Opening the Black Box- Analysis of the Use of Hydro-meteorological Information in Farmers Decision Making Practices at Bontanga

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MSc Thesis - Sociology of Development and Change

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MSc International Development Studies (Sociology of Development and Change Group)

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Dedication

To all farmers and management of the Bontanga Irrigation scheme who provided me the opportunity to share in their lives, and whose stories have resulted in the production of this piece.

Preface and Acknowledgement

All social life is essentially practical. All mysterious which lead theory to mysticism find their rational solution in human practice and in the comprehension of the practice- Karl Marx

At first sight we might almost imagine that Tarrou had a habit of observing events and people through the wrong end of a telescope. (...) All the same, it is undeniable that [his] notebooks, which form a sort of discursive diary, supply the chronicler of the period with a host of seeming trivial details yet have their importance (Camus, 1972)

The two citations capture the essence and basic intuition to why this study assumed a practice perspective to studying decision making. That, through the chronicling of actual doings and sayings, details overlooked in decision making can be brought to the fore which can provide some insight for appropriate intervention. But before I get started, I would like to express my sincere thanks to my sponsors, Anne van den Ban fund (ABF) for their decision on me to pursue further studies. I am grateful for the opportunity to be educated in such a structured community of learning and to rub shoulders with many academic giants and scholars. It has been an enormous journey of knowledge acquisition, application as well as self-reflection. I will always treasure the academic attitude of being critical- a component which was never lacking in any of the courses I undertook.

This thesis would not have been completed without the support of many. First of all, my appreciation to my supervisors Art Dewulf (Prof.) and Han van Dijk (Prof.) for painstakingly reading through the scripts and offering useful suggestions, direction and constructive criticisms. Your consistent guidance and encouragement helped me to improve myself and made this a masterpiece. Secondly, to the entire EVOCA team and the various funders, thanks for granting me the space to make a contribution to this project.

To my Dutch parents, Frouke and John for their unrelenting support and believe in me and for providing timely breaks necessary to recoup for academic work. Furthermore to my family for being the shoulder I could always lean on when the going became tough. Finally to all the great friends far and near whose diverse contribution, perspective and dialogues enabled the successful completion of this thesis.

List of Abbreviations

ACDI/VOCA	Agricultural Cooperative Development International/Volunteers in Overseas Cooperative Assistance
ADVANCE	Agriculture Development and Value Chain Enhancement
EPA	Environmental Protection Agency
EVOCA	Environmental Virtual Observatory for Connective Action
EVOs	Environmental Virtual Observatories
FGD	Focus Group Discussion
GIDA	Ghana Irrigation Development Authority
GMET	Ghana Meteorological Services Department
GSS	Ghana Statistical Services
IFDC	International Fertilizer Development Center
MOFA	Ministry of Food and Agriculture
MTN	Mobile Telecommunication Network
NGO	Non-Governmental Organisation
NMET	Nigeria Meteorological Services Department
SARI	Savanna Agricultural Research Institute
SNV	Netherlands Development Organisation
SPT	Social Practice Theory
SPSS	Statistical Package for Social Sciences
UNFCC	United Nations Framework on Climate Change
USAID	United States Agency for International Development
WRO	Wales Rural Observatory

Abstract

Exposure to climate change and climate variability is a feature of rain-fed Agriculture in most developing countries including Ghana; where unpredictability of rainfall and prolonged periods of drought adversely impacts farmers' decision making. With most farm level decisions being water dependent, hydro-meteorological information is estimated to improve knowledge co-creation, learning and adaptive decision making. This study departs from classical approaches of decision making by assuming a social practice perspective. The study investigates hydro-meteorological information sources available to farmers and how they are accessed. It also examines the role of meaning, competence and material resources at key decision points within the cropping cycle and analysed the extent to which hydro-meteorological information impacts these decisions. Using a qualitative research approach, the study engaged 74 farmers and 15 information providers using interview guides, Focus Group Discussions (FGDs) and participant observations. Data obtained was analysed using atlas.ti. Findings revealed that, farmers accessed information through radio, mobile phones, television as well as through family and friends. However, the salience, legitimacy and credibility of the information impacted farmers' choice of preference with radio being the highest preferred (59%), followed by mobile phones (33%) and television (8%). It also emerged that, trust, accuracy of information, risk perceptions, experience in farming, technological skills, access to land, availability of farm machinery, diseased conditions, water availability, farm inputs and market conditions largely influenced use of hydro-meteorological information. Other findings revealed that, farmers' decision with regards to choice of crop is mostly inspired by the logic of appropriateness where the role of hydro-meteorological information is minimal. In contrast, decisions with regards to land preparation, planting, weed control, fertilizer application and harvesting are largely informed by the logic of consequentiality where hydro-meteorological information plays a major role. The study concludes that, hydro-meteorological information providers seeking to make meaningful impact should engage in effective partnerships with users within the agricultural value-chain to ensure a holistic approach to knowledge co-creation and information utilization.

Key words: Hydro-meteorological information, decision making, social practice, climate change, food production.

Table of Contents

List of Tables, Figures & Pictures

1.0 Introduction

*We are at cross-roads and only decisive and immediate action will make it possible to influence the future consequences of climate change and climate variability. We need to act immediately or the window of opportunity for successful mitigation will clos*e (Bals, et. al 2008)

Climate change and climate variability is causing severe harm on food production especially for the poorest and most vulnerable people in Sub-Saharan Africa. Historical data for Ghana from 1961 to 2000 clearly shows a progressive rise in temperature and a decrease in mean annual rainfall in all the six agro-ecological zones in the country. According to the UNFCCC, 2007 report, agricultural production and food security in many African countries and regions are likely to be severely compromised due to changes in climate and variability.

To build capacity and resilience of farmers to be able to make adaptive decisions, the Ghanaian government has been focused on the introduction of measures such as irrigation infrastructure, climate smart practices and conservation Agriculture. For instance, in the Northern and Upper East Regions of Ghana where there are irregular rainfall patterns, dams have been constructed on rivers and streams to ensure all year round cultivation and also water supply for livestock and domestic purposes (Mabe, Nketiah, 2014). At the same time, NGOs and other international organisations have increased their initiatives in the area of hydro-meteorological information provision to aid in farmer decision making. Although, indigenous knowledge in weather prediction is prevalent in Ghana, the Ghana Meteorological Services Department (GMET) is responsible for collecting, analysing and providing weather related information through various media to farmers and other public and private institutions. However, over the last two (2) decades they have been criticized by the general public for providing generic and weak modelled information. With the increasing need for more consistent, location-specific and customized weather information, some private companies have become instrumental in this space including ESOKO, Votomobile and Syecomp. They collaborate with a host of other institutions and telecommunication companies to provide weather and market-efficient forecasts to a large number of users.

However, it is unknown the extent to which these initiatives have impacted farmer's decision making practices. To derive maximum benefit from hydro-meteorological information, I argue will depend on the understanding of the dynamic relationship between the elements that constitute farmer's decision making practice. This understanding becomes essential as starting point in the design and implementation of a more appropriate future intervention.

This Master thesis forms part of an initiative by Wageningen University and seven other partners to create knowledge sharing platforms to mitigate the impact of climate change on food production and water governance in Northern Ghana. The focus of this study is to firstly identify existing hydro-meteorological information sources and how they are accessed by farmers. Secondly, assess how elements of a practice are constituted in hydro-meteorological decision making of farmers and lastly, determine the extent to which this information impacts decision types in farming.

1.1 Problem Statement

Agriculture plays a crucial role in Ghana's economy, yet, it is predominantly reliant on natural rainfall. "It accounts for about a third of national income and export earnings and employs almost two thirds of the workforce. However, the sector is already exposed to variability, particularly in its northern regions, and this could worsen under climate change" (Arndt, Asante, & Thurlow, 2015). It is worth noting that, the Northern region currently experiences both climate change and variability manifested through long periods of drought, floods and water scarcity (Yaro, Teye, & Bawakyillenuo, 2015). Consequently, farmers who live in the rural areas and thrive mainly on rain-fed agriculture become unduly vulnerable (Mabe, Sienso, & Donkoh, 2014). Many studies have revealed the impact of climate variability on agricultural decisions and outcomes (Motha & Baier, 2005).

Hydro-meteorological information has been put forward as a proactive measure capable of providing early warnings and alerts to mitigate the impact of these phenomena. For instance, Mabe et al., (2014) assert that the range of potential application of hydro-meteorological forecasts is large, and can include flood warning, drought forecasting, reservoir operations, hydropower irrigation scheduling, and river basin management. Yet, very little information exists on the effectiveness of this information on the decision making practices of farmers

particularly in the Ghanaian context. Elsewhere, Chatterjee & Bonsall, (2009) critique the effectiveness of single-dimensional measures which assume provision of information or motivation will necessarily result in behaviour change (Bonsall, 2009). Furthermore, Ogallo, (2010) concluded that, climate information could not impact farmer's agricultural decisions due to a range of factors. These include lack of education and awareness regarding linkages among climate variability/change challenges, environmental resources availability and socio-economic well-being.

While a large body of research focused on improving forecast information (Magnusson, 2014), other characteristics pertaining to the forecast including its meaning and the context in which decisions are made may just be as important in increasing its use. Individualist and organisational decision making theories exist which may inform policies aimed at ensuring impact, however, they provide a framework that reduces the individual decision maker to a calculator of predetermined solutions for complex decision-problems (Planck, 1947). Besides, decision making under uncertainty in which alternatives are assessed in terms of their consequences is neither descriptive of behavior nor a good guide in choice situations (Bell, Raiffa, & Tversky, 1988). Consequently, most of these models neglect the role of shared meanings and common understandings farmers have of the information, their competence and material capacity in making decisions. Furthermore, decisions borne out of following rules are not considered in these models. This makes behavioural and individual theories insufficient to fully conceptualize these dynamics (Moloney, Horne, & Fien, 2010).

Despite the valuable contributions of Social Practice Theory (SPT) in other studies, the literature on farming decisions from a practice perspective is sparse. This studies therefore fills a knowledge gap to address these model limitations to study routine, collective and conventional practices (A. Reckwitz, 2002)(Shove, Elizabeth and Pantzar, Shove, & Pantzar, 2012). Studying decision making as a practice offers the window to focus on routinized decisions farmers engage in, particularly with regards to decision types of farmers and their everyday experiences (Warde, 2005). Furthermore, initiating a research stream to garner insights into the decision making practice of farmers might strengthen behaviour change approaches at policy level.

1.3 Objective

The overall objective of this study is to assess hydro-meteorological information sources available to farmers and how they impact their decision-making practices in food production.

1.4 Research Question

To this end, the main research question and sub-questions are as follows:

What are the hydro-meteorological information sources available to farmers and to what extent do they impact their decision-making practices in food production?

The study seeks to answer the following specific questions

I. What are the available hydro-meteorological information sources and how are they accessed by farmers?

II. How are the elements of a practice constituted in farmer's decision making in farming?

III. To what extent does available hydro-meteorological information impact decision types in farming systems?

1.5 Significance of Study

Farming activities in developing countries are heavily reliant on rainfall and as such any variation in weather conditions may have devastating impacts on farming decisions. Timely information on weather and climate is essential to prevent consequential effect on agricultural productivity, food security, employment, famine, nutrition, health, poverty reduction, household welfare and national income (Kankam-Yeboah, K., Amisigio, B., & Obuobi, 2010). Although some studies have focused on hydro-meteorological information use in decision making, very few of them have assessed their impact on decision making in the Ghanaian context (Kunstmann, Jung, Wagner, & Clottey, 2008). Additionally, the literature on decision making is dominated by individual and organisational models which neglect the role of meaning, competence and material resources in decision making (Guell, Panter, Jones, & Ogilvie, 2012). Decision making analysed using this frame of reference focuses on practices of farmers and offers the opportunity to understand traditional adaptive capacities of farmers. Furthermore, there is little evidence suggestive of efforts to build the capacity of smallholder farmers through the use of hydro-meteorological information in decision making practices with

regards to food production. This study therefore seeks to bridge this research gap. Determining the impact of hydro-meteorological information on farmers' decision making practices will firstly provide; information to policy makers and other stakeholders to develop technological innovations aligned with user practices ultimately aimed at helping smallholder farmers. Secondly, the knowledge that will be produced on existing information sources and their impact provides the opportunity for integration of relevant knowledge and information into EVOs to support adaptive decision making and information governance. Lastly, it will contribute to government effort in designing sustainable programs aimed at building resilience of vulnerable farmers towards climate change.

1.6 Scope of Study

The study will focus on farmers within the Bontanga irrigation scheme in the northern region as it represents the largest in the region and has patronage of about 600 farmers. The study location is equally informed by the EVOCA project which has pre-selected this area as an intervention site with claims of the potential impact of EVOs as decision support platform in water governance. For the effective functioning of this platform, an in-depth study is required to understand the decision making practices of farmers who are key stakeholders in the water, information decision making nexus. Understanding of these dynamics will enable policy makers and project implementers to take cognizance of contextual issues that can be incorporated into future interventions. Geographically, the study will cover 6 communities dispersed along the upper, middle and lower streams of the Bontansi River.

1.7 Thesis Outline

This thesis will consist of five (5) chapters. The first chapter focused on introducing the topic, the problem statement, objective and significance of the study. Decision making has been studied from a variety of perspectives; I assume a social practice perspective combined with logic of appropriateness to assess decision making practices using hydro-meteorological information in Chapter 2. I will introduce earlier works carried out in this field and thereafter present theories of practice. I will take up the empirical study of decision making practices with focus on methodology, research design and ethics in Chapter 3. I will present the results of the study in Chapter 4 and discuss in line with themes from ongoing debate in literature as well as

my own thoughts. These approaches are not without limitations hence the crux is to treat these aspects of my work reflexively and to stay open to the unforeseen. Finally, I will conclude with summary of major findings and give recommendations for the project as well as further studies in Chapter 5.

2.0 Literature Review and Theoretical Framework

2.1 Introduction

In the first part of this chapter, I will review relevant literature and materials by focusing on some emerging themes. Although hydro-meteorological information is presented in a variety of contexts, this paper will primarily focus on its impact on decision making practices in farming from a social practice and logic of appropriateness perspectives. Decision making theories will be discussed in the second part and subsequently the theoretical frameworks which provide the analytical bedrock for this study will be presented. Thorough conceptualization of these theories is necessary to understand decision making as a practice.

2.2 What is Hydro-meteorological Information?

Over the last two decades, climate change and climate variability has caused devastating effects globally and most especially in developing countries resulting in the growing need for hydro-meteorological information. To proceed, there is the need to define two concepts key to this study. Climate change refers to "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 persists for an extended period, typically decades or longer" (Cubasch et al., 2013). Umar, (2016) defines it as "any change in climate, rainfall or productivity caused by natural variability and direct or indirect human activities resulting in alterations in the earth's composition for an extended period of time". Climate variability on the other hand refers to "variations in the mean state and other statistics of the climate on all spatial and temporal scales beyond that of individual weather events" (Ibid). Variability may be due to variations in natural internal processes or anthropogenic external forces within the climate system (Mason, Kruczkiewicz, Ceccato, & Crawford, 2015). Although not all weather phenomena results from climate change; it is a fact that climate change and variability is already modifying natural weather patterns and aggravating extreme weather conditions (Müller-Kuckelberg, 2012). It is worth noting that Ghana is currently experiencing both climate change and climate variability with a negative impact on food production.

Two concepts used in relation to climate change which are often misunderstood and misapplied in the hydro-meteorological information literature are climate and weather. Weather is the

"state of the atmosphere as it is experienced at any given moment and location. It is usually defined in terms of temperature, humidity, precipitation and wind"(Mason et al., 2015). Climate on the other hand, is often operationalised in climate science as a 30-year average weather condition of a specific location. Nonetheless, climate is best described not only by the average but also by other measures describing climate variability including the extremes. Although farmers may respond to changing weather conditions differently, the heightened risks present potentially grave consequences which will require proactive rather than reactive measures (Ziervogel et al., 2008). Hydro-meteorological information is considered a necessary proactive measure to help farmers mitigate the impact of climate change in farming decisions. Unfortunately, the literature on climate information with regards to farmers' decision making practices in the Ghanaian context is limited. For the purposes of this study, hydro-meteorological information is defined as information that combines the occurrence, distribution, movement and properties of waters of the earth and their relationship with the environment with a major focus on daily to seasonal forecasting (Hallegatte, 2004). Coupling meteorological and hydrologic prediction models offers opportunity for improved operational water management and anticipation of hydrologic extremes (Kankam-Yeboah, K., Amisigio, B., & Obuobi, 2010). Thus, the complex interaction between the weather and water resources are provided through hydro-meteorological information with a view to harness their power and to inhibit their threats (Scott, 2011)

2.3 Sources of Hydro-meteorological Information in Sub-Saharan Africa

The development of weather forecast over the years involved several scholars in the field of climate and weather related studies. In a study conducted by Mabe and Nketiah, (2014) they indicated that, "weather forecasting can be traced back to early civilizations, where meteorological events were used to predict likely future happenings". For instance in the year 650 B.C., Babylonians predicted temporal weather changes based on visual signs of clouds and other such phenomena (Ibid). The study also discovered that scientific weather stations emerged in the early 1860's and spread across the globe in an attempt to provide synoptic weather forecasting (Mabe & Nketiah, 2014).

In spite of the growing need for hydro-meteorological information to aid farmers and water managers in their decision making, yet very few studies have been conducted within the Ghanaian context (Mabe, Sienso, & Donkoh, 2014). In a study by Cash et al., 2003 they argued that any hydro-meteorological information aimed at inspiring action needs to first of all be available and accessible in a format that creates knowledge and enhances understanding of the intended users. State owned Meteorological Services Departments over the years have been criticized for providing information in formats that are not easily comprehensible by users (Mabe et al., 2014). For instance in Ghana, daily weather forecasts provided by GMET is delivered in technical languages through electronic and print media. In a similar vein, a study conducted by Onwuemele, 2014 in Delta state Nigeria, indicated that Nigeria Meteorological Services Department (NMET) disseminate information through electronic media, thereby not achieving its intended objective. Aside from state owned institutions tasked with this role, studies have shown the proliferation of other sources to farmers.

For instance, in a study conducted in the farming and fishing communities of western Kenya, approximately 92% of respondents received weather and climate information. This information comprised of daily forecasts of the start and cessation of rains as well as forecasts of extreme events. Regarding the sources, 56% of households received their weather and climate information through radio while the second most popular source (26%) was public meetings (baraazas) convened by the provincial administration authorities (Onyango et al., 2014).

In other studies, the role of agricultural extension services have been heightened in providing information and promoting new technologies particularly in rural areas to enable farmers adapt to climate change (Davis, 2009). However studies by State, 2014 among some Nigerian farmers revealed that, most respondents (42%) did not get climate information from extension agents. Rather, they got information from several other sources including friends and relations. In essence, respondents of this study had no access to information from Agricultural extension officers in spite of the major role played in other contexts.

In contrast to the above findings, State, (2014) found that majority of respondents (58%) did not use radio as a source of information on climate change but rather for other purposes. In a related study conducted in the rural semi-arid areas of Tanzania, results on preference of

channels of agricultural information showed a statistical significant difference of the channels of climate information ($p \leq 0.01$), with radio and mobile phones ranking the highest preferred channels (Churi et al., 2012). Conversely, 52% of respondents preferred community channels of climate information dissemination (Onwuemele, 2014). The implication of this result may be that farmers resort to indigenous knowledge rather than technical knowledge in the face of climate change. Hence for policy implications, it will be important to include community groups and focus on integrating indigenous knowledge into scientific knowledge which brings to light inquiry into farmers' decision making practices.

The literature thus emphasised the availability of hydro-meteorological information in several contexts. A grey area which has not been adequately addressed is how easily accessible these sources are and why farmers tend to access information from a particular source other than others. In a study conducted by Mabe et al., 2014 in seven districts within northern Ghana, socio-economic factors such as age, education, farm size and income were identified as factors influencing farmers' choice of hydro-meteorological information in decision making. In a related study conducted by Jenkins et al., 2011 among 10 states in the U.S., it was evident that educated respondents preferred public sources of information (media, and extension services), whereas individuals with less education tend to prefer private sources of information. Here again, reasons why these sources are preferred were not adequately discussed. This paper makes a contribution to literature in several ways. Firstly, it is the first study that assumes a 3 model practice theory and the logic of appropriateness in analysing decision making. Previous studies on decision making from a practice perspective focused on decision making in terms of individual habits rather than practice. Secondly, by analysing all decision types and how they are impacted by hydro-meteorological information; the paper can inform policy on appropriate intervention strategies to be developed targeted at key decision types.

2.4 Decision Making in Farming

Decision-making is an integral part of the human race and most especially in farming where farmers rely extensively on changing climatic conditions for crops' survival. The study seeks to understand the extent to which farmers within the Bontanga communities use hydro-meteorological information in decision making in farming. Farmers are key stakeholders in the

agricultural value chain and are faced with daily tasks of making decisions ranging from operational, tactical to strategic decisions. A thorough study is thus required in this regard to enhance understanding.

Some definitions of decision making were reviewed. Mintzberg et al., (1976) defined decision making as 'a set of action and dynamic factors that begins with the identification of a stimulus for actions and ends with a specific commitment to action. McKenzie, (1996) also defined decision-making as the process by which a course of action is selected as the solution to a specific problem. Nonetheless, Huber, (1981) distinguishes decision making from 'choice making'. He suggests that choice making refers to the narrow set of activities involved in choosing one option from a set of alternatives whereas decision making entails a commitment to a certain course of action or inaction. To Weber & Johnson, (2009), it is a process which involves the ability to perceive the situation, gather and assess evidence and subsequently make a choice through selectivity in managing risks and uncertainties. These definitions present four features of decision making. Firstly, they suggest there should be two or more alternatives available from which to select. Secondly, the decision maker is engaged in a cognitive continuous process. Thus, decision-makers are faced with the task of weighing both negative and positive aspects of each available option, and thereafter, based on these assessments determine which option best suit a particular situation. This suggests that the selected option has some positive value over other alternatives and is definitely desired by the decision maker. Thirdly, there should be a commitment to action and lastly, the definitions stress the function of decision making geared towards managing risks, uncertainties and finding solutions to problems. Contrary to Weber & Johnson, (2009), Simon, (1972) in his definition on decision making emphasised the impossibility of reaching any high degree of rationality in decision making due to cognitive limitations and time constraints.

