Local Knowledge and Livelihood Sustainability under Environmental Change in Northern Ghana

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Acronyms

ADB	Agricultural Development Bank
AEA	Agriculture Extension Agent
AGDP	Agricultural Gross Domestic Product
BiGS	Bonn Interdisciplinary Graduate School for Development Research
BMBF	German Ministry for Education and Research
CBO	Community Based Organisation
CDMT	Community Development Management Training
CPP	Conventions Peoples Party
DAAD	German Academic Exchange Service
DGRD	Department of Geography and Resource Development
EPA	Environmental Protection Agency
ERP	Economic Recovery Programme
FAO	Food and Agriculture Organisation
FSC	Farmer Soil Classification
GLASOD	Global Assessment of Human Induced Soil Degradation
GLSS	Ghana Living Standards Survey
GNP	Gross National Product
GOG	Government of Ghana
GPRS	Ghana Poverty Reduction Strategy
GSS	Ghana Statistical Service
GVP	GLOWA Volta Project
HIPC	Highly Indebted Poor Country
IFAD	International Fund for Agricultural Development
IK	Indigenous Knowledge
IMF	International Monetary Fund
IPCC	Inter-Governmental Panel of Climate Change
ISDR	International Strategy for Disaster Reduction
ISRIC	International Soil Reference and Information Centre
ISSS	International Society for the Systems Sciences (ISSS)
JHS	Junior High School
KND	Kassena-Nankana District
KNDA	Kassena-Nankana District Assembly
LACOSREP	Land Conservation and Smallholder Rehabilitation Project
MCA	Millennium Challenge Account
MISO	Management Information System Officer
MIT	Massachusetts Institute of Technology
MoFA	Ministry of Food and Agriculture
MOH	Ministry of Health
MSD	Meteorological Service Department
NDPF	National Development Policy Framework
NGO	Non-Governmental Organisation
NHIS	National Health Insurance Scheme

NHRC	Navrongo Health Research Centre
NORPREP	Northern Region Poverty Reduction Programme
NR	Northern Region
OM	Organic Manure
PAMSCAD	Programme of Actions to Mitigate the Social Cost of Adjustment
PPMED	Policy, Planning, Monitoring and Evaluation Division
RPK	Rural Peoples Knowledge
SEISUD	Sirigu Ecological Initiative for Sustainable Development
SFP	School Feeding Programme
SHS	Senior High School
SPI	Standard Precipitation Index
TRAX	TRAX Program Support (Ghana)
UER	Upper East Region
UN	United Nations
UNDP	United Nations Development Programme
UNESCO	United Nations Educational, Scientific and Cultural Organisation
UNISDR	United Nations International Strategy for Disaster Reduction
UWADEP	Upper West Agricultural Development Project
UWR	Upper West Region
ZEF	Center for Development Research

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Dedication

I dedicate this thesis to the Derbile Family of Duori-Tankuri, Jirapa District, Ghana. First, I dedicate this work to my daughter Evilaa Derbile who was born in Christchurch, New Zealand during my fieldwork in Ghana. I am also grateful to my wife Lekanatu Guri for her endurance in my absence and for her support during my studies. I am thankful to my father Mr. D. S. Anglaawmine, a retired educationist and my mother Mrs. Gladys Assibi Anglaawmine also an educationist. I am thankful to them for taking me to school in the first place. I am also thankful to them for their encouragement and support throughout my educational career. Thanks also to my Uncle Mr. Richard K. Derbile and the family for their support in various ways. I also dedicate this work to Uncle Ekonye Derbile and family back in Tankuri itself. The support of the family in various ways saw me through to this end.

Deutsche Kurzzusammenfassung

Einleitung

Eine der größten Herausforderungen für die Entwicklung Sub-Sahara-Afrikas – und insbesondere auch für die Nord-Ghanas - wird die Sicherung des Lebensunterhaltes der ländlichen Bevölkerung unter den Bedingungen sich verändernder Umweltbedingungen sein. Das Zusammenwirken von Armut und ökologischem Wandel untergräbt massiv die Anstrengungen der Landbewohner ihre Lebensgrundlage abzusichern. In Ghana sind diese beiden miteinander verwobenen Probleme (Armut und Umweltwandel) nicht gleichmäßig verteilt: sowohl Armut als auch ökologischer Wandel sind im Nordteil des Landes viel stärker ausgeprägt als im südlichen Landesteil. Im Nordosten des Landes basiert die Lebensgrundlage des Großteiles der Bevölkerung auf Landwirtschaft bzw. der Verarbeitung landwirtschaftlicher Produkte. Das heißt auch, dass diese Menschen direkt abhängig sind von der Nutzbarmachung von zusehends stärker degradierten natürlichen Ressourcen unter stets ungünstiger werdenden klimatischen Bedingungen. Das setzt viele kleinbäuerliche Haushalte und deren Lebensunterhaltssicherung der Gefahr von ökologisch bedingten Risiken und Gefahren aus. Diesem Umstand ist es unter anderem geschuldet, dass die Armut im Nordteil Ghanas – und insbesondere im Nordosten des Landes - am gravierendsten ist.

Ein elementarer Auftrag für die Entwicklungsforschung ist demzufolge die Fokussierung auf Innovationen, die zur Sicherung kleinbäuerlicher Lebensunterhaltsstrategien unter sich wandelnden Umweltbedingungen beitragen. Lokales Wissen ist ein potentiell wichtiger Faktor, der entsprechende Innovationen zur Lebensunterhaltssicherung vorantreiben kann. In jüngster Zeit gab es eine verstärkte Beachtung des Umstandes, dass lokales Wissen eine strategische Ressource für Innovationen und nachhaltige Entwicklung ist (Drucker, 1995; Nissen, 2002; Pottier, 2003; Evers und Gerke, 2004). Es ist jedoch noch weitestgehend unklar, inwieweit kleinbäuerliche Haushalte (etwa in der

Studienregion des Atankwidi-Beckens) lokales Wissen anwenden, um ihren Lebensunterhalt unter den Umständen ökologischen Wandels zu sichern.

Diese Dissertation behandelt die zentrale Forschungsfrage: wie reduzieren ländliche Haushalte im Atankwidi-Becken Nordost-Ghanas generell die Verletzbarkeit bzw. Vulnerability ihrer Lebensgrundlagen bedingt durch Umweltwandel? Zur Beantwortung dieser Frage, wurde die vorliegende Studie von der Hypothese, dass lokales Wissen und die lokale Übersetzung von externem Wissen eine entscheidende Rolle bei der Reduzierung dieser Verwundbarkeit spielen, geleitet. Die Konzepte Nachhaltigkeit und Vulnerability und die Rolle von lokalen Wissens werden in diesem Erklärungsansatz miteinander verbunden.

Der Beitrag dieser Dissertation verfolgt für die generelle Entwicklungsforschung ein zweifaches Ziel: erstens soll zu einem besseren Verständnis beigetragen werden, inwieweit Wissen eine treibende Kraft von Innovation und Entwicklung ist; zweitens soll ein Beitrag geleistet werden, die große Lücke ein Stück weit zu füllen, die im Bereich der Wissensvermittlung in lokalen Kontexten definitiv noch besteht.

Konzeptioneller Rahmen

Zunächst sollen an dieser Stelle einige zentrale Begriffe dieser Dissertation näher beleuchtet werden. Diese Begriffe umfassen (1) Umweltwandel, (2) Lebensunterhalt bzw. Livelihood, (3) Vulnerability und (4) lokales Wissen. 1. Umweltwandel in Nord-Ghana ist ein entscheidender Teil des Kontextes, in dem in dieser Studie die Verbindung zwischen lokalem Wissen und Vulnerability untersucht wurden. Konkret bezieht sich Umweltwandel hier auf sich verschlechternde ökologische Faktoren, die zu Stressoren werden, Shocks verursachen oder in extremen Fällen gar Umweltgefahren nach sich ziehen, die sich dauerhaft und sehr negativ auf den Lebensunterhalt vieler Menschen auswirken können (Turner et al., 1990; Dolman und Verhagen, 2003; Adger und Brooks, 2003). 2. Livelihood wird hier als ganzheitliches Konzept verstanden, das alle Aktivitäten umfasst mit denen Menschen ihren Lebensunterhalt bestreiten. Livelihood umfasst aber auch verschiedene auf den Lebensunterhalt ermöglichenden Fähigkeiten und Mittel, und umfasst daher materielle Güter wie Einkommen, Vermögen, Ressourcen und Vorräte aber auch immaterielle Güter wie Ausbildung, Anrechte oder Nutzungsrechte (Chambers und Conway, 1991; Ellis und Freeman, 2005:4). 3.Vulnerability ist die Ausgesetztheit gegenüber bestimmten Risiken oder Schadensmöglichkeiten bzw. die Schwierigkeit mit diesen umzugehen. Vulnerability hat in diesem Kontext zwei Seiten: erstens umfasst es eine externe Komponente, die die Gefahren von Umweltwandel und deren Folgen beinhaltet; zweitens gibt es hier auch einen internen Faktor, der die Risiken der Unfähigkeit oder Schwierigkeit der Anpassung an diese Gefahren betrifft (Chambers, 1989, 2006; Bohle, 2001; van Dillen, 2004; Birkmann 2006). 4. Diese Dissertation macht sich einen multi-dimensionalen Blick auf lokales Wissen zu eigen, der zwei generelle Domänen von Wissen abdeckt. Zum einen umfasst lokales Wissen, so wie es verstanden werden soll, auch indigenes Wissen, welches dadurch gekennzeichnet ist, dass es lokal „produziert“ wurde und innerhalb einer Gruppe über Generation hinweg weitergeben wurde. Dieses Wissen ist nicht statisch, sondern kann sich auch aufgrund von externen Einflüssen ändern (Acre und Fisher, 2003). Zum anderen soll der in dieser Studie benutzte Begriff des lokalen Wissens auch den „Import“ und die lokale Anwendung von externem Wissen beinhalten. Beides steht in diesem Kontext natürlich immer im inhaltlichen Zusammenhang mit der nachhaltigen Sicherung des Lebensunterhalterwerbs von kleinbäuerlichen Haushalten und Gemeinschaften (siehe auch Cohen und Levintal, 1990; Evers, 2003; Gerke und Evers, 2005).

Forschungsziele

Die wichtigste Forschungszielstellung ist die Analyse der Frage, wie kleinbäuerliche Haushalte die Vulnerability ihrer Lebensunterhalte im Kontext von ökologischem Wandel mithilfe von lokalem Wissen reduzieren.

Im Einzelnen sollen folgenden Bereichen untersucht werden:

1. die sich verändernden Zusammensetzungen von Livelihood-Strategien über Generationen hinweg (in Betrachtung der Wechselwirkung der multiplen Risiken, die von Umweltwandel hervorgerufen werden);
2. die auf lokalem Wissen basierenden Strategien, denen kleinbäuerliche Haushalte nachgehen, um die Vulnerability im Bereich der Nahrungsmittelproduktion bei erodierenden Böden zu reduzieren;
3. die auf lokalem Wissen basierenden kleinbäuerlichen Strategien, um insbesondere die Vulnerability im Bereich der Nahrungsmittelproduktion bei zunehmender Regenfallvariabilität;
4. die Muster von Wissensflüssen und „Lokaliserungen" von externem Wissen für die Anpassung von Livelihoods unter den Bedingungen ökologischen Wandels.

Die Studienregion und angewandte Methodologie

Durchgeführt wurde die dieser Dissertation zugrundeliegende Forschung im Atankwidi-Becken in Nordost-Ghana. Dieses Flusseinzugsgebiet ist ein Unterbecken des Beckens des großen westafrikanischen Weissen Voltas. Das Atankwidi-Becken liegt größtenteils auf dem östlichen Teil des Territoriums des Kassena-Nankana-Districts (KND), welcher ein Gesamtfläche von ca. 1.700 m² und gemäß des letzten ghanaischen Census eine Gesamteinwohnerzahl von ungefähr 150.000 Menschen hat. Der KND ist einer von acht Distrikten der Upper East Region (UER). Das Atankwidi-Becken als auch der KND wird – wie es der Name bereits andeutet - größtenteils von zwei ethnischen Gruppen bewohnt: den Kassena und den Nankana. Linguistisch gehören die Kassena zu den Grusi (Niger-Kongo-Sprachfamilie), während die Nankana zur Übergruppe der Nankansi (Mole-Dagbani-Sprachfamilie) zugeordnet werden (Blench, 2005; Laube, 2007; Eguavoen, 2008).

Im Wesentlichen wurden qualitative Forschungsmethoden für die Datenerhebung und –analyse angewandt. Die Erhebung der Daten erfolgte in drei Gemeinden des KND innerhalb des Atankwidi-Beckens. Diese waren Yua, Mirigu (beide vorwiegend von Nankana bewohnt) und Pungu (vorwiegend von Kassena bewohnt). Die Methodik umfasste eine Reihe von Tiefeninterviews in neun zufällig ausgewählten Interviews. Insgesamt wurden 41 Tiefeninterviews in den ausgewählten Haushalten durchgeführt, wobei jedes Interview auf dem vorherigen aufbaute. Mithilfe der Interviews wurden Haushaltsfallstudien entwickelt. Daneben wurden noch andere Participatory Rapid Appraisal (PRA) - Methoden angewandt. Diese umfassen im Einzelnen Fokusgruppendiskussionen, Gruppeninterviews oder teilnehmende Beobachtungen. Erstgenannte Methode wurde insbesondere bei Bauern in Yua, in geringerem Masse aber auch in den anderen beiden Gemeinden angewendet. Verschiedene Interviews wurden zudem mit Mitarbeitern von unterschiedlichen Behörden und Organisationen geführt, deren Tätigkeitsbereiche im Zusammenhang mit den Hauptforschungsgegenständen dieser Studie stehen. Neben diesen qualitativen Forschungsansätzen wurde auch ein Fragebogen basierter Survey durchgeführt, bei dem 131 Haushalte in allen drei Gemeinden nach relevanten Informationen befragt wurden.

Forschungsergebnisse

Diese Dissertation hat eine ganze Reihe von Ergebnissen zur Rolle von lokalem Wissen zur Livelihood-Sicherung von kleinbäuerlichen Haushalten in der Studienregion erzielt. Diese sollen im Folgenden dargestellt werden.

Erstens diversifizieren Haushalte in der Studienregion unter Zuhilfenahme lokalen Wissens ihre Livelihoods zur Minimierung der Risiken von „Totalausfällen“ unter bestimmten Bedingungen. Diversifizierung bleibt auch umgekehrt ein elementarer Bestandteil bei der Neugenerierung von lokalem Wissen, was sich bei der genaueren Analyse über drei Generationen herausgestellt hat.

Zwar bleibt auch bei sich wandelnden Umweltrahmenbedingungen die Subsistenzlandwirtschaft die primäre Lebensunterhaltsstrategie, zugleich aber haben alternative Lebensunterhaltsstrategien, wie Arbeitsmigration und Handel, an Bedeutung gewonnen. Dis ist in erster Linie durch den durch ökologische Bedingungen verursachten erhöhten Anpassungsdruck bedingt. Ein schleichender Prozess der Deagrarisierung ist bei der Analyse über drei Generation hinweg zu beobachten. Im Laufe der Zeit haben sich Migration und (Lebensmittel-)Handel sich als immer essentieller für die soziale, aber auch die ökologische Nachhaltigkeit erwiesen .

