

# **Improving Information Uptake for Climate Change Adaptation by Integrating Indigenous Knowledge Systems with Climate Information Services**

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# **Improving Information Uptake for Climate Change Adaptation by Integrating Indigenous Knowledge Systems with Climate Information Services**

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**Title:** Improving Information Uptake for Climate Change Adaptation by Integrating Indigenous Knowledge Systems with Climate Information Services

**Sub-title:** Improving Information Uptake by Subsistence Farmers for Climate Change Adaptation by Integrating Indigenous Knowledge Systems with Climate Information Services: A Case Study from Karamoja, Northeast Uganda

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**Abstract:** Subsistence farmers in the developing world are one of the most vulnerable groups to the impacts of climate change. Strengthening their adaptive capacity requires information to inform their climate and agricultural-related decisions. Climate information services offer great potential to inform farmers' decision-making, enabling households to strengthen their ability to manage climate-related risks and to increase their agricultural productivity. However, climate information services often fail to build upon existing local capacities, e.g. indigenous knowledge systems, reducing the uptake of information, and subsequently the potential for enhancing resilience. Accordingly, the aim of this thesis was to: *increase the knowledge about the potential to improve information uptake for climate change adaptation by integrating indigenous knowledge systems with climate information services.* This was achieved through the application of two methods: 1) scoping study of the scientific literature, and 2) case study focusing on the Karamoja Sub-region of Northeast Uganda. Through the scoping study interrelated factors influencing information uptake were identified, they were: 1) access to information, 2) source of information, 3) utilisation of information, and 4) perceived usefulness of information source. The extent to which these factors were evident in Karamoja was subsequently examined through the analysis of household-level questionnaire data collected by the World Food Programme. It was discovered that farmers in Karamoja have low levels of access to information and that often the information is not tailored appropriately, reducing its utilisation. Furthermore, it was revealed that farmers rely upon indigenous knowledge systems for agricultural and climate information and that they perceive indigenous sources and modern sources as equally useful. These findings demonstrate that there is potential to improve information uptake for climate change adaptation in the region by integrating indigenous knowledge systems with climate information services.

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## List of Acronyms

<b>CCA:</b>	Climate Change Adaptation
<b>CIS:</b>	Climate Information Services
<b>FSNA:</b>	Food Security and Nutrition Assessment
<b>IKS:</b>	Indigenous Knowledge Systems
<b>JJA:</b>	June, July, August
<b>MAM:</b>	March, April, May
<b>NGO:</b>	Non-Governmental Organisation
<b>SON:</b>	September, October, November
<b>SPSS:</b>	Statistical Package for Social Scientists
<b>UNDP:</b>	United Nations Development Programme
<b>UNISDR:</b>	United Nations International Strategy for Disaster Risk Reduction
<b>UNSD:</b>	United Nations Statistics Division
<b>USAID:</b>	United States Agency for International Development
<b>WFP:</b>	The World Food Programme

# 1. Introduction

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This chapter introduces the thesis' purpose and its approach. First the rationale of the thesis is described, providing context and justification for the research aim. Following this, the two methodological approaches employed by the thesis are outlined and the research questions and objectives are presented. Finally, the structure of the thesis' chapters and their content are indicated.

## 1.1. Rationale and Research Aim

According to the Intergovernmental Panel on Climate Change: *'warming of the climate system is unequivocal'* and *'many of the observed changes since the 1950s are unprecedented over decades to millennia'* (Pachauri et al., 2014). These changes in climate have amplified existing risks to development and threaten to create new risks, endangering humanity's future. For instance, the increase in frequency and intensity of extreme weather events has had widespread negative impacts on societies, revealing their vulnerability and highlighting the need for adaptation (Field et al., 2012; Hewitson et al., 2014).

Though climate change is a global phenomenon, its impacts and the vulnerability of societies vary greatly. Generally, the impacts of climate change are superimposed on existing vulnerabilities, as is the case in underdeveloped societies with limited capacity to adapt (Abeygunawardena et al., 2003). Furthermore, climate change threatens to exacerbate existing threats to development through a combination of factors, including: the increasing severity of climate-related hazards, diminishing agricultural yields and increasing prevalence of livestock diseases (Field et al., 2012). The rural poor, e.g. subsistence farmers in the developing world, are especially vulnerable, as they have limited adaptive capacity, and depend upon climate sensitive activities and natural resources (Krishnamurthy et al., 2012; Gitz et al., 2016). Reducing their vulnerability to the impacts of climate change by strengthening their adaptive capacity is necessary to achieve sustainable development goals, particularly those related to poverty and food security (Field et al., 2014).

Adaptation is a process involving on-going learning, analysis, planning and adjustments to respond to an evolving context and changing risks (Becker, 2014). Effective adaptation efforts require information. In the context of subsistence farmers in the developing world, timely access to locally relevant climate information, such as extreme weather and seasonal forecasts, as well as related agricultural production and management information is a necessity (Daze et al., 2011).

Such information allows farmers to more effectively manage climate-related risks and to make better-informed agricultural decisions (Barbier et al., 2009; Vincent et al., 2011; Mubaya et al., 2012). However, it is recognised that lack of information represents a barrier to adaptation for subsistence farmers, particularly in Africa (Deressa et al., 2009; Mandleni & Anim, 2011; Nhemachena & Hassan, 2011; Bryan et al., 2013). At the local-level, a lack of information restricts improvement in knowledge, understanding and skills needed in helping farmers to cope with the impacts of climate change and undertake adaptation measures (Agrawala & Aalst, 2008). Closing this information gap is therefore critical to reducing climate-related threats to rural livelihoods in Africa (Fischer et al., 2002).

Climate information services (CIS) bridge the generation and application of scientific climate and agricultural information, offering great potential to strengthen the ability of subsistence farmers to manage climate-related risks and to increase agricultural productivity, developing the capacities of subsistence farmers from the bottom-up (Goddard et al., 2010; Hewitt et al., 2012; Bryan et al., 2013). At the local-level, CIS support farmers' ability to adapt and strengthen their resilience to climate change (Kadi et al., 2011; Mahoo et al., 2015). As such, developing countries are becoming increasingly aware of the need for CIS (Semazzi, 2011).

However, research indicates that CIS face a number of challenges in inducing behavioural change in the form of climate change adaptation (CCA) amongst subsistence farmers (Field et al., 2014; Hewitson et al., 2014). Specifically, they often fail to build upon existing local capacities, decreasing information uptake and subsequently the potential for enhancing local-level adaptation and strengthening the resilience of vulnerable groups (Abeygunawardena et al., 2003).

The concept of 'information uptake' is defined<sup>1</sup> as: *'the action of making use of available information to inform decision-making'*. A key term in this definition is 'action', which is understood as the process during which a farmer recognises and uses available information from an identifiable source to inform their adaptation and agricultural-related decisions and to subsequently undertake appropriate strategies. Information uptake in this context refers to the uptake of short-term information (sub-annual timescales) by subsistence farmers at the household-level, as opposed to the uptake of medium and long-term information (inter-annual to multi-decadal timescales) by decision-making bodies and organisations at the national and regional level.

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<sup>1</sup> This definition of information uptake was developed by the researcher as no clear and concise standard definition of information uptake (within the context of climate change adaptation at the local, household-level) could be identified from the literature.



So far the uptake of scientific climate and agricultural information by subsistence farmers in the developing world has been suboptimal (Vogel & O'Brien, 2006; Ziervogel et al. 2010). It is widely regarded that the successful uptake of information is often predicated on sustained interaction and engagement between those producing information and those that use it to inform decision-making (Jones et al., 2015). In particular, the merits of using participatory processes of engagement to bring stakeholders together are shown to encourage sharing of different perspectives and support greater collaboration in promoting information uptake (Barron et al., 2012; Picketts et al., 2013; Berkhout et al., 2014). Despite both the considerable amount of research made available and evidence that subsistence farmers are actively seeking to increase their information uptake, there is a persistent gap between information production and use (Lemos et al., 2012).

A means of increasing information uptake is to integrate CIS with indigenous knowledge systems (IKS). IKS represent a major resource for adapting to climate change but have not been used effectively in formal existing adaptation efforts (Strauss & Orlove, 2003; Crate & Nuttal, 2009; Krauss & von Storch, 2012). As such, IKS are increasingly valued as an existing local capacity that represents both an important information source and communication pathway to include in CIS for CCA (Orlove et al., 2010; Nkomwa et al., 2014; Jiri et al., 2015; Mapfumo et al., 2016). IKS can thus be considered an entry point for capacity development for CCA (Al-Roubaie, 2010).

Consequently, the **research aim** of this thesis is to: *increase the knowledge about the potential to improve information uptake for climate change adaptation by integrating indigenous knowledge systems with climate information services*. The thesis' research questions and objectives are presented in the next section.

## 1.2. Research Questions and Objectives

Three research questions were posed in relation to the research aim of the thesis:

### Research Questions

1. What factors influence information uptake for climate change adaptation from indigenous knowledge systems and climate information services?
2. To what extent are these factors evident in Karamoja?
3. Can information uptake in Karamoja be improved by integrating indigenous knowledge systems with climate information services?

In order to answer these three research questions and to achieve the research aim, four specific research objectives were met. In chronological order, the research objectives were:

### Research Objectives

1. Conduct scoping study into scientific literature on information uptake for climate change adaptation from indigenous knowledge systems and climate information services;
2. Identify factors that influence information uptake from indigenous knowledge systems and climate information services;
3. Perform analysis of household-level data from Karamoja using identified factors;
4. Establish the potential to improve information uptake in Karamoja by integrating indigenous knowledge systems with climate information services.

As such, the research aim of the thesis was achieved through the application of two methods: 1) a scoping study of the scientific literature, and 2) a case study focussing on a region in East Africa. The case study is the Karamoja Sub-region of Northeast Uganda, from which household-level questionnaire data was gathered by The World Food Programme (WFP). The scoping study was conducted in order to establish the current state of scientific knowledge on the topic. This was achieved through identifying and examining scientific literature on information uptake for CCA from IKS and CIS. Through the scoping study factors that influence information uptake were identified. These factors then formed the analytical framework that was applied to the household-level data from Karamoja, guiding the subsequent data analysis of the case study. The findings of the scoping study and the case study were then discussed in order to establish the potential to improve information uptake in Karamoja by integrating IKS with CIS and the wider implications (methods are further described in Chapter 3: Methodology).

## 1.3. Thesis Structure

Following this introductory chapter, the thesis contains the upcoming six chapters:

- *Chapter 2: Case Study Background*
  - Introduces the Karamoja Sub-region of Northeast Uganda, providing context to the case study. Further motivation for the thesis is also given.
- *Chapter 3: Methodology*
  - Describes how the thesis was undertaken, through the scoping study and case study. Limitations to the thesis' methods and the approaches to overcome them are also detailed.
- *Chapter 4: Scoping Study Results*
  - Main findings of the scoping study, including the overall and in-depth analysis. The main findings of the in-depth analysis are used to form the analytical framework.
- *Chapter 5: Case Study Results*
  - Main findings of the case study. Household-level questionnaire data from Karamoja was analysed, as guided by the analytical framework.
- *Chapter 6: Discussion*
  - Analysis and interpretation of the main findings from the scoping study and case study. Key findings are summarised and discussed. Answers to the thesis' aim and questions are sought.
- *Chapter 7: Conclusions*
  - Summary of the key findings and their discussion as well as a reflection upon the extent to which the thesis' aim was met.

## 2. Case Study Background

---

This chapter introduces the case study: the Karamoja Sub-region of Northeast Uganda. Household-level questionnaire data from the region was gathered by WFP and its partners in April 2016. Following the scoping study, analysis of this dataset forms the second methodological approach of the thesis. Key characteristics of Karamoja, relevant to the thesis, are described below.

### 2.1. Karamoja

The semi-arid region of Karamoja covers an area of 27,500km<sup>2</sup> in the northeast of Uganda, bordering South Sudan to the north and Kenya to the east and is home to 1.2 million people. Seven administrative districts constitute the region, from north to south: Kaabong, Kotido, Abim, Moroto, Napak, Nakapiripirit and Amudat (figure 1). The term ‘Karamojong’ refers to the inhabitants of Karamoja, with major ethnic groups including: the Dodoth (north), Jie (central), Pokot (east) and Bokora, Matheniko and Pian (south) (Powell, 2010). Three livelihood systems characterise the region: a predominantly ‘agriculture-based’ livelihood system in the west, a largely ‘agro-pastoral’ system in the region’s midsection and a mainly ‘pastoral’ system in the east (Gayfer et al., 2012). Climate variability and change has been observed with a persistence of high rainfall variability as well as increase in temperatures (Egeru et al., 2014; USAID, 2017). Rain distribution in Karamoja is usually poor, thus the risk of crop failure is largely a result of poor rainfall distribution rather than the lack of rains. As pasture and browse are not affected in the same manner as crops, pastoralism is regarded as a better coping and adaptation strategy in the region (Levine, 2010).

Karamoja has the worst development indicators in the country (UNDP, 2015). The region suffers from a combination of chronic poverty (over 80% of the population live below the poverty line), vulnerability to climatic shocks (particularly droughts), poor infrastructure and basic services delivery, limited marketing opportunities, natural resource degradation, social and cultural marginalisation, dependency on external aid, and insecurity (Mubiru, 2010; Powell, 2010).

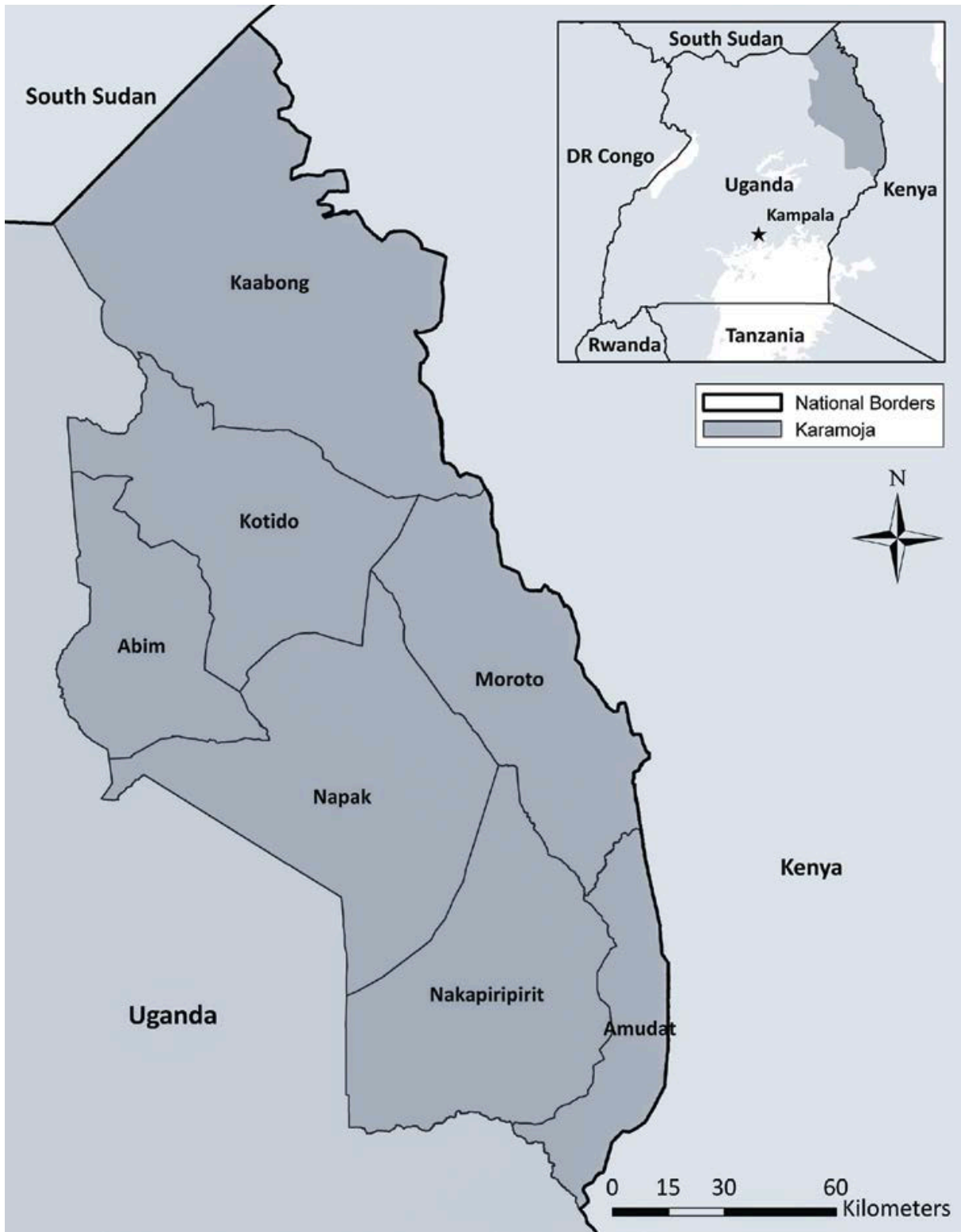


Figure 1: Overview map of Karamoja and its seven districts. Figure taken from Chaplin et al. (2016).

