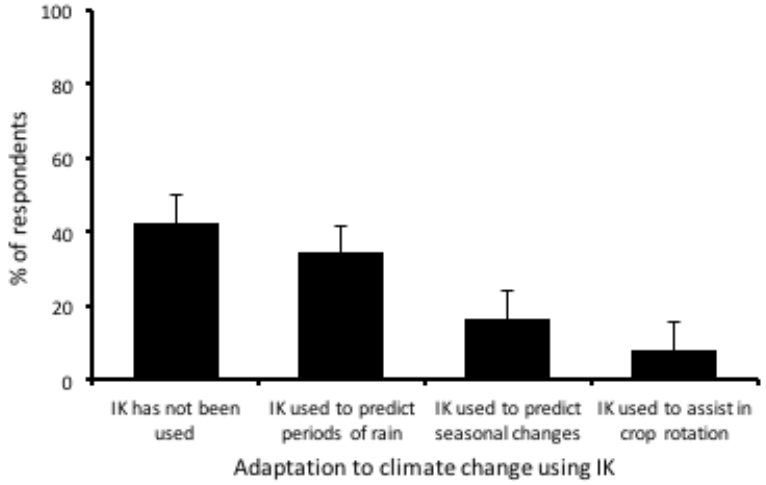


Figure 3: The use of indigenous knowledge to adapt to climate change

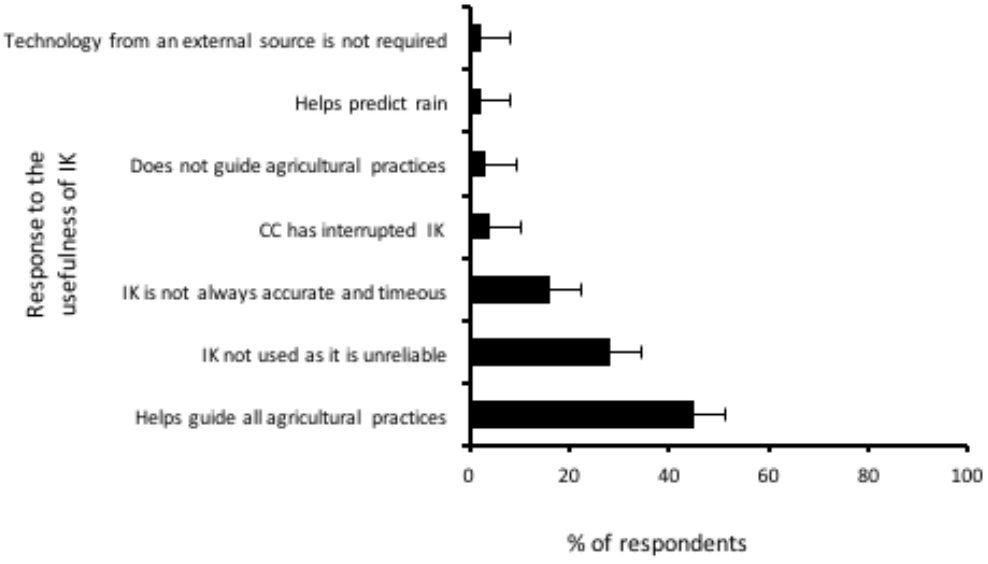


Figure 4: An explanation of the usefulness of indigenous to understand the effects of climate change

Table 1: Indigenous knowledge indicators and their significance

	Indigenous Knowledge Indicators	% 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

3.6 Role of IKS in household farming

Indigenous knowledge has a function with regards to crops and livestock. Twenty one percent of the respondents did not answer (Figure 5). Seventy seven respondents noted that it had a significant role to play (P £ 0.05). It was significant as it assisted them regarding their crops, 58% and their livestock, 21% (P £ 0.05).

3.7 Correlation of IKS and scientific knowledge

Respondents were asked if indigenous knowledge confirmed the findings of scientific knowledge and information. Seventy six percent said that the two spheres of knowledge do correlate while 12% thought they did not (P £ 0.05). Six percent mentioned that they correlate intermittently. Another 6% highlighted that they do not correlate because the role that scientific knowledge plays is insignificant.

Regarding sources of the scientific weather data, a significant 84% of the 100 residents relied on the daily weather conditions which were aired during the daily news on television (Figure 6; P £ 0.05). More than two means of climate information dissemination was used by 34% of the target population. Only 7% made use of the internet via their cell phones. A significant proportion of the respondents did not use internet, SMS or extension services to obtain weather data (P £ 0.05).

The results indicated that 55% of the farmers believe that indigenous knowledge is more reliable than scientific knowledge. 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.

3.8 Reliability of scientific information

Farmers were asked about their perceptions regarding the reliability of scientific sources of climate information. Twenty seven percent of the respondents said that radio and television were more trustable than any other means

of climate dissemination. 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.