Critical reviews of these definitions show principles of classical decision making theories which present decision making as a boundedly rational choice. Decision making in this regard is perceived as consequential in the sense that action depends on anticipations of the future outcomes of current actions. Furthermore, they are preference-based because consequences are evaluated before action is taken (March, 1991). These definitions in spite of their logics

have limitations as they ignore actions and decisions borne out of following rules without assessment of alternative outcomes of a course of action (March, 1991). Moreover, they assume that the decision maker embarks on decision making with some degree of certainty which rules out the element of risks and post decision regrets.

March & Olsen, (2009) argued that it is common practice for individuals to express both a preference for something and a recognition that the preference is repugnant to the moral standards they accept. Decisions are hence made with regards to preferences but also in consideration of set of rules, cultural norms, traditions and advice or action of others. Definitions of decision making therefore which focus only on the rationality or the bounds on the rationality without due consideration for decisions made beyond these boundaries may not be adequate in fully conceptualizing decision making.

2.4.1 Decision Making Types in Farming

Decision making in farming has been studied from various perspectives. WRO, (2011) identified 7 decision points in farming used by small holder farmers which includes: timely land preparation, planting, weeding, fertilizer application, harvesting, storage and marketing. Business models on decision making also acknowledge these decision points and further categorized them into 3 main groups namely: production, administration and marketing decisions. Fig. 1 depicts farming decision types classified according to a business model.

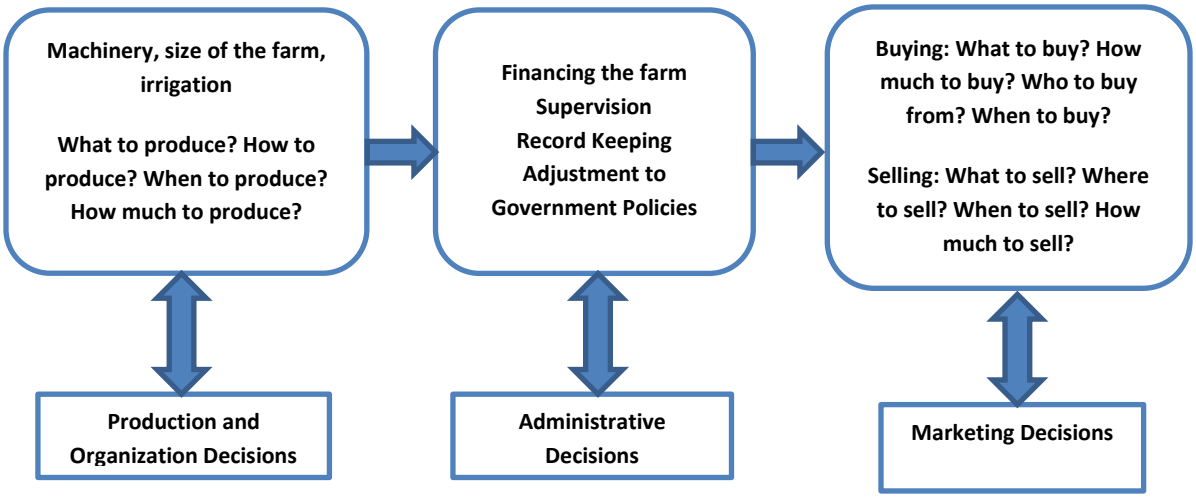


Fig. 1 showing decision making types in farming

I. Production and Organization Decisions

Production and organization decisions are important for the long term management of the farm. Decisions regarding what to produce, how to produce and when to produce are decisions taken in this category. Decisions in this category are further classified into (i) strategic and (ii) operational decisions.

a. **Strategic Decisions**

These are farm management decisions, which involve heavy investment and have long lasting effect (Haigh et al., 2015). Strategic decisions are geared towards providing direction for the general management of the farm. Decision making with regards to farm size, machineries, labourers, seed sowing and fertilizer application methods are taken within the scope of strategic decisions. Decisions with respect to use of irrigation facilities are also considered strategic as they involve huge investment with a long term benefit.

b. **Operational Decisions**

Operational decisions involve decision making in light of day-to-day operations. The investment involved in such decisions is relatively small compared to strategic decisions which make their impact short-lived. Martin-Clouaire & Rellier, 2009 argued that operational decisions consist of three components: the decision system (farmer as decision maker) the operating system (resources such as the labor force, machinery, inputs) and a biophysical system (soils, crops, livestock). These systems are in constant interaction and influenced by external environmental factors.

II. **Administrative Decisions**

Administrative decisions allow the farmer to ensure that work is carried out in an appropriate manner for the purpose of profitability. These decisions include decisions on financing, supervisions, records keeping and adjustment to government policies.

III. **Marketing Decisions**

Farmers make decisions regarding the purchase of farm inputs as well as the marketability of their produce. Farmers are expected to ask critical questions with regards to what to buy, when to buy, from whom to buy, how to buy and how much to buy. Similarly, in selling out the farm produce farmers are expected to carefully consider questions such as what to sell, when to sell, to whom to sell, how to sell and how much to sell.

Herein again, the literature emphasised optimum utilization of resources and relative profitability typical of every prudent business decision making model. However, for small holder farmers who perceive farming not only as their mainstay but also as a lifestyle choice, experience a wide range of complex factors which ultimately affects their decision making practices (WRO, 2011).

2.5 Relevance of Hydro-meteorological Information in Decision making

The relevance of hydro-meteorological information is found in its ability to impact decision making through timely preparation, planning and proactive response to risk and disaster. Ghana is already exposed to the hazardous effects of climate change and variability. Persistent droughts and floods as well as inconsistent rainfall patterns have caused low agricultural productivity for a country heavily reliant on rain fed agriculture (Resources, 2016). Hydro meteorological information has been put forward to provide early warnings and alerts which have the potential to reduce the impact of these events especially on lives and property.

Empirical evidence exists on the relevance of climate forecasts especially in regions that are highly vulnerable to some environmental disasters (Soropa et al., 2015). Mabe et al., (2014) posit that the range of application of hydro-meteorological forecasts is large, and can include flood warning, drought forecasting, reservoir operations, hydropower and irrigation scheduling, pollution control, and river basin management. In a comparative study between Africa and Asia, Singh et al., (2017) indicate that information on climate at larger spatial scales can be relevant. However, to be usable by decision makers, the local manifestation of that phenomenon must be translated into variables and processes that matter to end users.

2.6 Interplay between Hydro-meteorological Information and Decision making in Farming

Although hydro-meteorological information has the potential to impact decision making at all points in the cropping cycle, it is generally argued that there is a substantial gap between information provided and what is required to inform and support farmers' decisions. Tall et al., (2012) noted that, climate forecasts have been previously underutilized for several reasons. These include "information gap between critical stakeholders in the use of climate forecasts, cultural barriers, difficulties in changing from a mindset of disaster response to preparedness and early action, lack of sufficient funding from donor agencies and non-salience and reliability of provided information" (Ibid).

In a similar study by Patt & Gwata, (2002) among some Zimbabwean farmers, lack of trust in the messages, inability to provide location specific information and non-timeliness of the forecast were identified as factors that limited utilization of climatic forecasts. To corroborate these findings, Anjum, 2015 noted that although there is a growing potential for farmers to use mobile phones in rural areas for climate information, however, majority of the farmers still follow traditional agriculture system due to illiteracy. As a result, "they depend on indigenous knowledge weather forecast system which is based on myths and religious beliefs, including observing the patterns of plants, flowers, trees and positions of the sun, moon and stars (Ibid). Besides the above factors, Connor et al., (2000) found that, there is no significant difference between reliable and unreliable climate forecasts in terms of their usage. They asserted that, although larger systems and those reliant on surface water are more likely to use forecasts for some purposes, the strongest determinant of forecast use is risk perceptions. Thus, farmers and water managers who anticipate weather related problems in the long term are much more likely to use forecasts than those who envisage lesser problems. Other related studies have highlighted the role of education in the use of climate information (Maddison, 2007).

In summary, although hydro-meteorological information has the potential to support farmers and water managers to mitigate the impact of climate change, there are number of contextual issues inhibiting their usage. This includes the accuracy, reliability, trust, cultural barriers, low level of literacy, low levels of income and risk perceptions.

To provide hydro-meteorological information which can be used for its intended purpose requires an inquiry into these concerns. I argue that the local context is crucial to enable information to be packaged in a manner that empowers and enables farmers and water managers to make decisions that correspond to their local realities. Furthermore, since farmers make varied decisions and operate under the priorities and values of their respective communities (Busck, 2002), I call for a targeted approach which takes into account practices directly applicable and practical to the situation and environment of farmers to ensure actionable knowledge[1]. Ultimately, policy makers can locate the hook and craft a message that will resonate with farmers in future designs of hydro-meteorological information systems.

2.7 Towards Decision Making Theories

It is remarkable that the concept of decision making has been studied from varied perspectives. However, little attention has been given to it from a practice viewpoint. In this second part, I will summarize existing decision making theories and their limitations. Thereafter, I will develop a theoretical framework which looks at how decision making using hydro-meteorological information can be conceptualized as a practice and subsequently the elements which constitute this practice. This section therefore sets out a theoretical context on how decision making as a routinized behaviour is made and experienced. In doing this, I will attempt to develop academically sound view which will allow the reader to be familiar with this frame of reference and its underlying assumptions. I will also engage in intellectual debates especially with regards to what constitutes a practice.

2.7.1 Rational Decision Theory/ Logic of Consequentiality

The rational decision theory dates back to the ideas of early economist Adam Smith. Smith primarily sought to understand how an economy can work when everyone is self-interested and make choices based on their self-interest. He concluded based on his findings that, people ultimately act in their own self-interest but also take into consideration the greater good. Decision making following this theory is premised on the fundamental assumption that human

[1] Actionable knowledge represents a pragmatic view of knowledge creation and application towards specific ends. It emphasises the need to align knowledge to particular contexts in making it relevant. It makes reference to knowledge that leads to measurable progress and is conditioned by historical and environmental factors within the setting where it was created (Cross and Sproull, 2004)

action is the result of human choice which requires response to 4 fundamental questions: Firstly, the question of alternatives which stresses on the possible actions in a given situation. Second is the question of expectations, which highlights future consequences that might follow from choosing an alternative. Thirdly, the question of preferences which emphasise the value of consequences associated with each alternative and finally the question of the decision rule being employed in light of possible alternatives and their consequences. Rational choice theories assume that all decision makers share a common set of preferences. Furthermore, alternatives and their consequences are defined by the environment, and that decision makers have perfect knowledge of those alternatives and their consequences (March, 1991). Essentially, decision-making under this model pursues logic of consequentiality which entails making the most efficient choice that will result in the greatest benefit. In spite of its popularity it has received significant criticisms due to its presumptuous guesses: a guess about the future consequences of current actions and a guess about future individual preferences (March, 1991). Other critiques alleged that, it is a framework that reduces the individual decision maker to a calculator of predetermined solutions for complex decision-problems (Planck, 1947). Since then, there have been numerous attempts to modify the key assumptions on four (4) dimensions namely the knowledge, actors, preference and the decision rule. Although most of these theorists have been criticized for being conservative in their approach, the early writings of Simon, (1972) on bounded rationality opened up a new intellectual window for explaining the process of decision making.

Herbert Simon coined the term bounded rationality in 1957 after carefully assessing the pure rational decision theory. It became evident to him that decision making under risk involves uncertainty where the precise consequences are uncertain but their probabilities are known. Through the use of the term "bounded rationality," Simon did not only seek to criticize neoclassical economists for their lack of interest in the formal foundations of rationality, but also to advance the concept to make room for some limitations in the decision making process (Barros, 2010). He argued in his book on "*Administrative Behaviour"* that it is impossible for the behaviour of a single, isolated individual to reach any high degree of rationality due to a whole range of limitations on human knowledge, computation and time constraints (H. A. Simon,

2002). This prevents actors in the real world from behaving in ways that approximate the predictions of neoclassical theories (Klaes, 2005). Bounded rationality emphasised how people use loose rules of thumb and heuristics, when choosing among alternatives. This is because they have come to accept the bounds as basis for decision making. The choices made are usually due to their past success and not due to calculation of utilities as purported in classical theories. Thus, decision makers are "satisficers" rather than "optimizers" who seek satisfactory solutions and not necessarily optimal ones (Klaes, 2005: Robert et al., 2016).

The concept of bounded rationality fits within the logic of consequentiality. Through the use of this concept, Simon emphasised the processes involved in decision making rather than only the outcome. He also highlighted the relevance of capability and "satisficing" a terminology associated with search for alternatives in the decision making process. This decision making model gained prominence as it has been proven to have empirical evidence in a wide range of studies. However critiques argue that the model is inflexible and too narrowly focused on problems, organisations and the policy process. Simon was criticized for obscuring a distinction one might make between individual and organizational decisions (Bell et al., 1988). Thus for the most part, he proposed the same general ideas for both. In addition, while Simon anticipated that the model would be descriptive, it was perceived as prescriptive. This is as a result of his emphasis on how decision making ought to function in the ideal world rather than what actually happens in the policy world (Ibid).

Both theories regardless of their divergent views share similar assumptions. Thus decision making is considered as an outcome of evaluation of alternatives. Whereas, the former emphasised maximization, the lather emphasised satisficing. These concepts are still relevant in decision making in spite of the criticism.

2.8.2 Logic of Appropriateness

Satisficing or maximizing can hardly be observed in its pure state (Schwartz et al., 2002) hence I argue that decision makers may not only be "optimizers" or "satisficers" but rather may exhibit rule following behaviour in their decisions. This brings to the fore the need to consider the principles underlying the logic of appropriateness which essentially highlights a missing link.

The logic of appropriateness was developed due to increasing observation that preferences are not always consistent with decisions made by individuals in practice. Thus, individuals express both a preference for something (consequentiality) and a recognition that the preference is repugnant to the moral standards they accept (appropriateness) thereby influencing their choice (March & Olsen, 2009). The theory served to explain how decisions actually happen in organisations other than how they ought to. The logic of appropriateness differs largely from the earlier theories as it views human action as driven by rules of appropriate or exemplary behavior, organized into institutions (Ibid). The logic of appropriateness outlines internalized prescriptions of what is socially defined as normal, true, right or good without calculation of consequences and expected utility. Consequently, rules in this theory prescribe more or less precisely what appropriate action is for the individual decision maker. Furthermore, they also more or less precisely tell actors where to look for precedents and the authoritative interpreters of a given rule. Decision making following this logic entails following rules relevant to current situation (Schulz & Schulz, 2014). The logic of appropriateness allows the decision maker to ask 3 elementary questions:

- The question of recognition: What kind of situation is this?
- The question of identity: What kind of person am I? Or what kind of organization do I belong to?
- The question of rules: What does a person such as I, or an organization such as this, do in a situation such as this?

The rule following theory is therefore fundamentally premised on the assumption that rules and identities serve as guide to behaviour in every sphere of life. For instance, every individual is born and socialized into specific families, communities and diverse forms of professions based on rules. These rules in turn create identities and sense of belonging. They define the membership of the group and equally specify roles of each individual. To make a decision in this instance therefore does not rest solely with what the individual decision maker considers rational but that which is equally endorsed by the group. In essence, there is co-shaping of both the individual and the social structure (Bourdieu, 2005). While the external environment influences the decision of the individual, any action or decision taken by the individual equally

impacts the wider group. However, individuals found in this situation are more likely to put the group's interest before the self. They look for precedence which sets the tone for their decisions in order to be accepted within the group. Choices and decisions in any context can therefore be seen as being shaped by identities and rules and not by rational thinking as purported in most classical theories. What I seek to unravel in this study is to analyse key decision points in farming informed by rules other than consequences.

(i) Identities and Rules

Identities and rules are central to the logic of appropriateness. Identity is a conception of self-organized into rules for matching action to situations (March & Heath, 1994).There are rules which define the identities of the members of a particular community. All individuals who are part of the community can identify with pre-existing rules. People who cannot identify with pre-determined rules are socialized into adopting those identities befitting the group. Thus formal and informal rules help to define identities and roles. Although rule based decisions may seem predictable at face value, they are frightened by risks and uncertainties (Schulz & Schulz, 2014). In this instance, the decision maker uses processes of recognition to classify situations; processes of self-awareness to clarify identities and finally processes of search and recall to match appropriate rules to situations and identities (March, 1991). The essential element here is that, there is a precedence that allows the decision maker to compare situations in an attempt to answer the 3 elementary questions. Ultimately, the decision maker imitates a decision based on precedence similar to present situations.

Identities are developed as part of personal development as well as in relation to an understanding of the physical and social environment. Identity is therefore a personal and social construct by which the individual brings order to himself by learning to behave in a particular way. This has to be commensurate with the rules of the community of belonging. In the personal context, identity is seen as created and developed rather than imposed and adopted as in the case of the community. Here in emphasised is the process of individualization as against the process of socialization. This is also fundamental to Bourdieu's idea of Habitus in which habitus contributes to transforming that which transforms it and immediately offers a principle of sociation and individuation (Bourdieu, 1977). The concept of individualization and

socialization usually overlap during interactions but are necessary for understanding the logic of appropriateness (March & Heath, 1994).

(ii) Knowledge of Identities as Models

Rules act as basis for defining identities. Understanding of one's identity develops overtime into shared attitudes and behaviour. According to March, socially defined rules act as models for individual identities in 3 ways: Firstly, they define the essential way of "being" by allowing individuals to deal with identities as meaningful things. Identities therefore become labels through which reasoning is organized and act as codes for associating observed behavior with specific roles. Thus in a community, a farmer is distinguished from a doctor based on observed behaviour relating to those roles. Being able to identify a farmer requires knowledge of their behaviour and associating that knowledge with observed behaviour(March & Olsen, 2009). Secondly, social identities are pre-packaged contracts individuals accept in return for things they value. Rules are standardized which makes them reliable and enables them to serve as building blocks for every social system. Consequentially, rule following behaviour is rewarded and inconsistent behaviour is penalized. A farmer who is well aware of the rules of farming within a particular context will follow either due to fear of being penalized or in pursuit of some rewards. Lastly, social identities are templates for individual action as they are regularly associated with assertions of morality and accepted by individuals and society as what is morally good and true. Individuals therefore internalize this frame and pursue it without the presence of external incentives or sanctions. The identity is protected by conscience followed by a social control mechanism embedded in pride, shame, guilt and embarrassment depending on the appropriateness of the action(Schulz & Schulz, 2014). Identities are therefore socially constructed contracts, motives, and cognitions that connect to rules and this fine tapestry of obligations controls decision making (March, 1991)

(iii) Factors that can impede use of the Logic of Appropriateness

The theory recognizes that although behavior is rule based, it is difficult to imagine a social system without violations of rules. Rules are sometimes overlooked or ignored and decision makers can sometimes engage in bad conducts or fail to do things they are supposed to do. March argued that rule violations may not necessarily be intended but may be due to a wide

range of factors. Generally, rules can only be followed if people are aware of them and if they are clearly understood. Rule based decisions therefore require experiential knowledge and understanding of the rule being evoked in a particular situation. Decision makers whose knowledge and understanding is limited due to vast numbers and complexity of rules may lack the ability to use this logic. It has also been observed that many deviations from rules are necessitated by inconsistencies. Consistent and reliable rules are good premise for basing decisions. In the same vein, inconsistent and unreliable rules are basis for violation. Finally, decision makers who lack resources and the required competence may lack the ability to follow rules. The theory therefore acknowledges that, although actors may sometimes be aware of what to do in a particular circumstance, they are limited by the complexities of the demands upon them. These demands come in the form of the distribution and regulation of resources, competencies and capacities. Thus the prescriptive rules and capabilities may not be compatible (Rocher & Lefort, 1990) (Pelzer, 1978). The limitations identified by this logic are similar to elements identified by Shove, Pantzar, & Watson, (2012) when they concluded that a practice can only be enacted if the practitioner has the required meaning of the practice and possess the appropriate skills and material resources.

March studied decision making largely in the context of organisations. Nevertheless, it makes logical sense to argue that, the above factors can impede decision making in farming as proven in most empirical studies. My preoccupation in the next chapters is to carefully analyse farmers' decisions and attempt to situate them under the scope of the logics discussed. I will also analytically consider the role of these factors in either supporting or constraining farmers' decisions.

2.9 The Practice Turn

Theories of practice have roots stretching as far back as Wittgenstein and Heidegger (Shove, Pantzar, & Watson, 2012). Whilst Wittgenstein does not write directly about 'practices', his work conveys many of the key features of theories of practice (Ibid). Practice theories emerged in a quest to bridge the dualism of structure and agency popularly debated in sociological analysis. Earlier theorists asserted that, human behaviour is primarily determined by structure and or agency. Structure simply refers to the complex interrelations of human life with

institutions whereby human beings in a society interact and live together whereas agency refers to the individual's unique ability to act within the structure (Archer, 2004). The unending argument in literature is the extent to which the individual is free to act exclusively without the influence of the structure or how the individual's activity can be considered to be a product of the structure. As discussed earlier most utilitarian and rational choice theories emphasise agency, by viewing human action as calculated and rational where individuals maximise their preferences and interests. Value -oriented and norm-oriented theories on the other hand, stress the significance of collective norms and values affecting what individuals 'are' and 'ought' to do, thereby accentuating the dominance of structure (Reckwitz, 2002).