The region is also chronically food–insecure due to low human development, high levels of poverty and climate shocks (Government of Uganda, 2009). A recent food security and nutrition assessment (FSNA) carried out by WFP found that half of the population is food insecure (WFP, 2016). Karamoja’s population is highly dependent on subsistence agriculture, which relies upon rainfall and is therefore inherently sensitive to climate conditions, making it vulnerable to the impacts of climate change (Mubiru, 2010). Although all the agro-ecological zones of Uganda are grappling with the effects of climate change and variability, Karamoja is the most affected (Mubiru, 2010). Indeed, an economic assessment of the impacts of climate change in Uganda carried out by the Climate and Development Knowledge Network (2015) revealed that recent droughts in the region wiped out 50-100% of crop yields for affected households. As the majority of Karamoja’s population depend upon climate sensitive livelihoods, climate change represents a serious threat to development and food security in the region. Unfavourable weather and climatic conditions are one of the most commonly mentioned shocks to households; with nearly three-quarters of households have been impacted by drought in the last five years (WFP, 2016). These climate-related shocks often leave households more vulnerable and unable to adapt to future shocks (Gayfer et al., 2012).

A recent report by Chaplin et al. (2016) identified that adaptation rates amongst households in Karamoja are low, with less than a quarter reporting to have undertaken CCA measures. A potential cause of the low levels of CCA may be the low levels of information access. The finding that over half of farmers who have not made adaptation changes cite their main reason as ‘don’t know how to’ lends support to this and indeed analysis showed that there is a positive relationship between information access and CCA (Chaplin et al., 2016). Of the farmers that did receive information, local indigenous sources were an important source of information (Chaplin et al., 2016). The report concludes that low access to information in the region is detrimentally affecting the ability of households to make informed decisions on how to adapt, increasing their vulnerability to climate shocks. The reliance upon IKS for climate and agriculture-related information presents an opportunity to integrate CIS with these existing local sources, providing both a source of information and a communication pathway. This could improve information uptake for CCA amongst subsistence farmers in Karamoja, strengthening their resilience against the negative impacts of climate change. This context of the region makes it suitable to use as the case in this thesis.

## 3. Methodology

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This chapter describes and justifies the methods of data collection and analysis used. The thesis employed both qualitative and quantitative approaches and was undertaken in two-stages: first, a scoping study of available and relevant scientific literature, followed by a case study which involved analysis of secondary questionnaire data from households in Karamoja collected by WFP. Details of these two stages as well as their limitations are elaborated upon below.

### 3.1. Scoping Study

In order to answer research question one: *what factors influence information uptake for climate change adaptation from indigenous knowledge systems and climate information services?* An inductive approach was taken. Evidence was collected using a scoping method so as to provide a comprehensive overview of the scientific literature in the field.

Scoping studies represent an increasingly popular approach to mapping research fields (Levac et al., 2010). The aim of scoping studies is to map the literature on a particular topic or research area and to provide an opportunity to identify key concepts, gaps in the research, types and sources of evidence to inform practice, policymaking, and research (Daudt et al., 2013). As the aim of this thesis was both to provide an overview of the available scientific research and suggest improvements, the use of a scoping study fits the thesis' aim. Furthermore, as scoping studies do not usually analyse the quality of research in a specific area (Arksey & O'Malley, 2005) this further supported the employment of the scoping study method, given the thesis' scope and constraints. The scoping study was conducted in March 2017 using an adapted version of the framework outlined by Arksey and O'Malley (2005) as a guideline. The following section describes the framework and its application.

#### 3.1.1. Step 1: Identifying The Research Question

The first step was to identify the scoping study's research question. Whilst very wide definitions might reduce the likelihood of missing relevant articles, they could also generate an unmanageably large number of references. Arksey and O'Malley (2005) recommend that a broad and open approach is taken in order to generate breadth of coverage, arguing that decisions on how to set parameters can be made once some sense of the volume and general scope of the field

has been gained. As such, the research question was: *what is known in the scientific literature about the uptake of information for climate change adaptation from indigenous knowledge systems and climate information services?* Much deliberation was given regarding the formulation of the research question as it guides the way that the search strategies are built and the subsequent results.

Before starting the systematic search for material, quick scan searches were conducted in academic journals in the field of IKS and CIS. Such an approach enabled the researcher to develop a broad understanding of the material, where it might be found and the terminology used to address the topic (Beerens & Tehler, 2016). This information provided input for the subsequent steps.

### **3.1.2. Step 2: Identifying Relevant Articles**

The second step was to identify relevant articles. An electronic database was chosen as the source for the scoping study and the search strategy was developed from the research question and definitions of key concepts (Arksey & O'Malley, 2005). A distinction was made between database selection and search query identification (Beerens & Tehler, 2016).

#### **3.1.2.1. Database Selection**

The electronic database Scopus (<https://www.scopus.com>) owned by Elsevier was selected as the sole database as it is the largest database of peer-reviewed literature, multi-disciplinary and covers a wide range of research fields (Beerens & Tehler, 2016). Access to articles was possible through the subscription to the academic journals provided by Lund University. As the focus was limited to peer-reviewed scientific articles published in academic journals, no grey literature was searched.

#### **3.1.2.2. Search Query Identification**

The search string was based on a Boolean approach. The seven keywords in the research question were: (1) adaptation, (2) indigenous, (3) knowledge, (4) systems, (5) climate, (6) information, and (7) services. However, these key words have synonyms so searching these words alone would be insufficient (Beerens & Tehler, 2016). Therefore, a list of synonyms was compiled by searching thesauruses and reflecting upon the results of the quick scan searches of step 1. The synonyms were systematically combined and the various combinations of search queries were used to search the Scopus database and the number of results was noted for each



query. Synonyms that generated irrelevant results were removed from the list. Additionally, whilst knowledge is not a synonym for information and neither is systems for services, these key words were paired as separating them significantly reduced the number of results in Scopus (indicating perhaps limited literature spanning the two fields). Relatedly, whilst climate is not synonymous with weather, these words were paired given their pragmatic usage in the field of CIS, particularly related to early warning systems. This reduced the number of synonyms and merged the seven keywords to the following:

- 1) Indigenous OR Traditional OR Local;
- 2) Knowledge OR Information;
- 3) Climate OR Weather;
- 4) Systems OR Services;
- 5) Adaptation OR Adapt OR Adaptive.

Figure 2 (page 19) shows the search string and the initial number of results (1018). Filtering by publication type (articles) and language (English) reduced the number of results to 648. The 648 articles were then exported to Excel, where three duplicates were removed. This left a total of 645 articles to be analysed. No parameters related to the publication dates of the articles were applied.

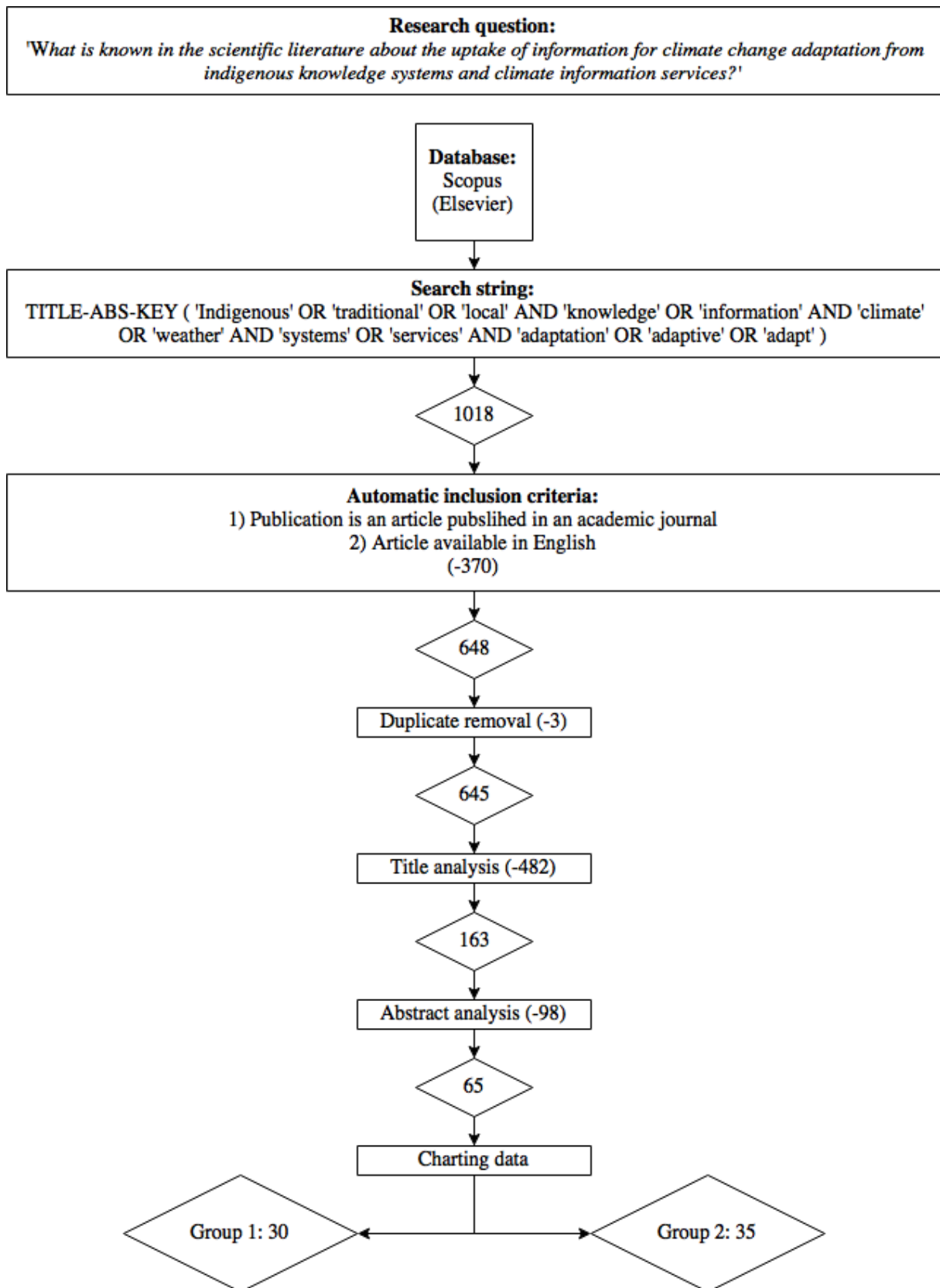
### **3.1.3. Step 3: Study Selection**

Articles that were clearly irrelevant e.g. *Population-level Variation in Juvenile Brown Trout Growth from Different Climatic Regions of Norway to an Experimental Thermal Gradient*, as determined through the analysis of their titles were removed and borderline cases were retained for further analysis. This led to the removal of 482 articles. The abstracts of each of the remaining 163 articles were then read and assessed against the inclusion criteria, described below, which was devised ad hoc, based on increasing familiarity with the literature.

#### **Inclusion Criteria:**

- 1) Article's geographic area of interest (regional focus) is located in the developing world;
- 2) Article focuses upon rural communities, e.g. subsistence farmers;
- 3) Article addresses aspect(s) of information uptake from either (or both) IKS and CIS;
- 4) Article relates the uptake of information to aspect(s) of CCA.

Following the application of the inclusion criteria, borderline cases were retained and the whole article was analysed, this left 65 articles. These 65 articles were then split into two groups. Group 1 contained 30 articles that addressed aspects of the research question per se and Group 2 contained 35 articles that addressed relevant aspects but to a lesser degree or closely related fields. Both Group 1 and 2 were included in the first sub-stage of step 4 (overall analysis), however only Group 1 was included in the second and more significant sub-stage (in-depth analysis).



**Figure 2:** Overview of the scoping study method.

### **3.1.4. Step 4: Analysis**

The scoping study analysis was performed in two sub-stages: 1) overall analysis of broad trends and characteristics, followed by 2) in-depth analysis focusing on identifying factors that emerged from the literature that influence information uptake for CCA from IKS and CIS. The in-depth analysis formed the focus of the scoping study, the key findings of which were used to form the analytical framework.

#### **3.1.4.1. Overall Analysis**

Articles from both Group 1 and 2 were included in the overall analysis. To identify broad characteristics and trends, articles were examined according to subject area, year of publication as well as region of publication and regional focus. These characteristics and trends were identified using information provided by Scopus as well as determined by the researcher's analysis of the article. The descriptive statistics of the overall analysis provide background to the articles and aid transparency. Graphs and tables were produced in Microsoft Excel and Word.

#### **3.1.4.2. In-depth Analysis**

Articles from Group 1 were analysed in detail to identify factors that emerged from the literature that influence information uptake for CCA from IKS and CIS. Through reading the articles and placing their results, discussions and conclusions into categories related to information uptake, factors were identified. The articles were then individually assessed using the Ctrl-F function to identify any explicit or implicit reference to the identified factors. An overview of the articles analysed is presented in the appendix (appendix 2). Sentences that contained a reference were copied and pasted into an Excel spreadsheet. In this way, a 'library of quotes' was amassed.

### **3.1.5. Analytical Framework**

The formulation of an analytical framework is not traditionally a step in the scoping study method. Through the in-depth analysis, factors that influence information uptake for CCA from climate IKS and CIS were identified. These factors were then used to form and justify an analytical framework consisting of four interrelated factors that influence information uptake. The analytical framework was then used to analyse the household-level data from Karamoja.

### 3.2. Case Study: Household-level Data Analysis

In order to answer the second research question: *to what extent are these factors evident in Karamoja?* A deductive approach was taken. Household-level data from Karamoja was analysed using the analytical framework that was formed by the factors that were identified through the in-depth analysis of the scoping study results.

Household-level data was collected by WFP and its partners in May 2016 during the bi-annual FSNA (WFP, 2016). The assessment covered all seven districts of Karamoja and the responses of 4,329 households were recorded. The data was collected using a standardised questionnaire uploaded on to mobile tablets and face-to-face interviews were conducted with the household-heads. The choice of the household-head as a primary source of information is justified as the household-head plays a primary role in the majority of household and farming decisions related to production, marketing, resource allocation and adaptation decisions in traditional farming (Debela et al., 2015). Once the data was collected and recorded from the tablets, it was converted to an Excel file and exported to the Statistical Package for Social Scientists (SPSS).

Whilst the FSNA assessment has traditionally focused upon factors and variables related to food security and nutrition, the May 2016 assessment included a sub-section that collected data related to information. The questionnaire data was processed using SPSS, with graphs and tables produced in Microsoft Excel and Word. The results of the household-level analysis were placed into the corresponding factors identified through the in-depth analysis of the scoping study. The findings of the scoping study and the household-level data results were then discussed so as to answer research question three: *can information uptake in Karamoja be improved by integrating indigenous knowledge systems with climate information services?*

### 3.3. Limitations

A frequently occurring limitation of the scoping studies is their broad nature and the large quantity of data generated. This can lead to difficult decisions about the extent to which breadth (covering all available material) is more important than depth (providing a detailed analysis and appraisal of a smaller number of studies) (Arksey & O'Malley, 2005). However, as it was quickly evident from the searches that there was limited relevant literature available in the thesis' field, the analysis thereby focused upon depth. In order to address the challenge of accumulating sufficient literature, the search query identification and study selection steps were modified (as well as the inclusion criteria) and repeated a number of times, so as to acquire a substantial number of relevant articles. Indeed, it is recognised that the scoping study process is not linear but iterative; requiring researchers to engage with each stage in a reflexive way and, where necessary, repeat steps to ensure that the literature is comprehensively covered (Arksey & O'Malley, 2005; Levac et al., 2010). This was time consuming and tedious, however eventually a sufficient number of relevant articles were collated.