Zweitens spielt neben alternativen Erwerbsstrategien aber vor allem lokales Wissen eine elementare Rolle bei der Sicherung des Nahrungsmittelanbaus und zur Erhaltung der Bodenfruchtbarkeit. Auf lokalem Wissen basierenden Techniken umfassen vor allem traditionelle organische Düngemittelapplikation aber auch Maßnahmen zur Bekämpfung der Bodenerosion, wie etwa das Anpflanzen von Grasstreifen. Mit diesen Techniken konnten schon einige Erfolge bei der Stabilisierung der Ernteertragsmengen und dem Schutz erodierender Böden erreicht werden. Zu diesen Erfolgen – zu denen auch das nunmehr in der Studienregion fest etablierte gemeinsame Kompostieren gehört - haben durchaus auch verschiedene ghanaische als auch internationale Organisationen beigetragen.

Drittens trägt lokales Wissen auch maßgeblich zur Reduzierung der Unsicherheiten bei der Nahrungsmittelproduktion bei, die von einer stetig zunehmenden Regenfallvariabilität hervorgerufen wird. Darauf in diesem Bereich basierende Strategien sind z.B. die zeitgleiche Kultivierung von verschiedenen Feldern, der Anbau von dürreresistenten Pflanzen, der vermehrte Anbau von frühreifen Varianten oder Pflanzendiversifizierung. Diese Strategien habe eine hybride Wissensbasis, da sie sowohl auf altem indigenem Wissen, welches von Generation zu Generation weitergegeben wurde, als auch neuen Wissensformen, die von externen Quellen bezogen wurden, beruhen. Für viele Haushalte haben diese Strategien massiv zur Sicherung von Ernteerträgen beigetragen bzw. sogar zu wieder ansteigenden Erntemengen beigetragen.

Viertens zeigen die Forschungsergebnisse, dass lokales Wissen eine strategische Ressource ist und dass entsprechende Wissensströme und der Zugang zu dieser Wissensform generell ein zentrales Element zur Reduzierung von Vulnerability gegenüber den vom Umweltwandel hervorgerufenen Risiken darstellt. (Intergenerationelle) Wissensströme fließen besonders leicht auf der Haushalteebene und auch auf den Ebenen der erweiterten Kernfamilie, der Nachbarschaft und Gemeinde, wobei Verwandschafts- und andere soziale Netzwerke die Muster von Wissensaufnahme und –austausch elementar prägen. Schwieriger ist der Wissensaustausch zwischen verschiedenen Gemeinden. Aber auch gerade der Wissensfluss zwischen Gemeinden hat sich als besonders wichtig herausgestellt für Anpassungsstrategien zur Reduzierung von Vulnerability. Aber auch kommunale Organisationen und externe Behörden spielen eine entscheidende Rolle bei der „Lokalisierung“ von relevantem Wissen.

Schlussbetrachtung

Die wichtigste Schlussfolgerung dieser Studie ist die, dass kleinbäuerliche Haushalte in der Studienregion durch die Anwendung von lokalem Wissen ihre Vulnerability entscheidend reduzieren. Diese Anwendung manifestiert sich in einer ganzen Reihe von Risiko-Management-Strategien. Zu diesen zählen Livelilhood-Diversifizierung, verschiedene lokale Methoden der Bodenkonservierung und Anpassungsstrategien an eine stets größer werdende Regenfallvariabilität im Nahrungsmittelanbau. Alle diese Strategien kombinieren sowohl indigenes Wissen als auch neues, externes Wissen in verschiedenen Formen. Die Systeme lokalen Wissens werden am Leben erhalten durch multiple Mechanismen zur Verbreitung und „Lokalisierung“ innerhalb einer unmittelbaren als auch einer erweiterten Lernumwelt der Haushalte. Wissen fließt demzufolge sehr leicht von einer Generation zur nächsten innerhalb eines Haushaltes aber auch innerhalb von erweiterten Familien- oder andern Sozialnetzwerken, die ganz maßgeblich die „Infrastruktur“ dieser Wissensströme gestalten. Ströme von lokalem Wissen zwischen Gemeinden haben sich als besonders wichtig für Innovationen auf Haushalts- und Gemeindeebenen erwiesen. Aber auch Organisationen verschiedenster Prägung tragen massiv zur Verbreitung von relevantem Wissen und dessen „Lokalisierung“ auf der Gemeindeebene bei.

Diese Ergebnisse leisten einen Beitrag dazu zu verstehen, wie – in der Forschungsregion und darüber hinaus – lokales Wissen unter Bedingngen des Umweltwandels als entscheidende Kraft für Innovation und Entwicklung wirkt. Darüber hinaus ist es der Anspruch dieser Dissertation, einen Beitrag zu leisten, die existierende Lücke im Bereich der Wissenstransferforschung ein Stück weit zu schließen. Dies gilt insbesondere für den Kontext von Livelihood-Studien generell als auch solche mit einem Fokus auf Nord-Ghana im Speziellen.

INTRODUCTION

I. Background and research problem

One of the most daunting challenges of development in Sub-Saharan Africa, and northeastern Ghana in particular, is how to secure livelihoods for rural populations under environmental change. The coincidence of poverty and environmental change undermine the efforts of rural populations towards sustaining their livelihoods. In Ghana, the 'twin' problems of 'poverty' and 'environmental change' are not evenly distributed. The incidence of poverty and environmental change are both higher in northern Ghana than in the southern half of the country. Against this background, rural households in northeastern Ghana largely depend on farming and agro-processing for their livelihoods. These livelihoods therefore, depend on the direct utilization of degraded natural resources and unfavourable climatic conditions. This exposes rural households to multiple environmental risks and shocks in the pursuit of their livelihoods. For this reason, most rural livelihoods have become vulnerable to environmental change. This sometimes results in unsustainable livelihood outcomes for households. In northeastern Ghana, the poverty is partly attributed to the impact of environmental change on people's livelihoods. This underscores the need for innovations for sustaining rural livelihoods under such difficult environmental conditions. Local knowledge is one such domain that has the potential for reducing livelihood vulnerability to environmental change especially for rural populations.

In recent times, there has been increased recognition that local knowledge is a strategic resource and driver of innovations for sustainable development (Marsden, 1990; Drucker, 1995; Antweiler, 1998; Chambers, 1999; Nuffic and UNESCO, 1999; Nissen, 2002; Pottier, 2003; Ramphele, 2004; Aluma, 2004; Sillitoe, 2004). However, it is unclear how rural households are involved with local knowledge for sustaining livelihoods under environmental change in the *Atankwidi* basin, northeastern Ghana. Hence, the following question captures the problem addressed in this study: *How are rural households reducing livelihood vulnerability to environmental change through local knowledge in* *the Atankwidi basin, northeastern Ghana?* To explore this problem, I set out with the assumption that *'local knowledge and the localization of knowledge from external sources play a major role in reducing household livelihood vulnerability to environmental change in the Atankwidi basin, northeastern Ghana*.' In my approach to this study, I linked *sustainability* with *vulnerability* for analyzing the role of local knowledge for sustaining household livelihoods. I have explained this link between sustainability and vulnerability in Chapter 1. The contributions of this study to development research in the *Atankwidi* basin are twofold. First, it contributes to an understanding of how knowledge is a driving force of innovation and development (Evers and Gerke, 2004:1). Secondly, it contributes to filling the large gap that exists in the body of knowledge transfer (Alavi and Leidner, 2001:126).

II. Research questions

For the main question, how are rural households reducing their livelihood vulnerability to environmental change through local knowledge in the *Atankwidi* basin, northeastern Ghana?

The study addressed the following specific questions:

1. How does the composition and inter-generational change in rural household livelihood portfolios reduce livelihood vulnerability to environmental change?
2. How are rural households reducing vulnerability of food crop production to degraded farmlands and soils through local knowledge?
3. How are rural households reducing vulnerability of food crop production to rainfall variability through local knowledge?
4. What are the patterns in knowledge flows and 'localization' for adapting household livelihoods to environmental change?

To set in clear terms what this study is about, four terminologies require some clarification. These include environmental change, livelihood, vulnerability and local knowledge. I will do a brief clarification here preceding a more detailed discussion in Chapter 1. [1] Environmental change in northern Ghana was an important contextual setting in which the link between local knowledge and livelihood vulnerability was studied. Environmental change refers to deteriorating environmental conditions that lead to environmental shocks, stressors and perturbations that negatively affect people's livelihoods. In this context, rainfall variability and drought, deforestation and land degradation, and or soil degradation are all indicative of environmental change (See Turner et al., 1990; Dolman and Verhagen, 2003; Adger and Brooks, 2003). As a student of Development Studies, I am interested in the implications of environmental change for livelihoods in northeastern Ghana. [2] Livelihood refers to what people do to make a living. A livelihood comprises people, their livelihood capabilities and means of living. This includes food, income, tangible assets such as resources and stores, and intangible assets, such as claims and access (Chambers and Conway, 1991; 1992). Thus, the term livelihood captures beyond what people do to make a living. It includes resources for building a satisfactory living, risks management in resource use, and institutional and policy opportunities or constraints (Ellis and Freeman, 2005:4). I employed the concept 'vulnerability' for analyzing the relationship between environmental change and household livelihoods. [3] Vulnerability refers to exposure to risks, contingencies and stress, and the difficulty in coping with them (Chambers, 1989; 2006). There is a strong link between vulnerability and sustainability. For instance, a livelihood is environmentally sustainable when it maintains the resource base on which it depends; and socially sustainable when it demonstrates capability of coping and recovering from stress and shocks (Chambers and Conway, 1992). Thus, reducing livelihood vulnerability is congruous with enhancing livelihood sustainability. I assumed that local knowledge [potentially] reduces livelihood vulnerability to environmental change. [4] In this regard, I adopted a pluralistic view of local knowledge for this study. First, local knowledge refers to the knowledge ('know how') that people apply for their daily sustenance in the local context. Alternative terminologies such as 'traditional knowledge', 'indigenous knowledge', 'indigenous knowledge systems', 'indigenous technical knowledge' and 'rural peoples knowledge' may be used to refer to this kind of knowledge (Arce and Fisher, 2003). Collectively, these terminologies describe the first domain of local knowledge as used in this study. Thus, local knowledge is the unique knowledge of a people. Secondly, this study also sides with the school of thought that local knowledge refers to the importation and adaptation of external knowledge to local conditions for meeting community needs (Cohen and Levinthal, 1990; Evers, 2003; Gerke and Evers, 2005).

III. Research objectives

The main objective of this study was to explore how rural households are reducing livelihood vulnerability to environmental change through local knowledge in the *Atankwidi* basin, northeastern Ghana.

The study explored the following specific objectives:

1. The composition and inter-generational changes in household livelihood portfolios and how that enables adaptation to environmental change;
2. How rural households are reducing vulnerability of food crop production to degraded farm lands and soils through local knowledge;
3. How farm households are reducing vulnerability of food crop production to rainfall variability through local knowledge;
4. Local knowledge flows and 'localization' of knowledge for adapting household livelihoods to environmental change.

IV. The study area, people and methodology

I conducted this study in the *Atankwidi* basin of northeastern Ghana (Map I). The *Atankwidi* is a sub-basin of the White Volta Basin, which is also a sub-basin of the larger Volta basin of Ghana and West Africa. The *Atankwidi* is largely located in the Kassena-Nankana District (KND) occupying the central and northeastern parts of the district (Map II). Covering a total area of 1,674 km^2 and comprising about 151 communities (Eguavoen 2008), the KND is one of the eight districts of the Upper East Region (UER). Thus, relatively smaller parts of the *Atankwidi* catchment extend into the Bolgatanga Municipality to the east of the basin and in the Bongo District to the extreme northeastern part. In the northern most part, the *Atankwidi* shares boundary (international) with Burkina Faso so that some of its catchment extends into that country too. See Map II for KND and locations of neighbouring districts. I selected the Atankwidi basin for this study through purposive sampling. The Centre for Development Research (ZEF) conducted the GLOWA Volta Project (GVP), a research project on sustainable water resources management in the Volta Basin. The project was implemented in collaboration with research partners in West Africa since June 2000 (Rodgers et al., 2007). Since the *Atankwidi* basin was part of the GVP research area, I sampled this basin in order that this study could benefit from research under the GVP. Furthermore, the *Atankwidi* basin is located in the UER and northeastern part of KND which are the worst affected by environmental degradation at the national and district levels, respectively. Given my focus on environmental change and livelihoods, the *Atankwidi* basin also provided a suitable setting for the study.

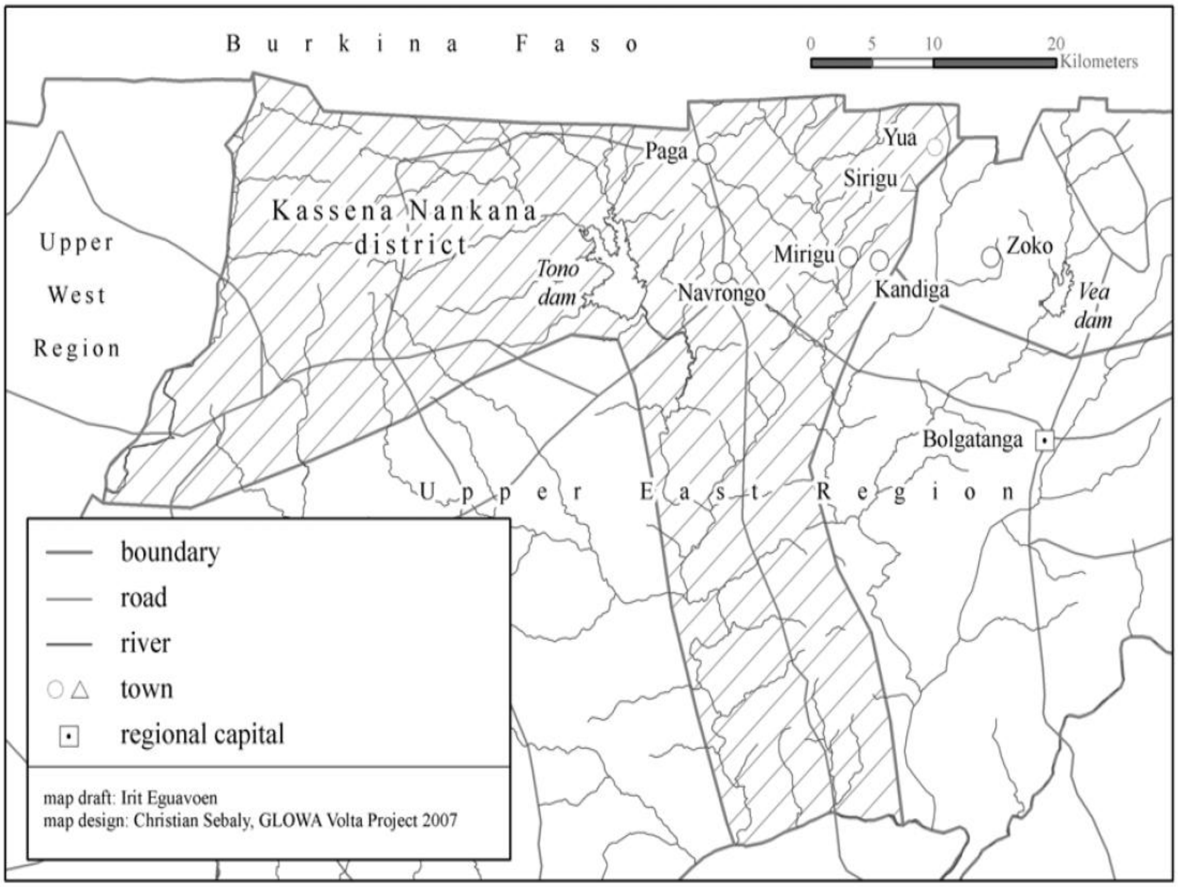
Map I: Location of *Atankwidi* basin in regional and national context

Source: Author, 2010

Two main ethnic groups populate the *Atankwidi* basin and KND at large. These include the *Kassem* and *Nankane* speaking people. Linguistically, the *Kassem* speaking people are *Grusi* and *Nankane* are *Nankansi*. *Nankane* belongs to the *Mole-Dabgane* group of languages (including *Dagaare*, *Buili*, *Kusase*) while *Kassem* belongs to the *Gur* (including *Mossi*, *Dagomba*, *Mamprusi*) of the Niger-Congo family. See Blench (2006), Laube (2007) and Eguavoen (2008) for ethnographic reviews on the area. The name of the district, Kassena-Nankana District (KND) derives from this dual ethnic composition. I conducted the study in three communities of the *Atankwidi* basin. These included *Yua* and *Mirigu*, which are *Nankane* speaking communities. The third community, *Pungu*, is a *Kassem* speaking community (Maps I & II). In most cases, these communities comprise family and clan groupings with migration histories from different areas, including present day Burkina Faso. The *Kassena* come from the north, while the origins of the *Nankane* were rather heterogeneous (Scott, 1977). However, oral histories show that many

Nankane speaking people, especially in the northeast of the district came from the north as well. Families form part of lineages and these in turn compose clans (See Blench, 2006).