Reckwitz maintained that, Practice theory is distinctively different from both perspectives because they focus on "the implicit, tacit or unconscious layer of knowledge which enables a symbolic organisation of reality" (Shove et al., 2012a). They further highlight how this layer of knowledge both enables and constrain agents to interpret their world in a specific way and act correspondingly (Ibid). Thus instead of considering either agency or structure, Practice theories intend to synthesise the dialectics of both phenomenon by assuming a practice perspective with focus on the practice as the unit of analysis (Giddens, 1984),(Bourdieu, 1977) (Schatzki, 2001), (Shove et al., 2012a). A range of different approaches established the foundations of a practice theory. However, the common element in all these approaches is that they do not consider and explain human action and doings from an individualistic or structural perspective. They rather view 'doings' as chains of actions and analyse them from a viewpoint that incorporates both phenomena. The early works of Giddens, 1984 and Bourdieu, 1977 marked a significant development point in Practice theories. For the purposes of this paper, I will briefly discuss the central themes in the works of Bourdieu and Giddens and argue how the Practice theory of Shove et al., 2012 offers an all en-compassing tool in analysing the decision making practices of farmers using hydro-meteorological information.

Central in Bourdieu's theory is his notion of habitus, which takes its root word from Aristotle's notion of hexis. Hexis means an acquired yet entrenched state of moral character that orients feelings and desires of the individual, and eventually leads to conduct (Malikail, 2003). Bourdieu, 1977 asserts that people do not act according to rational choice but operate

according to a personal set of cognitive and embodied dispositions called habitus. Decisions are thus driven by the sum of a person's economic, social, cultural and symbolic capital (Bourdieu, 1977). Habitus as a system of dispositions acts as "a past which survives in the present and tends to perpetuate itself into the future by making itself present" (Bourdieu, 1977 p.82). The notion of habitus discussed here emphasises the role of the individual rather than the practice. According to Bourdieu decisions are habitual (practice) rather than considered and deterministic where there is a co-shaping of both individual action and the habitus (Bourdieu, 1977 p.82).

A second authority in practice theory is Giddens. Central in his Structuration theory is the notion of a duality of structure: "rules and resources drawn upon in the production and reproduction of practices including the means of system reproduction" (Giddens, 1984). Giddens' structuration theory revolves round the conclusion that human activity, and the social structures which shape it are recursively related. Thus, activities are shaped and enabled by structures of rules and meanings, and these structures are in turn reproduced in the flow of human action. This "flow is neither the conscious, voluntary purpose of human actors, nor the determining force of given social structures" (Shove et al., 2012a). While people can discursively account for their actions, often framing them in terms of conscious purposes and intentions, Giddens emphasized that the greater part of the processes do not lie within the realm of discursive consciousness. The capability to 'go on' through the flow of largely routinized social life depends on forms of practical knowledge, guided by structural features which include rules and resources of the social systems which shape daily conduct (Ibid). It is through practices that the constitution of agents and structures are not two independently given sets of phenomena- a dualism, but represent a duality'(Giddens, 1984 p. 25).

Although these theories are insightful, the question remains the extent to which they are able to provide the analytical tool required for conceptualizing decision making using hydro-meteorological information. As Schatzki indicates, Bourdieu's habitus has a twofold relation to action: generating actions as well as selecting actions to generate (Schatzki, 1997). This implies that the actions selected within the habitus are both sensible and reasonable to the actor as they necessarily provide a "feel for the game" which originates from the habitus (Ibid). By

anchoring action in practical understanding, Schatzki argued Bourdieu has ignored one option to the study of practice which is impossible to carry out practices adequately. On the other hand, Shove et al., 2012 claimed that Bourdieu generally sees practices as a means of approaching habitus which embodies aspects of practical consciousness and of rules of conduct. Whereas other practice theorists perceive all as part of practices themselves. Thus habitus and practices are in recursive relation, such that habitus is 'constituted in practice and is always oriented towards practical functions' (Shove et al., 2012).

Shove et al., 2012 largely shares in Giddens account of practice but criticized him and Bourdieu to a greater extent on how they emphasize societal reproduction of practices at a general level which leaves many questions unanswered. For instance, questions such as how practices emerge, the elements constituted in them, how they evolve and eventually disappear. Practice theory from this perspective allows for in-depth study of routinized decisions using hydro-meteorological information.

2.9.1 What is a practice?

Regardless of the heterogeneity of thought among practice theorists, the definition of practice by Reckwitz has greatly influenced the works of Shove et al., (2012).

"A 'practice' is a routinized type of behaviour which consists of several elements, interconnected to one other: forms of bodily activities, forms of mental activities, things and their use, a background knowledge in the form of understanding, know-how, states of emotion and motivational knowledge" (Reckwitz, 2002)

Considering the first part of this definition in isolation "A practice is a routinized type of behaviour" can be potentially misleading in the sense that, it risks equating practices with the habits of individuals thereby overlooking its recursive character (Shove et al., 2012a). Reckwitz goes on to explain that a practice exists as a 'block' or 'a pattern which can be filled out by a multitude of single and often unique actions'(Reckwitz, 2002). In this sense, a practice is an activity which endures between and across specific moments of enactment (Ingram, Shove, & Watson, 2007). As Schatzki puts it, a practice is 'a temporally and spatially dispersed nexus of doings and sayings' (Schatzki, 2001). This implies that a practice can only be formed when there

is a “sustained circuit of reproduction” (Pantzar & Shove, 2010, p. 450). This definition highlights routinized nature of practices which focuses on the reproduction of the practice.

Notable in this definition as well is the agency of non-human actors in the performance of practice. The first point of concern to Shove et al., 2012 is how most Practice theories have focused on the significance of shared understandings, norms, meanings, practical consciousness and purposes, all of which count as classically ‘social’ phenomena (Shove et al., 2012a). However with inspiration from Latour, Schatzki and more explicitly Reckwitz, Shove et al., 2012 introduced “material resources”- a new dimension to the social in practice thereby filling a partial but significant gap to what is otherwise conventionally social. Reckwitz argued that ‘in order for a football to be played, balls as well as goals are indispensable “resources” (Ibid). Thus a ball alone does not constitute the game – an idea of playing, people to play with and a measure of competence are all necessary elements. Similarly in analyzing the decision making practices of farmers in Bontanga, there is the need to focus attention on the elements in the practice as they remain essential to the success of the overall practice. A key feature of this approach is therefore to highlight the constitutive role of the social and material in everyday life.

The second point of concern for Shove et al., 2012 is how most innovations perceive end users on the one hand and the innovators on the other hand. They therefore challenge literature representations of professional designers and inventors as the primary source of novelty. They argued for need to analyse moments of doing for an understanding of how practices are formed and how they evolve over time. This theory therefore offers a window through which future innovative approaches can be integrated into the decision making practices of farmers.

Shove et al., 2012 therefore differs explicitly from other Practice theorists by identifying 3 elements that form a practice: thus, (1) materials, (2) meaning and (3) competence. These 3 elements ought to be dynamically integrated by skilled practitioners through regular and repeated performance (Shove, Elizabeth and Pantzar et al., 2012). In this analysis, individuals feature as the carriers or hosts of a practice. Thus, it is prudent to treat understandings, know-how, meanings and materials not as the qualities of an individual but as ‘elements and qualities of a practice in which the single individual participates’ (A. Reckwitz, 2002). Nonetheless, the

individual requires these elements and qualities in order to perform and participate in the practice. According to them, the 3 elements (materials, meaning, and competence) initially exist without being linked. In such instance there is no practice. In the second illustration the elements are linked which implies existence of practice. In the last formulation they argued that practices are linked but no longer exist. The dynamics that exist between linked elements in the practice represents moments of doing which is of concern to this study. Fig, 2 represents elements that constitute a practice.

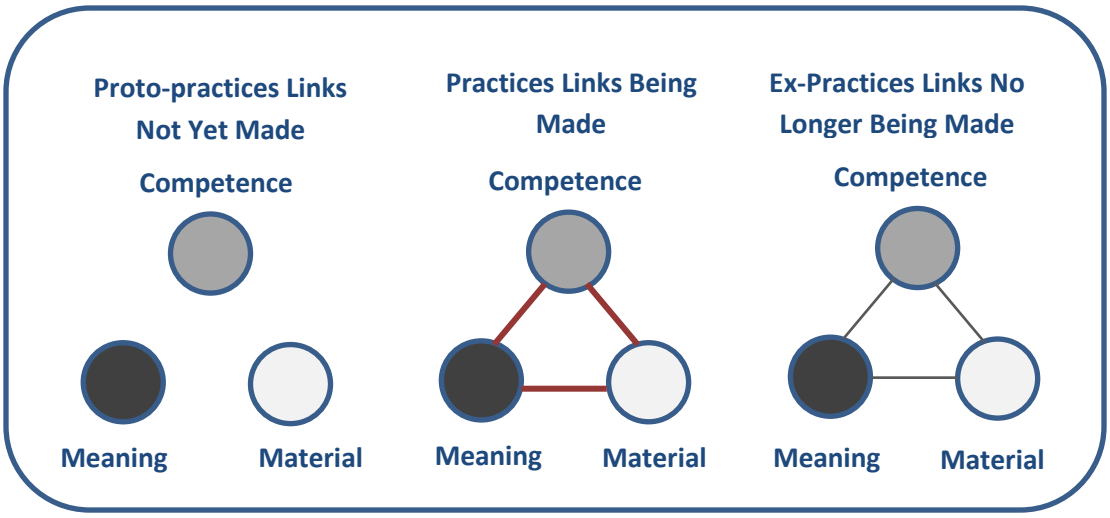


Fig. 2 showing elements of practice yet to be linked, linked and ex-practices

2.9.2 Elements of Practice

Farmers make several decisions particularly in the face of climate change. Decision making in this instance has therefore endured over time hence a practice. However, practices are not fixed phenomena. Humans reproduce them by connecting them to other activities which ultimately makes a practice social but also material (Shove, Elizabeth and Pantzar et al., 2012). For instance, in the past due to relative stable climatic conditions rain-fed farmers relied heavily on indigenous knowledge in predicting the weather and seasons. However, with the effects of climate change and risk associated with uncertainty farmers are observed to be combining both scientific and indigenous knowledge in decision making. The integration of both forms of knowledge has the potential to create new links in the performance of this practice. Additionally, new techniques as well as the rise in hydro-meteorological information provision

equally have the potential in altering the meaning associated with the long held belief of relying on indigenous knowledge. Thus, elements are not just interdependent, they are also mutually shaping (Shove et al., 2012a). Hence there is the need to focus on moments of "doings and sayings" in view of analysing how components are ultimately combined and linked to enact a practice.

(i) Material

Material is an essential part of the hydro-meteorological information decision making practice hence needs to be understood since "not only bodies but also artefacts are sites of understanding" (Reckwitz, 2002). The material component of the practice also represents the connection between human and non-human agents in the enactment of the practice. By "material arrangements" Schatzki means linked people, organisms, artifacts, and things of nature. However, materials are not just communicators of symbolic meaning, status or identity, but are often directly implicated in the conduct and reproduction of daily life' (Shove & Pantzar, 2005). Materials therefore have the ability to either enable or constrain a practice (A. Reckwitz, 2002). A practice study on decision making therefore requires a full understanding of the materials related to this practice. Practices are not fixed hence the introduction of new materials have the potential to transform a practice. However, it will be presumptuous to argue that the introduction of a new material will necessarily shape a practice. There is therefore the need to investigate the interaction between the material and the practitioners in the performance of a practice (Kuijer, Verbeek, Visser, & Elders, 2014).

It is important to state that material is not only limited to material resources but also the material environment under which the farming is carried out. For instance how weather conditions and variability interact with rainfall resulting in the availability and distribution of water both from a natural or manmade source are essential parts of the material resource. Without this environmental resource, farming and subsequently hydro-meteorological information use in decision making will be non-existent. The type of farming being practiced greatly influences the type of material resources that are needed.

(ii) Meaning

Shove et al., 2012 described meaning as "mental activities, emotion and motivational knowledge" which constitutes "the social and symbolic significance of participation at any moment". Meanings can therefore be said to be reliant on Bourdieu's concept of habitus, which suggests that understandings about significance of a practice are shared amongst a group, and thus bring the group together (Bourdieu, 1984). It can also be compared to the teleo-affective structure of Schatzki, 2001 which emphasises "the property of a practice linking its doings and sayings to a range of acceptable ends, purposes, beliefs, projects and task that ought to be accomplished". Strongly related to meaning is also the idea where a practice is considered 'right' based on the significant number of practitioners. Thus, "if people do not engage with a practice and do not see others engaging with it, they come to understand the world as a place where the practice does not exist" (Spotswood, Chatterton, Tapp, & Williams, 2015). Hydro-meteorological information use can therefore be said to be largely dependent on the meaning farmers attach to it in the decision making practice. Individual meanings are not the core of the analysis but the meanings shared by the group. Some studies have highlighted lack of trust and inability to understand key messages as factors limiting the use of hydro-meteorological information (Patt & Gwata, 2002). In this context, the shared meaning is that which is associated with lack of trust. Any information lacking this shared attributes risks the chance of not being used. Nonetheless, meaning is not fixed since practices "are maintained and transformed when performed by people"(Patt & Gwata, 2002).

(iii) Competence

Competence refers to embodied knowledge or skill required for the practice to succeed. Competence entails the "learned bodily and mental routines, including know-how, and ways of feeling and doing"(Lankshear & Knobel, 2006). Competence thus refers to shared or learned knowledge required in order to perform a practice in the appropriate way (Kuijer et al., 2014).

Decision making using hydro-meteorological information presumes certain knowledge and skills which farmers must necessarily have in order to use the information. They also require the skills to interpret the information in order to make decisions. It has been widely discussed that mobile phones present great potential especially for Africa in hydro-meteorological information

dissemination. But do farmers possess the requisite skills to use these devices? This is important to enable farmers interpret the information in terms of their impact on local realities. Thus, the intensity or otherwise of rainfall and what it means for production activities. However, since climate information is often given in isolation, more often than not they are disconnected from the real life agricultural decisions' (Rengalakshmi, 2007). So far, I have discussed the elements of social practice as separate entities. Nonetheless, practices constitute a 'block' whose existence necessarily depends on their interconnectedness which cannot be reduced to any one of these single elements'' (A. Reckwitz, 2002). Fig, 3 represents decision making being studied from a practice perspective.

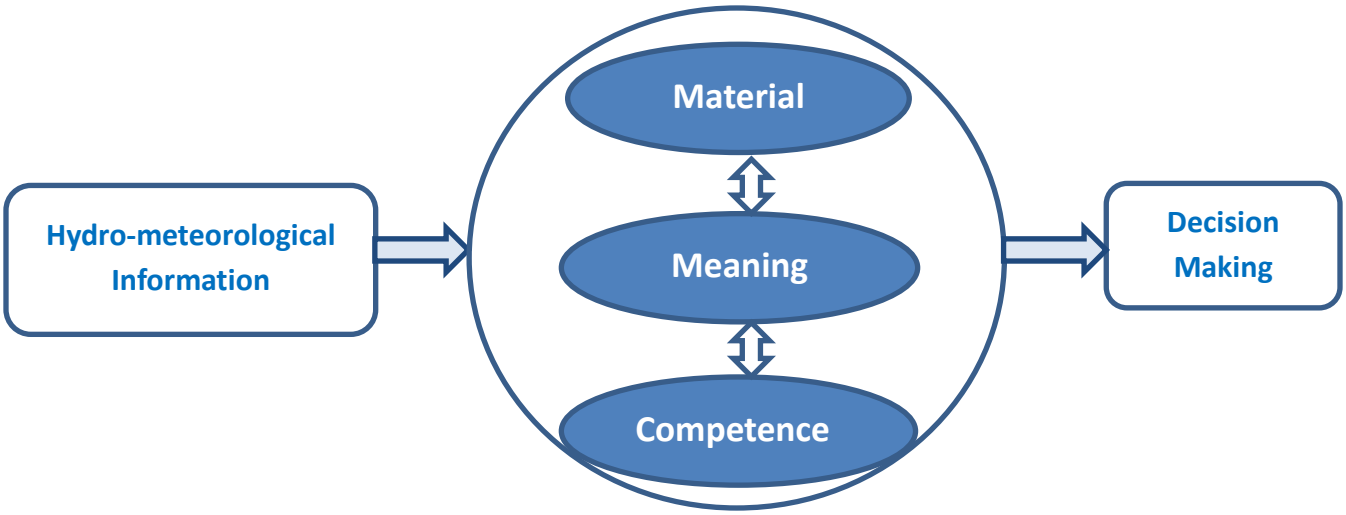


Fig. 3 Social Practice framework for studying decision making

2.9.3 Relationship between Social Practice Theory and Logic of Appropriateness

The logic of appropriateness and the social practice theories complement each other in explaining the information-decision making chain in food production. Through knowledge, experience and sense making people give meanings to their worlds which also inform the decisions they make. This notion is compatible with the logic of appropriateness which argues that decision making fundamentally follows rules- norms and behaviours considered right and acceptable within a particular context. An essential part of both theories is the recognition of moral standards, meanings and shared understandings people have of their specific environments. Decision making in such contexts therefore requires the shared understanding of

the standard norms and how that results in the selection of and commitment to an appropriate course of action. Nonetheless, decisions are not only based on the shared meaning of practitioners. It is also dependent on material resource availability and the competence required by the practice which practitioners essentially need to possess. Thus in order for one to perform a practice, the 3 elements (meaning, competence, and material) need to be integrated skillfully and dynamically. This represents the major departure point for the Social Practice Theory.

While the logic of appropriateness departs from classical rational decision theories by introducing a rule following dimension, I argue that rule following alone is not a sufficient requirement to perform a practice. Nonetheless, both theories, unlike rational decision making theories focus on the dialectic relationship between the individual's capacity and the role of their environment in the decision-making. I will engage the elements of practice discussed above in analysing the decision making practice of farmers. These theoretical lenses therefore present an all-encompassing framework to understand how hydro-meteorological information intersects with farmer decision making practices and the possible factors that may strengthen or weaken their interconnectedness.

2.10 Summary

Despite the growing literature on hydro-meteorological information, the devastating impacts of climate change and variability on food production remains alarming. A key point for consideration within the Bontanga communities will be to firstly, investigate and establish the existence or otherwise of hydro-meteorological sources and determine factors that either constrain or promote access and utilization. Secondly, I discussed several decision making models and argued why this paper assumes the 3 dimension practice theory and the logic of appropriateness in explaining the relationship between hydro-meteorological information and decision making. However, it is unknown how decision making by farmers happens within this context. My pre-occupation in this study is to analyse and conceptualise how decisions are actually made within the scope of the theories discussed. Before that, I will discuss the methods and materials used in arriving at the results in the next chapter.

3.0 Background to Study Area and Research Methodology

3.1 Introduction

The previous chapter reviewed the concepts that tied the research questions and objectives to relevant literature. This chapter focuses on the background of the study as well as the methodology used. Methodology refers to the methods, procedures and techniques employed in collecting, presenting and analyzing data to answer specific research questions (Holden & Lynch, 2004). It entails the research design, population, sample size, sampling techniques, data sources, data collection methods and analysis and their limitations. The background of the study as part of the EVOCA project is explained. Furthermore, to better understand the prevailing conditions in this context, a description of the Bontanga area is provided with focus on climate, vegetation and economic activities. In doing this, I reflexively considered some ethical concerns.

3.2 Background to EVOCA Project

This study analyses decision making practices of farmers within the Bontanga area and is linked to a four year interdisciplinary research project (EVOCA) by Wageningen University and seven other international partners with the theme "Responsible life-sciences innovation for development in the digital age: Environmental Virtual Observatories for Connective Action (EVOCA[2]). The programme runs in four African countries with the aim of developing and applying a framework for responsible digital innovations to help avert challenges in water, crop, disease and livestock management (Ibid). Within the Ghanaian context, the objective of the project is to explore how hydro-climatic EVO can make local governance of rice production more adaptive through creating actionable knowledge for water management decision-making in the Bontanga irrigation system. The long term vision therefore is to focus on EVO application in water management in rice production systems by creating a platform for stakeholders to synthesise information to support decision-making (Cross & Sproull, 2004). Environmental Virtual Observatories (EVOs) have been put forward as virtual information systems that can

[2] See (http://www.wageningenur.nl/en/project/EVOCA-Environmental-Virtual-Observatories-for-Connective-Action.htm)

promote stakeholder interaction, knowledge co-creation and decision-making towards managing complex problems such as water scarcity and climate change (Karpouzoglou et al., 2015). Understanding farmers' decision making practices in this context will enable EVOs to be embedded in existing social systems and aligned with user practices. These insights will be useful in the co-creation and design of knowledge sharing platforms and virtual communities to support farmers' decision making. Detailed information on project is available on the EVOCA website.