Additionally, scoping studies do not appraise the quality of the literature in any formal sense and it is unclear whether the lack of quality assessment impacts the relevance of scoping study findings (Arksey & O'Malley, 2005; Levac et al., 2010). Assessing the quality of the articles chosen for the scoping study was not regarded as relevant to the aim of this thesis. However, it is recognised that further research in this field may wish to assess the quality of literature in the field of information uptake from integrate IKS and CIS.

The decision to exclude grey literature was also recognised to be a limitation of the scoping study as contributions to the field also take the form of informal documents such as reports. Furthermore, by restricting the articles to those published in English, it was recognised that potentially relevant papers could have been missed. These limitations were adopted for practical reasons due to the scope of the thesis. The categorising of factors from the literature was recognised to be subjective as judgments had to be made by the researcher (Beerens & Tehler, 2016). Approaches to address this included ensuring that the categorising was kept consistent and that the procedure was well documented. The methodology of the scoping study was described in detail with the intention that the thesis can be replicated.

A limitation of the case study is that as it is context specific, its findings may not be applicable to other contexts; as such its external validity is limited. This limitation of the case study is seen as 'balanced' by the scoping study, which covers a broad array of contexts. In this way, though the scoping study may not contribute much 'new' detailed knowledge, the case study fills this gap by providing new, context specific knowledge. A significant limitation of the household-level data was that it was not collected by the researcher and was collected post-scoping study. As such, the factors that were identified through the in-depth analysis of the scoping study may not be represented in the extensive household-level questionnaire data set from Karamoja. In order to address this, a 'best-fit' approach was taken, by applying the factors to the household-level data in the most appropriate way according to the judgement of the researcher who was closely familiar with the data set. However, it is still recognised that this is a limitation of the thesis.

## 4. Scoping Study Results

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This chapter presents the results of the scoping study and is split into three sections: overall analysis, in-depth analysis (the latter the focus of the scoping study) and analytical framework.

### 4.1. Overall Analysis

Broad trends and characteristics were identified by examining the articles according to their subject area, year of publication as well as region of publication and regional focus. Articles from Group 1 and 2 were merged (total, n=65) and included in the overall analysis, however a distinction was made for articles from Group 1 (n=30), given its importance.

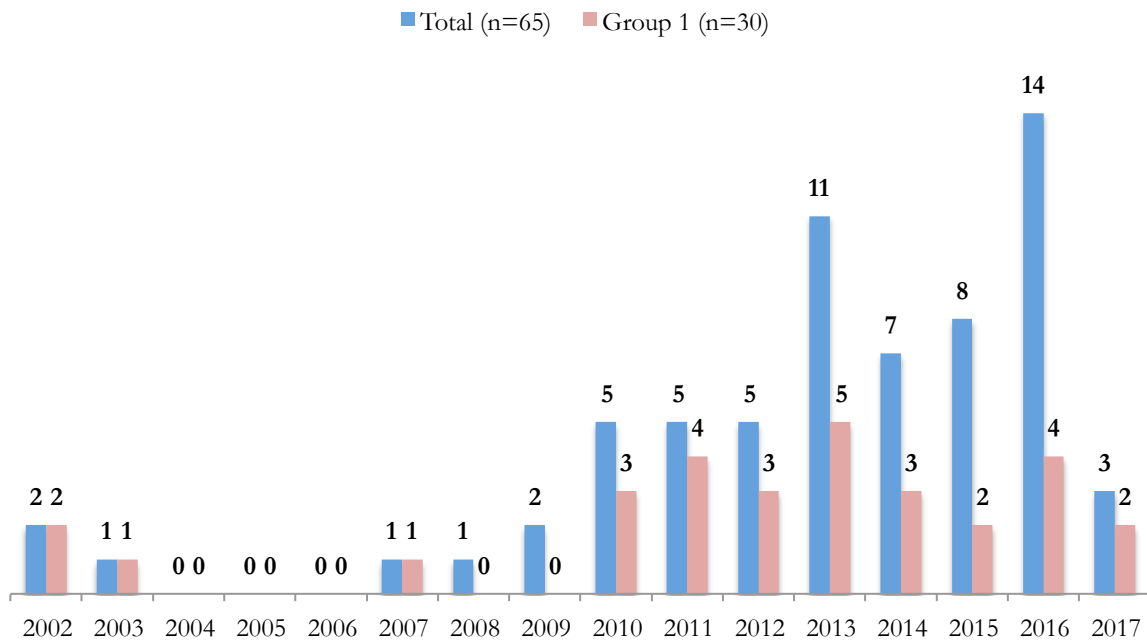
**Table 1:** Articles by subject area.

<b>Subject Area</b>	<b>Total (n=65)</b>		<b>Group 1 (n=30)</b>	
Social Sciences	32	49%	15	50%
Environmental Sciences	21	32%	6	20%
Agricultural and Biological Sciences	8	12%	6	20%
Earth and Planetary Sciences	3	5%	2	7%
Medicine	1	2%	1	3%

Articles were categorised based on their subject area as defined by Scopus and by the researcher's analysis of their title and abstract. Five subject areas were identified. In total, the Social Sciences and the Environmental Sciences were the subject areas that contributed the most, providing 32 (49%) and 21 (32%) of the articles respectively. The remaining 12 articles were split between the subject areas of: the Agricultural and Biological Sciences (8), the Earth and Planetary Sciences (3), and Medicine (1). In Group 1 the Social Sciences provided 15 articles (50%), however the relative contribution of the Environmental Sciences fell from 32% to 20%, with the Environmental Sciences and the Agricultural and Biological Sciences both contributing 6 (20%) articles to Group 1. The Earth and Planetary Sciences and Medicine provided 2 and 1 articles respectively.



### Articles by Year



**Figure 3:** Articles by year of publication.

Articles were charted according to their year of publication as indicated in Scopus. Generally over the sixteen year period examined there has been an increase in publications per year, suggesting a growing interest in research that broadly address information uptake for CCA from IKS and CIS. The first publications occurred in 2002, soon after which there was a hiatus in publications between 2004 and 2006. However, from 2007 the number of publications rises, peaking in 2016, with 14 publications. In Group 1, the increase in publications per year is less pronounced and the number of publications fluctuates between 2010 and 2017. The reduction in publications in 2017 is expected as the scoping study was carried out in March of that year.

**Table 2:** Articles by region of publication and regional focus.

Region	Region of Publication				Regional Focus			
	Total (n=65)		Group 1 (n=30)		Total (n=65)		Group 1 (n=30)	
Australasia	2	3%	1	3%	-	-	-	-
E. Africa	19	29%	13	43%	27	42%	17	56%
N. Africa	1	1%	-	-	1	1%	-	-
S. Africa	13	20%	9	30%	14	21%	8	27%
W. Africa	3	5%	2	7%	5	8%	2	7%
E. Asia	1	1%	-	-	2	3%	-	-
S. Asia	3	5%	1	3%	6	9%	1	3%
SE. Asia	2	3%	-	-	3	5%	-	-
N. America	8	12%	2	7%	-	-	-	-
N. Europe	7	11%	2	7%	-	-	-	-
W. Europe	6	9%	-	-	-	-	-	-
SSA	-	-	-	-	7	11%	2	7%

The region of the publishing institution and the regional focus of the articles were identified through the papers citation on Scopus and the researcher's analysis of their title, abstract and citation information<sup>2</sup>. In total, the majority of the articles were published from African institutions, predominately East Africa (29%) and Southern Africa (20%). There was a significant contribution of articles from Northern and Western European institutions, 11% and 9% respectively. From the Americas only 8 articles from Northern American institutions were present (12%). Contributions from Australasian and Asian institutions were small, ranging from 1% to 5%. In Group 1 the relative contribution of articles from Eastern African and Southern African institutions increased to 43% and 30% respectively. Combined, there were 35 articles from African institutions, making up 80% of the articles in Group 1. The relative contributions from the other regions disappeared, fell or remained unchanged. This finding demonstrates that African institutions (particularly East and Southern African institutions) published the majority of the articles that will be taken forward for the in-depth analysis.

In total, East Africa was the region of focus in 27 (42%) of the articles, followed by Southern Africa with 14 articles (21%). No other regions were focused upon by more than 10% of the articles, with the exception of Sub-Saharan Africa (SSA) at 11%. In Group 1, the relative

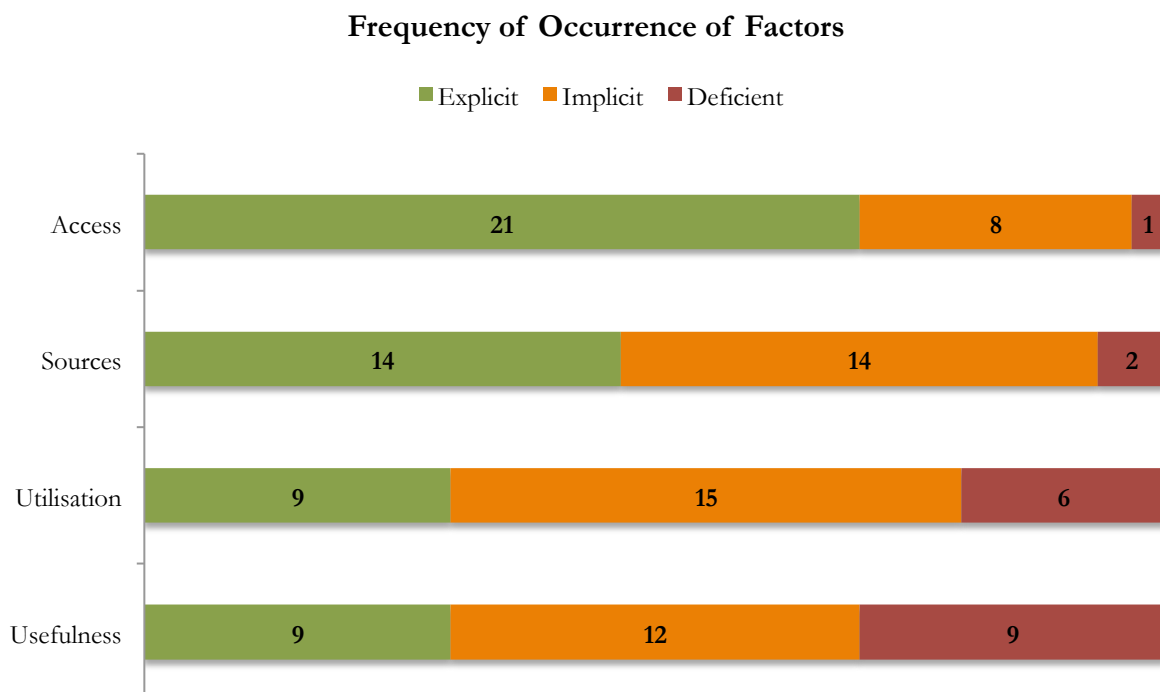
<sup>2</sup> Regions were defined according to the United Nations Statistics Division Geoscheme definition (UNSD, 2017). 'Global' refers to articles that did not have a specific regional focus and 'SSA' to articles that focused on multiple countries across Sub-Saharan Africa.

percentage of articles that focused on East and Southern Africa rose to 56% and 27% respectively. The only other regions from which articles were present were Western Africa (7%), Sub-Saharan Africa (SSA) (7%), and Southern Asia (3%). This finding indicates that the regional focus of the articles chosen for the in-depth analysis was again strongly African orientated, particularly East African.

## 4.2. In-depth Analysis

Articles from Group 1 selected from the scoping study were analysed in detail in order to identify factors that influence information uptake for CCA from IKS and CIS. In order of frequency of occurrence from highest to lowest, interrelated factors that emerged from the literature included:

1. Access to information;
2. Source of information;
3. Utilisation of information;
4. Perceived usefulness of information source (figure 4).



**Figure 4:** Frequency of occurrence of explicit and implicit references to the four factors that influence information uptake that emerged from the in-depth analysis of articles from Group 1 (n=30).

### 4.2.1. Access to Information

The most commonly occurring factor, 'Access to Information' was explicitly and implicitly present in 21/30 and 8/30 of the articles analysed respectively (figure 4). The benefits of access to CIS by subsistence farmers in the developing world were widely described and discussed in the literature. Notably, in regards to: raising awareness of climate change (Debela et al., 2015; Opiyo et al., 2016), informing decision-making (Mishra et al., 2012) – particularly in relation to adaptation strategies (Belay et al., 2017) – strengthening risk management (Egeru, 2016), improving agricultural development (Lwoga et al., 2011; Mwalukasa, 2013) and reducing vulnerability to climate change through facilitating local-level adaptation (Egeru, 2012; Mishra et al., 2012; Ajani et al., 2013; Mapfumo et al., 2016). Indeed, access to information by subsistence farmers was commonly regarded as a prerequisite for coping and adapting to the impacts of climate change and variability at the local-level (Obando & Munang, 2016). Relatedly, articles highlighted that subsistence farmers often face limited access to information, significantly, locally relevant scientific information related to forecasts, climate change and agricultural production and management, and that this information deficit inhibits the aforementioned benefits, representing a constraint to CCA (Ajani et al., 2013; Makwara et al., 2013; Jiri et al., 2015). Due to the often-restricted accessibility of scientific information, articles cited the reliance of subsistence farmers upon indigenous knowledge accessed from local IKS (Chang'a et al., 2010; Speranza et al., 2010; Jiri et al., 2015; Mapfumo et al., 2016).

The ownership of communication assets by subsistence farmers was identified from the literature to have a significant influence upon their ability to uptake information from CIS. A high proportion of subsistence farmers in the developing world lack physical capital, including communication assets (Chang'a et al., 2010). The low ownership of communication assets such as: radios, mobile phones and TVs, excludes them from accessing useful information, particularly forecast information (Luseno et al., 2003; Kangalawe et al., 2017). Subsistence farmers in remote rural areas especially face challenges in accessing scientific information communicated through such channels (Makwara et al., 2013; Mapfumo et al., 2016). This lack of communication assets reduces the accessibility of CIS communicated through these channels. IKS in contrast do not require the ownership of communication assets (nor the technical capacity to interpret them) as information is disseminated through face-to-face contact (Roncoli et al., 2002; Naess, 2013)

## **4.2.2. Sources of Information**

‘Source of information’ was the second most commonly occurring factor, being explicitly present in 14/30 articles and implicitly present in 14/30 (figure 4). The literature demonstrated that subsistence farmers in the developing world access scientific information and indigenous knowledge from a diverse array of sources (Cyprian et al., 2014; Kolawole et al., 2014; Egeru, 2016; Belay et al., 2017). It was recognised that farmers who receive information from multiple sources are more likely to be aware of climate change and to adapt (Patt & Gwata, 2002; Orlove et al., 2010). There are however disparities in the accessibility and effectiveness of the different sources of information (Mwalukasa, 2013). As such, there is a need to identify information sources and to improve the effectiveness of communication from the various sources so as to enable subsistence farmers to adapt to climate change (Lwoga et al., 2011; Mwalukasa, 2013; Obando & Munang, 2016). The common sources farmers uptake information from was divided into two broad categories: modern and indigenous.

### **4.2.2.1. Modern Sources**

Modern information sources represent a significant source of scientific information for subsistence farmers in the developing world. Notable modern sources as evident from the literature included: government extension workers, radio programmes and non-governmental organisations (NGOs).

Government extension workers were a frequently mentioned modern source of scientific information in the literature, providing an array of information types to subsistence farmers, including: forecast (Cherotich, 2012; Opiyo et al., 2016), agricultural production and management (Lwoga et al., 2011; Mwalukasa, 2013), and climate (Bryan et al., 2013; Mapfumo et al., 2016). Access to climate information from government extension workers raises awareness of climate change and facilitates local-level adaptation (Cyprian et al., 2014; Debela et al., 2015). A study by Opiyo et al. (2016) from Kenya found that access to government extension workers significantly increased the likelihood that households perceived climate change and influenced their choice of adaptation strategy. Indeed, Mapfumo et al. (2016) found that the existence of effective government extension workers stood out as a key enabler to adaptation in Zimbabwe. Government extension workers are also very effective in reaching women and the elderly, strengthening their adaptive capacity (Cherotich et al., 2012).