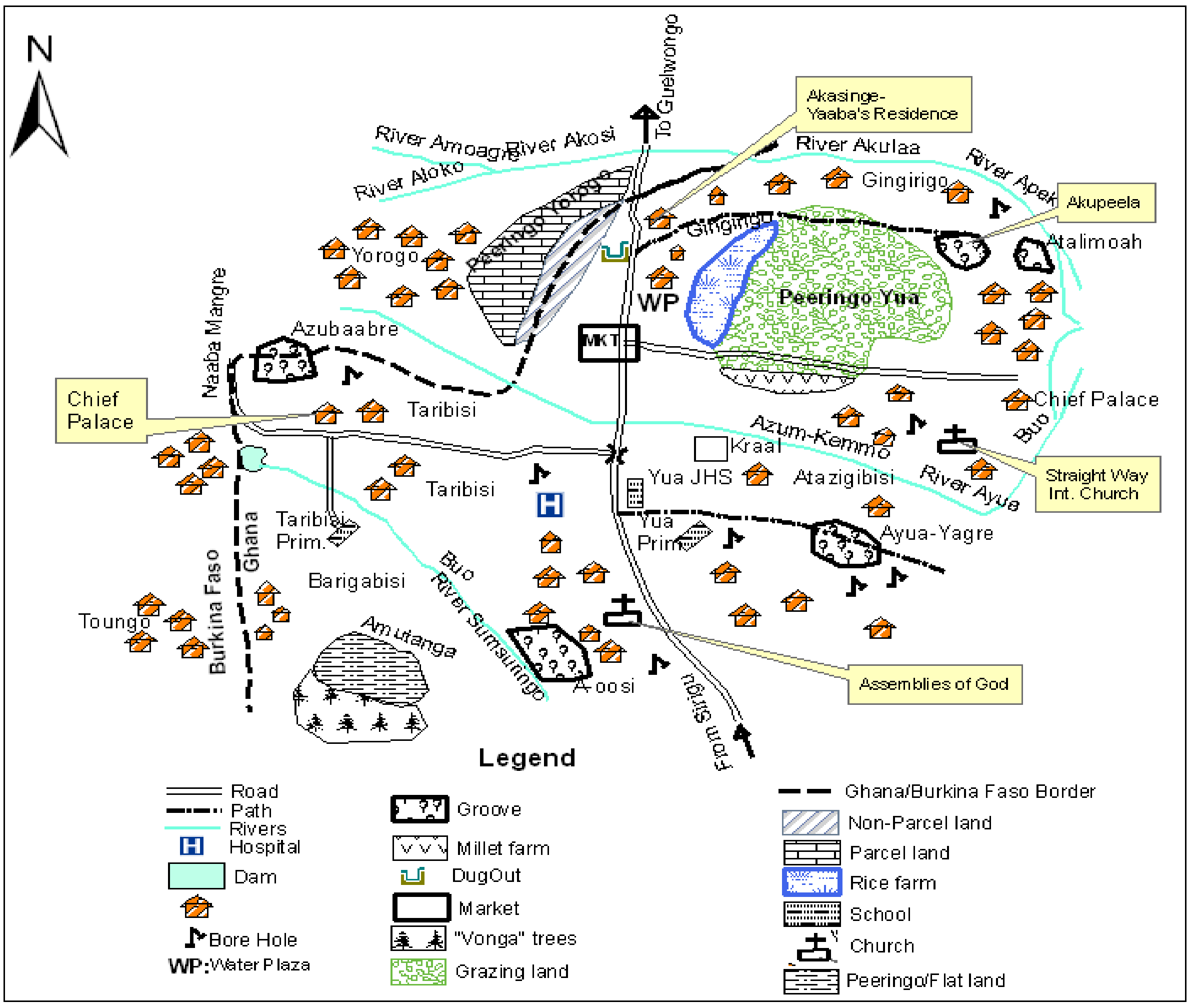
Map II: Map of KND showing neighbouring areas



Source: Eguavoen, 2008(74); designed by Christian Sebaly, GVP (2007).

In the evolution of many communities, paternal kinship shaped the organization of social groups (Scott, 1977). In present day communities, these different social and kin groupings are recognizable in the spatial organization of settlements. Very often, these different groups represent the different sections of the community. It is also common that sections are named after ancestors of the groups who lead them to settle in the community. This is the case for *Yua* where I conducted an in-depth study as part of my research design. According to oral history, the first settlers of *Yua* originated from the north in *Kanpalga-Yua* (present day Burkina Faso) to settle in present day *Yua*. *Ayeboa* is credited as the founding father of present day *Yua.* The original settlement (section) was named *Atisigibisi,* after *Atisige* the grandson of *Ayeboa.* These first settlers were receptive to migrants and this lead to the evolution of four other sections in the community. These sections were named after leading ancestors of settled immigrants. See Map III for sketch map showing spatial layout of *Yua* and location of the various sections (*Atisigibisi*, *Aforegabisi*, *Taribisi*, *Bargabisi* and *Gingirigo*). See Appendix 1 for a detail discussion on the social structure and people of *Yua*.

Map III: Sketch map showing the spatial layout of Yua[1]



Source: Author based on Transect/PRA Sessions, 2008

[1] H in map stands for health facility and in this context a community clinic. It is not a hospital in the true sense.

I will now present an overview of the research methodology. I have done a more detailed discussion of my research design, data collection methods and issues relating to limitations and validity in Appendix 2. For this study, I used a qualitative approach for data collection and analysis. As already stated, I conducted an in-depth study in *Yua*. For the in-depth study, I conducted household case studies though in-depth interviews. For the household case studies, I conducted 41 in-depth interviews. I sampled these households using purposive sampling technique. The respondents were mainly household heads[2] and spouses in cases involving male-headed households. I also employed additional methods for data collection. These included observation, focus group discussions, group interviews and key informant interviews. Selected male and female farmers were the participants in focus group discussions in *Yua*, but also in *Mirigu* and *Pungu*. I conducted key informant interviews at the institutional level. The interviews covered schedule officers of community and external organizations whose activities were a subject of interest in this study. I also conducted a survey among 131 households across all three-study communities in the basin.

V. Outline of thesis

I have structured this thesis in six chapters, aside the introduction and conclusion.

I discuss the relevant theoretical concepts in Chapter 1. These include environmental change, livelihood, vulnerability and local knowledge. I also present a conceptual framework that draws on 'vulnerability' for analyzing 'environmental change' and 'local knowledge' linkages in livelihoods.

In Chapter 2, I describe some characteristics of the environment in which households pursue their livelihoods. The discussion sheds light on how 'external' and 'collective'

[2] The real names of heads of households who were involved in the case studies have been replaced by dummy names in order to protect their privacy and also to conform to standard research ethics in the study.

variables of the environment influence household vulnerability – that is, constrain efforts of households in their efforts to make a living.

The empirical discussions are done in Chapters 3 to 6. The discussion in Chapter 3 shows how livelihood diversification and inter-generational changes in diversification enable households reduce livelihood vulnerability to environmental change.

In Chapter 4, I discuss adaptation of food crop production to land and soil degradation. The discussion reveals a range of local knowledge systems of soil conservation that enable households reduce their vulnerability to poor soil fertility.

In Chapter 5, I illustrate how rural households are reducing vulnerability of their food crop production to rainfall variability through local knowledge systems of adaptation.

In Chapter 6, I discuss local knowledge flows. The discussion sheds light on patterns of local knowledge flows. It also addresses the 'localization' of knowledge and the roles of community and external organizations.

I end the discussion by way of a summary and a conclusion thereafter.

Chapter 1

1.0 Theory: Environmental change, livelihood vulnerability and local knowledge

1.1 Introduction

This chapter entails a more detail discussion of the theoretical and conceptual issues arising from the problem definition. The discussion is in six parts. I proceed with a discussion on environmental change in part one. The discussion reviews conceptual issues relating to global and regional environmental change. I emphasize regional environmental change because of its direct implications for people's livelihoods. Since my interest is in the implications of environmental change for development, this is followed by discussions on livelihood, vulnerability and local knowledge. In part two, the discussion sheds light on the livelihoods approach and the components of a livelihood. The review illustrates how the components of a livelihood may be related to vulnerability and or sustainability. Hence, in part three, the discussion focused on vulnerability as a concept. The discussion emphasizes that vulnerability has a 'double structure' comprising two interrelated sequences of risks. In part four, local knowledge is discussed as a strategic resource for development in the context of environmental change. Drawing on these discussions, a conceptual framework that explores the linkages between environmental change and local knowledge for reducing livelihood vulnerability is presented in part five. The chapter is concluded in part six.

1.2 Environmental change

In the literature on environmental change, different terminologies are used for describing the change that has occurred in the environment over the past century or more. This includes 'environmental change' itself, often used to describe the changed phenomenon in general terms. It also includes 'global environmental change' often used to emphasize the global nature of the phenomenon and 'regional environmental change' denoting the regional dimensions in the change phenomenon. Although all these terminologies are taken to mean the same thing, the context of usage may vary. For instance, Adger et al. (2001) observe that the term 'global environmental change' is contested and problematic in the context of semantics. This is because all forms of environmental change are in some sense global or universal. For instance, 'global environmental change' as represented by climate change is described as systemic, in that environmental change at any locale can either affect the environment anywhere else or even affect the characteristics of the global environmental system (Turner et al., 1990; kasperski et al., 2001:2). The choice of terminology underlines or frames the way risk and response to environmental change is perceived in public policy. For instance, the use of the terminology 'global environmental change' underlines perceptions of the transnational nature, or global public-good nature, of 'environmental change' as justification for exclusively global and market-oriented solutions. This is exemplified by reference to bio-diversity loss, desertification and climate change as 'global environmental problems' (Adger et al., 2001; in Adger and Brooks, 2003:19). Dolman and Verhagen (2003:3) explain that changes in land use and land cover have contributed substantially to increased concentration of carbon dioxide in the atmosphere, exacerbated shortages of water, substantially changed biogeochemical cycles on the earth, and are causing dramatic losses of biodiversity around the globe. The combined effects of these forces on global climate, biodiversity, water availability and ecosystem are generally denoted as global environmental change. In the international front, the two interrelated problems of depletion of the stratospheric ozone layer and global climate change in particular dominated international attention in the domain of environmental problems since the 1990s. They have underpinned many international environmental agreements (e.g., the Earth Summit 1992, the Kyoto Convention, 1997) and spurred scientific networking and efforts at political-consensus within the scientific community (See Clark et al., 2001; Kasperson et al., 2001; Adger and Brooks, 2003).

In addition to these are the discussions of two types of global environmental change originally proposed by Turner et al. (1990) and discussed by others (e.g., Kasperson et al., 2001; Adger and Brooks, 2003). This range of global environmental problems as represented by a two-way typology of systemic and cumulative change (Table 1.1) come with them hugely different implications for environmental risk and hazard, for which global science and policy-making must deal with (Adger and Brooks, 2003).

Table 1.1: Types of global environmental change

Type	Characteristics	Example
Systemic	Direct impact on globally functioning system	(a) Industrial and land- use emissions of greenhouse gases (b) Industrial and consumer emissions of ozone-depleting gases (c) Land-cover changes in albdeo
Cumulative	Impact through world-wide distribution of change	(a) Groundwater pollution and depletion (b) Species depletion/genetic alteration (biodiversity)
	Impact through magnitude of change (share of global resources)	(a) Deforestation (b) Industrial toxic pollutants (c) Soil depletion on prime agricultural lands

Source: Turner et al, 1990:15; see Kasperson et al., 2001:3; Adger and Brooks, 2003:20

Global environmental change as represented by "systemic risks are those which impact on an environmental system operating at the planetary scale; cumulative global environmental change is that which becomes important because it occurs everywhere" (Adger and Brooks, 2003:20). In this respect, climate change, stratospheric ozone depletion and biodiversity loss associated with natural ecosystem, groundwater resources and forest cover change as humanly induced perturbations arising from social, economic and political context eclipse systemic global environmental change (Kasperski et al, 2001:2; Adger and Brooks, 2003:20). However, cumulative environmental change may well eclipse 'localized' systemic changes in both long-term and short-term consequences. This type of global environmental change refers to the accumulation of regional and localized changes that are distributed throughout the world. Such changes include ecosystem degradation such as coral reefs, groundwater resources, rain forests, soil loss but also the accumulative contamination of air, water and land under the pressures of population increase and economic growth (Kasperski et al., 2001; 2-3). Kasperson and colleagues (2001:3) argue that both types of environmental change pose distinctive challenges to the creation of an adequate knowledge on both drivers and processes of environmental perturbations and the vulnerability of human and ecological systems, and in the framing and enhancement of effective societal response capability. Since global environmental change arises from environment and human interactions, social vulnerability to these global environmental risks is a construct of both the physical and social worlds (Adger and Brooks, 2003:21). One important issue pertaining to environmental change is the overwhelming focus on the global scale debates to the relative neglect of local level perturbation processes and efforts at addressing social vulnerability at the local level. Adger and Brooks (2003:21) make this point in their assessment that global environmental change discussions and action are shaped by an "unshakable belief in the necessity of global-scale action to the exclusion of locally determined sustainable development priorities." It is against this backdrop that it is relevant for scientific enquiries to focus on environmental change and how communities are responding to these changes for addressing vulnerabilities at the local level. In the ensuing discussions, I shall turn my attention to regional environmental change, focusing on West Africa and the Sahel since this has a more direct bearing on my study. In doing so, I will focus on two broad domains of environmental change: (1) land cover change, desertification and land and soil degradation and; (2) climate change, especially changing rainfall patterns. The physical environment in Sub-Saharan Africa poses many challenges for the arable farmer but the two most serious factors that reinforce each other and adversely affect food production are rainfall and soils (Jones, 1986). This still holds true today. My discussion on environmental change draws on literature in general and research output under the GVP[3] in this chapter and in subsequent chapters.