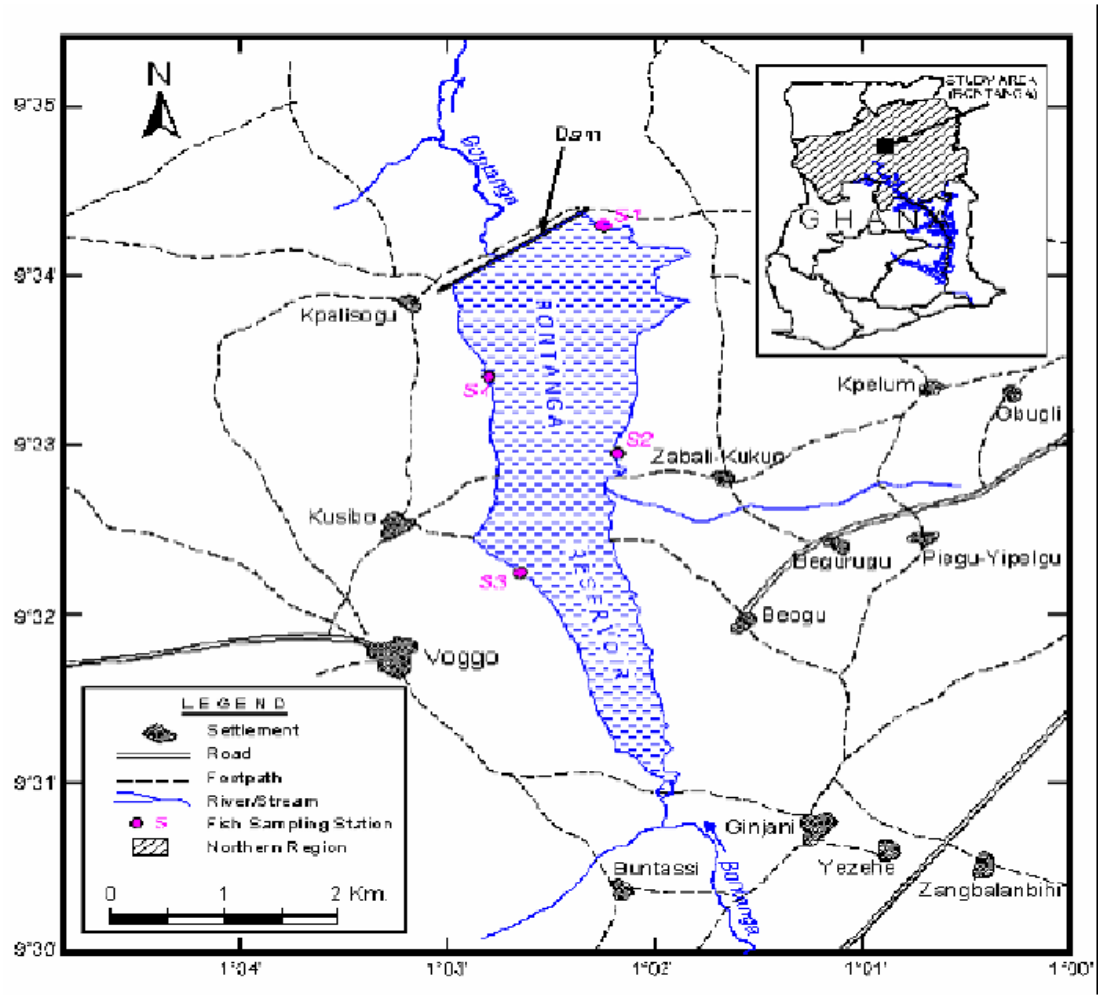
3.3 Bontanga Context

The Bontanga area is located in the Kumbungu District, 34km north-west of Tamale, the regional capital. The district was carved out of the then Tolon/Kumbungu District in 2011 and was inaugurated on 28th June, 2012 with Kumbungu as its capital (Medium & Development, 2017). The constructional work of the dam started in 1980 and was completed in 1986 with actual crop production commencing in 1987. The study thus focused on communities around the dam where farmers engaged in different types of farming (rain-fed-irrigation) were located. The irrigation scheme covers a potential area of 800 hectares. Currently, 570 hectares of irrigable land is covered out of which 300 hectares is used for lowland rice cultivation and 270 hectares for upland rice and vegetable production. At the moment, the population of farmers within the scheme is 600 drawn from over 16 communities within the Bontanga area. They include Bontanga, Wuba, Saakuba, Yiepelgu, Dalung, Voggu, Tibung, Kushibo, Kpalsegu, Zangbalun, Kumbungu, Gbugli, Kpalgu, Kpegu-Biegu, Kpegu-Bagurugu and Kpegu-Piegu and a number of other smaller villages within the catchment area of the scheme. The population of these communities vary from 25 to 100 households with about 8 to 20 persons per household. Farmers are organized into cooperative groups with the average farm holding size on the scheme being 1.08 hectares.

3.2.1 Economic Activities

The communities are endowed with two vital natural resources: arable land and water bodies. Agriculture represents the major economic mainstay and engages about 95.4% of the community aside other minor economic activities like hunting and trading (Ghana Statisical Service (GSS), 2014). The communities specialize in the cultivation of locally relevant crops such

as maize, rice, millet, sorghum, groundnuts and okra. Complementary to crops, the farmers also venture into livestock production such as cattle, sheep, goats, chicken, pigs and guinea fowls mainly for meat and eggs (Amuda & Thompson, 2010). Farm produce from these communities are sold in local markets such as the Kumbungu market, Abwabu market in Tamale or to traders from Southern Ghana. The Bontanga Irrigation Scheme therefore contributes a large portion of rice, maize and vegetables consumed in the region (Ghana Statisical Service (GSS), 2014). Despite the immense contribution to national food production by the region, the standard of living remains very low compared to the national average. Kumbungu is listed among the poor districts in the Northern region, as majority of its inhabitants are subsistent farmers.



Source: (Alhassan, Loomis, Frasier, Davies, & Andales, 2013) Figure 4: showing Bontanga Area in the Kumbungu District

3.2.2 Climate and Vegetation

The land in these communities is mostly low lying and drained by the Black and White Volta. The vegetative cover is largely guinea savanna interspersed with short drought resistant trees and grassland. Sandy loam is the soil type located in most parts except for the lowlands where alluvial deposits are found. There are also trees of economic value including sheanut, Parkia biglobosa locally known as dawadawa and mango from which some farmers derive their livelihood. Like all other parts of Ghana and by extension most other sub-Saharan countries in Western African, there are two main seasons: the rainy and the dry season. Whereas the south has two rainy seasons, from April to July and from September to November, the north has only one. The rainy season in the north typically begins in the month of May and ends in October, with the onset of the dry season from November until March/April. In Bontanga however, the climate is relatively dry, with annual rainfall ranging between 750 mm and 1050 mm compared to 2100 mm in the south. Maximum temperatures occur in March and April which represents the twilight of the dry season relative to the rather lower temperatures in December and January (Abdul-Malik & Mohammed, 2012). The “harmattan” winds, which occur during the months of December to early February, have an effect on the temperatures in the region, which may range between 14°C at night and 40°C during the day. Humidity is however very low and therefore mitigates the effect of the daytime heat (ibid).

Northern Ghana is already experiencing the impacts of climate change and climate variability in the form of shifting rainfall patterns and more frequent and extreme droughts and floods. A shift in rainfall has a direct implication on crop production and farm planning since agriculture in northern Ghana is mainly rain-fed (Armah, Yawson, Yengoh, Odoi, & Afrifa, 2010). An enquiry into how crucial decisions by farmers is influenced by information on variable rainfall patterns is relevant to help provide prior and targeted information on weather forecast; which can help to mitigate the impact of climate change and variability.

Source: Fieldwork, 2017

Picture 1: Landscape of Bontanga Communities

3.3 Methodology

I used an ethnographic approach targeted at providing thick description on everyday hydro-meteorological decision making practices of farmers with regards to food production. Farming decisions form part of the daily activities of most farmers within the Bontanga area. This approach provided the right methodological tools to be integrated into the real lives of these farmers to gain deeper insight. My eight (8) weeks stay in these communities helped to obtain culturally specific information on the values, opinions, behaviours, emotions, meanings and social contexts of research respondents. Information on the individual perspectives, social relations and group dynamics were also assessed.

3.3.2 Sampling Technique and Sample Size

I used a combined approach of probability and non-probability techniques in the selection of my respondents. There were sixteen (16) communities dispersed along three main strata namely the upper, middle and down streams of the Bontanga Irrigation Site who differed with respect to number of households, social amenities, and infrastructure. Based on the peculiarity of the study, time and resources, I used a purposive sampling technique in selecting six (6) communities, two (2) from each of the strata. This sampling technique was necessary because although all the sixteen (16) communities were farming communities they differed in terms of the type of farming they practiced. However, I was interested in understanding the dynamics and processes of decision making in rain fed and irrigation farming types hence this technique.

Non-probability sampling techniques are best suited to understand from practitioners' perspective cultural norms, processes and variations (Bernard, 2006). Furthermore, in a case study, where the objective is often to identify and understand a cultural phenomenon or a special population this approach makes it possible (Ibid).

In selecting the respondents I used a simple random technique. Household data were obtained from community leaders and formed basis for selection of individual households for interviews and focus group discussions. Overall, twenty four (24) farmers, four from each community were engaged in interviews and fifty (50) were involved in focus group discussions. This technique was best suited for the selection of participants' representative of the population. In this technique each farmer had a fair chance of being selected.

3.4 Data Collection

Although there are numerous methods in ethnographic research, I used combined approaches of focus group discussions, interviews and participant observation as my data collection techniques.

3.4.1 Interviews

In total, 24 farmers consisting of sixteen (16) men and eight (8) women participated in the interviews. Farmers were interviewed in the local language with the help of a research assistant. Prior to the study, questions were explained to ensure mutual understanding. Thereafter, questions were translated into the local language and responses translated back into English. Questions asked included; awareness and availability of hydro-meteorological information, access to the information, their preferred sources and reasons for the choice. Broader questions regarding other factors that could influence decision making practices aside from hydro-meteorological information were also examined. Follow up interviews were carried out in two instances to obtain clarity on some responses. To ascertain formal sources of hydro-meteorological information, snowball sampling method was used as these sources could not be determined beforehand. Farmers were essentially the main source of reference to identifying these institutions. In total, I interviewed stakeholders from five (5) public and private local radio stations, eight (8) public/private hydro-meteorological information institutions, two (2)

telecommunication companies and a local Non-Governmental Organisation (NGO). These interviews were conducted in English. All recorded interviews were transcribed and results sent via e-mail to respondents for cross checking to ensure mutual understanding.

3.4.2 Focus Group Discussions (FGD)

Farmers who participated in the interviews were different from those who took part in the focus group discussion as questions were framed similarly. This enabled analysis of responses relative to individual or group dynamics. A total of seven (7) to nine (9) farmers were engaged in each community and their responses were extrapolated to represent the views of their communities. To gain a deeper insight into their decision making practices hypothetical scenarios were also created to see the reaction of participants and how they will respond in those situations. Thus, the focus group discussion helped to distill the kind of information or action considered appropriate in group settings.

Source: Fieldwork, 2017

Picture 2: FGDs in Kpegu-Biegu and Saakuba respectively

3.4.3 Participant Observation

Participant observation is a process which provides the avenue for the researcher to be "part of the community and cultural group and cannot be grasped in a single observation (O'Leary, 2010). I participated in the life activities of farmers by either accompanying them to their farms or staying at home. It helped in seeing their everyday struggles in deciding which action to take

at what stage in the cropping cycle taking into account changing rainfall patterns. The initial engagements during interviews were important to enable farmers obtain full disclosure on the purpose of the research and to gain the researcher's trust on the entire process. It also created a cordial relationship and some level of security wherein the respondents accepted the researcher into their homes. The period of study coincided with the rainy and major cropping season of the area. Unfortunately, due to the erratic nature of the rains, some farmlands got flooded which also offered the researcher the opportunity to assess farmers' actions in these extreme moments. Engaging in the daily lives and routines of these farmers made them more open to share many of their challenges. For instance, I joined a group of women to dry and de-husk peanut which is also a household crop for making soup and also provided support in harvesting. These spontaneous and impulsive moments of my work offered great learning experiences. For instance, it underpinned the importance of timing in planting as a strategy to overcome pests and diseases.

The participation technique used in this research, though less structured and informal provided the added advantage of comparing the "sayings" and "doings" of these farmers and better clarified the motivation for most of their farming decisions. It also revealed a deeper understanding of the existing socio-political structure and potential approaches which might be more suitable in each community.

Source: Fieldwork, 2017 (Picture 3: Conversation with Memunatu, while dehusking peanut-locally produced crop by women)

Table 1: Data collection framework

Area	Community	Number of Households	Number of interviews	FGD No.	FGDs Participants
Downstream	Kpegu-Bagurugu	23	4	FGD 1	8
	Kpegu-Biegu	45	4	FGD 2	9
Mid-stream	Wuba	66	4	FGD 3	9
	Saakuba	84	4	FGD 4	8
Upstream	Tibung	121	4	FGD 5	9
	Kpalsegu	75	4	FGD 6	7
Total		**414**	**24**		**50**

Source: Fieldwork, 2017

3.5 Data Analysis

All interviews and outcomes of focus group discussions were recorded and transcribed in full. Overlaps and inconsistencies were edited and validated through double-checking with respondents. Notes taken on the field were combined with other primary data such as participant observation. Qualitative software Atlas.ti was used for content analysis. This software was chosen due to the variety of formats in which data can be analysed. It supports the synchronization and analysis of text, graphic, audio and video formats in a systematic and creative manner. It also provided the space to explore research materials to discover hidden connections and embedded meanings. Through this software, emerging themes were grouped into higher level themes and quotes from which events, practices and activities at their various levels of abstraction were coded to capture meaning. Codes such as decision making, meaning, identity, consequentiality, appropriateness, competence, material, hydro-meteorological information amongst others were classified. Related codes and networks between themes were also represented and interpreted.

3.6 Ethical Considerations

Ethical questions by nature do not lend themselves to strict categories of 'right' and 'wrong' (Bhattacherjee, 2012). Hence, aside from satisfying institutional requirements of using sound methodology, I approached this study with an attitude of thorough reflection, care and major ethical considerations. Firstly, the purpose of the research was explained to research participants before each interview. They were briefed on the possibility of withdrawing from the research at any point that they felt uncomfortable without any course for ramification. Informed consents were sought from all participants verbally and were recorded. Privacy, anonymity and confidentiality of respondents were also guaranteed. However, in cases where participants made emphatic statements which could be included as texts in the work, consent was sought for names of participants to be included to ensure credibility, openness and integrity of the data. In the same vein, consent was sought for the inclusion of names of companies if necessary. To ensure adequate preparedness to methodologically conduct interviews, the research assistant was trained on ethical concerns and appropriate approaches to gain respondents' trust and confidence through numerous trial sessions with other members involved in the research project. Data collected were securely saved on google drive to guarantee safety and restrict access.

3.7 Reflexivity

My access and positionality might have shaped my knowledge construction, sense-making of the narratives of participants as well as some policy recommendations. Regardless of the opportunities this presents, it holds potential of obscuring other alternatives hence the need for reflection. Conducting this research within the bigger EVOCA project provided the required access and the necessary contacts which resulted in a smooth fieldwork. However, it also raised a lot of expectations amongst respondents. For instance, I was always welcomed with the question "some of your colleagues came here last year and since then we never heard from them. How do we guarantee you are different"? This question and other sentiments expressed by the farmers were quite profound and underscored their trust in the project. It also emphasised their expectations to obtain solutions to their short and long-term farming challenges and not just be exploited as objects of cosmetic studies. My explanations on need

for multiple studies to comprehensively understand the problem so as to provide a solution calmed participants and allowed for subsequent engagements. Furthermore, the premium placed on hydro-meteorological information in the study might come intuitively as a result of my association with the project, nonetheless my theoretical approaches made it clear that provision of this information in isolation can result in underutilization.

My background in Sociology influenced my choice of theoretical frameworks. Highlighting the need for decision making to be perceived as a practice stemmed from my understanding of how context mattered in development initiatives. A practice approach in this context allowed for a much broader analysis to be made with regards to the socio-political and economic aspects of decision making. However this was not without limitations as it can obscure other alternatives.

Fieldwork was accompanied by interviews, focus group discussions and participant observations. Selected farmers were typically contacted and most convenient time sought for their engagement. However, since the time of the study was the major cropping season, most farmers in their quest to be part of the process had to postpone or delay their farming activities. This could have potential consequences for timing of farm activities. During this same period, there were erratic rainfalls causing floods and ultimately led to destruction of crops. The relevance of my research became evident to the respondents as it was easy for them to relate with the topic. This also made me reflect on my obligation towards these farmers with regards to incorporating the outcome of my research into the larger project for a better understanding of the most appropriate intervention.

The period of fieldwork was also characterized with major disease outbreak among crops called "fall army worm[3]". These worms destroyed several acres of farmlands. Although this was not directly related to my study, I was constantly confronted with the request to help solve the problem. Being unable to provide any concrete solutions brought to bear how susceptible researchers can be sometimes. These moments of my work were profound as I got caught up in a web of questions regarding the ethics of researching a relevant and timely topic that appeared otherwise given the circumstances. Reflecting on the need to be sensitive to the

[3]http://mofa.gov.gh/site/?p=15078

greatest need of research subjects, I assisted some of these farmers in the application of insecticides. Engaging in this activity also opened up another dimension and learning opportunity for my own study.

Finally, I worked with a PhD student and a research assistant on the field since I did not understand the local language. Knowledge in this sense is therefore co-produced together with my research assistant and the PhD student. The research encounters with these actors resultantly shaped the research outcomes. Collaborations in the field shapes knowledge construction (Van der Haar, Heijmans, & Hilhorst, 2013) and "what a researcher finds out is inherently connected to how it is found" (Emerson, Fretz, Shaw, & Emerson, 1995). A researchers' ability to think through ethical issues and respond appropriately is what brings out their ethical competence and makes reflexivity a central domain in qualitative research.

3.8 Limitation of Study

The major limitation of this research is the language barrier and difficulties in finding the appropriate local language to explain some technical words. For instance, hydro-meteorological information was sometimes equated with "weather information". This can have consequences for the outcome of the result. Studying decision making from a practice perspective meant the researcher should be embedded in the process. Thus, I did not assume a "fly on the wall" posture which made participants aware of my study. Although, this created some level of trust, it had no influence on farmers' perception. I was always seen and referred to as a researcher and not a member of the community group mainly because I could not speak the language. This could potentially lead to some unnatural behaviour of participants. Nonetheless, there is no value free science. Furthermore, the study focused and drew on a sample from three (3) communities out of a total of sixteen (16) communities and the analysis was thematically guided by theories reviewed in literature. Nonetheless, as with most qualitative studies, the aim was to produce in-depth and explanatory findings rather than to address expectations of representativeness and generalizability. Thus every methodology comes with some shortfalls and my sensitivity to these categories made it relatively easy to relate the empirical research to the academic debate.

Flooded Rice fields

Maize fields suffering from fall army worm

FGDs in Wuba

FGDs in Tibung

Crossing the only bridge leading to Tibung after a heavy downpour

FGDs in Kpegu-Bagurugu

Source: Fieldwork, 2017

4.0 Results and Discussion

4.1 Introduction

This chapter presents results of empirical study on decision making practices. The overall objective of the study was to assess hydro-meteorological information sources available to farmers and how they impact decision-making practices in food production. Results will be presented based on objectives of the study and within the scope of the theoretical frameworks to determine whether they support or are inconsistent with available literature.

4.2 Sources of Hydro-meteorological Information System

The first objective of the study was to investigate hydro-meteorological sources available within the Bontanga area and how they are accessed. Results are presented on two levels based on the types of farmers engaged (rain-fed and irrigation). The study revealed that both formal and informal sources of hydro-meteorological information sources exist outside the irrigation scheme which made information provisioning and seeking multi-faceted.

4.2.1 Formal Information Systems- Rainfed Farming

The formal system herein mentioned refers to network of information providers from the public and private sectors. The regional office of the Ghana Meteorological Services Department (GMET) leads on the operations of the public information providers. They work closely with the regional office of the Ministry of Food and Agriculture (MOFA) as well as public and community radio/ television stations. The regional MOFA is responsible for disseminating information to district and zonal offices who in turn work with farmers through extension officers. However, there appeared to be a weak coordination of information within this chain as all respondents reported lack of hydro-meteorological information from either of these sources. Similar finding was discovered by State, 2014 who found that, extension agents played minimal role in information dissemination among farmers within Delta state in Nigeria. While it cannot be established the factors that accounted for this, some farmers highlighted lack of infrastructure in the assigned communities as well as lack of supervision and accountability. The study also found that, the role of the Assembly member in hydro-meteorological information provisioning is almost non-existent as they did not consider it as part of their role.

A range of information providers were found within the private sector. Although they operate as individual institutions, some collaboration was identified. ACDI/VOCA an international NGO funded by USAID to improve maize, rice and soybean yield in the region occupied a large stake in the private sector due to the funding support they provide for hydro-meteorological information dissemination. Through their project called Agriculture Development for Value Chain Enhancement (ADVANCE), they work with partners within the Agricultural value chain to help farmers make smart farming decisions. For instance partnerships with ESOKO, Farmerline, Ignitia and Vodafone offered the opportunity to leverage on weather forecast technologies as well as telecommunication platforms in reaching farmers with timely information. However, findings of Etwire et al., 2017 revealed that, these information providers "lack meteorological data acquisition knowledge, resource models and proprietary rights to their own weather prediction algorithms. This has resulted in a partnership arrangement to pick processed data from their respective partner organisations across the globe in a revenue-sharing arrangement". For instance ESOKO picked information via a channel called insyt application, Farmerline via an application called mergdata and Ignitia via iska**"**

Private radio and television stations were not left out in the list of sources available to farmers within this sector. As evident in studies of Onwuemele, (2014) and Anjum, (2015) farmers in these communities also resort to other sources referred to here as informal systems. These include indigenous knowledge, family and friends and religious beliefs.

4.2.2 Informal Information System- Rainfed Farming

Due to the intensity and rate of change in weather conditions farmers indicated awareness of climate change and its resultant effect on their inability to accurately predict the weather with their own experiences. Nonetheless, they still consider their experiences vital sources of information. The most important manifestation of climate change indicated by farmers was relatively long dry seasons with erratic rainfalls which had significant consequences for agricultural production. In support of findings of Hiwasaki, Luna, Syamsidik, & Shaw, 2014 farmers relied on indigenous weather forecast system based on myths and experiences. They predicted the start and cessation of rainfall through the use of atmospheric and astronomic features, behaviour of plants, animals and insects. High temperatures and humidity during the

rainy season was indicative of rainfall. The brightness of the moon was symbolic of cessation of rain and the nearness of the dry season. Furthermore, the gathering of food, grass and eggs into holes by ants and termites was a sign of an impending rain. Similarly, the croaking of frogs and ripening of fruits on some local trees such as the neem tree were all indicative of the rainy season.

Aside from indigenous knowledge, the use of religion in predicting the weather was common amongst some farmers. In support of findings of Akinnagbe, Attamah, & Igbokwe, (2015) farmers belonged to one form of religious group or another which enhanced interaction and information seeking.

It's the beginning of a new year and each year we gather to ask the gods how the weather will be. This year we got information that it will rain heavily and crops will be destroyed and there will also be some terrible winds. We therefore had to perform 3 sacrifices in order to avert the situation - Anonymous.