Radio programmes were also identified as an important modern source of scientific information (particularly forecast information) for subsistence farmers, due to its oral nature, low cost and independence of electricity (Luseno et al., 2003; Mwalukasa, 2013). Kolawole et al. (2014) found that the majority of farmers in Botswana who had access to forecast information did so through the radio. Farmers also accessed agricultural production and management information through radio, as is the case in Tanzania (Mwalukasa, 2013). Radio programmes are also a popular source of climate information in Uganda (Egeru, 2016). Similarly, Luseno et al. (2003) revealed that pastoralists from Southern Ethiopia and Northern Kenya who accessed CIS were roughly the same proportion as those who own radios. However, not all farmers, especially those in remote areas, have access to radios and other media communicating information, let alone the capacity to interpret them (Makwara, 2013; Mapfumo et al., 2016).

NGOs represent a frequently accessed source of both agricultural and climate information by subsistence farmers. Lwoga et al. (2011) found that in rural areas in Tanzania, NGOs were an important source of agricultural information and that access to this information source improved agricultural performances and livelihoods in the climate sensitive region. NGOs also provide climate information. In a study by Cyprian et al. (2014) in Nigeria, it was found that the majority of farmers reported access to climate information from NGOs and that this improved their awareness of climate change. Relatedly, access to information from NGOs assists farmers in making decisions related to CCA. Hisali et al. (2011) identified the main reason subsistence farmers changed their crops to drought resilient varieties was due to campaigns made by NGOs. A study in Uganda, by Egeru (2016) revealed that NGOs were widely regarded as one of the most accessible and reliable sources of climate information, demonstrating the importance of this modern information source.

#### **4.2.2.2. Indigenous Sources**

While modern sources of scientific information featured heavily in the literature, there was still a strong reliance on indigenous knowledge from local indigenous sources. Notable sources as evident from the literature included: the farmers' own knowledge, elders/traditional forecasters and community meetings.

Many subsistence farmers are unable to access locally relevant scientific information from modern sources and those that do are often unable to meaningfully use the information due to high illiteracy levels, lack of resources and inadequate local support services (Jiri et al., 2015; Mapfumo et al., 2016; Obando & Munang, 2016). Farmers therefore often depend upon their

own knowledge (see glossary, appendix 1, for definition). The farmers own knowledge is the result of cumulative experience and observation tested in the context of everyday life and devolved by oral communication and repetitive engagement rather than through formal instruction (Orlove et al., 2010). Farmers use a range of local biological, geographical, and astronomic indicators to produce forecasts, inform agricultural decisions, and to adapt to climate variability and change (Jiri et al., 2015; Mapfumo et al., 2016; Obando & Munang, 2016). A study from Botswana by Kolawole et al. (2014) found that over 70% of farmers used their own knowledge to predict rainfall. In Uganda, 82% of farmers acknowledged using their own knowledge in everyday activities (Egeru, 2012). Farmers rely on their own indigenous knowledge as a means of adapting to constantly varying and changing climate (Chang'a et al., 2010; Nkomwa et al., 2014).

Elders/traditional forecasters were another commonly cited indigenous source of information from the literature. Indigenous knowledge is recognised to be largely held by the elderly in a community who are regarded to have institutional memory (Kalanda-Joshua, et al., 2011). Traditional African cultures comprise an institution of 'rainmakers' – individuals who do not invoke the rains, but forecast them based on ethno-meteorology (Kolawole et al., 2014; Obando & Munang, 2016). These traditional forecasters are selected individuals and view themselves as the custodians of the 'sacred' knowledge, which is based upon their ability to infer natural indicators (Patt & Gwata, 2002; Guthiga & Newsham, 2011). A study by Egeru (2016) in Uganda found that elders/traditional forecasters were regarded as an accessible and reliable source of climate information, particularly extreme weather forecasts. Similarly, Kolawole et al. (2014) found that in Botswana the majority of the farmers mainly obtained weather information from elders within their neighbourhood and through traditional forecasters.

Community meetings were also mentioned in the literature as an important indigenous source of information for subsistence farmers. In the study carried out by Egeru (2016) in Uganda, community meetings were identified as a popular source of climate information. Indeed, community meetings were perceived as the most accessible, reliable and dependable source of information. These findings are supported by Mwalukasa (2013), who found that community meetings in Tanzania were a major source of agricultural information for climate change, with 83% of farmers using this source of information. Farmers also considered community meetings as an appropriate and reliable information source (Mwalukasa, 2013). Community meetings also represent a forum through which scientific information and indigenous knowledge is shared (Lwoga et al., 2011; Cherotich et al., 2012; Kolawole et al., 2014).

#### **4.2.2.3. Combination of Sources**

It was also evident from the literature that farmers use a combination of sources (Orlove et al., 2010; Speranza et al., 2010; Jiri et al., 2015) and even those that rely primarily upon indigenous knowledge often seek scientific information from modern sources (Egeru, 2012; Mapfumo et al., 2016). For instance, Egeru (2012) found that in Uganda, farmers who observe natural indicators also rely on scientific information disseminated through radios. Indeed, farmers are increasingly integrating indigenous knowledge with information from modern sources, such as CIS, as climate change and variability detrimentally influences their ability to use natural indicators (Chang'a et al., 2010; Makwara et al., 2013; Obando & Munang, 2016). It may, therefore, be prudent to assert that farmers uptake information from a combination of information sources (Obando & Munang, 2016).

#### **4.2.3. Utilisation of Information**

'Utilisation of Information' occurred explicitly in 9/30 of the articles analysed and was implicitly referred to by 15/30 of the articles (figure 4). Information is one of the key factors determining farmers' choice of adaptation practice as it facilitates decision-making with regard to CCA (Opiyo et al., 2016; Belay et al., 2017). As such, farmers need to be able to utilise the information they obtain in order to inform decisions for enhancing CCA at the local-level, as well as on different agricultural and other livelihood activities. Appropriate information and its effective uptake can significantly increase the capacities of subsistence farmers to adapt to and cope with the impacts of climate change and variability (Debela et al., 2015; Mapfumo et al., 2016)

Information is used to guide a number of agricultural, livelihood and adaptation activities. Activities include the selection of appropriate tillage systems, crop varieties, planting dates, gauging potential markets and trends, planting of fast maturing varieties, saving planting materials (seeds), offering casual labour, begging, trading livestock with other food stuffs, migrating to other places, stopping sales of food stuffs, and bunkering the compound to prevent heavy runoff during floods (Kalanda-Joshua et al., 2011; Egeru, 2012; Belay et al., 2017). Egeru (2016) found that upon receiving extreme weather information, pastoralists in Uganda typically respond by preparing and shifting their livestock to dry season grazing areas, performing ritual sacrifices, storing food from their garden harvest, informally sensitising other community members, and preparing to shift to other places.



It was noted from the literature that there are many constraints impeding the full utilisation of information to guide farm level decisions, including CCA, among subsistence farmers (Kalanda-Joshua et al., 2011; Bryan et al., 2013). There is limited access to scientific information and relatively low capacity to meaningfully utilise the provided information that farmers have access to. This is often due to high illiteracy levels, lack of resources and inadequate technical and local institutional support services (Jiri et al., 2015; Mapfumo et al., 2016; Obando & Munang, 2016). Reasons for non-use include: that the information is too technical, confusing and difficult to translate, lack of trust and adequate timing, inappropriate spatial and temporal scales, that the information is not appropriately packaged and little meaningful use of the information (Luseno et al., 2003; Kalanda-Joshua et al., 2011; Mishra et al., 2012; Makwara, 2013; Jiri et al., 2015). Consequently, the information is difficult to translate into viable actions, undermining the ability of farmers to utilise this information and to make agricultural, livelihood and adaptation decisions.

#### **4.2.4. Perceived Usefulness of Information Source**

The factor: 'Perceived Usefulness of Information Source', appeared in the literature explicitly 9/30 times and implicitly 12/30 times (figure 4). The perception that the information source suits users' interests, i.e. its 'usefulness' is crucial for influencing action in the form of CCA (Obando & Munang, 2016). The perceived usefulness of information sources affects the propensity of farmers to uptake and use information from the source for their benefits. However, making scientific information from modern sources useful to subsistence farmers in developing countries remains a significant challenge (Patt & Gwata, 2002). Constraints include; credibility, legitimacy, scale, cognitive capacity, procedural and institutional barriers, and available choices (Patt & Gwata, 2002). Thus, local people often have more inclination towards indigenous knowledge from indigenous sources (Luseno et al., 2003; Kolawole et al., 2014). It is also worth noting that actual usefulness of information sources was well documented in the literature. For instance, Belay et al. (2015) found that the majority of farmers in their study practiced adaptation strategies, such as crop diversification, due to campaigns made by NGOs and government extension workers. Certainly, access to government extension workers was widely acknowledged to positively influence the choice of effective adaptation options. A study in Kenya by Bryan et al. (2013) found that access to government extension workers increased the likelihood of farmers implementing soil and water conservation by 35%, tree planting by 5%, early maturing crop varieties by 18% and changing planting date by 19%. The usefulness of indigenous sources was also commonly recognised (see Naess, 2013; Nkomwa et al., 2014; Jiri et al., 2015; Mapfumo et al., 2016).

#### 4.2.4.1. Modern Sources

Information from modern sources to inform agricultural activities and CCA is often not embraced by subsistence farmers due to a number of reasons, including: a lack of trust, confidence, ownership and relevance, its complex nature and the mismatch between information provided and information needed (Patt & Gwata, 2002; Luseno et al., 2003; Kolawole, 2014; Obando & Munang, 2016). Consequently, the effectiveness of information communicated through these sources is reduced and its uptake to inform viable actions at the local-level is limited (Egeru, 2016). Makwara (2013) found that only 3% of farmers use scientific information for planning purposes and that when scientific information deviates from indigenous knowledge, the farmers' inclination is towards indigenous knowledge for reasons that it blends well with culture, has been tried and tested over years and is in a language that the farmers understand.

However, the literature indicates that subsistence farmers are still open to scientific information from modern sources. Egeru (2016) found that in Uganda, government extension workers, radio programmes and NGOs were some of the most accessible and reliable sources of information in the area. In Tanzania, Mwalukasa (2013) identified these same three sources to also be widely regarded as useful sources of information by farmers. A study by Luseno et al. (2003) in Southern Ethiopia and Northern Kenya found that 76% of farmers expressed at least some confidence in modern sources of information. Clearly subsistence farmers do regard modern as useful. Farmers also often compliment scientific information from modern sources with indigenous knowledge (Mishra et al., 2012; Kolawole et al., 2014; Mapfumo et al., 2016), forming a knowledge frame within which other sources of information are positioned and interpreted (Speranza et al., 2010).

Furthermore, modern sources are acknowledged to be open and to offer easy access to those who have the skills to apply it for practical use, whilst IKS can sometimes be somewhat closed, often with only members having insights on what it entails (Kolawole et al., 2014). Farmers are also interested in receiving scientific information because they perceive indigenous knowledge as becoming less reliable as a result of increasing climate variability (Roncoli et al., 2002; Jiri et al., 2015; Mapfumo et al., 2016; Obando & Munang, 2016). Studies show that generally, farmers are open and willing to integrate new scientific information into their traditional forecasting methods as demonstrated by farmers readiness to engage, discuss and use modern scientific information (Orlove et al., 2010; Naess, 2013; Jiri et al., 2015; Obando & Munang, 2016).

#### 4.2.4.2. Indigenous Sources

According to the literature, information from indigenous sources is widely regarded by subsistence farmers in the developing world as being useful for informing decisions related to agriculture and local-level adaptation (Luseno et al., 2003; Makwara, 2013; Obando & Munang, 2016). Chang'a et al. (2010) found that 94% of farmers acknowledged the existence of IKS in their communities and 92% acknowledged using indigenous knowledge in their agricultural activities. Indigenous knowledge from indigenous sources tends to be more accurate and simple to understand to farmers as opposed to the complex nature of scientific information from modern sources that require sophisticated equipment and formal education and training and financial investment (Kalanda-Joshua et al., 2011; Kolawole et al., 2014; Obando & Munang, 2016). Indigenous knowledge therefore provides the basis for local-level decision-making in many rural communities (Kalanda-Joshua et al., 2011).

Whilst modern sources offer immense potential to support the delivery of climate information support services; they cannot replace the trust, visual communication of location-specific information, feedback and mutual learning that face-to-face interaction through indigenous sources (Cherotich et al., 2012). However the usefulness of indigenous knowledge faces a number of challenges. Increased climate variability (rainfall and temperature variability) has reduced the accuracy and the reliability of indigenous knowledge, which often relies upon natural, climate sensitive indicators (Roncoli et al., 2002; Luseno et al., 2003; Chang'a et al., 2010; Mwalukasa, 2013). As such, farmers' confidence in indigenous knowledge and its perceived usefulness for informing decisions has been undermined, reducing its uptake (Jiri et al., 2015; Obando & Munang, 2016). Other challenges include negative perceptions regarding indigenous knowledge and erosion due to modernisation (Obando & Munang, 2016).

The declining usefulness of indigenous knowledge has reduced the adaptive capacity and increased the vulnerability of subsistence farmers to climate change and variability (Kalanda-Joshua et al., 2011; Obando & Munang, 2016). Because they have lost confidence in their indigenous knowledge, farmers are open to and keenly interested in alternative sources of information. They do not resist the introduction of scientific information or regard it as threatening the integrity of local cultural traditions (Roncoli et al., 2002; Kalanda-Joshua et al., 2011). This has created a dilemma for those who recognise the limitations of indigenous knowledge but do not have access to or are unable to use scientific information (Kalanda-Joshua et al., 2011).

### 4.3. Analytical Framework

Through the in-depth analysis of the scoping study, factors, as evident from the literature, that influence information uptake for CCA by subsistence farmers in the developing world were identified. This section summarises these factors in a compact form. The interrelated factors, which form the analytical framework and justify the analysis of the household-level data from Karamoja are: access to information, source of information, utilisation of information, and perceived usefulness of information source.

‘Access to Information’ was the most commonly occurring factor in the literature, demonstrating its significant influence upon information uptake. The benefits of access to forecast, agricultural production and management, and climate information were widely acknowledged. Indeed, it is evident that amongst the scientific community, access to information is considered a prerequisite for CCA. However, articles highlighted that access to information by farmers is limited, constraining agricultural productivity and adaptation efforts. Clearly access to information is a principal factor influencing information uptake; therefore inclusion in the analytical framework is paramount. Relatedly, articles emphasised that one of the reasons farmers struggle to access information is because they lack communication assets. Accordingly, it is considered important to identify ownership of such assets amongst households in Karamoja.

‘Source of information’ was the second most frequently occurring factor, indicating its importance. Numerous articles recognised that farmers access their information from a diverse array of sources, with significant disparities in their accessibility and effectiveness. Whilst a plethora of sources exist, the literature made a distinction between modern and indigenous sources. Notable examples of modern sources included radio programmes, government extension workers and NGOs whilst examples of indigenous sources included the farmers’ own knowledge, community meetings and elders/traditional forecasters. The literature also revealed that farmers often depend on indigenous sources due to their limited access to modern sources. Consequently, identifying sources of information is deemed necessary.

‘Utilisation of Information’ was another factor evident from the articles examined, demonstrating the role of this factor in information uptake. Articles described how farmers must be able to utilise the information they have access to for it inform their decision-making and to effectively increase their capacity to improve productivity and adapt. The literature also discussed how subsistence farmers often struggle to utilise information effectively due to a lack of tailoring to

their capacities and needs. Evidently, investigation into whether or not households in Karamoja are able to utilise the information from the various sources they have access to is crucial, therefore the inclusion of this factor in the analytical framework is justified.