Environmental change is a broader regional phenomenon – evidenced both at the regional and country levels. A historical literature of pessimism about deforestation, erosion,

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[3] The GLOWA Volta Project (GVP) was an inter-disciplinary research project launched in May 2000. Its objective was to support sustainable water resource management in the riparian countries of the Volta Basin, West Africa. It analyzed the physical and socio-economic dominants of the hydrological cycle in the basin in the context of global environmental change. it also developed scientifically sound Decision Support Resources for institutions in the region. The GVP ended in May 2009 and is now replaced by a new project – "Sustainable Development of Research Capacity based on the GLOWA Volta Project" implementable from June 2009 to November 2010.

declining soil fertility in Sub-Saharan Africa dates back to the 1920s (Wiggens, 1999). Sub-Saharan Africa's estimated forest cover of 679 million ha in 1980 is said to have been diminishing at about 2.9 % per annum. The rate of deforestation has since been increasing. Studies and documentation under the GLOWA Volta Project (eg., Vlek and Rodgers, 2005; Rodgers et al., 2007) corroborates evidence of land cover conversions, deforestation, and degradation of the natural ecosystem spanning the period 1990 to 2000 in the Volta basin. The findings reveal that the natural vegetation is converted into agricultural land uses and settlements combined with deforestation as facilitated by anthropogenic factors such as firewood harvesting and perennial fire hazards across the Volta Basin[4] of West Africa. Similarly, Rodgers and colleagues attest to a decrease in tree cover density over the same period as occurring mainly in northern Ghana, and described as a transition from closed woodland to open woodland. In addition, they suggest a decrease in woody stock volumes and vegetation structure, that is, a change from woody to woody scrublands. This conversion is most noticeably occurring in northern Burkina Faso. Furthermore, there is an expansion of agricultural areas, often at the margins of natural wetlands at the expense of woodlands, especially in northern Ghana and southern Burkina Faso (Rodgers et al., 2007: 59). The findings also suggest that degradation of natural vegetation is caused by climate variability or change over decades whiles the degradation of pastureland is widespread and caused primarily by intensive farming systems. The areas worst affected by deforestation include the southern parts of Burkina Faso while in the UER of Ghana, minor land conversions took place (Vlek and Rodgers, 2005: 12). As a result, soil degradation and erosion has affected about half of its farmland while as much as 80 % of its pasture range shows signs of degradation (Wiggens, 1999). While the causes of deforestation, land degradation and poor soil fertility remains a subject of debate, the review so far attributes much of this phenomenon mainly to anthropogenic factors. This incidence of deforestation has also adversely affected regional and local rainfall hydrological systems; and some effects have been prolonged periods of below average rainfall in the Sahel in the 1970's and 1980s

[4] The Volta Basin, a major part of West Africa, covers 400,000 km^2 of which more than 80% lies in Ghana and Burkina Faso. The other riparian countries are Côte d'Ivoire, Mali, Benin, and Togo.

(Cleaver and Screiber,1994). At this point, I will turn my attention to the specific issue of regional climate change.

Climate change as represented by temperature, rainfall changes, runoff, evapotranspiration and soil moisture are the key components of regional climate change that affect food crop production and other livelihoods in West Africa. Issues of climate change in West Africa and the Sahel predates the Sahelian droughts of 1970s but has persisted since then. Rainfall in the region is described as characteristically low and variable, falling erratically and randomly. For most years, rainfall is either abnormally high or continuous to support cropping or drought sets in and crops fail (Foster, 1986). The distribution rather than the total amount of precipitation affects food production the most (Wilhite and Glantz, 1985; Yaro, 2004), so that in this context dry spells and drought or excessive rainfall occurs at different times of the production season. The 'Sahelian region' originating from the southern fringe of the Sahara and stretching from the West African coast to the East African highlands has gained notoriety for dry conditions and drought dating back to the late 1960s. Since the catastrophic drought of the early 1970s during which hundreds of thousands of people and millions of animals died (de Waal 1997; Mortimore 1998), dry conditions have persisted to date with some amelioration coming in the 1990s (Adger and Brooks, 2003:26). In the West African Sub-region, the Volta Basin is described as climatically sensitive so that any small changes in the water balance can have a profound influence on livelihoods extensively dependant on rain fed agriculture. Analysis of historical climatic data from the northern Volta Basin suggests increasing temperature and decreasing rainfall trends (Vlek and Rodgers, 2005:3). In West Africa, choice of crop, sowing dates and resulting yields strongly depend on the temporal and spatial distribution of rainfall, and on the date of onset of the rainy season. A shift in the onset time of rains has been widely reported within the last few decades. Temporal variability of rainfall has made prediction of the onset time of rains crucial to farmers. This is because the successes in prediction directly influence farmers' livelihoods and regional food security. While planting too early may cause crop failure, planting too late may equally lead to crop failure or reduce crop yields (Vlek and Rodgers, 2005:6; Rodgers et al., 2007:46). These observed climatic changes are consistent with scenarios of human-induced climate changes as described in modelling studies (eg. IPCC, 1996; Rodgers et al., 2007) and hence, they likely represent manifestations of systemic change driven by emissions of greenhouse gases from twentieth –century industrialization.

Regional environmental change as represented by climate and weather variability, deforestation and land degradation are significant constraining factors in human development (Adger and Brooks, 2003). This is particularly so for the West African sub-region and northern Ghana. Dealing with the challenges of regional environmental change in the search for livelihood sustainability is a major concern in policy debate at the regional level. These debates can draw on some historical experiences in adaptation as a means for dealing with environmental change. For instance, agriculture is a primary sector through which climate plays a role in economic development. In this arena, there is a long history of analysis of the adaptation of human societies to climate change in food production (Lamb, 1995; Adger and Brooks, 2003:23). However, sustainable adaptation rest on the contribution of a paradigm shift for understanding 'natural disasters' and 'livelihood' interactions. This new perspective draws on vulnerability analysis. Some authors distinguish between social vulnerability[5] on the one hand and biophysical vulnerability[6] on the other hand. The former is examined later in my discussion in view of its appropriateness for this study.

1.3 Livelihood

I have done some explanation of livelihood in the introduction. The review shows that livelihoods means people striving to make a living through existing resources, coping with uncertainties and exploring new opportunities to meet their basic needs (Long, 1997;

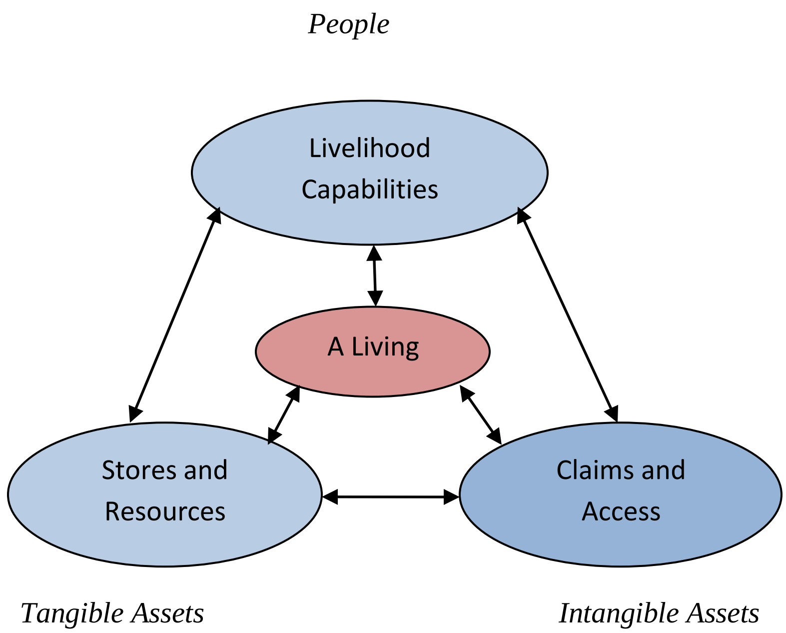
[5] Social vulnerability deals with the susceptibility of humans and the conditions necessary for their survival and adaptation (WBGU, 2005:33).

[6] Biophysical vulnerability originates from 'global environmental change research', and is widely used to describe the extent to which a system [eco-system] is vulnerable to adverse effects of climate change and to what extent it is (un)able to adapt to such impacts (WBGU, 2005:33).

Appendini 2001; de Haan and Zoomers, 2005). In the ensuing discussion, I will first examine the livelihoods approach as an analytical framework because my analysis of local knowledge in livelihoods would relate to some basic tenets of this framework. Thereafter, my discussion will centre on livelihood sustainability and livelihood activities/strategies as emergent concepts in modern livelihood studies that have a bearing on this study.

The pioneering work of Chambers and Conway (1991), *Sustainable rural livelihoods: practical concepts for the 21st century*, made a significant contribution to the livelihoods approach in modern livelihood studies. Two decades after this pioneering work, the sustainable livelihood approach has become even more relevant in today's development discourses. This is because the central objective of livelihood has remained the "search for more effective methods to support people and communities in ways that are more meaningful to their daily lives and needs, as opposed to ready-made, interventionist instruments" (Appendini, 2001:24; in, de Haan and Zoomers, 2005:30). As a departure from earlier household studies that painted a rather pessimistic picture of exclusion and marginalization in the process and benefits of economic growth in the 1990s, modern livelihood perspectives adopted a more optimistic approach (de Haan and Zoomers, 2005). Drawing on earlier research on food security and agro-ecological sustainability, Chambers and Conway (1991; 1992) underscore the relevance of people's survival abilities through their livelihoods. A number of ways may determine these livelihoods: a) ascriptive livelihood largely predetermined by accident of birth. For example, a child may be born into a caste with assigned role as potters in India; b) gender as socially defined may also be an ascriptive determinant of livelihood activity; c) inherited livelihood activity through socialization and apprenticeship for instance as a cultivator with tools or pastoralist with animals. These livelihoods then turn to be perpetuated or handed down to subsequent generations through the creation of new households. A livelihood may be defined at different hierarchical levels but the household is the commonest descriptive level. A livelihood as a means of securing a living is a complex system with many interrelated parts and flows (Figure 1.1).

Figure 1.1: Components and flows in a livelihood



Source: Chambers and Conway (1991:7; 1992:10).

Household livelihood comprises four components: a) people, with their livelihood capabilities; b) activities, being what they do; c) assets, comprising their resources and stores (tangible) and their claims and access (intangibles) which provide the material and social means; and d) the gains or outputs, which is the living they gain from what they do (Figure 1.1). A description of livelihood assets in relation to the livelihood framework is presented in Table 1.2. In the livelihoods approach, “the core of a livelihood can be expressed as a living” (Chambers and Conway, 1992:9), and that the portfolio of tangible and intangible assets are the most complex in terms of components and relationships. These tangible and intangible assets present the opportunities and at the same time constraints within which people construct and contrive a living, using physical labour, skills, knowledge, and creativity. These skills may have been acquired in the household as indigenous technical knowledge, or through apprenticeship, or more formally through education or extension services, or through experimentation and innovation.

Table 1.2: Livelihood assets and description

Component	Description
Stores & resources	• Tangible assets of the household; • **Stores** include food stocks, stores of values such as jewellery, textiles and cash savings; • **Resources** include land, water, trees, and livestock. Also, farm equipment, tools, and domestic utensils; • **Assets** are often both stores and resources.
Claims & access	• Intangible assets of a household; • **Claims** are demands and appeals for material support or access often at times of stress or shock, or other contingencies. Such support may take many forms- food, implements, loans, gifts or work. Claims may be made on individuals, relatives, neighbours, chiefs, social groups or communities, NGOs, government or international community - programmes for drought relief or poverty alleviation. Often based on combinations of right, precedent, social convention, moral obligation and power; • **Access** is the opportunity (in practice) to use a resource, store or service or to obtain information, material technology, employment, food or income. Services include transport, education, health, shops and market. Information includes extension services, radio, television, and news papers. Technology includes techniques for cultivation and new seed. Employment and other income – earning activities include rights to common property resources (CPRs) such as fuel wood or grazing on state or communal lands.

Source: Derived from Chambers and Conway (1992:9-11)

Since the development of the original components and flows diagram (Figure 1.1), it has been adapted for advancing understanding on various aspects of rural livelihoods by many researchers (e.g., Scoones, 1998; Carney, 1998; Ellis, 2000; de Haan and Zoomers, 2005). However, livelihood is said to go beyond economic and material life objectives. For instance, de Haan and Zoomers (2005; 32) observe that livelihood is not just about providing shelter, transacting money, securing food for consumption and exchange on the market place. It is also about ownership and circulation of information, management of skills and relationships. It is also about the affirmation of personal significance and group identity. Thus, the tasks of meeting obligations, security, identity and status and organizing time are as crucial to livelihood as food and shelter. Also, see Wallman (1984) and Appendini (2001). The point is not to say that material wellbeing is not important for livelihood sustainability, but that it includes non-material aspects of wellbeing central to sustainability. To illuminate this point further, "a person's assets, such as land, are not merely means with which he or she makes a living: they also give meaning to that person's world. Assets are not simply resources that people use in building livelihoods: they are assets that give them the capability to be and to act. Assets should not be understood only as things that allow survival, adaptation and poverty alleviation: they are also the basis of agents' power to act and to reproduce, challenge or change the rules that govern the control, use and transformation of resources." (Bebbington, 1999; in de Haan and Zoomers, 2005:32).

The birth of modern livelihood studies has given rise to a plethora of terminologies in the field. These include livelihood activities (eg., Chambers and Conway, 1992); livelihood strategies (eg., Zoomers, 1999; de Haan and Zoomers, 2005); livelihood styles (Arce and Hebinck, 2002; Noteboom, 2003); livelihood pathways (eg., Breusers, 2001; de Bruijn and van Dijk, 2003; Scoones and Wolmer, 2002); and livelihood trajectories (eg., Francis, 1992; de Haan and Zoomers, 2005). In the ensuing discussion, I will focus on livelihood activities and strategies because these are adequate, appropriate and have a relevant bearing on my empirical analysis. The rudimentary of all these terminologies is livelihood activities. Chambers and Conway describe rural livelihoods as comprising more often several activities. These activities can range from cultivation, herding, hunting, gathering, and reciprocal or wage labour, trading and hawking, artisanal work such as weaving and carving, processing, providing services in transport to fetching and carrying (Chambers and Conway, 1992). The study of livelihood activities serves as the basis for in-depth analysis of livelihoods. The use of 'livelihood strategy' is often taken to refer to strategic behaviour in the ways people organize their livelihoods at the household level. For instance, contemporary livelihood studies emphasise the active involvement of people in responding to and enforcing change. By this focus, researchers are able to make it clear that people respond to opportunities and play active roles in achieving their livelihoods so that it makes sense to describe such behaviour strategic[7] (de Haan and Zoomers, 2005). In this notion, the household was thought of as "a single

[7] Given emerging trends, de Haan and Zoomers (2005) have raised questions about the view of behaviour as strategic. They cite several of these trends: incidences of intra-household differences; individualization of livelihoods; increasing diversification of livelihoods; and organization of livelihoods over multiple places as the basis for such a position. These trends now show that individual and household goals may diverge so that the concept of household strategy is open to question.

decision-making unit maximising its welfare subject to a range of income earning opportunities and set of resource constraints" (Ellis, 1998:12: in, Ibid: 38). Drawing on livelihood studies in the Andes, Zoomers identifies four categories of strategies: accumulation, consolidation, compensatory and security. She does not consider these strategies as intentional or unintentional behaviour, but acknowledges structural component within them (Zoomers, 1999; de Haan and Zoomers, 2005).

Chambers and Conway also distinguish between environmental sustainable livelihood and socially sustainable livelihood. On the one hand, a livelihood is environmentally sustainable when it maintains the assets on which livelihood depends and further shows net beneficial multiplier effects on other livelihoods. On the other hand, a livelihood is socially sustainable when it demonstrates capability of coping and recovering from stress, shocks, and providing for future generations (Chambers and Conway, 1992). The relevance of sustainable livelihood derives from the objectives of the livelihood approach and the implications for research and policy. For the rich, environmental concerns are said to be paramount in the policy front. For the poor, building capabilities, improving equity and increasing social sustainability should dominate policy. In the research domain, the key questions are said to be a better understanding of "a)conditions for low human fertility, b) intensity, complexity and diversity in small-farming systems, c) the livelihood-intensity of local economies, and d) factors influencing migration"(Ibid.:iii).