The gathering together of people of similar faith to perform sacrifices through the slaughtering of goats and sheep was believed to be a collective way of appeasing the gods and to entreat them to grant favourable weather for increased yield. This asserts findings of (E. Ekong, 2003) that, membership of religious groups was useful in finding solutions collectively. Although, the beliefs of individuals were profound in this area, the role of traditional authorities and faith-based leaders in hydro-meteorological information provision was minimal. This was because; they did not consider the provision of hydro-meteorological information as their role. Contrary to findings of Risiro, Mashoko, Tshuma, & Rurinda, (2012) who noted lack of awareness on traditional methods of weather forecasting among traditional elders, these elders were aware of traditional methods but considered it outside of their scope of duty. They were however actively engaged in performance of sacrifices to avert extreme weather situations.

The last source identified under this category was family and friends. The communal life amongst farmers was profound which made family and friends a key source of information. However, the level of affinity and relations differed with respect to the size of the communities.

For instance, respondents from Tibung, the largest community with over 100 households indicated lack of information from friends whereas respondents from Kpegu-Bagurugu and Kpegu-Biegu, the least populated communities highlighted the role of friends and family members in the provision of hydro-meteorological information. It was evident that communities with many households tend to experience weakened social ties. In the smaller communities, male farmers were seen under neem trees after congregational prayers where they discussed issues of importance including information on good agricultural practices and information on rainfall patterns. Farmers who lacked access to formal information systems relied on these informal discussions and consultations with their neighbours. The reliance on these networks for information was a collective way of mitigating risk and responding to challenges. Contrary to findings of (State, 2014), there appeared to be a decline in farmers' preference to family and friends due to perceived notions of climate change and variability where these networks could not provide accurate information. Farmers tend to place premium on information disseminated through radio, television and mobile phones. A related finding was that, women in-spite of their own experiences and formal sources of information, still relied on their husbands and male farmers for hydro-meteorological information as well as when to commence planting. This was because the prevailing culture did not consider women as main actors in farming. Overall it was evident that, several sources of hydro-meteorological information exist among rainfed farmers. In the next section, I present findings from the irrigation scheme necessary to understand the dynamics between the 2 types of farming.

4.2.3 Information Sources within the Irrigation Scheme

As the largest irrigation site in the Northern region, its operations are jointly managed by the Ghana Irrigation Development Authority (GIDA) and farmer executives. The scheme manager is responsible for the day to day operations of the scheme as well as water scheduling activities. The Ghana Irrigation Development Authority (GIDA), Environmental Protection Agency (EPA), and the Ministry of Food and Agriculture (MOFA) serve as regulatory bodies on the scheme and at the same time provide information on best agricultural practices and weather information to farmers. The Water Research Institute (WRI) and the Savannah Agricultural Research Institute (SARI) play significant roles in the provision of appropriate technologies and water governance

to increase food production. The scheme also collaborates with many donor agencies such as ACDI/VOCA, Amsig Resources, TRIAS Ghana, International Fertilizer Development Center (IFDC) to plan, co-ordinate and implement various agricultural value chain projects within the scheme.

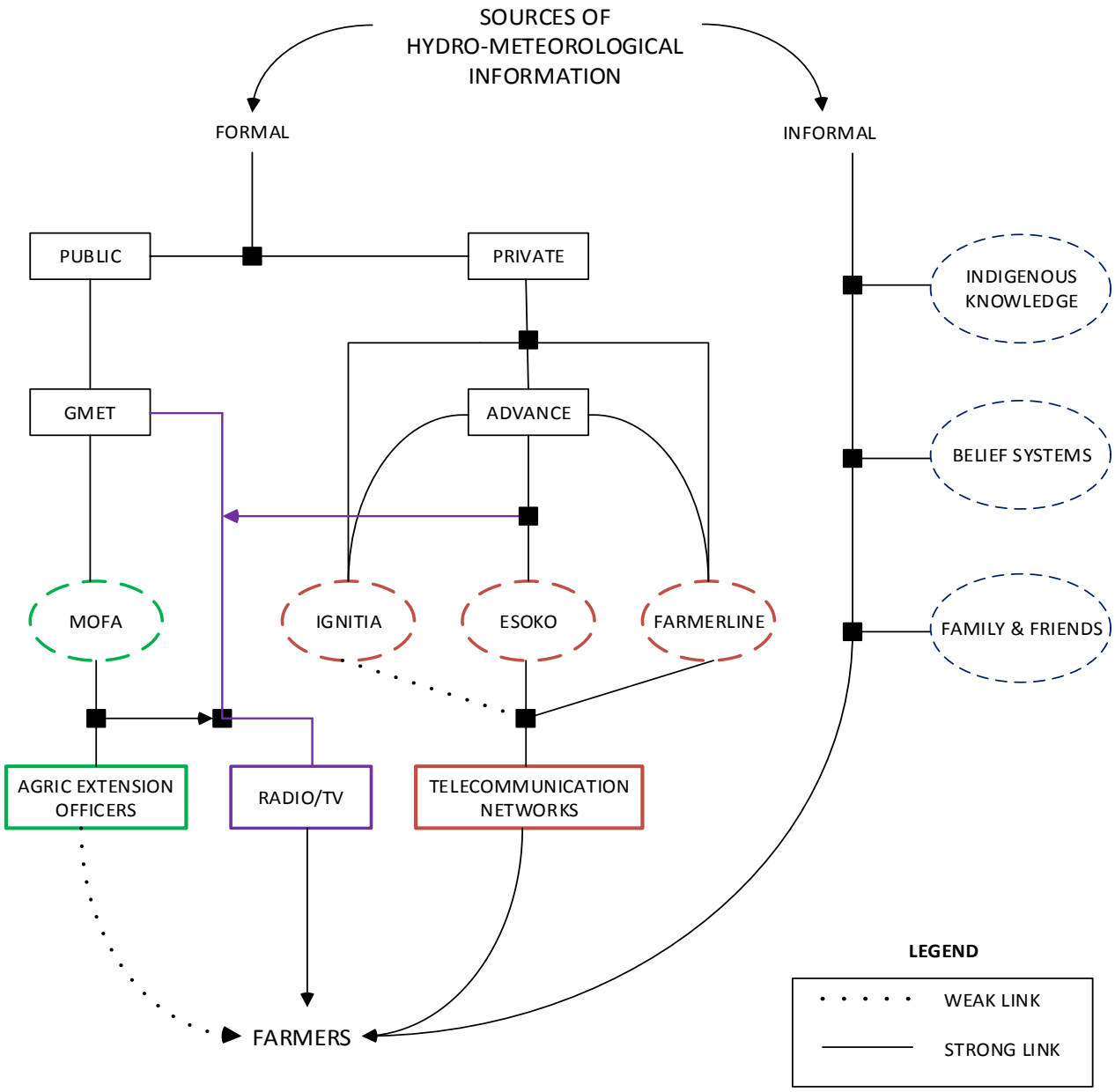
Contrary to the value attached to formal hydro-meteorological information by rain-fed farmers, it was rarely used by irrigation farmers and water managers for decision making. The manager attributed this to availability of water since the project inception in 1984.

We don't rely on any information on climatic conditions within the scheme since we haven't experienced any water shortage since the project commenced. Most of our farmers do not do any scientific farming. They rely on their own experiences in farming **- Anonymous.**

Forecast use in this case can be highly attributable to risk perceptions (Connor et al., 2000). Obsolete automatic weather stations were observed on the project site which the manager acknowledged was built at the commencement of the project but ceased to function few years after its installation. In addition to the fear of being redundant during the dry season, many farmers joined the irrigation scheme due to risk perceptions and uncertainty with weather and climatic conditions. Joining the scheme was also perceived as a secured alternative source of livelihood in extreme climatic conditions. The scheme therefore acted as a safety net for farmers to be engaged all year round. In essence, although there are different formal initiatives within the scheme to provide information to farmers, these initiatives received little attention due to perceived notions of water availability of water.

The practice of most farmers being engaged in both rainfed and irrigation farming made informal sources of information highlighted above available to all farmers. Farmers relied largely on indigenous knowledge in making most farming decisions. They observed and counted the months to determine when to commence planting. Additionally, information was cascaded to farmers through lateral heads who represented 14 identified farmer groups within the scheme. Information and decisions with regards to application of weedicides, fertilizers and pesticides were easily discussed due to proximities of farm plots. This was necessary to avert spill over of chemicals and diseases. Furthermore, through consultation with other farmer's

livestock owners safely kept their animals to avoid destruction of crops. Fig. 5 summarizes the available information sources within the Bontanga context



Source: Authors framework from field work, 2017

Fig. 5 showing available hydro-meteorological information systems

Evidently, diverse sources of hydro-meteorological information exist within the Bontanga communities to aid in decision making. Yet, as I argued hydro-meteorological information

aimed at inspiring action needs to be accessible in a format that creates knowledge and enhance the understanding of intended users. The grey area which this study also filled was to examine how easily accessible these sources were to farmers and reasons why farmers tend to access information from a particular source other than others.

4.3 Factors Influencing Access to Hydro-meteorological Information

The study identified four (4) main channels through which information was accessed. Table 2. below presents summary of the information channels and number of respondents who accessed them.

Type of Channel	**No. of Respondents**	**Percentage Total**
Radio	11	46%
Mobile phones	7	29%
TV	4	16%
Family and Friends	2	9%
Total	**24**	**100%**

Source: Field work, 2017

Consistent with findings of (Onyango et al., 2014) radio ranked the highest channel of information followed by mobile phones, television and family and friends. Similar to findings of Mabe et al., (2014) the presence of good transmission networks of radio coupled with their relatively cheaper prices made them accessible in five (5) communities. Furthermore, the user friendly nature, the portability of the device, the multi-power source, the content of radio programmes and the use of local language facilitated easy access and understanding. Further studies into the content of the radio programmes revealed that, community radio stations such as Smili radio, tailored segments of their programmes towards addressing the information needs of farmers. Their programme named “Farmers Time” was chosen to align farmers’ interest and also to enable them gain ownership of the programme. Resource persons who were either farmers, experts from MOFA or volunteers from NGOs provided pre, during and post season information to farmers on a host of issues including information on planting dates, rainfall patterns, use of irrigation facilities and crop varieties. They also made their programmes interactive through phone line activation where farmers engaged directly with experts. The

timing of their programmes also took into account Islamic prayer times thereby allowing maximum patronage.

It could be argued that community radio stations understood the information needs of farmers and used their channels to address them. Information from this source was perceived important, trustworthy and accurate hence largely influenced major decisions of farmers. Similarly, information which lacked understanding of farmers' needs and demands hardly influenced farmers' decisions.

Mobile phones ranked second as information channel and were accessed mostly by male farmers. Information from ACDI/VOCA, ESOKO Vodafone and MTN were all received via mobile phones. The provision of crop specific information and the mobile nature of this channel made it accessible than other channels. Furthermore, the prior engagement of farmers and the funding provided by some NGOs to disseminate information enabled free access to information. Thus, sufficient funding from donor agencies increased access to information (Tall et al., 2012). Except for MTN, all other private information providers delivered information through recorded voice in the preferred language of the farmer. Information provided to farmers' through this media included information on start and cessation of rainfall, planting dates, application of fertilizer, tips on disease control, market prices and nutrition tips. Due to culturally specific roles, women had less access to hydro-meteorological information from this channel and were thus less impacted in terms of farming decisions.

Information from television ranked third due to limited numbers of television in these communities. However, for the larger communities such as Tibung, and Saakuba, availability of electricity and other social infrastructure enabled farmers to access hydro-meteorological information through this medium. Watching farmer programmes on TV in groups offered the opportunity for information provided by GMET in technical languages to be explained by semi-literate farmers and a platform for ideas sharing and knowledge acquisition.

Family and friends ranked the least channel of access due to perceptions of trust, inaccurate information and weakened social ties especially in larger communities. Female farmers received information mostly through this medium. Male farmers who also lacked access to formal means

of information benefitted from informal discussions under neem trees usually after congregational prayers. Although this channel constitute an important channel to access hydro-meteorological information, lack of trust and perceptions of failure in indigenous knowledge led to a decline in access.

In examining farmers' preference and use of hydro-meteorological information channel, it became evident that, the criteria of Cash et al., 2003 (salience, credibility and legitimacy) of information played a significant role. Salience refers to the relevance of information for an actor's decision choices whereas credibility refers to whether an actor perceives information as meeting standards of scientific plausibility and technical adequacy. Legitimacy on the other hand, refers to the belief that the process and system of information dissemination is fair considering varied values, interest and concerns of users (Cash et al., 2003). Farmers within the Bontanga communities often assessed information provided based on these criteria and this determined the extent to which information source was preferred and its consequential impact on use. In support of findings of (Churi et al., 2012), radio received the highest rating of 59% followed by mobile phones 33% and TV 8%.

Table 3. below presents results of hydro-meteorological information channel preference.

Type of Channel	**Preference Percentage**	**Male**	**Female**	**Total**
Radio	59%	8	6	14
Mobile Phone	33%	7	1	8
TV	8%	1	1	2
Total	**100**	**16**	**8**	**24**

Both male and female farmers preferred radio due the opportunities it offers in terms of access and content of programmes (legitimacy). Phones on the other hand were predominantly preferred by men while TV stations were the preference of semi-elite and young farmers. Contrary to studies of (Onyango et al., 2014) and (Onwuemele, 2014) who emphasised preference to community channels of information dissemination, there was no preference for

this channel. The implication of this result may be that while indigenous knowledge is valued, farmers are gradually appreciating the relevance of scientific knowledge in the face of climate change. They demonstrated acceptance of scientific information through modern technologies which seemed to have proven suitable in meeting their needs (credibility). Farmers therefore tend to place premium on information from formal sources as they are deemed trustworthy, unbiased and relevant for decision making processes (Salience).

According to Cash et al., 2003 successful efforts to "connect knowledge to action are those that are not only effective at engendering favorable perceptions of salience, credibility, and legitimacy, but are also effective at balancing tradeoffs among these three attributes such that none of the three attributes falls below thresholds that will trigger the rejection of information or the resistance to recommended action"(Cash et al., 2003). Self-conscious efforts to engage users of the information could offer opportunities for balancing tradeoffs in this regard. For instance, through engagement with users, ESOKO understood the information needs of users and limits its hydro-meteorological forecast to three (3) days to ensure accuracy and relevance. Furthermore, the high accessibility and preference for radio for hydro-meteorological information should also provide the nook in the cranny for interventions to target the use of this medium.

I have discussed factors influencing access and preference of hydro-meteorological information. This insight can provide basis for effective design of interventions that will fit local realities and stimulate the required action. In the next section, I will look at elements of practice constituted in farmer's decision making practices.

4.7 Elements of Practice constituted in Decision Types

The study found that farmers make six decisions in the cropping cycle. This includes decisions with regards to choice of crop, land preparation, planting, weed control, fertilizer application and harvesting. Irrigation constitutes a major decision point for irrigation farmers. The study found that decision making using hydro-meteorological information in this context has endured for a period of time hence a practice (Ingram et al., 2007). It was however evident that, the practice was not performed as a result of the provision of information only but was aided by a

multitude of understandings, resources and skills (Reckwitz, 2002). Interview questions targeted at use of forecast information on rainfall received varied responses depending on the type of farming individuals were engaged in. In addition participants experienced a range of issues in their daily lives which resulted in the way decisions were made, negotiated and altered.

4.7.1 Meaning

The meaning of hydro-meteorological information decision making practice consists of the overall emotions, knowledge, and motivations towards the practice (Shove et al., 2012b). The study found different meanings commonly shared by farmers. It is however important to note that, farmers are not the core of the analysis but the practice itself.

Use of hydro-meteorological information in decision making was seen to be associated with the Supreme Being and an elite and trusted group of people in which there is no iota of variation or uncertainty. *"**In the past we used the months to predict the weather anytime we want to start planting. But due to new technology we have become reliant on the radio. We now use the information from the radio because these people are now like God."-FGD Wuba**.* Similar sentiments were echoed among a cross section of farmers during FGD in Kpalsegu ***"In the previous years, there was no hydro-meteorological information with technology. But now the educated people know everything and if they say something will happen surely it will happen".*** Embedded in this meaning was how people expressed the fluidity and change in everyday decision making as a result of new technologies. They particularly emphasised how their indigenous knowledge was insufficient to help them overcome current climatic changes. Furthermore, association with an elite and trusted group of people who were knowledgeable about everything made most farmers to use hydro-meteorological information in their decision making practices. ***"We always use information from Vodafone because they always give us accurate information".***

Besides association with a superior being and elite class of people, language played a major role in stimulating action. The study found that, emotions of farmers were evoked each time hydro-meteorological information was provided in the local language. Farmers interpreted and made

meaning of their life worlds including decisions once information was given in their local language. The Dagbani language thus became a fundamental stimulant of emotions, knowledge and action. ***"We were surprised when they called us on phone and mentioned our names. They spoke in Dagbani and told us that it was going to rain heavily this year. These are people we don't know so we were really excited they spoke Dagbani"*** FGD-Kpegu-Bagurugu. Farmers indicated that, the provision of personalized information in a language they clearly understood immediately bestowed on them a sense of responsibility to act. The emotions evoked had to do with the local language but also about how it was spoken. When asked whether they experience any challenges with current information being provided, farmers in Wuba mentioned lack of clarity and understanding although the local language was spoken. "***The problem is that the people providing us the information try to speak our language but they don't speak it well for us to understand. So we will prefer our own people to be calling us so that they can speak it well".*** This showed how language was crucial in the dissemination of information intended to make impact in the decision making practices of farmers. Farmers looked forward to associate with their own. Hydro-meteorological information was therefore assessed on this scale. A strong association of the source with indigenous people who could clearly communicate in a language they understood was more likely to evoke emotions and feelings which could lead to action.

Another element associated with meaning is perceptions of risks, fear and uncertainty by farmers due to long periods of drought and extreme rainfalls. Inability to predict the weather with indigenous knowledge called for more reliance on hydro-meteorological information which provided some sort of relief especially to rain-fed farmers. Not using this information meant the embracement of failure in production. ***"I heard the information from the radio that it was going to rain heavily this year so when people were busy cultivating maize at waterlogged areas I didn't take any action. Now they are all crying that their crops have been destroyed***"-**Anonymous**. In this case hydro-meteorological information helped to mitigate damages and future risks. Following one's own knowledge according to farmers was also considered to be embracing failure since indigenous knowledge had limitations considering the trend of weather conditions. ***"These people have more knowledge about the rain so we listen***

to them. Because if we take our own decisions we will fail" FGDs. In line with findings of Connor et al., (2000) and (Singh et al., 2017) forecast use in this instance can be linked to risk perceptions.

For farmers within the Bontanga communities, the ability of hydro-meteorological to match indigenous knowledge is crucial for decision making. Farmers have accumulated wealth of knowledge on farming as well as prediction of weather through the use of some environmental factors. However with the realisation of variability in weather conditions, many accepted limitation on indigenous knowledge but persisted need for it to match formal hydro-meteorological information before use in decision making. Hydro-meteorological information provided through any means was therefore subjected to comparison with indigenous knowledge. Ability of the information to match with existing knowledge resulted in higher use. Failure of the information to match with indigenous knowledge resulted in doubts where the farmer made decisions based on success rate of previously used source. This finding highlights how information is assembled in decision making practices.

Usually when we receive the information from radio or on our mobile phones we compare it with our own experiences and we sit together to discuss among ourselves. If the information matches our own experiences then we use it. And usually it matches!- FGD Tibung
In this community we determine rainy season by counting the months. Assuming we plant in May this year, next year May we have to plant again. So if we receive information which is contrary to our own experience we don't use it because we started farming long ago, even at the time when this information was not there we were farming-FGD Saakuba

Lastly, the study found that meanings associated with use of information were not only associated with obvious changes in technology but also less anticipated misfortunes such as illness. When asked whether there was ever a time when they heard hydro-meteorological information and never acted on it. 36 year old woman mentioned ***"I am the caretaker of my home, so if I hear the information on the radio that it's going to rain so we should start preparing and my child or any member of my family is sick I cannot act on the information"***.

Although gender roles may make women more susceptible in this situation, the ill health of male farmers could also lead to inability to use the information. Current hydro-meteorological information gave farmer's one month lead time to prepare in order to embark on their farming activities. This implies that sickness or any misfortune lasting beyond this period has the potential to prevent use of information.

Overall, farmers had a positive understanding of hydro-meteorological information which influenced its use in various aspects of their decision making. It gave them the feeling to be associated with a superior authority and modern technology. It also highlighted how indigenous knowledge still persisted and influenced farmer's meaning of hydro-meteorological information. The emotions related to local language strongly relates to association with one's own. For some, fear, risk and uncertainty were the motivations to information use. For others the tangible benefits in terms of increased yield and good harvest inspired them to use the information. These emotions and motivational knowledge constitutes the social and symbolic significance attached to hydro-meteorological information by farmers within this context which also brought them together in its use in decision making (Bourdieu, 1984). However, practices are reproduced by connecting them to other activities which ultimately makes a practice not only social but also material (Shove, Elizabeth and Pantzar et al., 2012). Thus, the meaning associated with the hydro-meteorological information needs to be connected to other components for the practice to be performed (decision to be made). The study found a number of material elements linked to this practice.

4.7.3 Material

Material does not only refer to the physical equipment and resources required to make a decision but also the environmental conditions such as access to land, water availability, soil structure as well as market imperatives.

Access to land remains an integral part of farming. The study revealed that, most female farmers did not have direct access to land as a result of land tenure arrangements and culturally defined roles. Married women either supported their husbands in the cultivation of the same piece of land or cultivated their own given to them by their husbands or older sons. This was

about 1-2 acres on the average. While diversification of crops was necessary to prevent complete crop failure in extreme weather conditions, most female farmers who are originally peanut farmers consider their size of plot too small for mixed cropping. Additional plots of land were thus required to cultivate other crops. Lack of access to additional land thus limited their ability to use hydro-meteorological information especially when diversification of crop was required by the information.