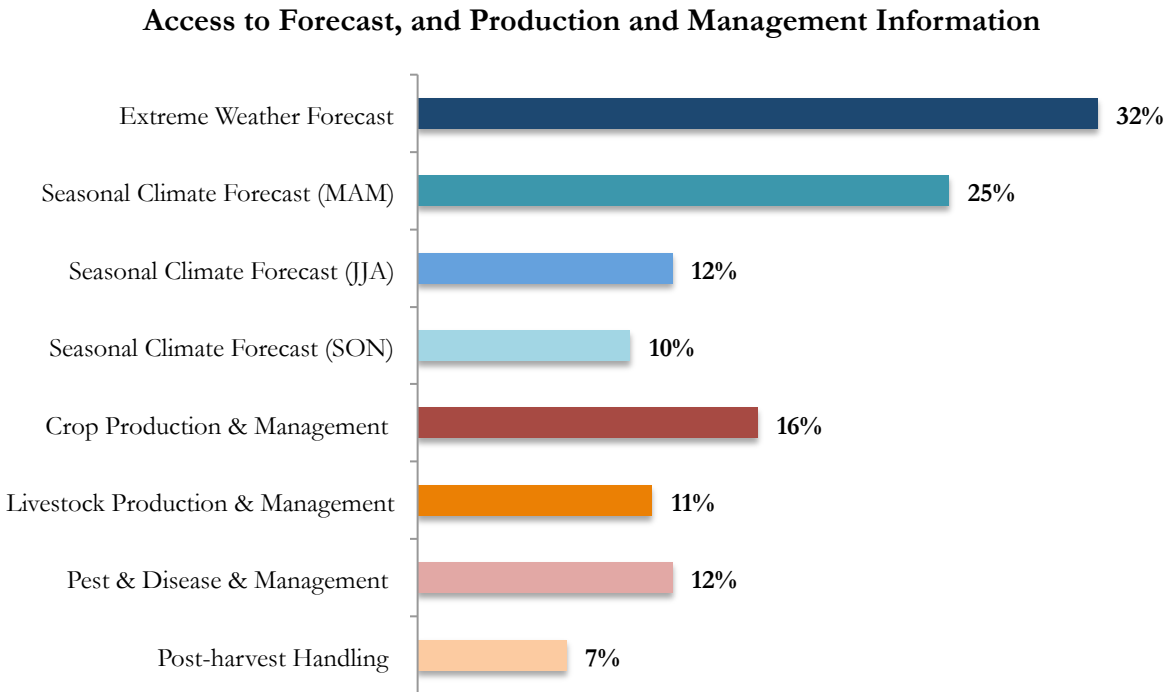
Finally, 'Perceived Usefulness of Information Source', was found to influence information uptake. The literature emphasised how the perceived usefulness of information sources affects the readiness of farmers to utilise the information to inform their decisions. Many articles described how farmers do not embrace information from modern sources, whilst others demonstrated that farmers are open to information from such sources. The majority of articles that addressed usability highlighted that indigenous knowledge is widely regarded as useful and that farmers have a natural inclination towards indigenous sources. However, many articles reported that climate change is having a negative impact upon the natural indicators that inform indigenous knowledge. Given that climate change is occurring in Karamoja, gauging perceptions towards indigenous sources and others is considered key.

The analytical framework was used to guide the analysis of the household-level data from Karamoja, i.e. an analytical lens to use as a tool to inform 'what to look for in the data analysis'. The analytical framework linked the inductive, qualitative research approach of the scoping study and its findings to the deductive, quantitative approach of the household-level analysis by summarising what is known from the literature about factors that influence information uptake and subsequently applying this knowledge to the household-level data from Karamoja. In doing so, the analytical framework bridges the first research question: *what factors influence information uptake for climate change adaptation from indigenous knowledge systems and climate information services?* to the second: *to what extent are these factors evident in Karamoja?*

# 5. Case Study Results

This chapter presents the results of the household-level analysis. The analytical framework was applied to the household-level data from Karamoja, Uganda, using a best-fit approach in order to identify the extent to which these factors were evident. Key findings are summarised at the end of the chapter. A table describing the household characteristics of the study population can be found in the appendix (appendix 3).

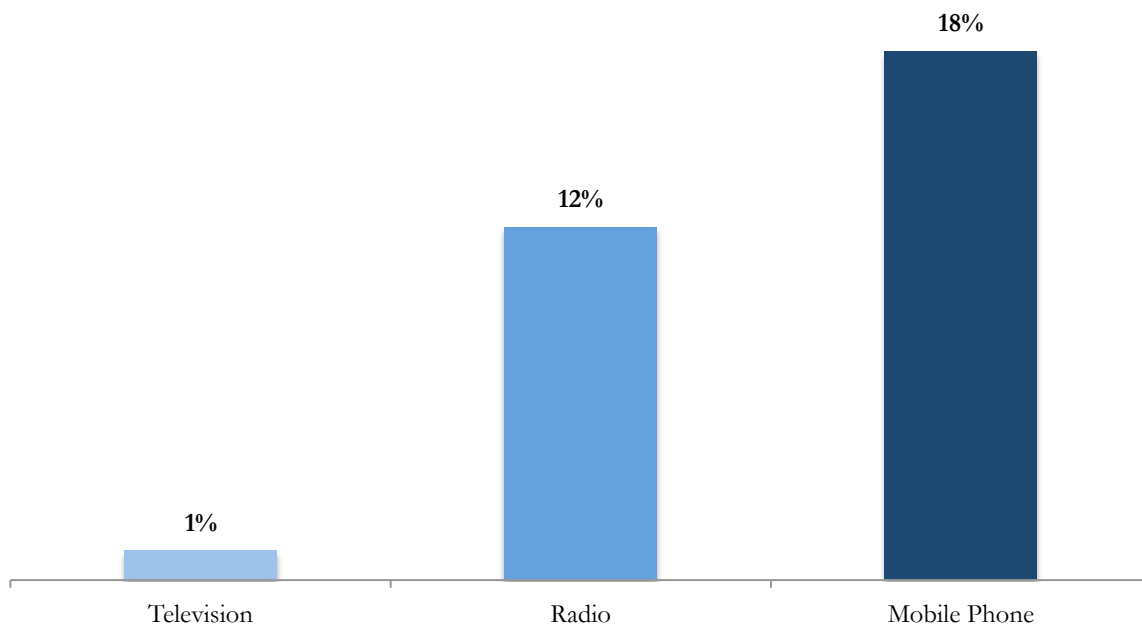
## 5.1. Access to Forecast, Production and Management Information



**Figure 5:** Percentages of farmers from across Karamoja who had access to the eight types of information (related to forecasts, and production and management) in the last twelve months.

Access to both forecast, and production and management information is low across Karamoja. The most accessed information type was extreme weather forecasts, which 32% of farmers reported access to. The least accessed information type was post-harvest handling, with only 7% of farmers reporting access. Noticeably, there was a decline in access to seasonal climate forecast information from the March-April-May (MAM) period (25%), through the June-July-August (JJA) period (12%), to the September-October-November (SON) period (10%), which was the least accessed forecast information type. Generally, forecast information was more accessible than production and management information (20% compared to 12%).

### Communication Asset Ownership

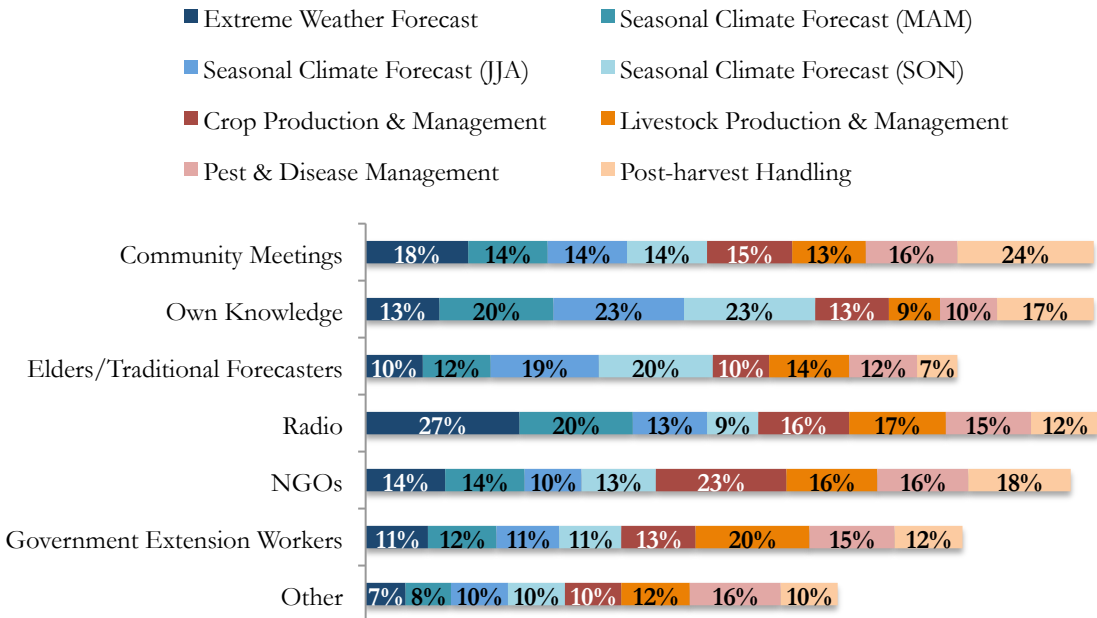


**Figure 6:** Percentages of farmers from across Karamoja who owned communication assets.

Communication asset ownership is low across Karamoja. The most frequently owned communication asset was mobile phones, with 18% of farmers reporting ownership. The second most frequently owned communication asset was radio, which 12% of farmers reported ownership of. Only 1% of farmers owned a TV.

## 5.2. Sources of Forecast, Production and Management Information

Sources of Forecast, and Production and Management Information



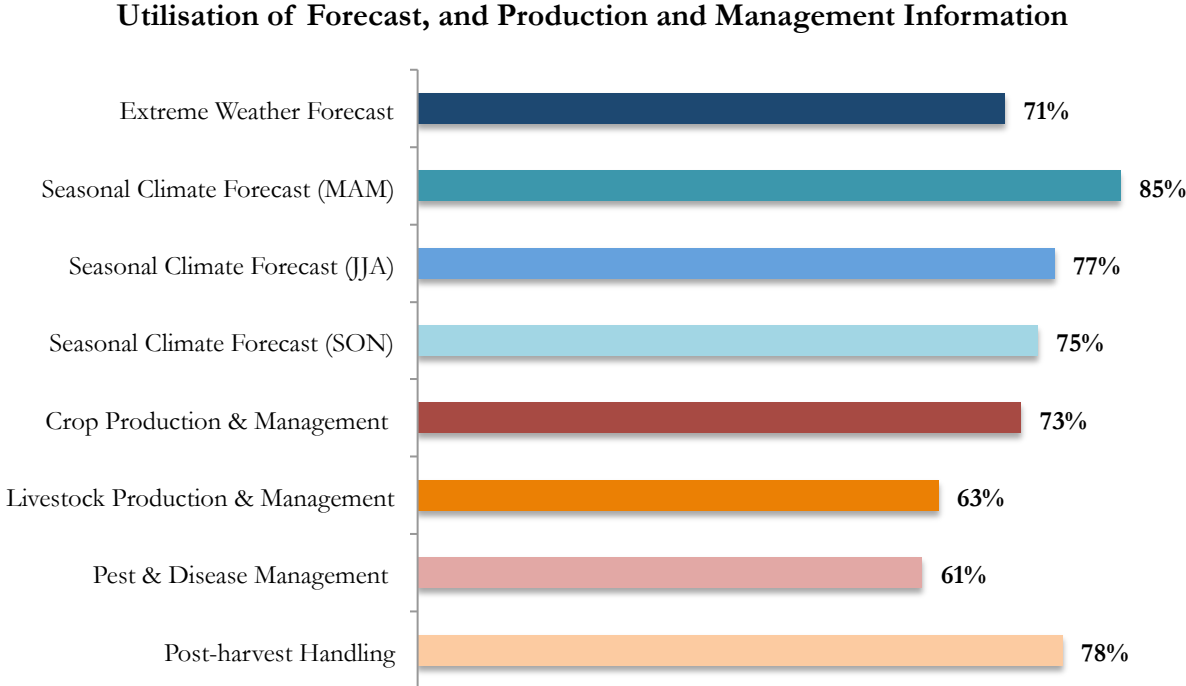
**Figure 7:** Percentages of farmers from across Karamoja who had access to forecast, and production and management information from the seven sources in the last twelve months. The category ‘Other’ includes seven sources: 1) Farmer Organisations/Cooperatives, 2) Religious Groups, 3) Agri-service Providers/Seed Companies, 4) Newspapers/Bulletins, 5) Schools/Teachers, 6) Farmer Field Schools/Demonstrations, and 7) Mobile Phones, of which access to was negligible (<2%). Total percentages of access to information types may be over 100% due to rounding up of individual percentages.

Farmers across Karamoja rely upon local indigenous sources (community meetings, own knowledge, elders/traditional forecasters) and modern sources (radio, NGOs, government extension workers) for forecast, and production and management information to a similar extent overall. However, further analysis revealed that forecast information is more commonly sourced from local indigenous sources and production and management information from modern sources. Specifically, community meetings are an important source of both forecast, and production and management information and are heavily relied upon for post-harvest handling information (24%) and to a lesser extent, extreme weather forecasts (18%). The farmers own knowledge is important source of seasonal forecast information and is heavily depended upon for all three periods of the seasonal climate forecasts; MAM (20%), JJA (23%) and SON (23%). Own knowledge is also relied upon for post-harvest handling information (17%), but is otherwise a mediocre source of production and management information. Elders/traditional forecasters are also an important source of forecast information, specifically for JJA (19%) and SON (20%) seasonal climate forecasts. Radio programmes are an important source of both forecast, and



production and management information and is heavily depended upon for extreme weather forecasts (27%). Radio is also relied upon for MAM seasonal climate forecasts (20%), and livestock production and management information (17%). NGOs are an important source of production and management information, particularly for crops (23%) and to a lesser extent, post-harvest handling (18%). Government extension workers are also a common source of production and management information, specifically livestock information (16%), however they are a poor source of forecast information.

### 5.3. Utilisation of Forecast, Production and Management Information



**Figure 8:** Percentages of farmers from across Karamoja who were able to utilise the eight types of information (related to forecasts, and production and management) in the last twelve months.

Utilisation of forecast, and production and management information is high across Karamoja. The most utilised information type was MAM seasonal climate forecasts (85%) and the least utilised was pest and disease management (61%). Generally, forecast information was utilised more often than production and management information. On average, utilisation of forecast information was 77% compared to 69% for production and management information, of which the most utilised information type was post-harvest handling (78%). Noticeably, there was a decline in utilisation of seasonal climate forecasts from the MAM period (85%), through the JJA period (77%), to the SON period (75%). Extreme weather forecasts were the least utilised forecast information type (71%).

**Table 3:** Uses of the eight types of forecast, and production and management information cited by farmers. Uses were derived from open-ended questions, hence the qualitative presentation of the results.

Extreme Weather Forecast:	<ul style="list-style-type: none"> <li>• Land preparation: early bush and garden clearance;</li> <li>• Cultivation: early/delayed planting and planting of fast maturing crops;</li> <li>• Income generating activities: selling of assets, petty trading, casual labour, mining and charcoal/firewood production;</li> <li>• Food stocking and migrating to the green belt;</li> <li>• Construction of water management structures and tree planting;</li> <li>• Community meetings during which this information is shared.</li> </ul>
Seasonal Climate Forecasts (MAM):	<ul style="list-style-type: none"> <li>• Land preparation: bush and garden clearance;</li> <li>• Cultivation: tilling, early planting, planting of drought resistant crops and weeding;</li> <li>• Purchasing farm equipment and seeds.</li> </ul>
Seasonal Climate Forecasts (JJA):	<ul style="list-style-type: none"> <li>• Cultivation: planting, protecting crops from pests (birds), weeding and early harvesting.</li> </ul>
Seasonal Climate Forecasts (SON):	<ul style="list-style-type: none"> <li>• Cultivation: harvesting, drying and storing.</li> </ul>
Crop Production & Management:	<ul style="list-style-type: none"> <li>• Land preparation: bush and garden clearance;</li> <li>• Cultivation: tilling, planting (early planting and planting of drought resistant and fast maturing crops), weeding and harvesting;</li> <li>• Seeds: purchasing, treating, correct handling and storage;</li> <li>• Mixed farming techniques.</li> </ul>
Livestock Production & Management:	<ul style="list-style-type: none"> <li>• Purchasing vaccinations and medication;</li> <li>• Vaccinating and controlling parasites (spraying and deworming);</li> <li>• Migrating to new pastures.</li> </ul>
Pest & Disease Management:	<ul style="list-style-type: none"> <li>• Purchasing vaccinations, medication, insecticides;</li> <li>• Vaccinating (early against outbreaks);</li> <li>• Pest and parasite control (spraying and deworming);</li> <li>• Hygiene and sanitation.</li> </ul>
Post-harvest Handling:	<ul style="list-style-type: none"> <li>• Proper harvesting, handling and storage techniques;</li> <li>• Construction of granaries and purchasing storage equipment;</li> <li>• Transportation of harvest.</li> </ul>

Farmers use extreme weather forecasts for a range of activities, including deciding whether or not to carry out cultivation activities earlier (or later). Farmers also use this information to prepare for droughts and floods, by stocking food, migrating and construction water management structures. Farmers also plant trees, a long-term adaptation measure for extreme weather events. A number

of farmers also reported sharing this specific type of information through community meetings. Seasonal climate forecast are used to plan cultivation activities. The cultivation activities reflect the growing season of the region, with land preparation (bush and garden clearance), tilling and some early planting taking part during the MAM period. During the JJA period, farmers continue planting and begin to protect their crops from pests. Some early harvesting also takes place within this period. Finally, during the SON period farmers harvest, dry and store their crops.