1.4 Vulnerability

In my discussion, I first give a brief overview of the evolution of vulnerability as a social science concept. This historical overview provides a contextual setting for understanding 'vulnerability' and setting the stage for a better clarification of the concept as applied in this study. In the final part of my discussion, I examine the 'double structure' of vulnerability and some related theoretical propositions that further illuminate the theory on vulnerability.

Vulnerability evolved as a concept in the social sciences to help explain the impact of natural hazards on people's livelihoods and the implications for development interventions. The early theory on vulnerability evolved first, to explain how famines occur (Watts and Bohle, 1993) and second, as an alternative response to the purely hazard orientated perception of disaster risk in the 1970s (Lewis, 1999; Schneiderbauer and Ehrlich, 2004: 13; Birkman, 2006:11). My concern as a student of Development Studies is not environmental change in itself, but its implications for livelihood sustainability and development. This link between environmental hazards and peoples livelihoods is what defines the space for understanding livelihood vulnerability. Historically, disasters among the human populations were seen as the direct causes of natural hazards. The use of the terminology 'natural disasters' in disaster management depicts this perception that 'natural hazards' cause 'natural disasters'. While this was the understanding for many years past, it is now widely accepted that although a natural hazard may occur, it does not have to lead to a disaster (Cannon, 1990:1; van der Geest, 2004:8). This is a significant contribution of the social sciences to theorizing about vulnerability. Although drought, heavy precipitation, floods, rainstorms and soil degradation may occur in West Africa, they will not affect individuals and household livelihoods across the affected population evenly. Van der Geest illustrates this point. He states that "a drought does not have to result in a famine" and that "when an area is affected by floods, for one family this can result in a tragedy from which it might take years to recover, while for a neighbouring family, it might be a mere disturbance of daily life" (van der Geest, 2004:8). This presupposes that additional factors determine vulnerability and predispose individuals, households and communities to disasters aside the natural hazard itself. Consequently, a natural hazard becomes a disaster when it hits vulnerable people (Blaikie et al., 1994:22; van der Geest, 2004:8) and that inequality is the root cause of vulnerability (Ribot, 1995:121). In this respect, hazards are not exclusively natural. They may also be social, economic or political (van der Geest, 2004:9).

There are varied definitions of vulnerability. To emphasize the integrated nature of vulnerability, UNISDR defines vulnerability as "the characteristics and circumstances of a community, system or asset that make it susceptible to the damaging effects of a hazard." (UNISDR, 2009:12). It further explains that vulnerability embodies many aspects arising from various physical, social, economic and environmental factors. It cites multiple examples such as inadequate protection of assets, lack of public information and awareness, limited official recognition and preparedness measures and disregard for proper environmental management as some factors that predispose individuals, households and communities to varied levels of vulnerability. Vulnerability, it maintains varies significantly within a community and over time (Ibid.12-13). Implicit in this definition is the recognition that vulnerability arises from a 'systems failure' where the system comprises different components that were meant to interrelate and function to secure livelihoods at the various levels, for instance at household or societal level. Despite the integrative view of the UNISDR definition, the human centeredness of vulnerability is not given prominence relative to other definitions. Human centeredness remains paramount in the theory on vulnerability. The UNDP recognises this in its concept of 'human vulnerability'. It defines 'human vulnerability' as "a condition or process resulting from physical, social and environmental factors, which determine the likelihood and scale of damage from the impact of a given hazard. Human vulnerability includes within it the vulnerability of social and economic systems, health status, physical infrastructure and environmental assets. It is possible to look at these subsets of vulnerable systems in isolation, but here we are concerned with the broad picture of human vulnerability."*(*UNDP, 2004:11). Relating the concept 'vulnerability' to the more specific issue of climate change, the IPCC defines vulnerability as the degree to which a system is susceptible to, or unable to cope with, adverse effects of climate change, including climate variability as a result of adaptive capacity (Parry et al, 2007: 783). An additional contribution of this definition is how the IPCC relates vulnerability to the coping ability and or adaptive capacity of communities. By implication, not only are individuals, households and communities vulnerable to the extent to which hazards impact them differently, but their vulnerabilities are also defined by their varied abilities to cope, adapt or recover from the impact of hazards. However, there is a distinction between poverty and vulnerability although resource wellbeing plays a role in vulnerability. Vulnerability varies from poverty in that "it means not lack or want, but defencelessness, insecurity and exposure to risks, shocks and stress" (Chambers, 2006).

Also, see Chambers (1989: 1). Vulnerability and its opposite, security, are determined by the degree of risk exposure, coping capacity and recovery potential (Blaikie et al., 1994:59; van der Geest, 2004: 8). This overview brings my discussion to the dual nature of vulnerability.

The literature as reviewed present vulnerability as having a dual structure (See Chambers, 1989, 2006; Bohle, 2001; Van Dillen, 2004; Birkmann, 2006). Vulnerability has *"two sides: an external side of risks, shocks and stress to which an individual or household is subject; and an internal side which is defencelessness, meaning a lack of means to cope without damaging loss. Loss can take many forms- becoming or being physically weaker, economically impoverished, and socially dependent, humiliated or psychologically harmed"* (Chambers, 2006:33). Similarly, Bohle (2001) describes the external side of vulnerability as comprising the exposure to risks and shocks in contrast to the internal side, which deals with the capacity to anticipate, cope with, resist and recover from the impact of a hazard. It is this distinction between the exposure to external threats and the ability to cope with them that is described as the 'double structure' of vulnerability in the social sciences (van Dillen, 2004).

In general, many social scientists have contributed to the evolution of different approaches in vulnerability theory. Many of these approaches have constituted in themselves frameworks for development research and in many cases; they have been adapted to address various aspects of the dual nature of vulnerability. My intension here is not to delve into these different approaches but to give an overview of these approaches keeping in mind that the 'double structure' of vulnerability is my major subject of interest in this research. To do this, I draw on a conceptual framework developed by Bohle (2001:119) based on perspectives from social geography for his famine research. His research underline that vulnerability is the result of interaction between exposure to external stressors and the coping capacity of the affected household, group or society. The core of his conceptual framework is the double structure of vulnerability. In this context, different theoretical propositions contribute to the external and internal sides of vulnerability in his analytical framework for analyzing vulnerability.

On the external side for instance, political economy approaches are explored for comprehensive analysis of exposure in vulnerability analysis. Some of these approaches include the entitlement[8] approach as exemplified by (Sen, 1987), the extended entitlement approach as exemplified by Swift (1989) and Davies (1996) and the empowerment and political economy approaches as exemplified by Watts and Bhole (1993). Although Sen employed his entitlement approach in the 1980s to analyze vulnerability to hunger and famine, it is still influential in vulnerability research today. In this approach Sen argues that hunger and famine are not caused by a decline in the availability of food (i.e. Production failures) but in the failure of people to exert their command over food (i.e. exchange failures or entitlement failures). In this context, a person will go hungry if his/her entitlement set does not include a commodity bundle with enough food. Thus, famines occur when large groups of people experience this type of entitlement failure (Sen, 1987: 7-8). Also, see Van der Geest (2004: 9) for his review of the literature. In normal years, entitlement to food and livelihood is gained through a combination of production, exchange (cash, goods and services, sale of labour) and assets (including investments, stores and claims). Households with an adequate endowment portfolio comprising these three categories are relatively secure. In times of food stress for instance, coping strategies and adaptation form two more additional sets of entitlements that are then derived from endowments. Adaptation however, occurs when households have to respond to more permanent changes in their environment or changes to household composition or entitlement base. On the internal side for instance**,** crisis and conflict theory embodying models of access to assets and action theory approaches combined with political economy approaches are explored for vulnerability analysis, including coping or adaptation. For instance, the contribution of Watts and Bhole (1993) to theorizing vulnerability through their empowerment and political economy approaches is significant. Their contribution was significant in that it brought together different approaches for vulnerability analysis and narrowed the 'theoretical gap in vulnerability analysis' although they still do not present methods of measurement at the household

[8] A person's entitlement is defined as the set of different commodity bundles (including food) that s/he can acquire by putting his original bundle of ownership (i.e endowment) to production and the various alternative bundles s/he can generate by using this endowment.

level in particular (van der Geest (2004:12; also see Ribot, 1995). In the assessment of van der Geest (2004:12), empirical analysis of vulnerability at the household level is relatively unexplored and evolving. To this effect, "vulnerability as a concept does not rest on a well developed theory; neither is it associated with widely accepted indicators or methods of measurement."(Watts and Bhole, 1993:45). The significant contribution of Watts and Bhole (1993) should be understood in this context. They bring together three approaches, namely the entitlement, empowerment and political economy approaches in developing a causal structure of hunger and famine, which they termed as the 'space of vulnerability'. Their space of vulnerability is represented by an analytical triangle. "The empowerment approach emphasises that limited command over food results from limited rights and power in three political domains: the domestic domain, referring to intra-household politics; the work domain, referring to production politics; and the public – civil sphere, referring to state politics" (Bhole, 1993:49-51; in van der Geest, 2004:12). The political economy approach draws on class structure to explain structural –historical patterns of entitlement and empowerment processes of marginalization that created inequality and vulnerability. In reference to the triangle, "the space of vulnerability is the intersection where the three causal factors determine risk exposure, coping capacity and recovery potential. The three bundles of causality are not mutually exclusive: they exist simultaneously and reinforce each other. Their relative weights can explain the distribution of vulnerability and security among different regions and social groups in the real world. Vulnerable groups in society are (1) the resource poor and those vulnerable to market disturbances; (2) the peripheral/dependant regions and (3) the crisis – prone regions (Watts & Bhole, 1993:52-57).

1.5 Local knowledge

My discussion on local knowledge centres around three areas relevant to this study. First, I attempt to define local knowledge in the context of terminologies associated with knowledge. This helps explain local knowledge as used in this study. Second, I examine the role of local knowledge in development since this is my interest in the context of environmental change. Finally, I discuss the social construction of local knowledge and how power shape processes of local knowledge production.

In general, knowledge concerns the way people understand and interpret the world, and attach meaning to their experiences (Arce and Long, 1992; Blaikie et al, 1997). All terminologies of knowledge therefore, relate to this general understanding of knowledge. A distinction between ‘local knowledge’ and ‘scientific knowledge’ is a useful starting point for understanding the former. Some authors use alternative terminologies to classify knowledge systems along similar lines: ‘western’ or ‘indigenous’, ‘formal’ or ‘informal’, ‘insider’ or ‘outsider’ (Okali et al, 1994; Blaikie et al, 1997: 218). According to Piers Blaikie and others, the distinction between ‘local knowledge’ and ‘scientific knowledge’ depend on the particular development paradigm and set of assumptions being used. They distinguish these knowledge systems by the following characteristics: local knowledge is holistic and contextualized while scientific knowledge is abstract; it is conservative and adaptive while scientific knowledge puts in motion radical and rapid technological change; it is transmitted informally while scientific knowledge is transmitted formally (Blaikie et al, 1997:219). They note that depending on the paradigm, development professionals have distinguished between local knowledge and scientific knowledge in ways that give advantage to one over the other. Local knowledge is one of a plethora of terms that is used to refer to the knowledge that people hold and apply for their daily sustenance. I will like to restate that a pluralistic view of local knowledge is adopted for this study. This view combines two distinctive schools of thought on local knowledge. First, depending on disciplinary orientations, some authors use alternative terminologies that ‘share’ in the first school of thought. These include ‘traditional knowledge’, ‘indigenous knowledge’, ‘indigenous knowledge systems’, ‘indigenous technical knowledge’ and ‘rural peoples knowledge’ (Arce and Fisher, 2003). Blaikie et al (1997) classify these terminologies as sub-categories of ‘local knowledge’. For Antweiler (1998) local knowledge may also be called indigenous knowledge. The second school of thought is a departure from associating ‘local knowledge’ to the unique and bounded knowledge of a group of people residing in their unique environment. In this school of thought, it is widely acknowledged that local knowledge embodies a fusion of both ‘indigenous knowledge' and 'scientific knowledge' at local levels. For instance, it is asserted that knowledge is an embodied practice and its production is negotiated within the context of knowledge interfaces (Long and Long, 1992; Pottier, 2003). The processes in local knowledge production involve the interaction between local communities who have their own practices and discourses, and external agents of change, who have their own practices and discourses (Pottier, 2003). Beyond this, local knowledge may have properties beyond language (Machand, 2003; in Pottier, 2003) and even beyond the strictly local (Kaur, 2003; in Pottier, 2003). Thus, 'localization' of knowledge i.e. allowing in and adapting external knowledge to local situations is done through the mediation of established cultural parameters. As a result, the view that 'local knowledge' is strictly local and always accessible by verbal communication is a misconception that ought to be corrected (Pottier, 2003). It is important to note that the origin of knowledge as emanating either from 'within' or 'outside' the community is implied in distinguishing between these two schools of thought on local knowledge.

Local knowledge is considered an important strategic resource for development. In its generic form, knowledge is regarded as the major driving force of innovation and development (World Bank, 1999; Also see Evers and Gerke, 2004:1). Despite the strategic role of knowledge in development, 'wide knowledge gaps' are said to exist between the Developed and Developing Countries. The World Bank (1999) underscore two important issues: First, that knowledge is the driving force for global scientific development; and second, that the development gap between the Developed and Developing Countries is much greater in terms of knowledge than GNP. Closing this 'knowledge gap' is recommended as a development strategy (Evers, 2003). Much as the role of development experts is important for closing this gap, they have been criticized for a biased preference for scientific-rational knowledge to the neglect of social and cultural considerations (Goulet, 1980; Evers and Gerke, 2005). This gives rise to a neglect of the role of 'local knowledge' in development (Evers and Gerke, 2005). However, many scholars e.g., Chambers et al, 1989; Warren et al, 1989; Marsden, 1990; Antweiler, 1998; Pottier, 2003; Evers and Gerke, 2005 acknowledge the important role of local knowledge in development. For instance, local knowledge is asserted to have a big development potential because it the knowledge that actors posses at that level for effecting change or improving their livelihoods. The rationale for promoting local knowledge in development therefore, lies in its effective role in sustainable development, especially for the sustainable management of natural resources (Antweiler, 1998). The importance of local knowledge in development is captured vividly by Pottier (2003:3-4):

> *"The problems of rural development are no longer seen to reside in 'traditional cultures' of under-developed people, but rather in the partial and biased understandings that have emanated from the unreflexive application of a western scientific rationality…….Indeed 'traditional cultures' are now seen as containing the bases for any effective development………There is a heightened awareness of the central importance of indigenous knowledge systems in the construction of sustainable strategies for rural development……The 'blue-print' approach is giving way to a negotiated, situation-specific approach which demands a dialogue between the different parties to the interventions that are constructed in the name of development, and which recognises the important, often crucial knowledge that traditional recipients of development aid have to offer"*

There is growing awareness that local knowledge can no longer be presumed a system in isolation or bounded, but that, it interacts in a variety of ways with the science and practices of development agencies. Indeed, local knowledge is dynamic and ever changing (Sikana, 1994; Niarmir, 1995; Sillitoe, 1998; Aluma, 2004). This gives rise to diverse knowledge and practices (Pottier, 2003). People's knowledge is never exclusively local, but results from complex negotiation practices linked to knowledge interfaces (Pottier, 2003). Scoones and Thompson are accredited for arguing in the mid 1990's that rural people's knowledge (RPK) and western agricultural science is similar. They are general and specific, theoretical and practical. Both are value laden and context specific and are influenced by social relations of power (Scoones and Thompson, 1994: 29-30; Also see Pottier (2003:4). These opposing knowledge systems very often interact in complex and contradictory processes to structure development at the local level (Pottier, 2003).