Additionally, soil types in the area influenced decision making especially on choice of crop. Within the rain-fed system waterlogged areas were dedicated to the cultivation of rice and vegetables such as okra whereas highland areas were mostly for maize, soybean and groundnut. Within the irrigation system, upland fields were solely for vegetable cultivation while lowland fields were predominantly for rice cultivation. These fields were predefined with specific crops hence farmers selected crops based on their survival rates on the soil types. Ultimately, farmers with waterlogged plots were more prone to cultivate rice and vice versa. Hydro-meteorological information suggestive of crops which were inconsistent with these predefined fields was hardly used due to the mismatch with indigenous knowledge.

Furthermore, water availability interfered in decision making at all stages. This is most crucial especially for farmers within the rain-fed system due to uncertainty in weather and long term impact of climate change. In all the stages, it was evident that hydro-meteorological information was useful in providing early warning in land preparation and planting. With regards to other decisions such as application of fertilizer and weedicides, most farmers relied on the physical manifestation of rainfall before taking action partly due to the perceived investment in these inputs but also due to difficulties in changing from a mindset of disaster response to preparedness and early action (Tall et al., 2012). "***At this time we rely on rainfall for our cropping activities. We can't go to the irrigation site now because is blocked and they will open it up in the dry season"*** Immoro Abdullai***.*** Although the decision to embark on planting was influenced by hydro-meteorological information, farmers sometimes made decisions independent of this information as a result of anticipated rains and limited alternative livelihood activities***.*** Similarly within the scheme, irrigation was considered a crucial decision

point for irrigation farmers. However, decisions were not influenced by hydro-meteorological information due to perceptions of water availability in the Botansi river. Access to water was influenced by water distribution schedule as well as location of plot (upland, lowland) within the scheme. Farmers made water dependent decisions either to ensure access to water through engaging in both rain-fed and irrigation farming or conversion of crops grown on fields to ensure constant access to water (Tibung, Kpalsegu).

Disease conditions and crop failures were found to be crucial material elements which influenced farming decisions. For instance within the irrigation scheme, most upland fields originally meant for vegetable cultivation were converted to rice fields. In addition, the period under study witnessed a disease outbreak which destroyed most maize crops resulting in decisions to decrease acreage of farmlands in subsequent years. Farmers in such situations sought after information on pests and disease control mechanisms other than hydro-meteorological information.

Besides the above material elements, most farmers consider sound financial status as a key factor in adopting good agricultural practices as well as using hydro-meteorological information. All the major decision making points (crop choice, land preparation, planting, application of fertilizer, weedicides and harvesting) required some level of financial commitment which essentially prevented some farmers from using the information. ***"In farming you need money and once you hear the information and you don't have money you can't use it. As for seeds we don't have problem is money for fertilizer, weedicides and to pay for tractor services that we need"*** Seidu. Similar to findings of (van der Geest, 2004) strong social ties within the smaller communities such as Kpegu-Bagurugu and Kpegu-Biegu offered opportunities such as labour in the clearing of land and weeding. Seeds were easily obtained from close friends and families either for free or with the intention of paying back in kind after harvesting. Maize seeds were received at no cost since they were cheap and were also readily available. Rice seeds on the other hand were expensive hence could not be given for free.

The weakened social ties in larger communities prevented such reciprocities and made the use of hydro-meteorological information in such conditions even more difficult.

Although farmers' financial capacity determines access to farm equipment, farm equipment in these communities was inadequate hence limited access. Sound financial capacity of the farmer therefore does not guarantee access. Rainfed farmers use manual labour, bullock-powered ploughs or tractors depending on their economic capacity and the availability of these services. Irrigation farmers however have limited options and use tractors due to the waterlogged nature of the land. Unavailability of farm equipment results in limited use of information. "S***ometimes you hear the information and you can't use it since this community we don't have any tractor or plough. We go to one man in Kpalsegu who hires these things"- FGD Kpegu Bagurugu.*** For smaller communities tractors were rented from Kpalsegu which costed 200-450 Ghana Cedis for one acre of land to be cleared. There were also arrangements which enabled farmers to pay in kind with bags of harvested crops. Farmers' inability to mobilise money to pay for these services meant that decisions were either delayed or post-poned.

The time of delivery of hydro-meteorological information was of significance and contributed to whether information was used or not. Generally, farmers use information at all stages of the decision making process but mostly at the stage of application of fertilizer and least in harvesting and marketing. This finding is consistent with findings of Artikov et al., (2006) who concluded that "farmers worry less about the crop damage once it is harvested". Information provided at this stage was therefore perceived as irrelevant. Nevertheless, some women acknowledged the importance of information after harvesting in drying and preservation of crops. The month of April and May were considered significant periods in the farming season. Inability to plant during this period rendered the use of hydro-meteorological information redundant since the specific planting time was missed. Hydro-meteorological information provided during Islamic prayer times were hardly accessed due to the significant number of Muslim farmers.

Forces of demand and supply played significant roles in decision making practice. Decisions with regards to planting and harvesting were highly influenced by market incentives. Some farmers selected crops based on their demand and prevailing prices. Rice for instance had a high commercial value and readily available market in the south hence was produced by most

farmers. Other farmers also delayed the sale of crops until prices increase. In essence, information about available markets, buyers and prices were highly sought for at this stage to make decisions.

To sum up, it can be observed how material elements of the practice represent the connection between human and non-human agents in the enactment of the practice. Essentially how the use of land, fertilizers, weedicides, tractors, water, soil type, time and capital are intertwined and often directly implicated in the conduct and reproduction of decision making using hydro-meteorological information (Shove & Pantzar, 2005). Ultimately, materials therefore have the ability to either enable or constrain a practice (A. Reckwitz, 2002).

4.7.4 Competence

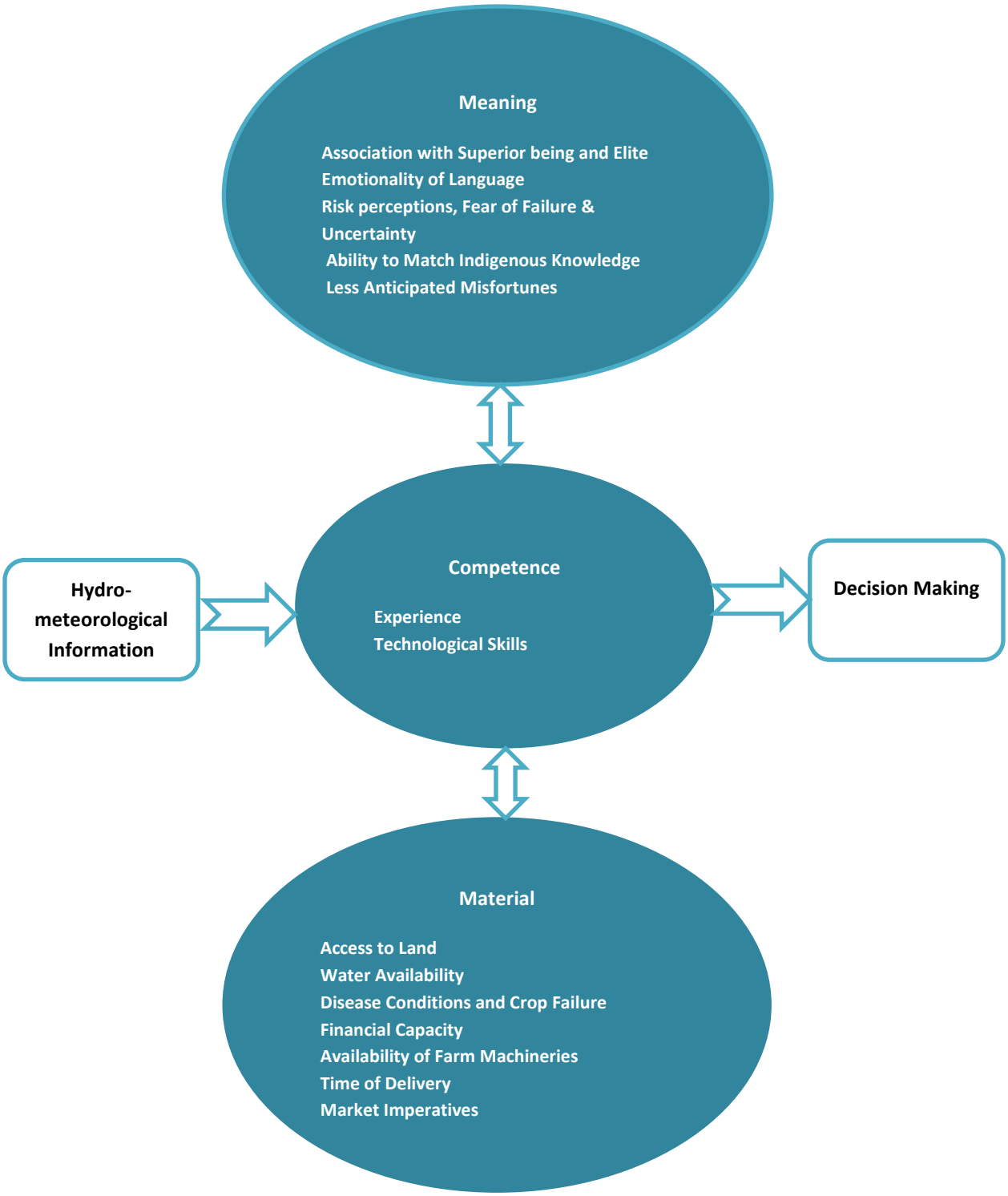
Lastly, embodied knowledge and skills are required in the performance of practices. The study found that, technological skills and acquired competence as a result of experience in farming influenced hydro-meteorological information use in decision making.

The study identified lack of technological skills to use modern gadgets such as mobile phones and interpret information sent through them as a major skills challenge. Most farmers in these communities were uneducated. Men who owned phones used them predominantly for the purposes of receiving calls. Information provided via text messages thus received little attention since it could be hardly read or interpreted. ***"These people (hydro-meteorological information providers) they send messages in English as though we understand English. It is so difficult to find people to explain to you so when I am busy I just ignore it" Iddrissu Seidu.*** Information provided in this format was therefore out of reach of farmers and ultimately had less impact in decision making. Information provided via TV stations also had less impact as they were not understood due to language barrier.

Additionally, farmers believed that, acquired competence and experience in farming as well as use of hydro-meteorological information made them better decision makers. Ibrahim reiterated ***"I have been farming for some time so I have my own experience but I also talk to my friend who works with MOFA. This helps me to make accurate decisions all the time. I don't follow the village folks".*** When a farmer has successful experiences with the use of the information, it

becomes easier and convenient to use in decision making. Experience does not only relate to the information use but also the ability to cultivate a particular crop. Hydro-meteorological information suggestive of crops which farmers had no skills and competence to cultivate are likely to be ignored.

As highlighted, use of hydro-meteorological information presumes certain knowledge and skills which farmers must necessarily have in order to use the information. In this context it is evident that farmers lack the technological skills to interpret information sent in English let alone explain what the implication of the information is on farming activities. In the same vein, farmers without the acquired competence to cultivate some crops are less likely to use information suggestive of alternative crops in extreme weather conditions. Hydro-meteorological information which is disconnected from these real life situations of farmers in this context risks a chance of not being used in decision making (Rengalakshmi, 2007). Social Practice theory thus revealed how decision making have large scale and complex roots which requires a comprehensive approach to initiate any meaningful change (Spotswood et al., 2015). The comprehensive approach is based on the principle that changing a practice requires breaking or challenging the links between its many interrelated elements (Shove & Pantzar, 2005). It is important to note that, the various elements of decision making practice discussed above should not be considered as separate entities but a “block’ whose existence necessarily depends on their interconnectedness (A. Reckwitz, 2002). Figure 6 below shows summary of elements constituted in hydro-meteorological information decision making.



Source: Fieldwork, (2017).

Fig. 6 showing summary of elements constituted in decision making practices.

4.3 Impact of Hydro-meteorological Information on Decision Types in Farming

Having discussed available hydro-meteorological information systems and how they are accessed by farmers as well as elements of practice constituted in decision making, I will now proceed to present findings of the final objective. The aim was to assess the extent to which hydro-meteorological information impacts decision types in farming. As highlighted earlier, farmers make 6 major decisions which include; decisions with regards to crop choice, land preparation, planting, weed control, fertilizer application and harvesting. Irrigation constitutes an additional decision stage for irrigation farmers as it is highly dependent on water availability.

In assessing the impact of hydro-meteorological information on choice of crop, findings revealed that, hydro-meteorological information did not play any major role in decision making. Farmers stated several reasons for their choice of crop including commercial value, maturity period, household consumption and nativity of crops.

Table 3. shows commonly cultivated crops within the Bontanga area and reasons for their selection.

Reason for Cultivation	**Rice**	**Maize**	**Peanut**	**Soyabeans**
Easy to cultivate	0%	0%	12%	6%
Commercial value	24%	5%	0%	3%
Maturity period	0%	0%	0%	17%
Native crop	72%	83%	65%	48%
Household consumption	4%	12%	23%	26%
Total	**100%**	**100%**	**100%**	**100%**

The varied reasons given for the choice of crop revealed how traces of the logic of consequentiality can be found in this decision type. Nonetheless, the increased number of farmers who emphasised that their choices were based on the fact that these crops were native crops called for a deeper analysis. For instance, the cultivation of rice and maize stemmed from a fundamental believe that, they are traditional crops hence required to be cultivated by every household. All respondents interviewed, were either involved in rice or maize production or had family members engaged in the production which created a strong sense of identity and social cohesion among these farmers. Male children are socialized to acquire skills in the

production. "***I chose maize and rice because my family taught me how to cultivate them so that I can use the proceeds to take care of my family since I am the man***" Iddi Fuseini**.** The decision to cultivate peanut was equally associated with female farmers as it was used predominantly in soup making, a household activity considered to be the preserve of women. Rice as a commercial crop was also valued in social events such as outdooring, funerals and marriage ceremonies while maize was cultivated largely for household consumption as well as for commercial purposes. When asked how long they have been cultivating these crops some responded ***"all my life".*** Aside from the weight of this response, it implies that this was not only a tradition that was passed on from earlier generations but also typified how farmers in these communities have lived from and with these crops. The use of collective pronouns such as ***"we are maize farmers" "our land is suited for rice" "we can only grow peanut"*** are all indicative of the embeddedness of their lives in these crops.

4.3.1 Impact of Hydro-meteorological Information on Crop Choice

Abdul Rahman a 47 year old farmer with 20 year experience in farming was aware of the possibilities of cultivating other crops especially in unfavourable weather conditions as they were suggested via hydro-meteorological information providers but he chose to continue the production of his original crop. Abdul narrates his reason as follows:

> ***I chose to cultivate maize. Sometimes Vodafone even asks me to grow watermelon, peanut and other crops but I am not practicing them because I am a maize farmer. Maize is our traditional crop***

When asked whether his choice of crop in future will be influenced by unfavourable weather conditions, Abdul responded in the negative and reiterated his reasons as follows:

"No I am a maize farmer and I cannot practice any other crop. My land is best suited for maize. This year I know because of the insects that have destroyed the maize I will not harvest much since I haven't produced any other crop. But I will not change it".

From the preceding narratives, Abdul has emphasised that his decision to cultivate maize was not borne out of information from any information provider but by himself. On first count,

Abdul's decision to cultivate maize appeared to be personal due to the use of "I", however the expression because ***"maize is our traditional crop"*** largely shows the influence of societal norms and existing rules on the decision. In this instance, it appeared the choice to cultivate maize was reactive and immediate (Bourdieu, 2002) rather than rational due to the recognition of rules governing these communities where maize and rice are considered traditional crops. Moreover, due to the significant number of people involved in the production it was also considered 'right' and 'appropriate' (Spotswood et al., 2015). Thus Abdul's decision cannot be considered rational choice decision as there was no calculation of utilities. Furthermore, the decision to continue the production of maize into the foreseeable future may not necessarily result in the greatest benefit hence Abdul cannot be considered an optimizer. Secondly, although it was evident that the probabilities of the outcome of the decision he was embarking on was known to him, he did not opt for a 'satisficing' solution. According to (H. A. Simon, 2002) "decision makers use loose rules of thumb and heuristics, when choosing among alternatives and the choices made are usually due to their past success". In the case of Abdul, the loose rule of thumb used was not based on success as his maize crops got destroyed by insects resulting in low yield.

Following from this theory Abdul should have discontinued maize production or choose an alternative crop with higher probabilities of success. However, he insisted on the continuous production of maize which provides basis for the conceptualization of his decision under the logic of appropriateness. While not articulated by Abdul, there might be an implication that since he has been cultivating maize for 20 years, he has developed the competence and skills required in the cultivation which might be lacking for watermelon and peanut hence the resistant to change. Additionally, the material resources such as seeds, fertilizers needed to engage in maize production might perhaps be readily available since the practice has been enacted over a period of time.

The recursive character of this decision makes it a practice that has endured between and across specific moments of enactment (Ingram et al., 2007). It can also be argued that the "rule of crop cultivation" in this context provided a guide to Abdul's decision on crop choice which

makes his decision to be inspired by the logic of appropriateness based on what is considered 'right' in terms of crop selection and not success as purported in theories of bounded rationality (March & Olsen, 2009). According to Schulz & Schulz, (2014) inherent in following rules are also pre-packaged contracts received as rewards. For instance, the feeling of belonging to a community of maize producers where he made a contribution came with some pride and prestige.

In the case of Memunatu- 28 year old female farmer who has been cultivating peanut for 5 years stated the following as her reason for choice of crop:

"I didn't choose peanut because of information from radio. I don't have money to be buying peanut from the market. We (women) grow peanut in this community because we are cooking for the family"- Memunatu**.**

In Memunatu's response, it was evident that, her choice of crop is not informed by hydro-meteorological information. The first part of her response appeared as a decision influenced by the logic of consequentiality where she perhaps calculated the cost associated with the alternative of buying but eventually settled for its production due to cost implications. However, an inquiry into the second part revealed the embeddedness of gender rules in these communities where peanut cultivation is associated with female farmers. Thus, although the choice was made by the individual it could be observed the influence imposed by the existing structure resulting in the co-shaping of her decision (Bourdieu, 2002). The rules governing peanut cultivation thus provided a guide and precedence for her decision. Her decision can therefore be argued to be inspired by the logic of appropriateness.

In essence, the cultivation of traditional crops in this context is more than a productive labour. It is an activity through which farmers express their aspirations, dreams and preserve their identity. It also shows how decisions with regards to choice of crops can be difficult to change without the required understanding of local conditions and farmers' information needs.

4.3.2 Impact of Hydro-meteorological Information on Land Preparation

The second stage of decision making in the cropping cycle is land preparation. Decision making at this stage is characterized by demand for hydro-meteorological information especially by

rain-fed farmers for timely preparation, planning and proactive response to risk and disaster. Farmers' awareness of changing climate and inability to accurately predict weather conditions with indigenous knowledge made this information even more relevant. Before land preparation, farmers pay attention to media and social relations to obtain information on start, variability and cessation of rainfall. In a conversation with a 54 year old farmer- Ibrahim, it was evident how hydro-meteorological information helps in making decisions at this stage.

"***The very moment I hear it's going to rain I need to start preparing the land so that when it rains I can start planting". If I don't start preparing early and the rains come I will miss the right time for planting and my crop will not do well".***

Land preparation can be done manually or mechanically depending on the cropping history of the farmer and several other factors. Firstly, it is carried out usually after about two (2) or three (3) rainfalls when the soil moisture content is high or estimated to be sufficient. In order for land preparation to be effective and depending on the soil type, the farmer has to rely on hydro-meteorological information in order to decide whether to wait or proceed. Secondly, farm tools such as machetes and hoes, bullock-powered ploughs or tractors are required for the process to be completed. The choice of tool is highly dependent on the economic capacity of the farmer, physical access to machineries and the soil type. It also depends on the size of farm and the availability of labour (family, household size etc.). For instance, under the irrigation system the use of a tractor is required for land preparation due to the waterlogged nature of the land. Use of tractor also comes with higher cost and longer waiting period due to the limited quantities. Nonetheless, ability to secure tractors on time could lead to early preparation and avoid the future risks of missing the rains.

In the rain-fed system bullock powered tractors or manual labour could be used depending on the size of the farm. This option is less expensive and if done on time could be ready before the onset of the rains. The farmer is thus mostly torn between decisions to go with cheaper options such as using manual labour which can take longer days to complete or more expensive options such as tractor for fewer days. Although the outcomes of the choice of method is not known for certainty, based on precedence and loose rules of thumb most farmers made decisions based

on the probabilities of outcomes which is evident of the logic of consequentiality (H. A. Simon, 2002). Here, farmers attempt to rationalize their decisions by weighing alternative options and probable outcomes and based on precedence use a rule of thumb which appears to give the most satisfactory solution. It is worthy of note that, although most farmers were inspired by the logic of consequentiality at this decision point, there were few farmers who took decisions reflective of the logic of appropriateness. For instance, some farmers still chose manual labour in land clearance under conditions of uncertainty and risks mainly due to perceived communal approach to farming and for reasons embedded in their practice as a people.

4.3.3 Impact of Hydro-meteorological Information on Planting

Land preparation is followed by planting. However, in some cases both stages can also be combined given the prevailing conditions and resources of the farmer. Daily and seasonal rainfall forecasts guide farmers' decisions as they depend on the rains directly to meet water needs. Timing in planting is considered crucial for any good harvest and July is believed to be the right timing for planting. Failure to plant during this period may have consequences such as poor yield as there is the likelihood of missing the rains. In essence, early planting enables the farmer to avoid future risks and uncertainties. Yet; limited access to farm machineries and seeds poses challenge for early planting.

While unpredictability of the weather remains a problem for rain fed water dependent decisions, farming under the irrigation system presents less stress due to availability of water. Nonetheless, farming under the irrigation system is more expensive due to cost of plot and irrigation services. Thus, farmers' choice of method and variety of seed is largely influenced by the logic of consequentiality where hydro-meteorological information plays a significant role.