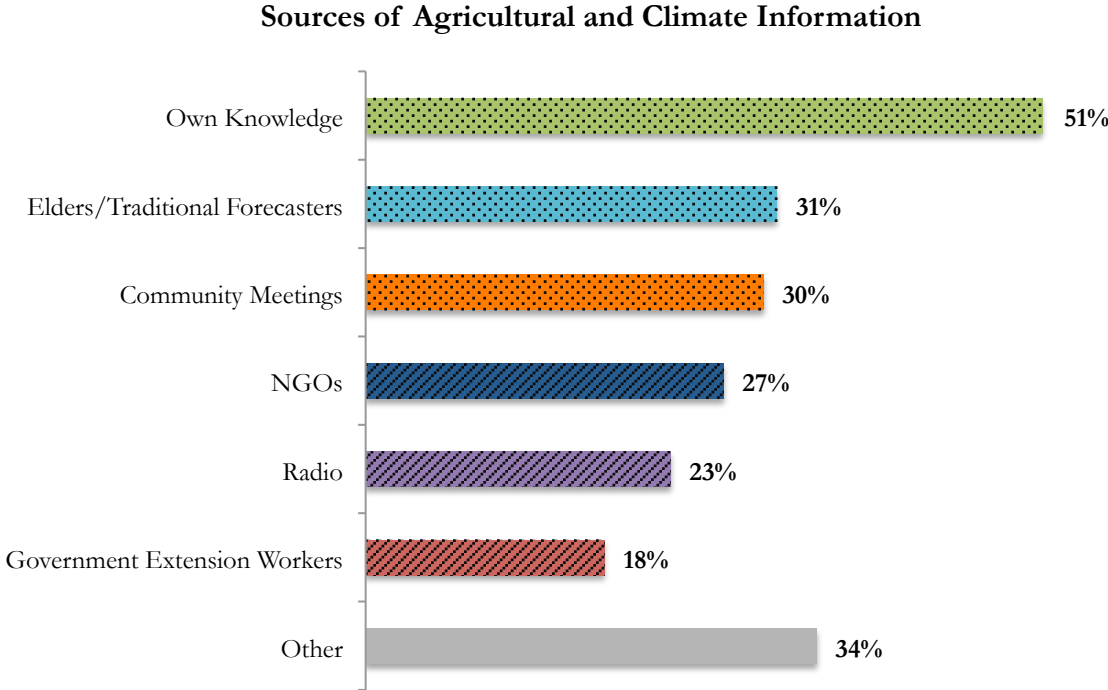
Crop production and management information is also used for cultivation activities, as well as informing farmers of correct seed procurement, treatment, handling and storage techniques. Livestock production and management information is used for informing farmers of vaccination and medication procurement, treating their livestock for parasites and migrating to new pastures. Pest and disease management information is used in a similar manner to livestock production and management information, but pre-emptively, in order to prevent outbreaks. Post-harvest handling information is used to inform farmer of correct handling techniques, as well as the construction and purchase of storage equipment.

**Table 4:** Reasons the eight types of forecast, and production and management information could not be utilised by farmers. Reasons were derived from open-ended questions, hence the qualitative presentation of the results.

Extreme Weather Forecast:	<ul style="list-style-type: none"> <li>• Did not know how to (lacked knowledge/information);</li> <li>• Did not consider information important/useful;</li> <li>• Limited capacity: financial and time constraints, illness, illiterate;</li> <li>• Prohibited by family members.</li> </ul>
Seasonal Climate Forecasts (MAM):	<ul style="list-style-type: none"> <li>• Did not know how to (lacked knowledge/information);</li> <li>• Limited capacity: shortage of land and labour, illness.</li> </ul>
Seasonal Climate Forecasts (JJA):	<ul style="list-style-type: none"> <li>• Did not know how to (lacked knowledge/information);</li> <li>• Limited capacity: shortage of land, labour and illness.</li> </ul>
Seasonal Climate Forecasts (SON):	<ul style="list-style-type: none"> <li>• Did not know how to (lacked knowledge/information);</li> <li>• Did not consider information important/useful;</li> <li>• Limited capacity: time constraints, illness.</li> </ul>
Crop Production & Management:	<ul style="list-style-type: none"> <li>• Did not know how to (lacked knowledge/information);</li> <li>• Did not consider information important/useful;</li> <li>• Limited capacity: time constraints, illness;</li> <li>• Climatic factors: erratic rainfall and drought;</li> <li>• Lack of resources: seeds.</li> </ul>
Livestock Production & Management:	<ul style="list-style-type: none"> <li>• Did not know how to (lacked knowledge/information);</li> <li>• Did not consider information important/useful (no livestock);</li> <li>• Limited capacity: financial constraints;</li> <li>• Do not own any livestock.</li> </ul>
Pest & Disease Management:	<ul style="list-style-type: none"> <li>• Don't know how to (lacked knowledge/information);</li> <li>• Did not consider information important/useful;</li> <li>• Limited capacity: financial and time constraints.</li> </ul>
Post-harvest Handling:	<ul style="list-style-type: none"> <li>• Don't know how to (lacked knowledge/information).</li> </ul>

The most frequently reported reason that farmers were unable to utilise the forecast, or production and management information across all eight of the information types was that they 'did not know how to' as they lacked knowledge and/or information. Another reason farmers did not utilise the forecast, or production and management information was that they 'did not consider the information important or useful', so did not take any action. Other reasons for the inability to utilise the information included; limited capacity to interpret the information and limited capacity to take action, particularly due to financial and time constraints, illness and shortage of labour.

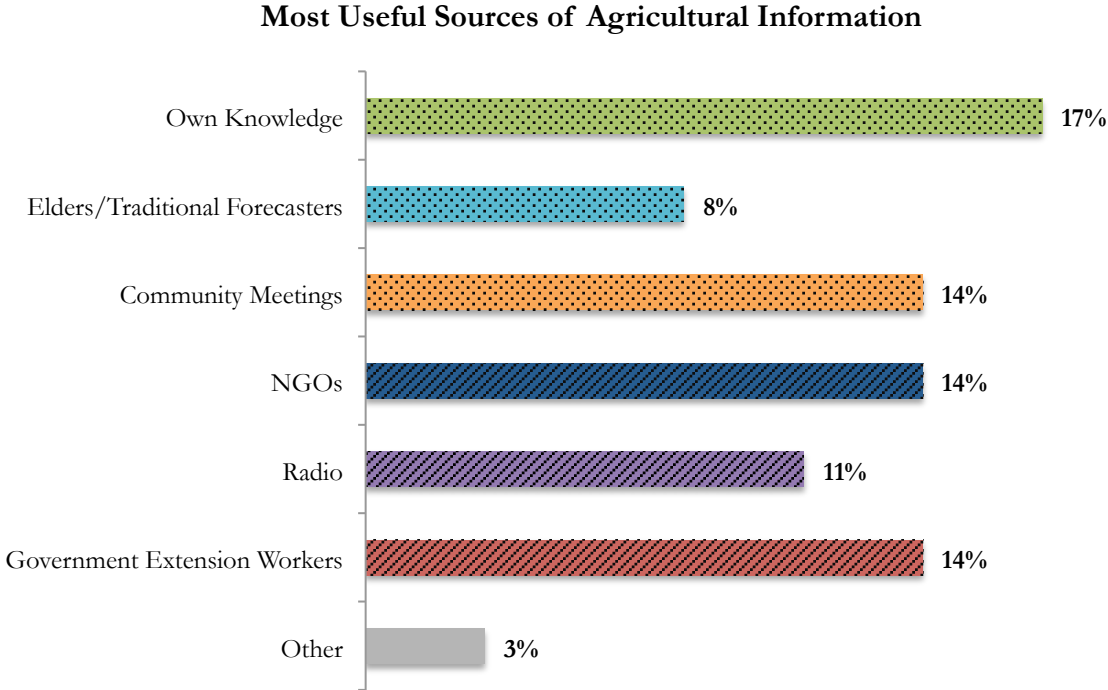
### 5.4. Sources of Agricultural and Climate Information



**Figure 9:** Percentages of farmers from across Karamoja who had access to agricultural and climate information from the seven sources in the last twelve months. The category ‘Other’ includes eight sources: 1) Farmer Organisations/Cooperatives, 2) Religious Groups, 3) Agri-service Providers/Seed Companies, 4) Newspapers/Bulletins, 5) Schools/Teachers, 6) Farmer Field Schools/Demonstrations, 7) Mobile Phones, and 8) TV, of which individual access to seven (excluding ‘Religious Groups’ 14%) was negligible (<5%).

Access to sources of agricultural and climate information is low across Karamoja. The most accessed source of agricultural and climate information was the farmers’ own knowledge (51%) and the least accessed source was government extension workers (18%) (excluding the seven information sources of ‘other’). All three indigenous sources (own knowledge, elders/traditional forecasters, community meetings) of agricultural and climate knowledge were more frequently accessed by farmers than any of the three modern sources (NGOs, radio, government extension workers). On average, access to local indigenous sources was 37% compared to 23% for modern sources, of which the most accessed source was NGOs (27%).

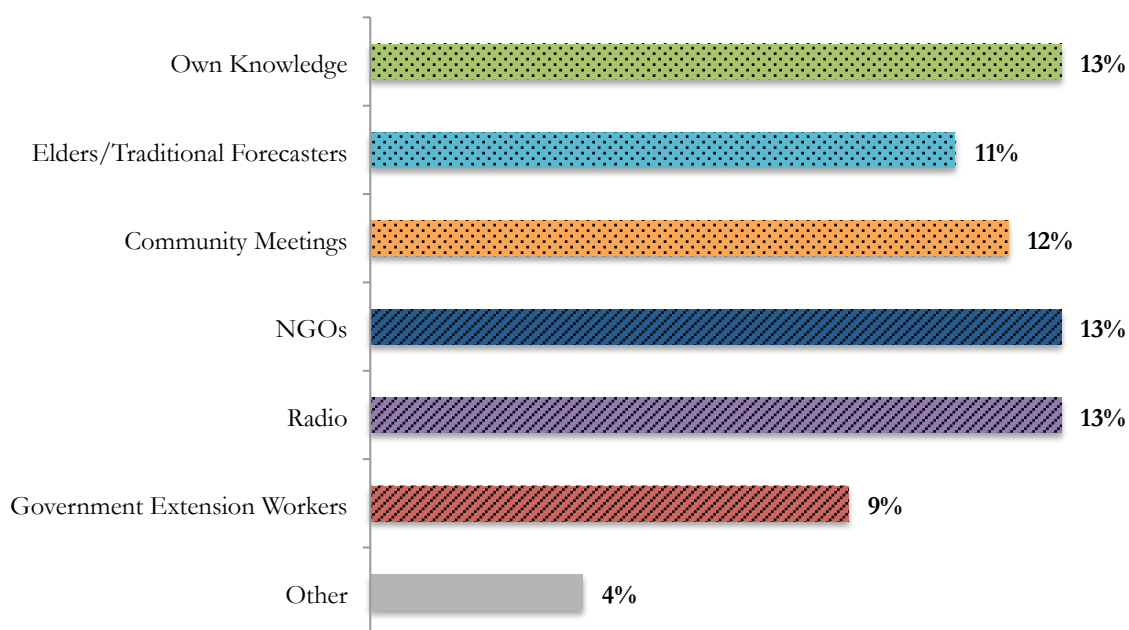
### 5.5. Perceived Usefulness of Agricultural and Climate Information Sources



**Figure 10:** Most useful sources of agricultural information according to farmers from across Karamoja. The category ‘Other’ includes seven sources: 1) Farmer Organisations/Cooperatives, 2) Religious Groups, 3) Agri-service Providers/Seed Companies, 4) Newspapers/Bulletins, 5) Schools/Teachers, 6) Farmer Field Schools/Demonstrations, and 7) Mobile Phones, to which the responses were negligible (<2%). 19% of farmers answered ‘Not Applicable’.

Farmers perceived their own knowledge as the most useful source of agricultural information (17%). Community meetings, NGOs and government extension workers were also perceived as useful sources of information (14%). Elders/traditional forecasters were regarded as the least useful source of agricultural information (excluding the seven information sources of ‘other’), with 8% of farmers perceiving them as the most useful source of agricultural information. Indigenous and modern sources of agricultural information were perceived as equally useful. On average, 39% of farmers considered local indigenous sources to be the most useful and 39% considered modern.

### Most Useful Sources of Climate Information



**Figure 11:** Most useful sources of climate information according to farmers from across Karamoja. The category ‘Other’ includes seven sources: 1) Farmer Organisations/Cooperatives, 2) Religious Groups, 3) Agri-service Providers/Seed Companies, 4) Newspapers/Bulletins, 5) Schools/Teachers, 6) Farmer Field Schools/Demonstrations, and 7) Mobile Phones, to which the responses were negligible (<3%). 25% of farmers answered ‘Not Applicable’.

Farmers perceived their own knowledge, NGOs and radio as the most useful sources of climate information (13%). Community meetings (12%) and elders/traditional forecasters (11%) were also perceived as useful sources of information. Government extension workers were regarded as the least useful source of climate information (excluding the seven information sources of ‘other’), with 9% of farmers perceiving them as the most useful source of climate information. Indigenous and modern sources of climate information were perceived as equally useful. On average, 36% of farmers considered local indigenous sources to be the most useful and 35% considered modern.

## 5.6. Key Findings

The results indicate that access to forecast, and production and management information is low across Karamoja, with only one in ten farmers reporting access to production and management information. Linked to this, the ownership of communication assets is also low, with only one in five farmers owning a mobile phone (the most frequently owned communication asset). In regards to information sources, farmers depend upon indigenous and modern sources for forecast, and production and management information to a similar extent. Common sources of forecast information include the farmers' own knowledge and radio programmes, whilst common sources of production and management information include community meetings and NGOs.

Whilst access to forecast, and production and management information is low, its utilisation is high, with three-quarters of farmers reporting being able to utilise the information they had access to. For those that were unable to utilise the information, the most frequently reported reason was that they 'did not know how to'. Other reasons included that they did not consider the information important/useful and limited capacity to take action.

There is limited access to modern sources of agricultural and climate information. As such, farmers depend upon local indigenous sources, with over half of farmers dependent upon their own knowledge. Farmers perceive indigenous and modern sources of agricultural and climate information to be equally useful, though perceptions of usefulness vary markedly between the different sources.



## 6. Discussion

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This chapter discusses the findings of the scoping study and the case study. First the findings of the thesis thus far are summarised in relation to the first and second research questions and how they were met through the two methods. Following this, the findings of the scoping study and case study are discussed in relation to research question three, with the intention of fulfilling the research aim. Limitations of the thesis are also discussed at the end of the chapter.

### 6.1. Summary of Findings

The research aim of this thesis is to: *increase the knowledge about the potential to improve information uptake for climate change adaptation by integrating indigenous knowledge systems with climate information services*. This aim was achieved through the application of two methods: a scoping study and a case study. The scoping study was broad in focus, covering an array of contexts. As such, a comprehensive overview of the scientific literature on the topic was achieved. However, it was recognised that whilst the systematic analysis of previous studies represents a novel approach, the scoping study did not contribute much detailed ‘new’ knowledge. Therefore, a context specific case study was included. Through the analysis of household-level data from Karamoja, Northeast Uganda, novel detailed knowledge on the thesis’ topic was gained. In this way, the relatively broad analysis and findings of the scoping study were ‘balanced’ by the detailed analysis and findings of the case study. Three research questions were posed in relation to the aim of this thesis. How these research questions were answered by meeting the thesis’ objectives is summarised below.