The role of 'local knowledge' in development brings to attention the need to examine ways in which 'local knowledge' is expressed and shared. This is important for understanding patterns in knowledge flows and how this can be tapped into for local level development. Anthropologists have questioned whether language is a sufficient tool for accessing knowledge in how knowledge is expressed and accessed. Paul Richards has shown that indigenous knowledge among farmers in West Africa contains strong elements of improvisation. These include drumming and altering cropping patterns to address contingencies. These however go without notice when 'scientific' agricultural experts assess farmer knowledge (Richards, 1993). This point is re-echoed in the assertion that focusing on language as the principal means of knowledge transmission may be inadequate for understanding the transmission of knowledge skills (Marchand, 2003). Although the discussion point to different modes in knowledge expression, according to Pottier (2003), there seem to be a thin line between verbally expressed knowledge, performance and creativity.

Local knowledge everywhere is the output of a social construction that shapes the way it flows and the way it is shared. In contrast to positivist view that knowledge is unitary and systematized, Long (1992) and Pottier (2003) share the view that the dynamic nature of development necessitates a consideration of different guiding principles regarding knowledge. In a review of the work of Long (1992), Pottier identifies these principles:

> *These among others include discontinuity and not linkage, transformation and not transfer of meaning. Knowledge then emerges as a product of interaction and dialogue between specific actors. There may be a multiplicity of possible frames of meaning. It may be fragmentary and diffuse rather than unitary and systematized. Different parties including farmers, extensionists and researchers may share the same priorities and parameters of knowledge. However, 'epistemic' communities (that is, those that share roughly the same sources and modes of knowledge) ought to be differentiated internally in knowledge repertoires and application* (Pottier, 2003:15).

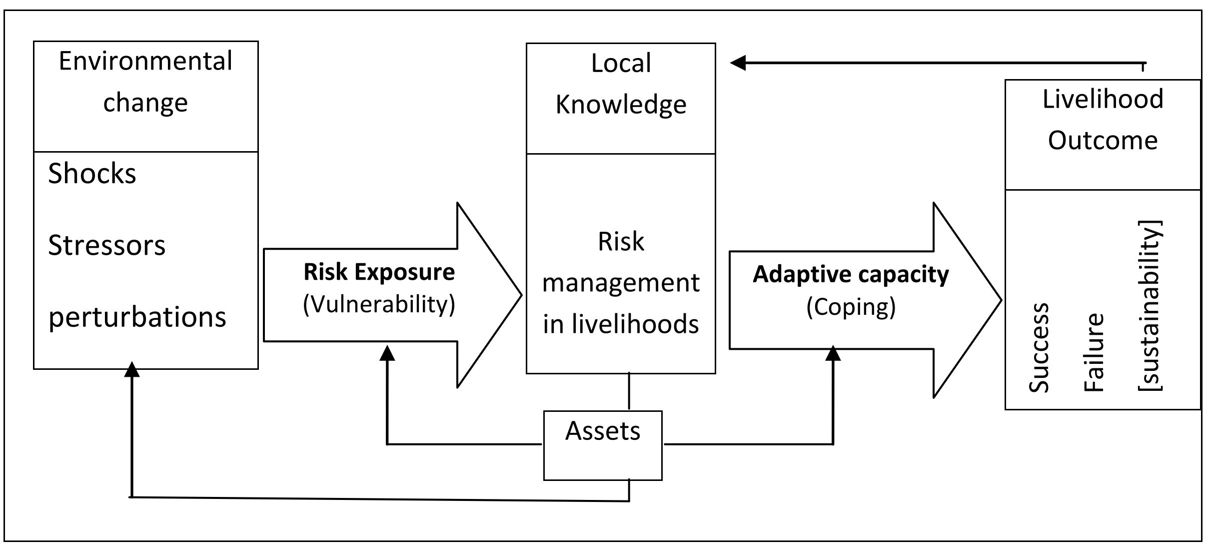
The positivists regard science as superior to local bodies of knowledge, and therefore, believe that their superior knowledge can easily be transferred or should be transferred to replace 'backward' local knowledge (Pottier, 2003). This understanding very often runs contrary to reality. Reality is often characterized by intended and unintended consequences and outcomes. Such outcomes also being shaped by ongoing, interlocking, interplay and mutual transformation of different actors' projects (Long and van der Ploeg, 1994:81). In-depth understanding of knowledge in development therefore, requires grasping the ways that different knowledge processes interrelate, reinforce and transform each other in rural development interfaces (Arce et al, 1994: 156; Pottier, 2003:15). Knowledge is therefore, a social construction that emanates from a particular context and often reshaped by the encounters and discontinuities that emerge at the points of intersection between actors' life worlds (Long and Villarreal, 1993: 160). Contributions to ethnographies of development dialogue emphasize the social context of knowledge. The point is made local knowledge should be understood in its broadest terms to encompass both peoples understanding of the universe they inhabit and their rights (Pottier, 2003). Sillitoe and Willson contextualize this understanding in relation to mining in Papua New Guinea, thus, "when we talk about indigenous knowledge…we are referring largely to the need for a better understanding of, accommodation to, people's knowledge of their rights to land, their tenure arrangements and their approach to payments such as compensation" (Sillitoe and Wilson, 2003:244). Knowledge is therefore, inseparable from the social context. The social context and underpinning power relations are central to a meaningful understanding and analysis of knowledge production (Pottier, 2003). In addition, it is also important for understanding knowledge flows and sharing in the local context.

In my discussion of the theories relevant to this study, I have pointed out that the implications of environmental change for development is my concern. Environmental change presents a range of perturbations as a result of which people's livelihoods are to 'some extent' vulnerable to the former in the Volta Basin, West Africa. In order to analyze how households respond to these vulnerabilities, I will turn my attention to a conceptual framework that enables this study explore and analyze the role of local knowledge for reducing livelihood vulnerability to environmental change in the *Atankwidi* basin.

1.6 Livelihood vulnerability: Environment and local knowledge linkages

In this section, I present a conceptual framework (Figure 1.2) that draws on the 'double structure' of vulnerability. The framework uses 'vulnerability' as a concept for conceptualizing 'environmental change' – 'local knowledge' linkages for analyzing the efforts of households towards reducing livelihood vulnerability in the *Atankwidi* basin. It conceptualizes household response to 'vulnerability' as a sequence of risk management strategies comprising two interrelated cardinal stages. The first stage represents the first line of defence. This entails the use of local knowledge to 'moderate exposure' of risk to environmental hazards (e.g., soil degradation, drought and rainstorm) in livelihoods, especially in food crop farming. The second stage is the final line of defence. This also comprises the capacity of households to adapt to environmental shocks, stressors and perturbations through local knowledge systems that reduce the risk of livelihood failure.

Figure 1.2: Vulnerability: Conceptualizing environment and local knowledge linkages



Source: Adapted from Ellis (2003) and modified by author

I used this framework for analyzing the role of local knowledge in reducing household livelihood vulnerability to environmental change in the *Atankwidi* basin. In order to clarify how this framework guided my analysis, I will describe how the components and processes interrelate to produce varied livelihood outcomes. Three main components make up the framework for analyzing vulnerability as conceptualized in this study. These include environmental change, local knowledge and livelihood outcome (sustainability).

Environmental change is taken as the starting point in this conceptual framework. Earlier on, I discussed environmental change as a factor that affects livelihoods at local levels. I pointed out that environmental change (deforestation, land and soil degradation, and rainfall variability) adversely impact livelihoods in northern Ghana and the Volta Basin as a whole. In this framework environmental change and the risks arising from shocks, stressors and perturbations are taken as given. Thus, households have to figure out a way of dealing with these risks in their livelihoods. The model presents households as resorting to their local knowledge systems for moderating their exposure to the risk[9] arising from environmental change**.** Although I am aware of on-going discourses on risk as a social science concept with application across many disciplines, I do not intend to do an extensive discussion of the literature here for three reasons. First, I have conceptualized this study using 'vulnerability' as the research concept and risk is an essential component of 'vulnerability' itself. Second, the discussion on 'vulnerability' earlier on in this chapter also addresses some issues on risk. Third, I presume that a brief explanation of risk as a concept here is adequate for supporting a better explanation of 'vulnerability' as conceptualized for my analysis in this study.

Local knowledge is represented by risk management strategies comprising a wide range of localized farming techniques and systems, kinship and social mechanisms of support

[9] Risk is a social science concept with predominant applications and discourses in the fields' of economics, finance and management, including disaster management. According to the *Encyclopaedia of Global Warming and Climate Change* (2008), risk captures the probability, and in some instances, the potential severity of the occurrence of a negative outcome, such as in the case of exposure to a natural hazard. Discourses on risks associated with global warming and climate change, especially those related to the environment, ecosystem, human health and the world economy are underscored in the Encyclopaedia. For economists, risk captures the situation in which the probability of an outcome is not precisely known (Todaro, 1981:547; in, Evers and Mehmet, 1994:1). For Sociologists, risk is the unintended consequence of rational action (Evers and Mehmet, 1994). In a study on risk and and its consequences in the Indonesian informal sector, Evers and Mehmet (1994:4) found that many businesses, especially petty traders failed because of several risk factors:(1) fluctuations in markets; (2) profit erosion resulting from social obligations to kin, neighbours and government officials; (3) limited understanding of such key concepts as income, cost and profit by traders themselves; (4) failure to impute costs of own labour or un-paid family labour, and; (5) inadequate depreciation of working capital.

and strategic management of productive assets. The applications of local knowledge systems here have a 'dual effect' in the management of risk arising from environmental change. First, local knowledge systems of risk management have the effect of moderating the exposure of risk to environmental shocks, stressors or perturbations in livelihoods. Thus, the degree to which livelihoods are exposed and vulnerable to environmental shocks or perturbations is greatly reduced. This can be described as preparedness and or 'pre-hazard' phase local risk management. The model presents this as a first line of defence against livelihood vulnerability. Second, the framework presents local knowledge systems of risk management as having the effect of also enhancing capacity for adaptation (coping) to environmental shocks in household livelihoods. This is the second line of defence as conceptualized in the framework. This phase however, benefits enormously from the first line of defence. This is because by moderating exposure to risk in the first line of defence, the level of risks or impacts (vulnerability) that has to be dealt with in the second line of defence is minimized. This also have the effect of enhancing adaptive capacity in the second line of defence. Furthermore, when shocks and perturbations occur, local knowledge systems also manifest in response measures, such as risk management strategies that enable adaptation of livelihoods to the environmental hazards. For instance, when shocks occur, a series of local risk management[10] systems of adaptation to uncertainties (e.g., diversified livelihoods sources, entitlements, kinship and social support systems) are either automatically helpful or are triggered to enhance adaptation. Collectively, both preparedness and adaptive phases to environmental shocks and perturbations work in tandem to enhance adaptive (coping) ability of the household.

[10] Power (2004) suggests that there has been an explosion of risk management practices since the mid-1990s across a wide variety of organizational contexts. Risk management is a primary objective of all firms (Miller, 1992; Froot et al., 1993). Major uses of risk have been in reference to unanticipated variation or negative variation (i.e., "downside of risks") in business outcomes such as revenues, costs, profit and market share (Miller, 1992:311). The need for risk management by firms arises from uncertainties categorized by Miller into: (1) general environmental uncertainties including political, policy and macro-economic uncertainties; (2) industry related uncertainty including input market uncertainty, product market uncertainty and competitive uncertainty and ; (3) firm specific uncertainties arising from operations, liability, research and development, credit and behavioural uncertainties (Miller, 1992: 313-320). Miller outlines two approaches namely, financial risk management and changes in firm strategy as potential firm responses to deal with exposure to environmental uncertainties. The principal financial risk-reduction techniques include purchasing insurance, and buying and selling financial instruments. Strategic management relates to five 'generic' responses to environmental uncertainties which include avoidance, control, cooperation, imitation and flexibility (Miller, 1992: 320-325)

The overall result of all these interlinked components and processes is the livelihood outcome, which the model presents as the final output. Livelihood outcome could be one of two ways. A livelihood may be successful as represented by reduction in livelihood vulnerability, resilience and or sustainability. On the other hand, a livelihood could also be a failure as represented by total livelihood vulnerability and or total failure. As households engage in local knowledge systems for addressing environmental challenges in their livelihoods, the ultimate goal is to secure a livelihood. As pointed out in earlier discussion, "*the core of a livelihood can be expressed as a living*" (Chambers and Conway, 1992:9). They also point out that the portfolio of tangible and intangible assets are the most complex in terms of components and relationships. The important role of local knowledge in securing livelihoods is underscored in relation to intangible assets. They assert that, "out of these tangible and intangible assets people construct and contrive a living, using physical labour, skills, knowledge, and creativity. Skills and knowledge may be acquired within the household, passed on from generation to generation as indigenous technical knowledge, or through apprenticeship, or more formally through education or extension services, or through experiment and innovation"(Chambers and Conway, 1992:11).

Although the ultimate goal of every household is to secure a livelihood, the outcome as mentioned could either be successful or a failure. Irrespective of the outcome, the experience of the household is drawn on for evaluation and review of local knowledge application as a response measure. On the one hand, a successful livelihood serves as an incentive and increases commitment to the application of local knowledge at the household level. On the other hand, a failure drives the household to step up its effort in the application of local knowledge in subsequent production cycles. The essence is to reduce exposure to risk and to enhance adaptive capability. This feedback of livelihood outcome is represented in the framework by two feedback loops. One loop links livelihood outcome to local knowledge. The other links local knowledge to environmental change. As a result, the framework captures a cyclical and continuous process of household local knowledge utilization towards sustaining their livelihoods under environmental change in the *Atankwidi* basin.

1.7 Summary and emerging issues

In this chapter, I have explored environmental change, livelihood, vulnerability and local knowledge as the theoretical concepts that guided this study. The discussions reveal some pertinent issues, which I now summarize here.

First, I conceptualized environmental change at two levels - global environmental change or regional environmental change. Global environmental change is systemic in that environmental change at any locale can affect the environment anywhere else. This conceptualization underlines the transnational and global nature of the change and may require global effort to deal with. On the other hand, regional environmental change denotes the regional impact of global environmental change – which people easily observe because it affects their livelihoods at the local level. Environmental change may also be systemic or cumulative. Systemic change turn to have a direct impact on globally functioning systems as exemplified by the impact of industrial and land use emissions of green house gases on global climatic systems. Cumulative change underpins impact of the worldwide distribution of the change as exemplified by deforestation and soil depletion. Relative to my discussions on livelihoods in this study, 'regional' and 'cumulative' environmental changes as evidenced in the Volta Basin of West Africa are more important because of their direct bearings on peoples livelihoods.

Secondly, I have shown in my discussions that livelihoods depict the phenomenon of households striving to make a living through the management of existing resources, coping with uncertainties and exploring new opportunities. Thus, a household livelihood comprises four components: a) people and their livelihood capabilities; b) what they do for a living; c) assets, both tangible and intangibles and; d) the living they make out of what they do. In the quest for livelihood sustainability, there is a distinction between environmental sustainable livelihood and socially sustainable livelihood. First, a livelihood is environmentally sustainable when it maintains the assets on which it depends. Second, a livelihood is socially sustainable when it demonstrates capability of coping and recovering from stress and shocks arising from environmental change in this context. Overall, both are important for household livelihood sustainability. This is because while environmental sustainability may be important for minimizing exposure to risk, social sustainability will be important for coping or recovery should shocks impact adversely on livelihoods. Thus, building capacity in both is consistent with addressing risks arising from both external and internal sides of vulnerability. This will be important for sustaining household livelihoods under difficult environments. I have pointed out already in the introduction that I am linking vulnerability with sustainability in this study. Thus, reducing livelihood vulnerability is coterminous with enhancing livelihood sustainability.