3.9 External factors affecting farm level decision-making

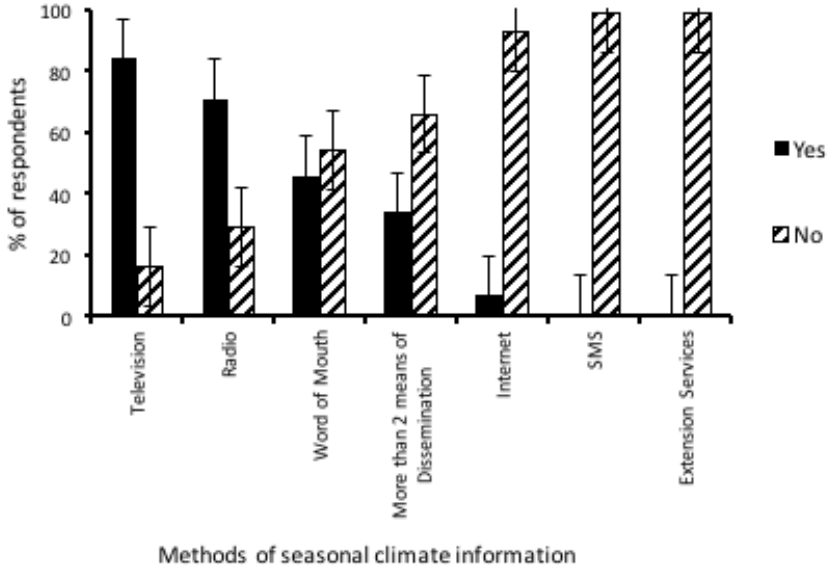
Besides climate variability, various factors affect crop production at the farm level. A significant proportion of the respondents (32%) indicated that their crops are destroyed by animals (Figure 7; P £ 0.05). Other significant factors included lack of finance and increased pest and disease pressure (P £ 0.05).

3.10 Advantages of indigenous knowledge

Table 2 shows an analysis of IKS by respondents. The majority of the respondents acknowledge that IKS has been used for generations to predict seasonal rainfall.

Data collected revealed that 54% of the target population accounted for scientific knowledge being more realistic and reliable. 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

Figure 5: The role of indigenous knowledge regarding crops and livestock



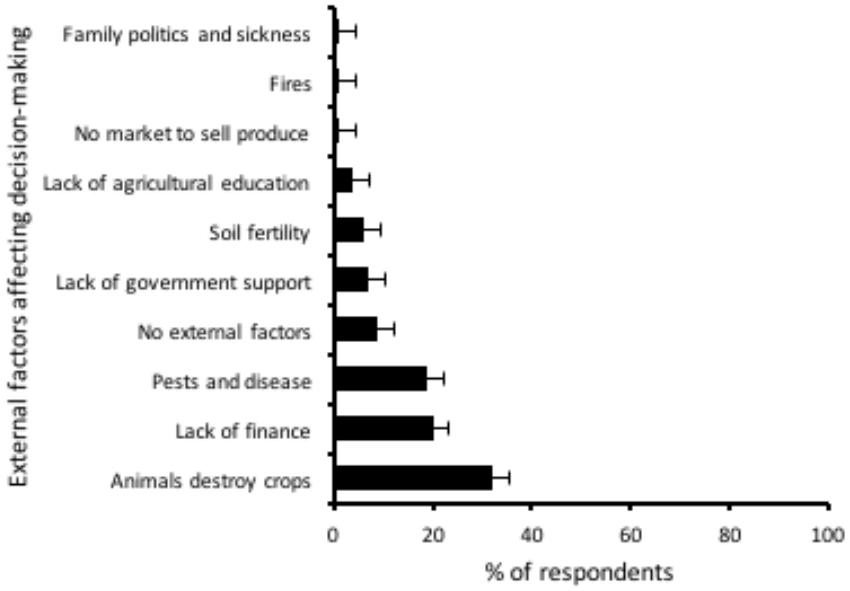


Figure 7: External factors which affect and influence farm level planning, decision making and information

Table 2: Advantages and disadvantages of Indigenous Knowledge

Indigenous Knowledge	**% 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

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.

3.11 Combining the two knowledge systems

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 respondents assured that it would improve all agricultural practices. 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. The dissemination is scientific weather information was mainly via television and radio [5]. Rural communities did 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.

4 Discussion

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. According to [5] 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. 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.

4.2 Adaptation

Majority of the Swayimane subsistence farmers did not have adaptive measures in place to react to the effects of climate change. These farmers were aware of the use of indigenous knowledge in the community. 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 67 were female. Seventy nine percent of the females were between the ages of 41-80. This has confirmed [11] findings that female farmers accounted for a large percent of the farmers in developing countries (about 43%). Women are also unable to act on seasonal climate information as well as information regarding rainfall and drought [11]. 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 [11,12]

4.3 Indigenous Knowledge Indicators

Climate change according to [13] 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 when the farmers observed 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 [8]. 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 [8]. Questionnaire data from the 100 respondents also identified that the appearance of worms in the soil signifies excessive rain and that it is the season of summer. Also, an increase in pests means that more rainfall is to come. [14] mentioned that the appearance of worms, mainly army worms signified an abundance of precipitation in the season to come. Contrary to this, the study conducted by [8] 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. [8] 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 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 [8], 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.

4.5 Usefulness of Indigenous Knowledge

According to [15] climate change and variability 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.

4.6 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 of the 100 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. Rather, 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.

4.7 Advantages of Indigenous and Scientific Knowledge

According to [16] 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. [5] 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 [5].

The community of Swayimane emphasized that indigenous knowledge has been used for generations. 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 [17] 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. 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.

4.8 Disadvantages of Indigenous and Scientific Knowledge

According to [7] 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. [7] 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.

4.9 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 [5,17] 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. [5] 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 [17] 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 [5]. By utilising different technologies to communicate integrated knowledge, a cost-effective means of dissemination can be created [5,17]. Rural communities will benefit as communication will include the technologies they already own. 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.

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. However, the lack of computers and internet connectivity does not allow for enough detail to be gathered by the farmers. Scientific information, therefore, requires dissemination methods which will benefit the local farmers.

6 Future Research

1. 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.

2. Indigenous indicators can be mainstreamed into scientific literature to create a robust system for farmers to use.

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