The first research question: *what factors influence information uptake for climate change adaptation from indigenous knowledge systems and climate information services?* Was answered by meeting objective one: *conduct scoping study into the scientific literature on information uptake for climate change adaptation from indigenous knowledge systems and climate information services* and two: *identify factors that influence information uptake from indigenous knowledge systems and climate information services*. Through the scoping study’s overall analysis it was discovered that the two subject areas that have contributed the most literature to the topic of information uptake for CCA from IKS and CIS were the Social Sciences and the Environmental Sciences. It was also found that the number of publications on the topic has been steadily increasing since the early 2000s, demonstrating a growing interest in research that addresses the thesis’ topic. Finally, it was revealed that there is a strong African presence, both in terms of regions of publication and regional focus, demonstrating the recognition by the

scientific community of the richness of indigenous knowledge on the continent. These findings of the overall analysis are not discussed in further detail as they are not the focus of the thesis and do not specifically achieve the thesis' aim. Rather, they provide an overview of the literature on the topic and suffice in meeting objective one, the importance of which was the method itself and facilitating the achievement of the three other objectives.

After the scoping study was conducted and objective one met, the in-depth analysis of the articles from Group 1 was carried out in order to meet objective two: *identify factors that influence information uptake from indigenous knowledge systems and climate information services*. Through the in-depth analysis of the articles content and placing their findings into themes, factors emerged that influence information uptake from IKS and CIS. The interrelated factors identified were: access to information, source of information, utilisation of information, and perceived usefulness of information source. These factors were then examined and condensed to form an analytical framework that would be used as a tool to analyse the household-level data from the case study. By meeting these two objectives, the research question: *what factors influence information uptake for climate change adaptation from indigenous knowledge systems and climate information services?* Was answered and the answer to the second research question could be sought.

The second research question: *to what extent are these factors evident in Karamoja?* Related to the case study and was answered by meeting objective three: *perform analysis of household-level data from Karamoja using identified factors*. Through the analysis of the household-level data using the analytical framework, it was found that the factors identified prior, in the scoping study in-depth analysis, were evident to varying extents. By meeting objective three, research question two was answered.

Finally, the third research question: *can information uptake in Karamoja be improved by integrating indigenous knowledge systems with climate information services?* Will now be answered by meeting objective four: *establish the potential to improve information uptake in Karamoja by integrating indigenous knowledge systems with climate information services*. The discussion of these findings will be split into two sections: 1) the need to improve information uptake and 2) the potential to improve information uptake by integrating IKS and CIS. Accordingly, the research aim of the thesis, to: *increase the knowledge about the potential to improve information uptake for climate change adaptation by integrating indigenous knowledge systems with climate information services*, will be achieved. Limitations of the thesis will also be discussed at the end of the chapter and how they were addressed.

## 6.2. Information Uptake

Through the scoping study's in-depth analysis, factors that influence information uptake were identified and through the subsequent case study's household-level analysis, the need to improve information uptake in Karamoja was revealed. This section discusses the current state of access to and utilisation of information in the region and the need to improve information uptake.

Access to forecast, and production and management information in Karamoja is low, with less than one-fifths of farmers reporting access. There were significant disparities in the rates of access to information types. For instance, farmers were twice as likely to have access to forecast rather than production and management information. More specifically, extreme weather forecasts were the most frequently accessed, with a third of farmers reporting access. The second most frequently accessed were MAM seasonal climate forecasts, to which a quarter of farmers reported access. In regards to production and management information, less than one-fifth of farmers reported access to crop information and one in ten to livestock, and pest and disease. Post-harvest handling was the least frequently accessed, with fewer than one in ten farmers reporting access. Relatedly, it was found that communication asset ownership is low, with only around one-fifth of households owning a mobile phone and one in ten a radio. This finding that access to information in Karamoja is low in agreement with the findings of multiple articles analysed in the scoping study, notably by Makwara et al. (2013), Jiri et al. (2015) and Obando & Munang, (2016), that access to information by subsistence farmers in the developing world is often limited. The low level of access to scientific information may force farmers in the region to depend upon indigenous knowledge accessed from local IKS (Chang'a et al., 2010; Speranza et al., 2010; Jiri et al., 2015; Mapfumo et al., 2016). Additionally, the finding that communication asset ownership is also low is in accordance with the findings of Luseno et al. (2003) and Kangalawe et al. (2017) that a high proportion of farmers lack communication assets, excluding them from accessing scientific information from CIS communicated through these channels.

Access to information is regarded as a prerequisite for CCA at the local-level and was identified to be a significant factor influencing information uptake. Due to the low levels of information access, the adaptive capacity of farmers in the region is restricted and the benefits of access to information that were acknowledged in the literature in regards to facilitating CCA are inhibited (Egeru, 2012; Mishra et al., 2012; Ajani et al., 2013; Mapfumo et al., 2016). Given that climate change is occurring in Karamoja (USAID, 2017) and that the majority of Karamoja's population depend upon climate sensitive livelihoods (Mubiru, 2010), the accessibility of information related

to forecasts, and production and management should be improved in order to strengthen the adaptive capacity of households in the region. An approach to improve information accessibility is to support local institutions. Appropriate platforms and institutional support for farmers to share information is recognised to assist dissemination of information to subsistence farmers (Mapfumo et al., 2016). Relatedly, elaborate social networks (based upon kin, ethnicity, age and other principles) in rural communities are often relied upon in accessing and communicating information (Kolawole et al., 2015; Egeru, 2016), therefore fostering local informal groups could also aid information accessibility.

The role of information for CCA in the developing countries is increasingly receiving more attention amongst the scientific community. Adaptation needs in developing countries often took a hazard-based approach, with a focus on drivers of impacts and options to moderate them (Finzi et al., 2012). However more recently, the focus has been on tackling the underlying causes of vulnerability (Füssel, 2007). Burton et al. (2006) recognises informational needs as one of the major categories of adaptation needs. As such, the successful implementation of adaptation actions at the local-level depends to a large extent upon the availability and accessibility of information (Noble et al., 2014). However, providing information alone does not mean that farmers will be able to make effective use of it, information needs to be tailored to the context (Webb & Beh, 2013). This can be achieved through participatory approaches, where the farmers are actively engaged in the production and communication of information, rather than passive users. Such two-way communication is acknowledged to improve the perceived salience, credibility and legitimacy of the information - crucial for improving information uptake (Lemos et al., 2012; Jones et al., 2015).

In contrast to the low information accessibility, the utilisation rates of forecast, and production and management information in Karamoja is generally high, with three-quarters of farmers reporting being able to use the information they had access to. However, there were disparities in the utilisation rates of the information types. Generally, forecasts were more likely to be utilised than production and management information. For instance, seasonal climate forecasts were the most frequently utilised information types, being utilised by four-fifths of farmers. The percentage of farmers who were able to use extreme weather forecasts was also high. In regards to production and management information, post-harvest handling was the most frequently utilised, with over three-quarters of farmers able to utilise the information (in marked contrast to its low accessibility). However, the utilisation rates of livestock, and pest and disease information was low (less than two-thirds of farmers). The ability to utilise information was identified from the literature as a significant factor that influenced information uptake. It was recognised that

farmers need to be able to utilise the information they obtain in order to inform decisions for CCA and agricultural activities (Mwalukasa, 2013; Obando & Munang, 2016; Kangalawe et al., 2017). If utilised correctly, appropriate information can significantly increase the capacities of subsistence farmers to cope with and adapt to the impacts of climate change and variability (Mishra et al., 2012; Debela et al., 2015; Mapfumo et al., 2016). The relatively high rates of information utilisation evident from the household-level analysis suggests households are open to receiving information and they are typically able to use this information successfully to inform their decisions. For instance, farmers reported using seasonal climate forecasts for a range of activities, including timing land preparation and cultivation activities. These information uses are typical of subsistence farmers in the developing world and were corroborated by the findings of the scoping study (Kalanda-Joshua et al., 2011; Egeru, 2012; Belay et al., 2017). Specifically, farmers reported using extreme weather forecasts for planting trees, a recognised adaptation strategy in the region (Mbogga et al., 2014) and for informing coping strategies, such as stocking food and migrating. It was also reported that farmers in Karamoja share this information through community meetings, an integral component of IKS (Lwoga et al., 2011; Cherotich et al., 2012).

However, the utilisation rates of information were far from 100% and for some information types was significantly lacking. The most frequently cited reason that farmers were unable to utilise the information they had access to was that they 'did not know how to' due to a lack of knowledge or information and that they 'did not consider the information important or useful'. These reasons may indicate that the information is not being tailored appropriately to the farmers' capacities or needs. Accordingly, the literature acknowledged there are many constraints impeding the full utilisation of information to guide farm-level decisions among subsistence farmers in the developing world, including that scientific information is often not packaged appropriately (Kalanda-Joshua et al., 2011; Bryan et al., 2013). These constraints make it difficult to translate CIS into viable actions, undermining the ability of farmers to utilise this information and to make CCA and agricultural decisions. Efficacy of scientific information can be improved by its integration with indigenous knowledge (Field et al., 2014).

In summary, the current state of information uptake for CCA by subsistence farmers in Karamoja is inhibited by low information access. For farmers that were able to access information, utilisation rates are generally high, indicating that farmers do seek information to inform their decisions and activities. However, not all farmers were able to use the information, perhaps due to a lack of tailoring that reduced their ability and willingness to utilise information. Clearly there is a need to improve information uptake in the region. The next section examines the potential to improve information uptake in Karamoja by integrating IKS with CIS.

### 6.3. Integrating Indigenous Sources with Modern Sources

The information source and its perception is recognised to influence the propensity of subsistence farmers in the developing world to uptake information for CCA. Sources of indigenous knowledge and scientific information do differ, as do their perceptions. IKS are characterised by indigenous sources whereas CIS are typically modern. This section discusses the information sources in Karamoja and their perceived usefulness, establishing the potential to improve information uptake by integrating IKS with CIS.

The sources of forecast, production and management, agricultural, and climate information were examined. Six information sources were found to be dominant in Karamoja, agreeing with the findings of the scoping study that subsistence farmers in the developing world access information from multiple sources (Cyprian et al., 2014; Kolawole et al., 2014; Egeru, 2016). This is encouraging as it is recognised that farmers who uptake information from multiple sources are more likely to be aware of climate change and to adapt (Patt & Gwata, 2002; Orlove et al., 2010). Three of the sources were local indigenous sources and three were modern sources. Local indigenous sources were: 1) the farmers own knowledge, 2) community meetings and 3) elders/traditional forecasters, whilst modern sources were: 4) radio programmes, 5) NGOs, and 6) government extension workers. Farmers were found to access forecast, and production and management information from indigenous and modern sources to a similar extent, however there were disparities. Relatedly, a study by Egeru (2016) identified differences in the accessibility of information sources in Karamoja and in a similar fashion, distinguished between indigenous and modern sources. Own knowledge was the leading source of seasonal climate forecasts and was a notable source of post-harvest handling information, however it was otherwise a poor source of production and management information. Indeed, a study by Gayfer et al. (2012) identified a vacuum in indigenous knowledge to inform crop production and management in Karamoja. This is perhaps expected given that historically the Karamojong have been pastoralists (Levine, 2010); therefore their IKS are centred upon cattle. However, the finding that own knowledge was not a common source of livestock information either is surprising. Community meetings were a prominent source of both forecast, and production and management information, particularly extreme weather forecasts and post-harvest handling. Certainly, community meetings are recognised to be an important source of information in the region (Egeru, 2016). Through community meetings, farmers are able to acquire information and knowledge to which they might not otherwise have access (Orlove et al., 2010) and to share their own knowledge and experience with others (Obando & Munang, 2016). Radio programmes were also a common source of both forecast, and production and management information, being the major source of

extreme weather forecasts and an important source of crop and livestock information (unexpected given the low ownership of this communication asset). NGOs were a significant source of production and management information, particularly crop and post-harvest handling information. However, their role as a source of forecast information was small. Elders/traditional forecasters and government extension workers were less frequently accessed overall. Elders/traditional forecasts were a popular source of seasonal climate forecasts, however they were a poor source of production and management information. On the contrary, government extension workers were a popular source of production and management information, however were a poor source for forecasts.

Though disparities do exist, clearly farmers in Karamoja use a combination of sources, agreeing with the findings of (Orlove et al., 2010; Speranza et al., 2010; Jiri et al., 2015). This finding suggests that farmers may be open to integrating IKS with CIS as they already seek information from both indigenous and modern sources.

In regards to access to agricultural and climate information, there was a marked difference in sources, with access to indigenous sources higher than that of modern sources. Own knowledge was the most accessed source of agricultural and climate information, with over half of farmers citing it as a source. The second and third most accessed sources were elders/traditional forecasters and community meetings respectively. NGOs were the fourth most frequently accessed source, followed by radio programmes and finally government extension workers – the modern sources. The high reliance upon local indigenous sources for agricultural and climate information may indicate that CIS and scientific information are not readily available or accessible in the region (Chang'a et al., 2010; Speranza et al., 2010). More specifically, the high reliance upon own knowledge is in agreement with the findings of Belay et al. (2017), who found that the majority of farmers become aware of climate change and its impacts through their own experience and understanding. Indeed, the Karamojong are recognised to have a detailed understanding of climate and weather (Mubiru, 2010) and recommendations have been made to identify, document and promote indigenous knowledge in Karamoja in order to reduce vulnerability to climate change (DanChurchAid, 2010). This finding indicates that efforts to improve information uptake from CIS in Karamoja should recognise and incorporate the existing local indigenous knowledge sources given their importance. To accomplish this requires a top-down approach both by CIS institutions (perhaps assisted by UN agencies, such as WFP, as well as NGOs) at the organisational level, as well as the political commitment by the Government of Uganda to provide a conducive, enabling environment. However, as noted from the literature, farmers are increasingly integrating indigenous knowledge with information from modern

sources as climate change and variability detrimentally influences their ability to use natural indicators (Chang'a et al., 2010; Makwara et al., 2013; Obando & Munang, 2016). Other studies in Uganda by Orlove et al. (2010) and Egeru, (2012) found that persistently changing weather patterns have challenged farmers reliance upon indigenous knowledge from indigenous sources for CCA. Climate change in Karamoja will threaten the indigenous sources of information, which have been historically relied upon for CCA by so many in the region.

Perceptions of the agricultural and climate information sources were assessed. It was found that indigenous and modern sources are perceived as equally useful for both agricultural and climate information, indicating potential for the acceptance of their integration. This finding was in contrast to some of the findings of the scoping study that subsistence farmers normally have more inclination towards IKS as opposed to CIS (Luseno et al., 2003; Kolawole et al., 2014). The articles described how information from modern sources to inform agricultural activities and CCA are often not embraced due to a number of reasons, including: a lack of trust, confidence, ownership and relevance, its complex nature, and the mismatch between information provided and information needed (Patt & Gwata, 2002; Kolawole, 2014; Obando & Munang, 2016), reducing the uptake of information. Clearly that is not the case in Karamoja, as evident from the household-level analysis. There were however differences in the perceived usefulness of the six sources. Own knowledge and community meetings were considered to be beneficial sources of agricultural and climate information. Indeed, own knowledge was perceived to be the most valuable source of climate information. Farmers often value highly their own knowledge and use it as a knowledge frame within which information from other sources (including modern sources) are positioned and interpreted (Speranza et al., 2010; Kolawole et al., 2014). Own knowledge is often complemented by consulting other sources (Speranza et al., 2010), as seems to be occurring in Karamoja. The prominence of community meetings is encouraging as they are recognised to be an entry point for participatory approaches involving information dissemination (Chang'a et al., 2010; Mwalukasa, 2013, Egeru, 2016). Elders/traditional forecasters were also regarded as helpful source of climate information, however they were not considered as a useful source of agricultural information. Indigenous knowledge from local indigenous sources tends to be more accurate and simple to understand to farmers as opposed to the complex nature of scientific information from modern sources that require sophisticated equipment and formal education and training and financial investment (Kalanda-Joshua et al., 2011; Kolawole et al., 2014; Obando & Munang, 2016). The high illiteracy rates and limited financial capability of farmers in Karamoja may provide a reason for the popularity of indigenous information sources in the region. However, it is known that even those that rely primarily upon indigenous knowledge often seek scientific information from modern sources (Egeru, 2012; Mapfumo et al., 2016).