Thirdly, this study adopts the 'double structure' of vulnerability as a theoretical approach to analysis. In this context, vulnerability has two sides (external and internal sides) of risk that households encounter in their livelihoods under difficult environments. The external side in the context of this study is the exposure to risks, including contingencies, stressors and shocks arising from environmental change. The internal side comprises risks from defencelessness or the lack of means to cope with shocks, which can lead to total livelihood failure. In this regard, I have pointed out in the conceptual framework that strengthening capabilities to deal with risks associated with both sides is crucial for sustaining rural household livelihoods under environmental change. This is because the two reinforce each other. For instance, if exposure is minimized (external side) through local knowledge it will certainly minimize the risk of lacking ability or means to deal with shocks (internal side) arising from environmental change. Even if shocks occur, the impact may be minimal and within the limits of existing coping ability.

Fourth, a pluralistic view of local knowledge is adopted for this study. This view first, embraces indigenous knowledge as unique knowledge of a community that evolved and accumulated through years of experiential practice. This knowledge may have changed as manifest in innovations that result from 'internal re-evaluation', experimentation or incorporating external elements. Secondly, local knowledge is also taken to mean drawing on external knowledge and adapting it to local situations for the purpose of solving community development problems. As pointed out in my discussion, local knowledge is a driver of innovation and a strategic resource for development as acknowledged by many scholars. Given the daunting challenges arising from environmental change, local knowledge will be central for community development. In the quest for sustaining rural livelihoods where environmental change is pronounced, such as in the *Atankwidi* basin of northern Ghana, the role of local knowledge will be crucial. As a result, the subject of local knowledge flows and sharing attract my attention as an important subject in this research. This is because access to local knowledge will influence vulnerability of livelihoods to environmental change. Understanding the patterns and drivers of local knowledge flows and innovations will therefore be important for guiding appropriate policy interventions in rural development in the context of environmental change.

Finally, I formulated a conceptual framework drawing on the 'double structure' of vulnerability. I used 'vulnerability' for conceptualizing 'environmental change' – 'local knowledge' linkages for analyzing the efforts of households towards reducing livelihood vulnerability in the *Atankwidi* basin. It presents household response to 'vulnerability' as a sequence of local risk management strategies as part of local knowledge of households.

1.8 Conclusion

In this chapter, I discussed the theoretical and conceptual issues relevant for this study. The discussion underscore that environmental change may be conceptualized as either 'global' or 'regional' or as 'systemic' or 'cumulative'. I placed emphasis on regional and cumulative environmental changes because of their direct implications for people's livelihoods. Since I have a 'pro-development' interest in this research, I also examined conceptual issues on livelihood, vulnerability and local knowledge. I underscore that environmental change has adverse implications for livelihood vulnerability and sustainability, especially in rural areas. Hence, local knowledge as a strategic resource will be crucial for reducing livelihood vulnerability, and enhancing livelihood sustainability under environmental change. Drawing on these theoretical reviews and propositions, I formulated a conceptual framework that explores the linkages between environmental change, livelihood vulnerability and local knowledge. This framework guided my empirical analysis on the role of local knowledge for reducing household livelihood vulnerability under environmental change in the *Atankwidi* basin. In Chapter 2, I will examine some characteristics of the *Atankwidi* basin that makes households susceptible to vulnerability.

Chapter 2

2.0 The space of vulnerability: *Atankwidi* Basin and the broader perspective

2.1 Introduction

Households in the *Atankwidi* basin, UER of Ghana pursue their livelihoods within a wider socio-demographic, physical, and economic and policy environment. While individual households may be separable units, they are not autonomous actors in their environment. The wider environment in which they exist presents both constraints and opportunities in the pursuit of their livelihoods. These opportunities and constraints of the environment may change over time and these changes impact on people's livelihoods in various ways (De Briun & Van Dijk 1998:1). Also, see Van der Geest (2004:76). Thus, the characteristics of the wider environment shape the nature of household livelihoods and the vulnerabilities they face. This chapter discusses some characteristics of the environment in which households pursue their livelihoods. The essence is to shed light on how 'external' and 'collective' variables of the environment influence household vulnerability – that is, constraint the efforts of households in their livelihoods.

This chapter is structured in seven parts. In the first part, I discuss population change and density in the study area, focusing on the Kassena-Nankana District[11] (KND) within the regional and national context (Map I). This is because the *Atankwidi* basin is largely located within this district and it is at this level that census data is available. This analysis serves as an important background for understanding how population growth contributes to environmental degradation in the study area. In the second part, I discuss environmental change in northern Ghana, with a focus on the *Atankwidi* basin and Upper

[11] *Kassena-Nankana District* is used in this thesis to refer to both present day *Kassena-Nankana West* and *Kassena-Nankana East* districts. These two district administrative areas previously constituted the *Kassena-Nankana District* prior to its split into two separate district administrative areas in 2007 by an instrument of government. Much data on the area are still aggregated at the scale of the old district administrative area – thus, the convenience of using the Kassena-Nankana District to refer to the 'old' district administrative area prior to its split in 2007

East Region. The discussion illustrate that environmental degradation is a larger phenomenon affecting the entire Volta Basin, Ghana and West Africa. In the third part, the discussion focuses on economic production and poverty arising from the impact of environmental change on livelihoods, especially agriculture. I also discussed some socio-cultural factors that contribute to vulnerability among households in the basin. The role of policy planning at the national level by both colonial and post colonial governments and their implications for vulnerability in northern Ghana is reviewed in part five. I summarize issues from the discussion in part six while part seven entails a conclusion.

2.2 Population change and density

Population change is an important anthropogenic factor, which shape land use and landscapes in ways that has implications for livelihood vulnerability. I will examine population dynamics focusing on the KND, the district within which the *Atankwidi* basin is largely located. The discussion is done in the context of population change at the regional and national levels. This will provide a broader picture of population change affecting land resource management. My discussion centres on these levels because these are the levels census data is available. The population of the KND and that of the regional and national levels has consistently increased since 1960 (Table 2.1).

Table 2.1: Population change of KND in regional and national context

Year	Ghana		Upper East Region		Kassena-Nankana District	
	Population	Increase (%)	Population	Increase (%)	Population	Increase (%)
1960	6,728,815		468,638		93,397	
1970	8,559,313	27.2	542,858	15.8	99,006	6.0
1984	12,296,081	43.7	772,774	42.3	149,680	51.0
2000	18,912,079	53.8	920,089	19.1	149,491	-0.1

Source: GSS (2005)

In 1960, the population of the district was 93, 397 and this increased by 6% in 1970. The population further increased by 51% (149, 680) over a 14 years period from 1970 to 1984. A decrease in the population was recorded in 2000 but this negative growth was insignificant (-0.1). This decrease in population may have been partly due to the impact of out-migration and birth control measures introduced by MOH and NHRC. Similar increasing trends in population are recorded for the region and the country as a whole. The population of the region grew from 772,774 in 1984 to 920, 089 in 2000 which is less than one twentieth (4.9%) of the national population. The increment represents an increase of 19% over the 1984 population, which is the lowest rate of increase among all the regions in the country. The national population growth rate is however, declining. From 2.4% as revealed by the 2000 census, it is estimated at about 1.25% as at 2005. The inter censual growth rate for the region which is 1.1% per annum is slightly below one-half the national growth rate of 2.7% and is the lowest regional growth rate recorded. The population as at 2000 was primarily rural (84.3%) declining from 87.1% in 1984. This represented a 2.8 percentage point reduction in the rural share of the population between 1984 and 2000 (GSS, 2005). This rural population is generally scattered over a dispersed rural settlement system. Although the national population growth rate is declining, population will continue to grow due to the 'population momentum'[12] effect arising from the young population and sex structure at the district level in particular (Appendix 2.1). For instance, the younger population, age group (0-4) to (10-14) are in the majority. In the reproductive age group (20-44), the excess of females over the males is about 23.3% for the district. Overall, 51.9% of the population of the district are females while 48.1% are males. Thus, a young population structure combined with higher proportion of females suggests that a decline in the growth rate will be 'neutralized'. The large number of people in the reproductive age group who would bring forth children will keep population increasing for the next few decades even if growth rate declines.

The effect of increasing population has lead to an increasing trend in population density at the district, regional and national levels (Table 2.2).

[12] Population momentum refers to population growth that will occur even if levels of child bearing immediately declined to replacement level. This phenomenon arises simply because a large cohort of children grew into a large cohort of 'child bearers' whose child deliveries add up to absolute population figures even if birth rate is lower than the previous generation of child bearers.

Table 2.2: Population density of KND in regional and national context

Year	Ghana	Upper East Region	Kassena-Nankana District
1960	28.2	53.0	37.2
1970	35.9	61.4	60.3
1984	51.5	87.4	91.2
2000	79.3	104.0	91.0
Land	238, 530 sq.km	8, 842 sq. km	1,642 sq.km

Source: GSS (2005)

Population density for the district increased from 37.2 in 1960 to 60.3 in 1970. It has however, stabilized at around 91 between 1984 and 2000. Generally, population density in the area is one of the highest in the country. The region's population density of 104.1 persons per square kilometre is higher than the national density of 79.3 persons per square kilometre and ranks fifth in the country. High population density increases demand for land and forest resources for production purposes in order to meet increasing needs, especially food for the population. This brings pressure to bear on such natural resources and thereby, setting in motion degradation processes of natural resources that can undermine livelihoods, especially food supply. The relevance of the Malthusian thesis lies in the question of securing food in the context of population and environment dynamics. According to the Malthusian thesis, food production can only increase at an arithmetic rate whereas population tend to grow at geometric rate. As such, the number of people will increase faster than the food supply if population is not checked (Malthus, 1798). Opposed to the Malthusian thesis, Boserup (1965) assert that food crop producers will always find innovative ways to deal with the pressure of population on agricultural resources. This will enable them produce enough food for meeting consumption requirements. Contemporary analysis tends to appreciate the principles and significant contributions of these opposing views rather than emphasizing their contradictions (see Pender et al., 1999). For instance, this thesis deals with innovations for sustaining crop production for meeting food requirements of households under difficult environmental conditions. In the ensuing discussions, I will show how population change is partly a cause of deforestation, land degradation and soil fertility loss in the *Atankwidi* basin and northern Ghana as a whole.

2.3 Physical space of vulnerability

2.3.1 Vegetation and the incidence of desertification

In Ghana, six agro-ecological zones make up the natural vegetation. These agro-ecological zones include the Guinea, Sudan and Coastal Savanna zones. The rest include the Forest Savanna Transition zone, the Semi-Deciduous Forest and High Rain Forest zones (EPA 2002:28). In more general terms, the vegetation of Ghana is divided into the Savannah of the north which is my focus here and the rich forest lands of the south (Buah, 1998). Different researchers and organizations have adapted different terminologies for describing the vegetation of northern Ghana depending on their assessment of extent of desertification. These include 'Guinea Savannah' (Dickson and Benneh, 1988; DGRD 1992), 'Guinea Savannah Woodland' (van der Geest 2004) and 'Sudan Savannah' (Laube 2007). For Blench (2005), the Upper East Region is a semi-arid savannah, divided into Guinea along its southern limits, grading into Sudan savannah above the escarpment [along the extreme south – north – eastern strip] around *Nakpanduri/Gambaga* and bordering Togo. The dominant trees are locust (*dawadawa*)(*parkia biglobosa*), shea (*Vitellaria paradoxa*) and kapok (*Ceiba pentandra*) interspersed with a ground cover of perennial grasses such as *Andropogon gayanus*. Further north, baobab (*Adansonia digitata*) and whitethorn (*Faidherbia albida*) predominate. In reference to the *Atankwidi* basin and KND, the vegetation belongs to the 'Guinea Savannah' agro-ecological classification. Covering an area of about 147, 900 km^2, the Guinea Savannah covers almost the northern two-thirds of the country and is the largest ecological zone in Ghana. The vegetation consists typically of a ground cover of grasses of varying heights interspersed with fire resistant, deciduous, broad-leaved trees at the forest margins in the south (Rose-Innes, 1977). This change into a more open grassland with widely spaced shorter trees, especially fire resistant and economic trees towards the north. The EPA of Ghana describes the Guinea Savannah typical of northern Ghana as follows:

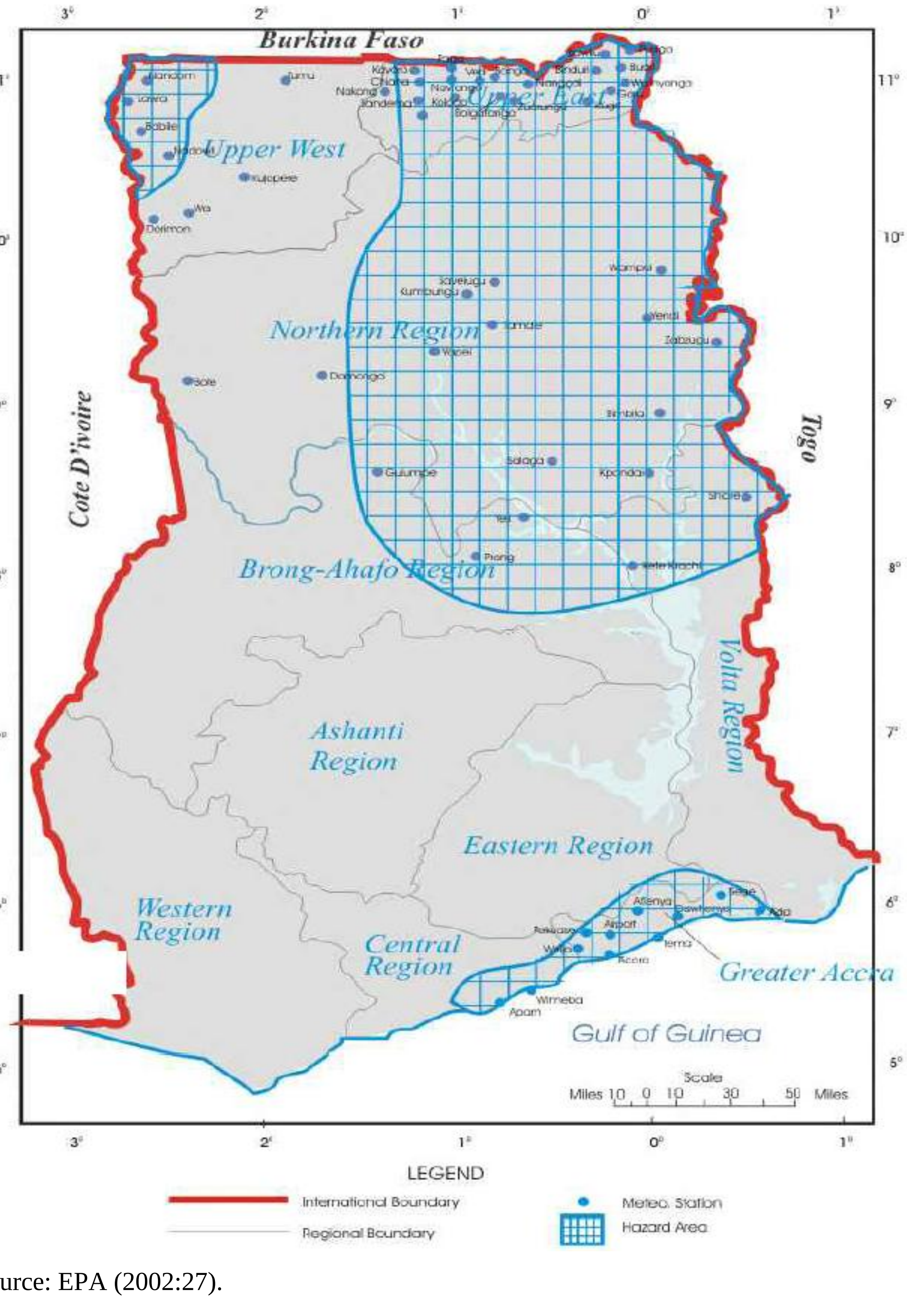
> The grasses of the Guinea Savannah are tussocky in nature giving rise to the common occurrence of bare patches of land. During the dry season, November to March, the dry grasses are highly inflammable. In the less eroded areas, *Andropogon gayanus*, the commonest grass may be replaced by *Hyparrhenia* and *Heteropogon spp*, while *Aristida*, *sporobulus, Imperata* and *Cymbopogon gigantus* dominate severely eroded and poor soil sites. *Vetiveria nigritana, Siteria anceps* and *Sedges* occur in alluvial sites. The common tree species include *Lophira lanceolata, Anogeisssus leiocarpus, Afzelia Africana, Parkia filicoidea, Butyrospermum parkii* and *Antiaris Africana*. Fringe forest and woodland may be found along water courses or river banks (EPA, 2002: 28).