The choice to either use broadcasting or dibbering is largely dependent on the type of soil, available time and the expected outcome. Using a dibber[4] allows for an even distribution of seed, more accurate planting and good seed to soil contact ensuring proper germination. However, this process is time consuming. Most farmers in a quest to cover more acres at a cheap and faster rate resort to the broadcasting method which has the potential to result in

[4] A dibber is a pointed wooden stick for making holes in the ground so that seeds, seedlings or small bulbs can be planted.

poor seed to soil contact and lower chances of high germination. Most rain-fed farmers use broadcasting considering low financial and labour capital requirements. Additionally, farmers' choice of long or short term varieties are based on their ability to withstand drought, and their market value. In effect, planting decisions involves multiple calculations, where alternatives are weighed against possible outcomes and based on heuristics, decisions are made although their outcomes may not be known with certainty. Herein, lays decisions taken in light of risks and uncertainties where the precise consequences are uncertain but their probabilities are known (H. Simon, 1972).

It is important to highlight that, some traces of decisions inspired by the logic of appropriateness were again observed at this stage. For instance in the choice of seeds, it became evident that some farmers were resistant to use unknown varieties. Furthermore, although some rice farmers were aware that nursing seeds before transplanting could result to higher yield, they still persisted on using the broadcasting method as it was the most used method.

4.3.4 Impact of Hydro-meteorological Information on Weed Control

The fourth decision is weed control and is also considered an important stage in the decision making process. Weeds compete with crops for light, nutrients, soil water and space thereby leading to low yield. Weed control is therefore crucial for ensuring increased production. The process can either be done manually or through the use of chemicals. Depending on the financial capacity of the farmer and where timeliness is critical weedicides are used. Weedicides can be applied in a single or double phase. Pre-emergent weedicides are applied immediately after planting to control existing weeds that survived land preparation. Post emergent weedicides are applied upon germination and a period of 25 days maximum is required before application of fertilizer. Pre and post-emergent weedicides were applied in the case of crops such as maize and rice.

Findings revealed that, farmers with large acres of farmland invested in the purchase of weedicides as they consider it to be faster and less tedious. Hydro-meteorological information use in weed control was thus crucial to ensure investments in farm inputs were put to good use; as any application which coincides with heavy rainfall has the potential to wash away

chemicals leading to waste of resources. On the other hand, soil moisture is required for the effective activation of the weedicide. In effect, successful application of weedicides depends on several factors including; type of weedicide, method and time of application and climatic conditions.

While timing is important to ensure that weeds are controlled early enough to avoid competition with crops, the choice of method in the control mechanism largely depends on the farmer and mostly inspired by the logic of consequentiality. Similar to decisions in land preparation, few farmers were observed using manual labour due to perceptions related to communal farming.

4.3.5 Impact of Hydro-meteorological Information on Fertilizer Application

Fertilizer application just like weedicide control is considered a major investment worth returns in terms of higher yield. This makes the role of hydro-meteorological information valuable at this stage. Fertilizer application can be done either by using organic or inorganic manure. Organic manure is used mainly by farmers engaged in livestock production and small scale farming for domestic consumption. Commercial farmers relied on inorganic fertilizers as they allowed for quick vegetative growth and supplied adequate nutritional value during active crop growth resulting in increased yield. The most common fertilizer applied was NPK. The impact of hydro-meteorological information on the time and the choice of method in application are important. Fertilizer application occurs mostly in August however there is tendency for the process to be postponed when there is a prediction for delayed rains or when rains are erratic. Farmers within these communities either use broadcasting or placement in the application of fertilizer. Broadcasting is used to spread fertilizers all over the field to allow a uniform mix with the soil. This is usually the case in large scale production and where there are large scale doses of fertilizers to be applied. Although, this method is fast and less tedious nutrients are not fully utilized by plant roots due to the distance. This method is also prone to nutrient losses with any change in climatic conditions. The placement method on the other hand, requires placement of fertilizer in small holes in the soil regardless of the position of the crop. Before application, the soil moisture content is required to be high. This process can be time consuming but minimizes nutrient losses. In the end, majority of farmers made decisions largely inspired by the logic of

consequentiality where factors such as hydro-meteorological information, financial capacity of farmer, perceived high yield associated with using a particular method and type of fertilizer influences the farmers' decision.

4.3.6 Impact of Hydro-meteorological Information on Harvesting

Harvesting is the last stage in the farming cycle and also represents the stage where hydro-meteorological information is least used. For most crops, the period between September and October is noted for harvesting. The choice to use manual labour or combined harvesters at this stage is dependent on size of the family, size of farmland or financial capacity. Farmers with large family size and relations rely on manual labour although it could take more days to complete. The use of combined harvesters on the other hand is limited and more expensive although it takes less time to harvest. Once crops are matured, hydro-meteorological information is hardly used. Conditions that predominantly influence farmers' decision at this point are market conditions, financial capacity, and estimate output from the farm. Nonetheless, erratic and unexpected rainfalls during harvesting can influence harvesting and storage decisions.

Overall, it is evident that farmers within the Bontanga communities operate under different conditions where multiple variables, risk profiles and complex interactions as well as hydro-meteorological information impact most of their decisions. In support of findings of Mabe et al., (2014), I argue that the range of potential application of hydro-meteorological forecasts among farmers within the Bontanga communities is large.

Fig. 7. illustrates key decision points in farming and impact of hydro-meteorological information.

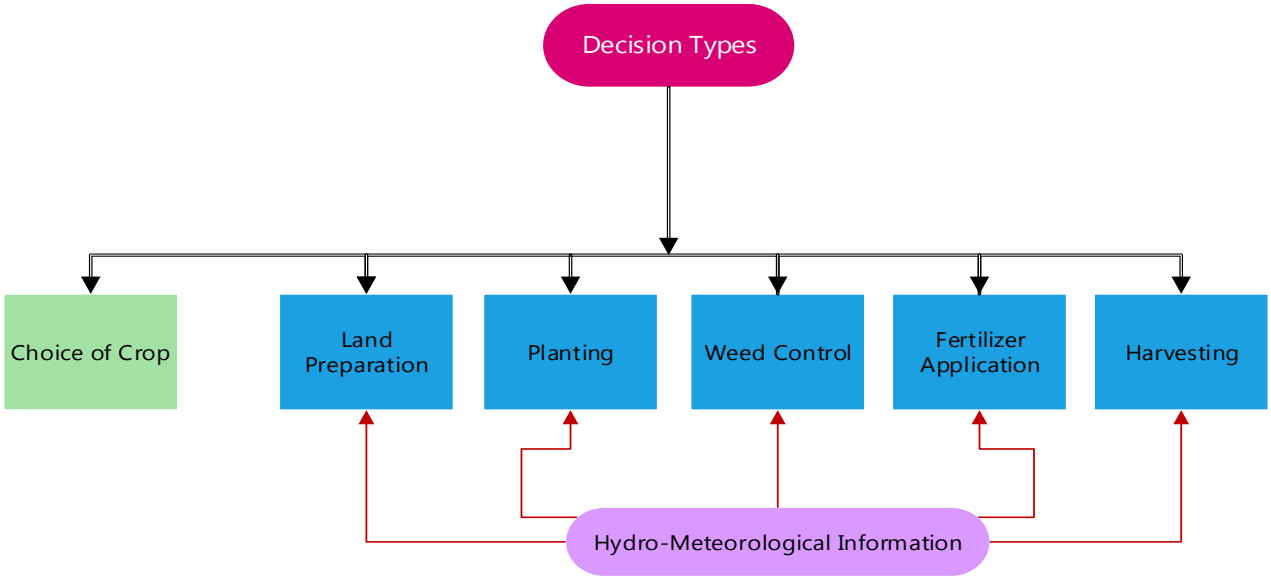


Fig. 7 shows impact of hydro-meteorological information on decision types in farming

4.4 Discussion

4.4.1 Increasing the value of Hydro-meteorological Information in Decision Making

For farmers, accurate and reliable climate information offers significant benefits in making decisions in all stages within the cropping cycle (Soropa et al., 2015). As presented in the result, although the value attached to information varied with regards to the type of farming and the stages of the cropping cycle, the overall relevance is dependent on timely access, knowledge creation and availability of farm resources to effect changes in production decisions in line with forecasts (Tall et al., (2012).

The existence of both formal and informal information systems within the Bontanga communities enables information dissemination and decision making by both rain fed and irrigation farmers. However, it is important for hydro-meteorological information providers seeking to make impact, to re-look into current modules of information dissemination.

Firstly, the weakened chain of information coordination and the absence of the role of extension officers through the District Assembly programmes offer significant insight into how information flow from this chain could have limited impact without adequate supervision and

accountability. Secondly, the high ratings of radio and mobile phones as information preference source and the emphasis on local language shows how farmers could reject information transmitted through any other source which does not take into account the availability and accessibility of these media. Thirdly, the strong belief in indigenous knowledge in the prediction of weather patterns implies that, hydro-meteorological information provided through modern scientific media must match with indigenous knowledge as contradictions could lead to rejection of new information. Lastly, although, there is a decline in preference of social networks as information source, farmers owe allegiance and belong to various religious groups and perform sacrifices necessary for averting risks. Insight into the timing and place of activities of these religious groups could create opportunity for information providers to share relevant information and understand the information needs of farmers. Traditional authorities who do not consider information dissemination as part of their role in-spite of their vast knowledge could equally be engaged through this process. Within the irrigation system, although water availability within the reservoir makes water dependent decisions less stressful, hydro-meteorological information could provide information for tracking water levels within the reservoir. The decentralised system operated within the scheme coupled with the partnership between MOFA, GIDA and GMET could serve as avenues for channelling hydro-meteorological information to farmers.

4.4.2 Connecting Information to Decision Making in Food Production

Through knowledge, experience and sense making, people give meaning to their worlds, which informs the decisions they make and ultimately the action they take. Within the Bontanga communities it was evident that, aside from water needs farmers encounter other challenges which inhibit the effective linkage of information to decision making. Such challenges include social norms, material and financial resources and the competence to adapt to changing climatic conditions. For instance in the choice of crop, decisions are based on feel right factor. In this instance, the reward associated with following appropriate behaviour to ensure preservation of culture and identity outweighs the calculation of utilities associated with making satisfactory decisions (March, 1991). The implication is that, hydro-meteorological information targeted at crop choice will have little impact since decisions are pre-determined.

The works of (Willock et al. 1999) also highlight how farmers are reluctant to use forecast if it contradicts social norms. Providing only hydro-meteorological information with the aim of impacting crop choice especially where a non-native crop is being recommended risks the chance of being used. Nonetheless practices are not permanent. A comprehensive strategy including education on the relevance of the new crop, provision of farm inputs, capacity building workshops to equip farmers with skills, advice on best practice specific to new crop and lastly, provision of monitoring services could offer an opportunity in this regard.

Furthermore, other decision types (land preparation, planting, weed control, application of fertilizer and harvesting) which are largely inspired by the logic of consequentiality offer opportunities for use of hydro-meteorological information. Yet, all material and financial resources ought to be met before decisions can be made. In essence, it is important to take into account the extent to which the aforementioned external factors constrain adaptive decision making. Hydro-meteorological information providers should engage in effective partnerships with all users within the agricultural value chain to ensure that information provision is framed within the capacities of farmers to ensure a holistic approach to knowledge co-creation and information utilization.

4.4.3 Reflection on Theories

The study leveraged on the combined effects of 3 theories namely the Practice theory, Logic of Appropriateness and the Logic of Consequentiality. In an attempt to understand how the elements of practice are constituted in the decision making practice of farmers, practice theory enabled a broadened vision of decision making. It provided alternative insight to the often narrowed theoretical framing of human action as series of conscious choices which largely ignores the complexities of daily life. The disaggregation of the analysis into 3 components (meaning, material, competence) examined decision making practice as the phenomenon of inquiry and not individual behaviours which provides a nook in the cranny for influence and appropriate intervention. In particular it addresses the question of materiality and role of things and technologies in decision making. For instance it was evident from the analysis that, although meanings associated with hydro-meteorological information has gained relevance

among farmers, action is taken only after all 3 essential components are linked. This analysis can thus enable strategic interventions to be targeted at the ”complex but rigorous web of interrelating factors which can form the basis for a multi-layered behaviour change strategy” (Warde, 2005).

The combined use of social practice, logic of appropriateness and the logic of consequentiality in studying the impact of hydro-meteorological information on decision types in farming, provided evidence of how decisions with regards to choice of crops can be understood as productive labour and identity symbol where farmers express their aspirations, dreams and preserve their tradition. This implies that decisions relating to crop choice can hardly be changed as they are not determined at the individual level but highly influenced by structural factors (Bourdieu, 2002).

In analysing decisions with regards to land preparation, planting, weedicide control, fertilizer application and harvesting; the combined value of the logic of appropriateness and the logic of consequentiality enabled a view on the importance of hydro-meteorological information in decision making. Specifically, it shows how the farmer is inspired to make timely and right decisions at every stage but yet limited but several factors which results in evaluation of alternatives and outcomes (Simon, 1972).

These theories thus reveal how decision making in this context have large scale and complex roots which requires a broad range of comprehensive approach involving key stakeholders within the agricultural value chain to initiate any meaningful change (Marsden et al., 2014).

5.0 Conclusion

The study sought to assess hydro-meteorological information sources available to farmers and how they impact decision-making practices in food production with specific objectives as: investigating available hydro-meteorological information sources available to farmers and how they are accessed, determining the elements of practice constituted in farmer's decision making and analysing the extent to which hydro-meteorological information impacts farmers' decisions in food production.

Primary data was collected from a total of 74 farmers in interviews and focus group discussions and 15 respondents from hydro-meteorological information providers. Both probability and non-probability sampling techniques were used to select respondents. Stage one involved purposive selection of the 6 communities while stage two involved simple random sampling technique to select respondents from within the communities. Obtained data were analysed using Atlas.ti.

Findings revealed that, both formal and informal systems exist which made information seeking and provisioning within this context multi-faceted. Farmers accessed information through radios, mobile phones and television sets within the formal sector. Informal means of access included, indigenous knowledge, religious beliefs, family and friends. It also emerged that, farmers access was largely influenced by the salience, legitimacy and credibility of information with radio being the highest preferred source with (59%), followed by mobile phones (33%) and lastly television with (8%).

In relation to elements of practice constituted in decision making, the results revealed that, several factors including feelings of trust, risk perceptions and fear of failure and less anticipated misfortunes were associated with meaning of hydro-meteorological information. In addition material elements such as access to land, water availability, farm machineries, farm inputs, capital, were all required at different stages of the cropping cycle to make timely decisions. To combine the use of these social and material resources required farmers'

technological skills as well as experience. The different, yet, mutually shaping and supporting elements need to be in place for decision making to be performed as a practice.

Lastly, to assess the extent to which hydro-meteorological information impacts on decision types in farming, findings indicated that, choice of crop was not informed by hydro-meteorological information. Most farmers exhibited rule following behaviour in their decisions with regards to choice of crop. On the other hand, decisions with regards to land preparation, planting, weed control, fertilizer application and harvesting were largely inspired by the logic of consequentiality where hydro-meteorological information was deemed crucial in decision making.

5.1 Recommendation

Based on the findings, the following recommendations are made:

I. Based on preference for radio and mobile phones, information providers should target the use of these media and focus on the use of local language in information dissemination. Additionally, information provided should describe complex weather phenomenon in a manner which is easily understood by farmers by relating the forecast to everyday happening. Questions such as when the rains will begin and end, what will be the rainfall intensity, what the precipitation type will be, how much total rainfall is expected and what the impact of that will be on daily activities need to be included in future forecast to enable farmers make meaningful decisions and prepare in advance for any future eventuality.The use of EVOs to enable users to share relevant information has potential in this regard.

II. Government and Telecommunication network providers should ensure provision of the required infrastructure (electricity, network coverage) in respective communities to increase access to information.

III. EVOCAs should engage all stakeholders within the agricultural value chain such as input dealers, buyers, financial institutions, machinery and equipment suppliers. A virtual community sustained by interacting organizations and individuals will provide the platform to deal with factors which constrain adaptive decision making.

IV. Information providers and institutions need to play more active role in their engagement with farmers to be able to understand their needs and also to build trust.

V. Information providers should ensure provision of accurate forecast through the provision of short-term forecasts. The use of real-time integrated monitoring systems into weather stations and future EVOs to produce real-time alerts will ensure credibility of the system. Medium and long term forecasts which come with uncertainties should be minimized or communicated to farmers with uncertainty. In addition, the provision of daily rather than weekly forecasts should be explored.

VI. Information providers seeking to make impact on choice of crop should consider factors found to have significant effects on crop choice (traditional crops, skills & experience in crop cultivation, market imperatives, gender) before engaging farmers.

5.2 Further Studies

Current information provided via mobile phones is paid for by donor organisations. The system which was originally operated by ESOKO required individual farmers to pay. However due to some anomalies, the system was halted and future modalities are being determined. Although some studies exist to show the willingness of farmers to pay for such services, there is no study in this context. Considering the economic capacity of farmers, it will be important for further studies to be carried out to investigate the willingness of farmers and under what conditions they will like to pay for such service. A follow up research is welcomed in this area.

References

Abdul-Malik, A., & Mohammed, A. (2012). Technical efficiency of beekeeping farmers in Tolon-Kumbungu district of Northern region of Ghana. *Journal of Development and Agricultural Economics*, *4*(11), 304–310. https://doi.org/10.5897/JDAE12

Akinnagbe, O. M., Attamah, C. O., & Igbokwe, E. M. (2015). Sources of Information on Climate Change among Crop Farmers in Enugu North Agricultural Zone , Nigeria, *2*(11), 27–33.

Alhassan, M., Loomis, J., Frasier, M., Davies, S., & Andales, A. (2013). Estimating Farmers' Willingness to Pay for Improved Irrigation: An Economic Study of the Bontanga Irrigation Scheme in Northern Ghana. *Journal of Agricultural Science*, *5*(4). https://doi.org/10.5539/jas.v5n4p31

Amuda, J. M., & Thompson, E. S. (2010). Information provision for sustainable agricultural production in the Tolon- Kumbungu district of the northern region, Ghana. *Ghana Library Journal*, *22*(1–2), 22–34.

Anjum, R. (2015). Design of mobile phone services to support farmers in developing countries, (December), 2–72.

Archer, M. (2004). Structure, Agency, and the Internal Conversation. *Contemporary Sociology: A Journal of Reviews*, *33*(6), 731–732. https://doi.org/10.1177/009430610403300664

Armah, F. A., Yawson, D. O., Yengoh, G. T., Odoi, J. O., & Afrifa, E. K. A. (2010). Impact of Floods on Livelihoods and Vulnerability of Natural Resource Dependent Communities in Northern Ghana. *Water*, *2*(2), 120–139. https://doi.org/10.3390/w2020120

Arndt, C., Asante, F., & Thurlow, J. (2015). Implications of climate change for Ghana's economy. *Sustainability (Switzerland)*, *7*(6), 7214–7231. https://doi.org/10.3390/su7067214

Artikov, I., Hoffman, S. J., Lynne, G. D., Zillig, L. M. P., Hu, Q., Tomkins, A. J., … Waltman, W. (2006). Understanding the influence of climate forecasts on farmer decisions as planned behavior. *Journal of Applied Meteorology and Climatology*, *45*(9), 1202–1214. https://doi.org/10.1175/jam2415.1

Asante, F., & Amuakwa-Mensah, F. (2014). Climate Change and Variability in Ghana:

Stocktaking. *Climate*, *3*(1), 78–99. https://doi.org/10.3390/cli3010078

Bals, C., Harmeling, S., & Windfuhr, M. (2008). Climate change, food security and the right to adequate food. *Diakonisches Werk Der Evangelischen Kirche in Deutschland*, 8–196. Retrieved from https://germanwatch.org/klima/climfood.htm

Barros, G. (2010). Herbert A. Simon and the concept of rationality: boundaries and procedures. *Revista de Economia Política*, *30*(3), 455–472. https://doi.org/10.1590/S0101-31572010000300006

Bell, D. E., Raiffa, H., & Tversky, A. (1988). Descriptive, normative, and prescriptive interactions in decision making. In *Decision making: descriptive, normative, and prescriptive interactions* (pp. 9–30). https://doi.org/10.1017/CBO9780511598951

Bernard, H. R. (2006). *Research methods in Anthropology*. *Psychological Methods*. https://doi.org/10.1525/aa.2000.102.1.183

Bhattacherjee, A. (2012). *Social Science Research: principles, methods, and practices*. *Textbooks collection* (Vol. 9). https://doi.org/10.1186/1478-4505-9-2

Bourdieu, P. (1977). Structures and the habitus. *Outline of a Theory of Practice*, 72–96. https://doi.org/http://dx.doi.org/10.1017/CBO9780511812507

Bourdieu, P. (1984). The Habitus and the Space of Lifestyles. *Distinction: A Social Critique of the Judgment of Taste*, (1984), 169–180. https://doi.org/10.1016/0376-6357(79)90009-3

Bourdieu, P. (2005). Habitus. In *Habitus: A Sense of Place* (pp. 43–52). https://doi.org/307.76 HAB

Busck, A. G. (2002). Farmers' Landscape Decisions: Relationships between Farmers' Values and Landscape Practices. *Sociologia Ruralis*, *42*(3), 233–249. https://doi.org/10.1111/1467-9523.00213

Cash, D., Clark, W. C., Alcock, F., Dickson, N., Eckley, N., & Jger, J. (2003). Salience, Credibility, Legitimacy and Boundaries: Linking Research, Assessment and Decision Making. *SSRN Electronic Journal*. https://doi.org/10.2139/ssrn.372280

Chatterjee, K., & Bonsall, P. (2009). Special Issue on Evaluation of programmes promoting voluntary change in travel behavior. *Transport Policy*, *16*(6), 279–280. https://doi.org/10.1016/j.tranpol.2009.10.001

Churi, A. J., Mlozi, M. R. S., Tumbo, S. D., & Casmir, R. (2012). Understanding Farmers Information Communication Strategies for Managing Climate Risks in Rural Semi-Arid Areas , Tanzania Description of the Study Area, *2*(11), 838–845.