In regards to the modern sources, NGOs were perceived to be a beneficial source of both agricultural and climate information. Indeed, a study by Egeru (2016) revealed that NGOs were widely regarded as one of the most accessible and reliable sources of climate information in Karamoja, demonstrating the importance of this modern information source. Whilst radio was not regarded as a particularly useful source of agricultural information, it was considered a helpful source of climate information. Radio programmes are recognised to be an important modern source of scientific information for subsistence farmers, due to its oral nature, low cost and independence of electricity (Luseno et al., 2003; Mwalukasa, 2013). In previous studies of information sources in Karamoja, radio programmes were found to be a popular source of climate information (Egeru, 2016), supporting this finding. On the contrary, government extension workers were regarded as a useful source of agricultural information, though not a useful source for climate information. This finding suggests that government extension workers must be sensitised on climate change. This can be achieved by bringing together government extension workers and climate science professionals (from NGOs or consultancies), for instance through workshops and seminars. Through such engagements, government extension workers can improve their knowledge and understanding of climate change, thus making them more effective sources of climate information. The positive perception of modern sources may be due to them being regarded as open and to offer easy access to those who have the skills to apply it for practical use (Kolawole et al., 2014).

The usefulness of indigenous knowledge faces a number of challenges. Increased climate variability has reduced the accuracy and the reliability of indigenous knowledge, which often relies upon natural, climate sensitive indicators (Roncoli et al., 2002; Luseno et al., 2003; Chang'a et al., 2010; Mwalukasa, 2013). A report by Gayfer et al. (2012) found that increasing climate variability in the region had resulted in the reduced utilisation and usefulness of indigenous knowledge. However this research indicates that IKS are still relied upon and valued in Karamoja. Formal efforts to improve information uptake from CIS for CCA in the region should recognise and integrate this existing local capacity. To attain this, further research should seek to develop a framework for the pragmatic integration of IKS with CIS, specific to the Karamoja context.

## 6.4. Limitations

Despite the best efforts of the researcher, this thesis had its limitations. Most significant was that the household-level data was not collected by the researcher and was collected before the scoping study was conducted. The implication of this was that the factors that were identified through the scoping study had to be applied to the household-level data according to what was available in the data set; as such, some potentially useful data was not available. For instance, knowing the farmers perceived usefulness of the forecast, and production and management sources would have been beneficial to the thesis, however unfortunately this data was not collected by the WFP questionnaire. This required using a 'best-fit' approach and the researcher's judgement as to what was/not appropriate. This was assisted by the researcher's knowledge of the data set, having worked with it previously. However, it was also recognised that this familiarity with the data set could have resulted in preconceptions as to what was sought in the literature in regards to the factors. As such, this bias was addressed by conducting a rigorous and systematic scoping study. Overall it is regarded that the household-level dataset was sufficient in meeting the aim of the thesis, which was exploratory.

Other limitations included the depth of the analysis of the household-level data set. The analysis employed by the thesis was basic. No complex statistical analysis was conducted, for instance into correlation and causation. Whilst this kind of analysis would assess the relationships between the various factors and variables, given the limitation described above, the researcher felt this step would have been too speculative. In a way, the broader, more basic analysis that was employed is regarded to be more appropriate in light of this limitation. Additional limitations in regards to the analysis of the household-level data include that the dataset was not disaggregated by gender, or by socioeconomic factors such as education and income. This analysis was not conducted due to the scope of the thesis and as the researcher was conscious about overloading the reader with further numerical analysis that would have required additional figures and tables.

## 7. Conclusion

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The aim of this thesis was to: *increase the knowledge about the potential to improve information uptake for climate change adaptation by integrating indigenous knowledge systems with climate information services*. This aim was met through the application of two methods. The first method, a scoping study of the scientific literature, revealed factors that influence information uptake for CCA from IKS and CIS. The interrelated factors were: access to information, source of information, utilisation of information, and the perceived usefulness of the information source. The second method, a case study focusing on the Karamoja Sub-region of Northeast Uganda was then conducted.

Through the analysis of household-level data from Karamoja, the extent to which the factors that were identified through the scoping study were evident was discovered. The household-level analysis revealed that farmers in Karamoja have low levels of access to information, however for those that do access information, utilisation rates are relatively high. Nonetheless, the utilisation rates of some of the information types are considerably lacking, the principal reason being that the information is not tailored appropriately to the farmers' capacities or needs. These findings demonstrate that information uptake must be improved in the region in order to strengthen CCA efforts. Specifically, information must be packaged appropriately for the farmers. This can be achieved by integrating IKS with CIS. In order to establish the potential to integrate IKS with CIS, the sources of information and their perceived usefulness was assessed. It was found that farmers source their forecast, and production and management information from indigenous and modern sources to a similar extent, indicating that farmers already use a combination of sources and may therefore be receptive to their integration. In regards to agricultural and climate information, farmers depend heavily upon indigenous knowledge from IKS and they perceive indigenous sources and modern sources as equally useful, indicating that farmers are open to information from both indigenous and modern sources. This finding demonstrates the potential for formal information dissemination efforts through CIS to improve their information uptake by incorporating the local IKS, which are relied upon and valued. This thesis contributes to the existing knowledge on information uptake for CCA from IKS and CIS by providing an extensive review of the scientific literature and a detailed analysis of a context specific case study. Importantly, issues were identified that can be addressed by policy and decision makers to improve information uptake for CCA through the integration of IKS with CIS.

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# Appendices

## Appendix 1: Glossary

**Adaptive Capacity:** The combination of the strengths, attributes, and resources available to an individual, community, society, or organisation that can be used to prepare for and undertake actions to reduce adverse impacts, moderate harm, or exploit beneficial opportunities (Field et al., 2012).

**Capacity:** The combination of all the strengths, attributes, and resources available to an individual, community, society, or organisation, which can be used to achieve established goals (Field et al., 2012).

**Climate Change:** A change in the state of the climate that can be identified by changes in the mean and/or the variability of its properties, and that persists for an extended period, typically decades or longer. Climate change may be due to natural internal processes or external forcings, or to persistent anthropogenic changes in the composition of the atmosphere or in land use (Field et al., 2012).

**Climate Change Adaptation:** In human systems, the process of adjustment to actual or expected climate and its effects, in order to moderate harm or exploit beneficial opportunities (Field et al, 2012).

**Climate Information Services:** Institutions that provide climate-related information – and other relevant information, e.g. related to agriculture – to assist decision-making by individuals, communities, societies and organisations for the management of the risks of climate variability and change, and adaptation to climate change, as an important component of sustainable development. Climate information services bridge the generation and application of climate information and are most effective through collaboration between providers and users (adapted from GFCS, 2017 and CSP, 2017).

**Climate Variability:** Variations in the mean state and other statistics of the climate at all spatial and temporal scales beyond that of individual weather events. Variability may be due to natural internal processes within the climate system, or to variations in natural or anthropogenic external forcing (Field et al., 2012).

**Extreme Weather:** The occurrence of a value of a weather or climate variable above (or below) a threshold value near the upper (or lower) ends of the range of observed values of the variable (Field et al., 2012).

**Forecast:** Definite statement or statistical estimate of the likely occurrence of a future event or conditions for a specific area (UNISDR, 2009).

**Household:** A farm family unit consisting of a group of interrelated people living together, sharing the same dwelling house, working on the family farm, making farm-level decisions (including adaptation) and pooling their labour to manage their farm under the prime leadership of the household-head (Debela et al., 2015).

**Indigenous Knowledge Systems:** Knowledge systems developed across generations by a community as opposed to the scientific knowledge that is generally referred to as 'modern' knowledge. Indigenous knowledge is uniquely local to a given socio-cultural setting and embraced in the tradition of the said society. Indigenous knowledge is the basis for local-level decision-making in many rural communities and is used to cope and adapt to climate change and variability (adapted from the Parry et al., 2007).

**Information Uptake:** The action of making use of available information to inform decision-making.

**Own Knowledge:** Refers to the farmer's knowledge of their environment that is used to inform their decision-making at the local-level. This knowledge has a strong practical emphasis and has been developed by the individual through empirical observation and cumulative experience. It is recognised that this form of knowledge is dynamic and open to the influence of other forms of information, including from modern sources

**Resilience:** The ability of a system, community or society exposed to hazards to resist, absorb, accommodate to and recover from the effects of a hazard in a timely and efficient manner, including through the preservation and restoration of its essential basic structures and functions (UNISDR, 2009).

**Subsistence Farmer:** A person who owns or manages a farm on which they grow crops or raise livestock sufficient only for their own use, without any surplus for trade (Oxford Dictionary, 2017).

**Vulnerability:** The characteristics and circumstances of a community, system or asset that make it susceptible to the damaging effects of a hazard (UNISDR, 2009).

## Appendix 2: Overview of Articles from Group 1

**Appendix 2:** Overview of the 30 articles from Group 1 analysed in the in-depth analysis of the scoping study. ‘3’ = explicit reference and ‘2’ = implicit reference to the four factors identified from the literature. ‘1’ = deficient in the factor.

Author(s)	Title	Year	Access to information	Sources of information	Utilisation of information	Usefulness of sources
Kangalawe, R.Y.M., Mungongo, C.G., Mwakaje, A.G., Kalumanga, E., Yanda, P.Z.	Climate Change and Variability Impacts on Agricultural Production and Livelihood Systems in Western Tanzania	2017	3	3	2	1
----- Smallholder Farmers						
Belay, A., Recha, J.W., Woldeamanuel, T., Morton, J.F.	Adaptation to Climate Change and Determinants of Their Adaptation Decisions in the Central Rift Valley of Ethiopia	2017	3	3	2	2
----- Building on Indigenous						
Mapfumo, P., Mtambanengwe, F., Chikowo, R.	Knowledge to Strengthen the Capacity of Smallholder Farming Communities to Adapt to Climate Change and Variability in Southern Africa	2016	3	3	3	2
----- Determinants of Perceptions						
Opiyo, F., Wasonga, O., Nyangito, M., Mureithi, S.	of Climate Change and Adaptation Among Turkana Pastoralists in Northwestern Kenya	2016	3	3	2	1
----- Seasonal Climate Prediction						
Obando, J. & Munang, R.	and Adaptation Using Indigenous Knowledge Systems in Agriculture Systems in Southern Africa	2016	3	2	3	3
----- Climate Risk Management						
Egeru, A.	Information, Sources and Responses in a Pastoral Region in East Africa	2016	3	3	3	3
----- Perception of Climate						
Debela, N., Mohammed, C., Bridle, K., Corkrey, R., McNeil, D.	Change and its Impact by Smallholders in Pastoral/Agropastoral Systems of Borana, South Ethiopia	2015	3	3	2	1

Jiri, O., Mafongoya, P.L., Chivenge, P.	Indigenous Knowledge Systems, Seasonal 'Quality' and Climate Change Adaptation in Zimbabwe	2015	3	2	2	3
Kolawole, O.D., Wolski, P., Ngwenya, B., Mmopelwa, G.	Ethno-meteorology and Scientific Weather Forecasting: Small Farmers and Scientists' Perspectives on Climate Variability in the Okavango Delta, Botswana	2014	3	3	3	2
Cyprian, E., Margaret, Y., Okon, A., Bisong, F.	Rural Peoples' Perception to Climate Variability and Change in Cross River State, Nigeria	2014	3	3	1	2
Nkomwa, E.C., Joshua, M.K., Ngongondo, C., Monjerezi, M., Chipungu, F.	Assessing Indigenous Knowledge Systems and Climate Change Adaptation Strategies in Agriculture: A Case Study of Chagaka Village, Chikhwawa, Southern Malawi	2014	2	2	1	2
Naess, L.	The Role of Local Knowledge in Adaptation to Climate Change	2013	2	2	1	1
Bryan, E., Ringler, C., Okoba, B., Roncoli, C., Silvestri, S., Herrero, M.	Adapting Agriculture to Climate Change in Kenya: Household Strategies and Determinants	2013	3	2	2	1
Ajani, E., Mgbenka, R., Okeke, M.	Use of Indigenous Knowledge as a Strategy for Climate Change Adaptation Among Farmers in Sub- Saharan Africa	2013	2	2	1	1
Makwara, E.	Indigenous Knowledge Systems and Modern Weather Forecasting: Exploring the Linkages	2013	3	2	3	3

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	Agricultural Information					
Mwalukasa, N.	Sources used for Climate Change Adaptation in Tanzania	2013	3	3	2	3
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	Role of Indigenous Knowledge in Climate Change Adaptation: a Case Study of the Teso Sub-Region, Eastern Uganda					
Egeru, A.		2012	2	2	3	2
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	Access to Climate Change Information and Support Services by the Vulnerable Groups in Semi-arid Kenya for Adaptive Capacity Development					
Cherotich, K., Saidu, O., Bebe, O.		2012	3	3	2	1
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	Establishing Climate Information Service System for Climate Change Adaptation in Himalayan region					
Mishra, M., Upadhyay, D.K., Mishra, S.K.		2012	3	1	3	2
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	Adaptation to Climate Change in Uganda: Evidence from Micro-level Data					
Hisali, E., Birungi, P., Buyinza, F.		2011	3	2	2	1
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	Integrating Indigenous Knowledge with Conventional Science: Enhancing Localised Climate and Weather Forecasts in Nessa, Mulanje, Malawi					
Kalanda-Joshua, M., Ngongondo, C., Chipeta, L., Mpembeka, F.		2011	3	2	2	2
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	Meteorologists Meeting Rainmakers: Indigenous Knowledge and Climate Policy Processes in Kenya					
Guthiga, P. & Newsham, A.		2011	2	1	2	2
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	Access and Use of Agricultural Information and Knowledge in Tanzania					
Lwoga, E., Stilwell, C., Ngulube, P.		2011	3	3	2	2
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Orlove, B., Roncoli, C., Kabugo, M., Majugu, A.	Indigenous Climate Knowledge in Southern Uganda: The Multiple Components of a Dynamic Regional System	2010	3	3	3	2
Chang'a, L., Yanda, P., Ngana, J.	Indigenous Knowledge in Seasonal Rainfall Predication in Tanzania: a Case of the South-western Highland of Tanzania	2010	3	2	3	2
Speranza, C., Kiteme, B., Ambenje, P., Wiesmann, U., Makali, S.	Indigenous Knowledge Related to Climate Variability and Change: Insights from Droughts in Semi-arid Areas of Former Makueni District, Kenya	2010	2	3	1	3
Nyong, A., Adesina, F., Osman Elasha, B.	The Value of Indigenous Knowledge in Climate Change Mitigation and Adaptation Strategies in the African Sahel	2007	1	2	2	1
Luseno, W.K., McPeak, J.G., Barrett, C.B., Little, P.D., Gebru, G.	Assessing the Value of Climate Forecast Information for Pastoralists: Evidence from Southern Ethiopia and Northern Kenya	2003	3	3	2	3
Roncoli, C., Ingram, K., Kirshen, P.	Reading the Rains: Local Knowledge and Rainfall Forecasting in Burkina Faso	2002	2	2	1	3
Patt, A. & Gwata, C.	Effective Seasonal Climate Forecast Applications: Examining Constraints for Subsistence Farmers in Zimbabwe	2002	2	2	2	3

## Appendix 3: Household Characteristics of Study Population

**Appendix 3:** Household characteristics of the study population.

	<b>Category</b>	<b>Number</b>	<b>Percent</b>
Sex of household-head:	Male	2772	64%
	Female	1557	36%
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Age of household head:	<19	52	1%
	20-29	1119	26%
	30-39	1402	32%
	40-49	804	19%
	50<	952	22%
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Physical status of household head:	Able bodied	3862	89%
	Disabled	346	8%
	Chronically ill	121	3%
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Education level of household head:	No formal education	3019	70%
	Primary	733	17%
	Secondary	491	11%
	Tertiary	86	2%
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Household family size:	Small (<5)	2136	49%
	Medium (6-9)	1899	44%
	Large (>10)	294	7%
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