Connor, R. E. O., Yarnal, B., Neff, R., Bord, R., Wiefek, N., Reenock, C., … Knight, C. G. (2000). Views of Community Water System Managers in Pennsylvania â€™ s Susquehanna River Basin â€™ management plan alerts CWSs of impending, *35*(6), 1411–1419.

Cross, R., & Sproull, L. (2004). More Than an Answer: Information Relationships for Actionable Knowledge. *Organization Science*, *15*(4), 446–462. https://doi.org/10.1287/orsc.1040.0075

Cubasch, U., Wuebbles, D., Chen, D., Facchini, M. C., Frame, D., Mahowald, N., & Winther, J.-G. (2013). Introduction in Climate Change 2013. *Intergovernmental Panel on Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*, 119–158. https://doi.org/10.1017/CBO9781107415324.007

Davis, K. (2009). The important role of extension systems, agriculture and climate change: An agenda for negotiation in Copenhagen. *2020 Vision for Food, Agriculture and the Environment*, *16*(11), 1–2. Retrieved from www.ifpri.org

E. Ekong. (2003). *Rural sociology: An Introduction and Analysis of Rural Nigeria. Uyo, Nigeria: Dove Publishers*.

Emerson, R., Fretz, R., Shaw, L., & Emerson, R. (1995). In the field: Participating, observing, and jotting notes. *Writing Ethnographic Field Notes*, 17–65. https://doi.org/10.1037/0022-3514.90.4.644

Etwire, P. M., Buah, S., Ouédraogo, M., Zougmoré, R., Partey, S. T., Martey, E., … Bayala, J. (2017). An assessment of mobile phone-based dissemination of weather and market information in the Upper West Region of Ghana. *Agriculture & Food Security*, *6*(1), 8.

https://doi.org/10.1186/s40066-016-0088-y

Ghana Statisical Service (GSS). (2014). 2010 Population & Housing Census. District Analytical Report: Kumbungu District.

Giddens, A. (1984). Elements of the Theory of Structuration. *The Constitution of Society: Outline of the Theory of Structuration*, 1–40. https://doi.org/10.1111/j.1468-5914.1983.tb00463.x

Guell, C., Panter, J., Jones, N. R., & Ogilvie, D. (2012). Towards a differentiated understanding of active travel behaviour: Using social theory to explore everyday commuting. *Social Science and Medicine*, *75*(1), 233–239. https://doi.org/10.1016/j.socscimed.2012.01.038

Haigh, T., Takle, E., Andresen, J., Widhalm, M., Carlton, J. S., & Angel, J. (2015). Mapping the decision points and climate information use of agricultural producers across the U.S. Corn Belt. *Climate Risk Management*, *7*, 20–30. https://doi.org/10.1016/j.crm.2015.01.004

Hallegatte, S. (2004). The value of hydro - meteorological information. *Ecole Nationale de La Météorologie, Météo-France and*, *4*, 10. Retrieved from ftp://ftp.wmo.int/Documents/PublicWeb/dra/eur/SEB_Conf_Oct2011/presentations/RA6SEB_S3_Perron_HydrometInfo_MF.pdf

Hiwasaki, L., Luna, E., Syamsidik, & Shaw, R. (2014). Process for integrating local and indigenous knowledge with science for hydro-meteorological disaster risk reduction and climate change adaptation in coastal and small island communities. *International Journal of Disaster Risk Reduction*, *10*, 15–27. https://doi.org/10.1016/j.ijdrr.2014.07.007

Holden, M. T., & Lynch, P. (2004). Choosing the Appropriate Methodology: Understanding Research Philosophy. *The Marketing Review*, *4*(4), 397–409. https://doi.org/10.1362/1469347042772428

Huber, G. P. (1981). The Nature of Organizational Decision Making and the Design of Decision Support Systems. *MIS Quarterly*, *5*(2), 1–10. https://doi.org/10.2307/249220

Ingram, J., Shove, E., & Watson, M. (2007). Products and Practices: Selected Concepts from Science and Technology Studies and from Social Theories of Consumption and Practice. *Design Issues*, *23*(2), 3–16. https://doi.org/10.1162/desi.2007.23.2.3

Jenkins, A., Velandia, M., Lambert, D. M., Roberts, R. K., Larson, J. A., English, B. C., & Martin, S. W. (2011). Factors influencing the selection of precision farming information sources by cotton producers. *Agricultural and Resource Economics Review*, *40*(2), 307–320.

Kankam-Yeboah, K., Amisigio, B., & Obuobi, E. (2010). Climate Change Impacts on Water Resources in Ghana. *Climatic Change*, *15*(1), 83–93. https://doi.org/10.1007/bf00138847

Karpouzoglou, T., Zulkafli, Z., Grainger, S., Dewulf, A., Buytaert, W., & Hannah, D. M. (2015). Environmental Virtual Observatories (EVOs): Prospects for knowledge co-creation and resilience in the Information Age. *Current Opinion in Environmental Sustainability*, *18*, 40–48. https://doi.org/10.1016/j.cosust.2015.07.015

Klaes, M. (2005). A Conceptual History of the Emergence of Bounded Rationality. *History of Political Economy*, *37*(1), 27–59. https://doi.org/10.1215/00182702-37-1-27

Kuijer, P. P., Verbeek, J. H., Visser, B., & Elders, L. A. (2014). An evidence-based multidisciplinary practice guideline to reduce the workload due to lifting for preventing work-related low back pain. *Annals of Occupational and Environmental Medicine*, *26*(16), 1–9. https://doi.org/10.1186/2052-4374-26-16

Kunstmann, H., Jung, G., Wagner, S., & Clottey, H. (2008). Integration of atmospheric sciences and hydrology for the development of decision support systems in sustainable water management. *Physics and Chemistry of the Earth, Parts A/B/C*, *33*(1–2), 165–174. https://doi.org/10.1016/j.pce.2007.04.010

Lankshear, C., & Knobel, M. (2006). *New Literacies. Everyday Practices and Classroom Learning*. *Learning*. https://doi.org/10.1093/deafed/enj039

Mabe, Nketiah, D. 2014. (2014). RJOAS, 12(36), December 2014. *Rjoas*, *12*(36), 34–44.

Mabe, F. N., Sienso, G., & Donkoh, S. A. (2014). Determinants of Choice of Climate Change Adaptation Strategies in Northern Ghana. *Research in Applied Economics*, *6*(4), 75. https://doi.org/10.5296/rae.v6i4.6121

Maddison, D. (2007). The Perception of and Adaptation to Climate Change in Africa. *Policy Research Working Paper*, (August), 53.

https://doi.org/http://elibrary.worldbank.org/doi/pdf/10.1596/1813-9450-4308

Magnusson, W. E. (2014). “Population” and “community” are still not useful to conservation biology - reply to Prado & El-Hani 2013. *Natureza a Conservacao*. https://doi.org/10.4322/natcon.2014.016

Malikail, J. (2003). Moral Character: Hexis, Habitus And `Habit’. *Minerva - An Internet Journal of Philosophy*, *7*, 1–22.

March, J. G. (1991). How Decisions Happen in Organizations, *6*, 95–117.

March, J. G., & Heath, C. (1994). A Primer on Decision Making: How Decisions Happen. *Gestión Y Politica Pública*, p. 289.

March, J. G., & Olsen, J. P. (2009). The Logic of Appropriateness. In *The Oxford Handbook of Public Policy*. https://doi.org/10.1093/oxfordhb/9780199548453.003.0034

Martin-Clouaire, R., & Rellier, J. P. (2009). Modelling and simulating work practices in agriculture. *International Journal of Metadata, Semantics and Ontologies*, *4*(1/2), 42. https://doi.org/10.1504/IJMSO.2009.026253

Mason, S., Kruczkiewicz, A., Ceccato, P., & Crawford, A. (2015). Accessing and Using Climate Data and Information in Fragile , Data-Poor States, (May), 1–27. Retrieved from https://www.iisd.org/sites/default/files/publications/accessing-climate-data-information-fragile-data-poor-states.pdf

McKenzie, C. R. M. (1996). Judgement and decision making. *Handbook of Cognition*, 321–338. https://doi.org/doi:10.1146/annurev.psych.49.1.447

Medium, D., & Development, T. (2017). KUMBUNGU DISTRICT ASSEMBLY, (November 2013).

Mintzberg, H., Raisinghani, D., & Theoret, A. (1976). The Structure of “Unstructured” Decision Processes. *Administrative Science Quarterly*, *21*(2), 246. https://doi.org/10.2307/2392045

Moloney, S., Horne, R. E., & And Fien, J. (2010). Transitioning to Low Carbon Communities – From Behaviour Change to Systemic Change: Lessons from Australia. *Energy Policy Dec*. https://doi.org/10.1016/j.enpol.2009.06.058

Motha, R. P., & Baier, W. (2005). Impacts of present and future climate change and climate variability on agriculture in the temperate regions: North America. *CLIMATIC CHANGE*, *70*(1–2), 137–164. https://doi.org/10.1007/s10584-005-5940-1

Müller-Kuckelberg, K. (2012). Climate Change and its Impact on the Livelihood of Farmers and Agricultural Workers in Ghana, (July), 1–47.

O'Leary, Z. (2010). The Essential Guide to Doing Your Research Project: Zina O'Leary. *London [Etc.]: Sage*, 196.

Ogallo, L. (2010). The mainstreaming of climate change and variability information into planning and policy development for Africa. In *Procedia Environmental Sciences* (Vol. 1, pp. 405–410). https://doi.org/10.1016/j.proenv.2010.09.028

Onwuemele, A. (2014). Access and Utilization of Climate Services among Vulnerable Communities in Nigeria : A Case Study of Isoko Communities in Delta State, *6*(2), 15–24.

Onyango, E., Ochieng, S., Awiti, A., Onyango, E., Ochieng, S., & Awiti, A. O. (2014). Weather and climate information needs of small- scale farming and fishing communities in western Kenya for enhanced adaptive potential to climate change Weather and climate information needs of small-scale farming and fishing communities in western Kenya , (January), 187–193.

Patt, A., & Gwata, C. (2002). Effective seasonal climate forecast applications: Examining constraints for subsistence farmers in Zimbabwe. *Global Environmental Change*. https://doi.org/10.1016/S0959-3780(02)00013-4

Pelzer, K. J. (1978). The Moral Economy of the Peasant. Rebellion and Subsistence in Southeast Asia, by James C. Scott (Book Review). *Pacific Affairs*. https://doi.org/10.2307/2064685

Ramos, M. H., Van Andel, S. J., & Pappenberger, F. (2013). Do probabilistic forecasts lead to better decisions? *Hydrology and Earth System Sciences*, *17*(6), 2219–2232. https://doi.org/10.5194/hess-17-2219-2013

Reckwitz, A. (2002). Toward a Theory of Social Practices. *European Journal of Social Theory*, *5*(2), 243–263. https://doi.org/10.1177/13684310222225432

Reckwitz, a. (2002). Toward a theory of social practices. *European Journal of Sociology*, *5*(2), 243–263.

Rengalakshmi, R. (2007). Localized climate forecasting system: Seasonal climate and weather prediction for farm-level decision-making. In *Climate Prediction and Agriculture: Advances and Challenges* (pp. 129–134). https://doi.org/10.1007/978-3-540-44650-7_13

Resources, W. (2016). Held from 12, *2016*(December).

Risiro, J., Mashoko, D., Tshuma, T., & Rurinda, E. (2012). Weather Forecasting and Indigenous Knowledge Systems in Chimanimani District of Manicaland , Zimbabwe. *Journal of Emerging Trends in Educational Research and Policy Studies*, *3*(4), 561–566.

Rocher, G., & Lefort, C. (1990). Democracy and Political Theory. *Contemporary Sociology*, *19*(5), 700. https://doi.org/10.2307/2072337

Schatzki, T. R. (1997). Practices and Actions A Wittgensteinian Critique of Bourdieu and Giddens. *Philosophy of the Social Sciences*, *27*(3), 283–308. https://doi.org/10.1177/004839319702700301

Schatzki, T. R. (2001). Introduction: Practice theory. In *The Practice Turn in Contemporary Theory* (pp. 10–23). https://doi.org/10.4324/9780203643778

Schulz, M., & Schulz, M. (2014). Logic of Consequences and Logic of Appropriateness Logic of Consequences and Logic of Appropriateness.

Schwartz, B., Ward, A., Monterosso, J., Lyubomirsky, S., White, K., & Lehman, D. R. (2002). Maximizing versus satisficing: Happiness is a matter of choice. *Journal of Personality and Social Psychology*, *83*(5), 1178–1197. https://doi.org/10.1037/0022-3514.83.5.1178

Scott, C. A. (2011). The water-energy-climate nexus: Resources and policy outlook for aquifers in Mexico. *Water Resources Research*, *47*(12). https://doi.org/10.1029/2011WR010805

Shove, Elizabeth and Pantzar, M., Shove, E., & Pantzar, M. (2012). Connections between practices. *The Dynamics of Social Practice: Everyday Life and How It Changes*, 81–97. https://doi.org/10.4135/9781446250655

Shove, E., & Pantzar, M. (2005). Consumers, Producers and Practices. *Journal of Consumer Culture*, *5*(1), 43–64. https://doi.org/10.1177/1469540505049846

Shove, E., Pantzar, M., & Watson, M. (2012a). The Dynamics of Social Practice. *The Dynamics of Social Practice. Everyday Life and How It Changes*, 1–19. https://doi.org/10.4135/9781446250655.n1

Shove, E., Pantzar, M., & Watson, M. (2012b). The Dynamics of Social Practice: Everyday Life and How it Changes, (November). https://doi.org/10.4135/9781446250655

Simon, H. (1972). Theories of Bounded Rationality. *Decision and Organization*. https://doi.org/http://innovbfa.viabloga.com/files/Herbert_Simon___theories_of_bounded_rationality___1972.pdf

Simon, H. A. (2002). Administrative Behavior: A Study of Decision-Making Processes in Administrative Organizations. By SIMON (HERBERT A.). *The Economic Journal*, *62*(4), 621–622. https://doi.org/10.1111/1468-0297.t01-17-00050

Singh, C., Daron, J., Bazaz, A., Ziervogel, G., Spear, D., Krishnaswamy, J., … Kituyi, E. (2017). The utility of weather and climate information for adaptation decision-making: current uses and future prospects in Africa and India. *Climate and Development*, *0*(0), 1–17. https://doi.org/10.1080/17565529.2017.1318744

Soropa, G., Gwatibaya, S., Musiyiwa, K., Rusere, F., Mavima, G. A., & Kasasa, P. (2015). Indigenous knowledge system weather forecasts as a climate change adaptation strategy in smallholder farming systems of Zimbabwe: Case study of Murehwa, Tsholotsho and Chiredzi districts. *African Journal of Agricultural Research*, *10*(10), 1067–1075. https://doi.org/10.5897/AJAR2013.7205

Spotswood, F., Chatterton, T., Tapp, A., & Williams, D. (2015). Analysing cycling as a social practice: An empirical grounding for behaviour change. *Transportation Research Part F: Traffic Psychology and Behaviour*, *29*, 22–33. https://doi.org/10.1016/j.trf.2014.12.001

State, A. (2014). Sources of Information on Climate Change among Arable Crop Farmers , In Adamawa State , Nigeria, *7*(8), 32–36.

Tall, A., Mason, S. J., Van Aalst, M., Suarez, P., Ait-Chellouche, Y., Diallo, A. A., & Braman, L. (2012). Using seasonal climate forecasts to guide disaster management: The Red Cross experience during the 2008 West Africa floods. *International Journal of Geophysics*, *2012*. https://doi.org/10.1155/2012/986016

Umar, S. (2016). Awareness , Manifestation and Information Sources on Climate Change among Irrigation Farmers in Katsina State , Nigeria. *Scholars Journal of Agriculture and Veterinary Sciences*, *3*(1), 37–41. https://doi.org/10.21276/sjavs

UNFCCC. (2007). Climate Change: Impacts, Vulnerabilities and Adaptation in Developing Countries. *United Nations Framework Convention on Climate Change*, 68. https://doi.org/10.1029/2005JD006289

Van der Geest. (2004). "We're Managing!" Climate Change and Livelihood Vulnerability in Northwest Ghana.

Van der Haar, G., Heijmans, A., & Hilhorst, D. (2013). Interactive research and the construction of knowledge in conflict-affected settings. *Disasters*, *37*(SUPPL.1). https://doi.org/10.1111/disa.12010

Warde, A. (2005). Consumption and Theories of Practice. *Journal of Consumer Culture*, *5*(2), 131–153. https://doi.org/10.1177/1469540505053090

Weber, E. U., & Johnson, E. J. (2009). Mindful judgment and Decision Making. *Annual Review of Psychology*, *60*, 53–85. https://doi.org/DOI 10.1146/annurev.psych.60.110707.163633

WRO. (2011). Farmers' Decision Making, (December). Retrieved from http://www.walesruralobservatory.org.uk/sites/default/files/Farmers%27 Decision Making Final Report.pdf

Yaro, J. A., Teye, J., & Bawakyillenuo, S. (2015). Local institutions and adaptive capacity to climate change/variability in the northern savannah of Ghana. *Climate and Development*, *7*(3), 235–245. https://doi.org/10.1080/17565529.2014.951018

Ziervogel, G., Cartwright, A., Tas, A., Adejuwon, J., Zermoglio, F., Shale, M., & Smith, B. (2008). Climate change and adaptation in African agriculture, (March).

Appendix 1- Interview Guide

Consent Form

The main objective of the study is to assess hydro-meteorological information sources available to farmers and how this impacts their decision-making practices in food production. This study is a partial fulfillment for the award of an Msc degree in Masters in International Development Studies- Sociology of Development and Change group from the Wageningen University & Research.

You have been randomly selected and I will be grateful if you could kindly participate in my interview. Your participation is completely voluntary and you have the right NOT to participate at all or stop participation at any point in time during the interview.

Apart from your time, there is no cost or remuneration involved. This interview would last for about 25 to 30 minutes and it includes information on biodata, hydro-meteorological information, the factors influencing decision making with regards to use of a particular hydro-meteorological information and finally its impact on choice of crops.

All individual findings will be confidential. All reports produced out of this interview would be anonymous and all analysis would be in general terms.

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Farmers Socio Demographic -Data

Name of Respondent

Sex of respondent

Age of respondent……..years

What is your highest level of formal education?

What is your major occupation?

Are you engaged in other economic activity?

What other economic activities are you engaged in?

How many years have you been farming?

What is your religion?

Hydro-meteorological Information Systems and Access

Are you rain-fed or Irrigation farmer?

What crops do you cultivate?

What is the size of your farm?

Do you receive information on rainfall forecast?

Where do you get information from?

Which medium do you access the information from?

How do you access it?

When do you access it?

Do you have any challenges accessing the information?

Determinants of Information Source Preference

Which is your best information source and why?

Why don't you prefer other sources?

Is there anything they can do to improve their information?

Elements of Practice in Decision Making

Do you make any decisions in your farming?

When you receive the information do you use it?

What do you use the information for?

Do you use the information in making any of your decisions?

Why do you use the information?

What are your motivations to use the information?

How important is the information to you in decision making?

What are the characteristics you look out for the information?

Why do you relate these characteristics to decision making?

Do you need some skills or experience to use the information?

What do you do when you receive the information?

What factors make it possible for you to implement the hydro-meteorological information you have received?

Are there any factors that will prevent you from implementing hydro-meteorological information you have received in decision making?

Do you need the information more at some stages of your decision making?

At what stage do you think you don't need the information?

Impact of hydro-meteorological information on choice of crop

Which crops do you cultivate now?

Why did you choose these crops?

Is your choice based on previously heard hydro-meteorological information?

What will you do in future if rainfall forecast will not favour your current crops?

Why that choice/decision?

Resource persons or institutions providing Hydro-meteorological Information

Do you provide hydro-meteorological information to farmers?

How do you come by this information?

How long have you been providing this information?

How often do you provide this information?

Which medium do you use to disseminate the information?

How accessible is this medium to farmers?

Do farmers pay for the information?

How effective/ineffective has the medium been?

How often do you engage farmers to know if they are satisfied with the information?

Have you done any evaluation on the impact of the information to farmers?

What has been the success rate?

Do you provide any extra support in ensuring maximum use of this information on their decision making practices?

Have you identified any challenge with current dissemination platform?

Any suggestions to improve information flow in future?

Closure: Thank you for your time and participation in this research

Appendix 2- Figures on Bio- Data and Access to Information

Gender

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Female	8	33.3	33.3	33.3
	Male	16	66.7	66.7	100.0
	Total	24	100.0	100.0	

Farming Experience

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	1	4.2	4.2	4.2
	2	1	4.2	4.2	8.3
	4	4	16.7	16.7	25.0
	5	2	8.3	8.3	33.3
	6	3	12.5	12.5	45.8
	7	2	8.3	8.3	54.2
	8	2	8.3	8.3	62.5
	9	1	4.2	4.2	66.7
	10	3	12.5	12.5	79.2
	12	1	4.2	4.2	83.3
	27	1	4.2	4.2	87.5
	30	1	4.2	4.2	91.7
	34	1	4.2	4.2	95.8
	38	1	4.2	4.2	100.0
	Total	24	100.0	100.0	

Level Of Education

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Drop-out	7	29.2	29.2	29.2
	JHS	4	16.7	16.7	16.7
	None	13	54.1	54.1	100.0
	Total	24	100.0	100.0	

Religion

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Muslim	21	87.5	87.5	87.5
	Traditionalist	3	12.5	12.5	100.0

Access to Hydro-meteorological Information

Radio	Mobile Phones	TV	Total	
14	8	2	24	

Preference of Channels

Radio	Mobile Phones	TV	Family & Friends	Total
11	7	4	2	24