The natural vegetation (Guinea Savannah) has undergone considerable change as a result of human activities (EPA, 2002; Yaro, 2004). This has given rise to the gradual onslaught of desertification in most parts of northern Ghana, especially in the UER. In general, evidence of desertification is much greater in the UER than other parts of Ghana. Thus, the description of the vegetation in the KND as degenerated Guinea Savannah (Yaro, 2004) better reflects the degenerative nature of the vegetation in that area. Short savannah grasses, and scattered shrubs and drought resistant trees characterize such degenerated Savannah vegetation. Specific to the district:

> The vegetation consists of fire-swept grassland of varying heights occurring between deciduous trees, which mostly have economic and social values. In the forest reserves and sparsely populated areas, tree species such as *Annogeissus leiocarpus, utyrospermum parkii, Detarium mictocarpum, Acacias and Parkia clappertoniana* are common. In the densely inhabited areas tree densities are low and species found are the most economically and socially important trees such as *Ceiba pentandra, Butyrospernum, Parkia, Acacias, Adansonia digitata* (baobab), *Tamarindus indica* and *Blighia sapida*. Tree species such as *Heteropogon contortus, Imperata cylinderica* and *Penissetum polystachyon* can be found on arable lands, but degeneration has introduced species such as *Dactyloctenium aegyptium, Chloris spp, Aristida kerstingli* and *Eragrostis spp* (Yaro, 2004:32).

As already mentioned, the problem of desertification is essentially a northern Ghana problem (Map 2.1). From the map, the most affected area of desertification is the entire northeastern corridor of the country spanning the entire Upper East Region (in the north) through to the northern fringes of the Brong-Ahafo Region. The worst desertification area, the Sudan Savannah occurs in a small portion in the extreme northeastern corner around the *Bawku* area as described by Blench (2006) (though not demarcated in Map 2.1).

Map 2.1: Map showing desertification hazard areas in Ghana



Source: EPA (2002:27).

Much of the land area of the UER is described as “an extreme anthropogenic landscape” (Blench, 2006:2). The natural vegetation (tree fauna) has been severely depleted. Almost every species except *Parkia* and *Vitellaria* has been systematically eliminated from the farming areas (Hunter 1967; in Blench, 2005:2). Perennial bush fires have lead to the ‘extinction’ of all the large trees so that the vegetation, especially trees are young even in remote areas. The conservation of sacred grooves (sacred forests) close to settlements has conserved a tiny proportion of the original biodiversity (Blench, 2006) but this is far from reversing the situation. In his assertion (ibid), “up –to- date figures for vegetation” are lacking for the UER. He draws on estimates compiled by the original FAO/IFAD identification mission dating back to 1989 (Table 2.3).

Table 2.3: Vegetation and land use in the Upper East Region, Ghana

Category of use	1978 Satellite Imagery (‘000 ha)	1989 Preparatory Mission Estimate (‘000 ha)	Derived Mean (‘000 ha)	Percentage (%)
Tree Savannah	134	134	134 to 153	15.2 to 17.3
Shrub Savannah	222	222	222	25.1
Grass Savannah	26	26	26	2.9
Fallow	206	128	167	18.9
Cultivated	223	300	261.1	29.6
Plantations	5	5	5	0.6
Wet Bottomland	51	51	51	5.8
Other	18	18	18	2.0
Total	884	884	884	100.1

Source: (IFAD, 1989; in Blench, 2006:3)

Though estimates (Table 2.3) date back to 1989, they are relevant for analyzing the historical perspective on tendencies and dynamics that lead to desertification. Although the analysis does not show [clearly] land cover change for the natural vegetation between 1978 and 1989, reduction in fallow land between 1978 and 1989 by 68000 ha and the increase of cultivated land by 77000 ha clearly show that more land was put into cultivation over the period. Thus, increased demand for land for agricultural purposes arising from increased population pressure is a driver of land cover change. This phenomenon of land use change and especially, land cover change occurs extensively within the country at large. I will draw extensively on a publication by Braimoh and Vlek

(2004) on land-cover change analyses in the Volta basin of Ghana. Braimoh and Vlek (2004:1) use Multitemporal Landsat Thematic Mapper (TM) images for 1984, 1992 and 1999 for mapping and detecting land-cover changes in a 5400 – km^2 area within the Volta Lake basin of Ghana. The Volta basin occupies about 70% of mainland Ghana and includes the entire northern Ghana including the *Atankwidi* sub-basin and UER where I conducted my study. The analyses resulting from the study suggest that the most dominant land-cover change was the conversion of natural vegetation to cropland and that this occurred at an annual rate of 5% between 1984 and 1999. In order to discuss the details of their findings, I will first examine the land cover classification[13] scheme used for the change detection (Table 2.4) and then proceed to examine the patterns of change in land-cover (vegetation) in the Volta basin of Ghana.

Table 2.4: Land-cover classification scheme used for change detection in the Volta Basin of Ghana from 1984 to 1999.

Land - cover class	Description
Closed woodland	Mainly trees 5 m high, riparian vegetation (>150 tree per ha)
Open woodland	Mainly trees (57-150 trees per ha) with shrub undergrowth
Grassland	Mainly a mixture of grasses and shrubs without or with scattered trees (<10 trees per ha)
Cropland	Agricultural land with crops, harvested agricultural land
Built up area	Settlement, airport, roads
Water	Rivers, inland waters, reservoirs

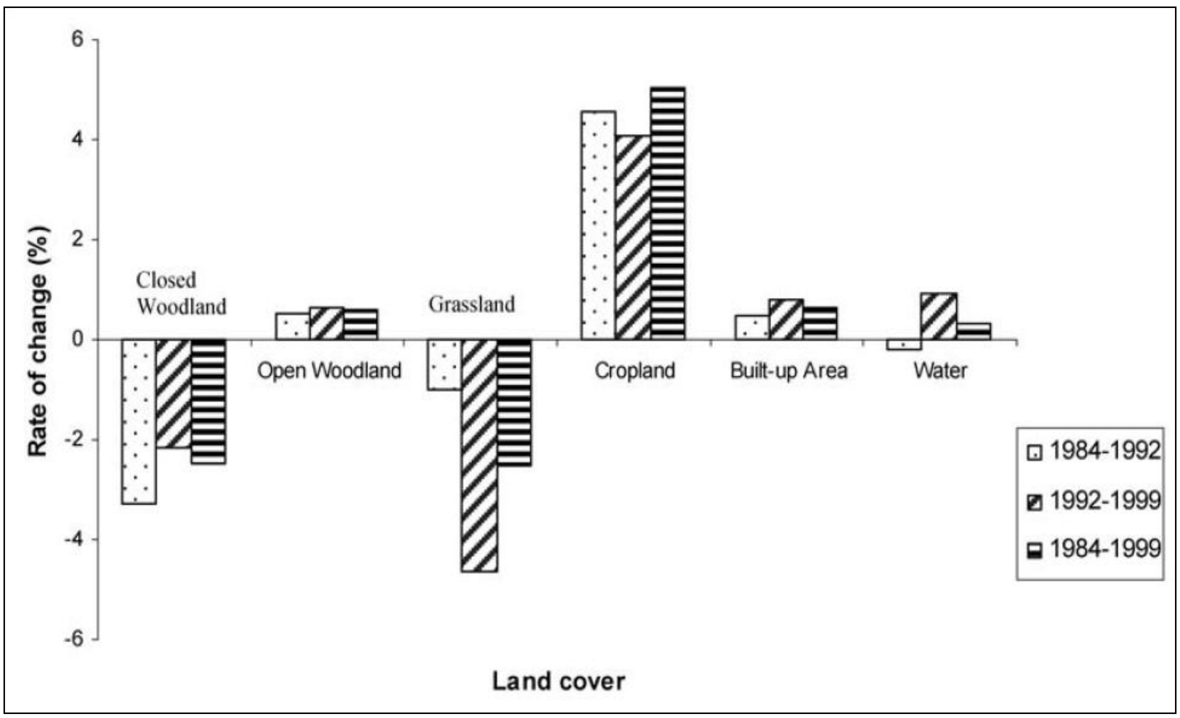
Source: Braimoh and Vlek (2004:4)

In Table 2.4, six land cover types were used as the basis for assessing change detection. The analysis resulting from change detection reveals that as at 1984, the land -cover in the Volta Basin of Ghana was predominantly natural vegetation especially of the woodland and grassland types. However, 15 years down the line, this natural vegetation decreased from 76 % of total land-cover to 59 % in 1999 (Braimoh and Vlek, 2004). An analysis of the proportions of land-cover types for the three years considered in the change detection reveals some patterns in vegetative change. The proportion of cropland

[13] According to Braimoh and Vlek (2004:6), the overall classification accuracies were 85%, 81 % and 88% for 1984, 1992, and 1999, respectively. In 1984, the landscape was predominantly natural vegetation especially of the woodland and grassland types.

increased from 23 % in 1984 to nearly 40 % in 1999. This suggests that more natural vegetation was converted for agricultural purposes over the period. In the conversion process, closed woodland and grassland were the most converted. From 28 % in 1984, closed woodland for instance declined progressively to 18 % in 1999. Similarly, grassland experienced a progressive decline from 1984 to 1999. From 22 % in 1984, the proportion of grassland reduced to about 20 % and further to about 15 % in 1999. Where land-cover was not converted into cropland, most of it was converted into open woodland. The proportion of open woodland increased progressively over the period although percentage increases are negligible (about 1 %). Since most land cover was converted into cropland, much of the land-cover change is attributable to population growth and the need to feed more mouths in the Volta basin. The rates of land cover changes over the period (Figure 2.1) have shaped the current state of desertification.

Figure 2.1: Rates of land-cover change in the Volta basin of Ghana



Source: Braimoh and Vlek (2004:8)

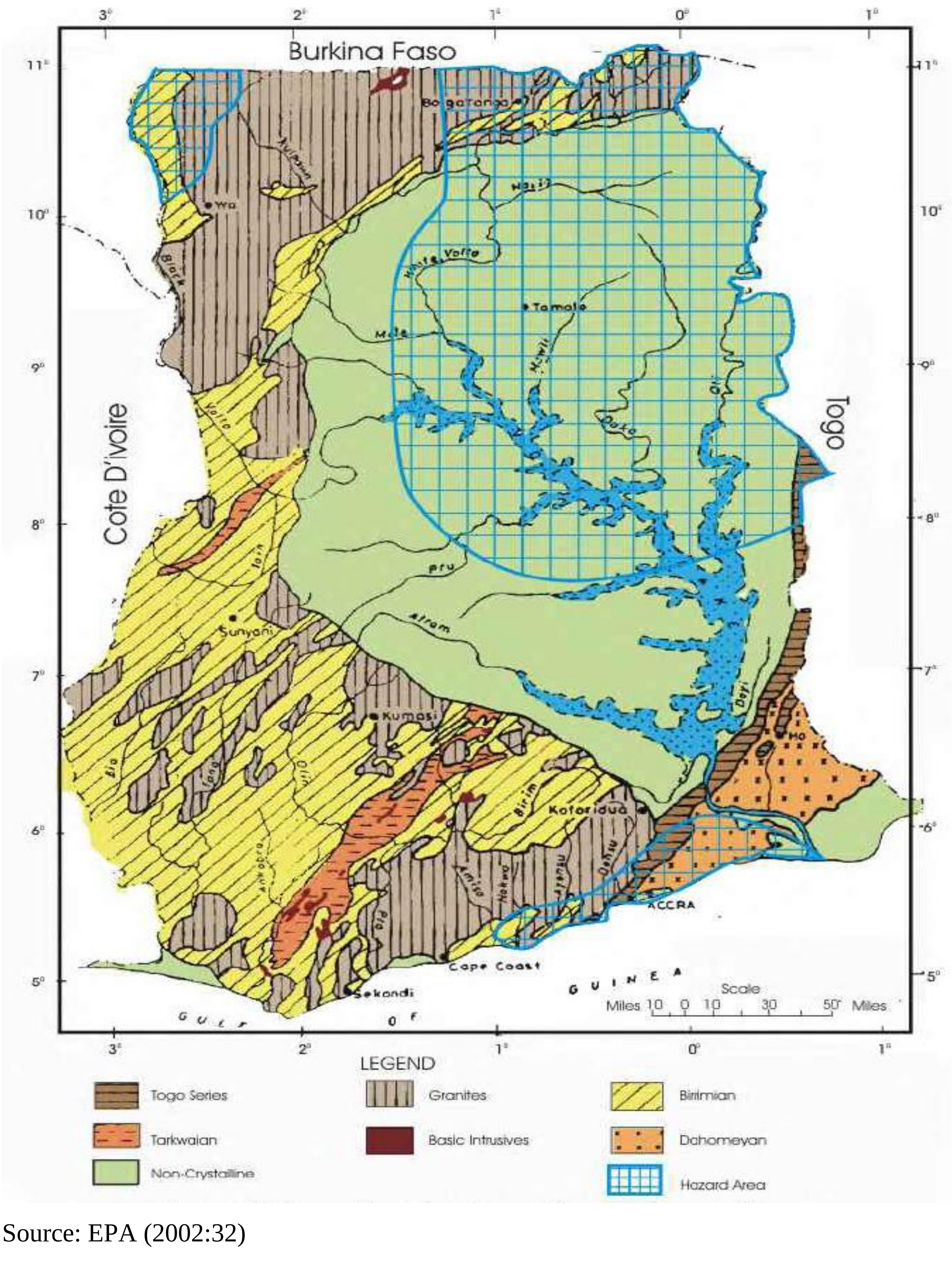
The analysis of rates of change have been grouped into three different periods, 1984-1992, 1992-1999 and 1984 to 1999 (Figure 2.1). My discussion here focuses on three land-cover types namely, closed woodland, grassland and cropland. Over the entire period, that is, from 1984 to 1999, crop land increased by 4.5%. This increased demand for cropland lead to significant decline of mainly closed woodlands and grasslands. Woodland and grassland declined by approximately 2.4% each and this conversation was essentially conversions into croplands to meet food production requirements in the basin and country at large. Over the period under review, about 4% land-cover changes were reversible changes occurring in woodlands while 2% were reversible changes occurring in grasslands. A higher proportion of the reversible land-cover occurred in about 14% of the landscape in relation to fallow agriculture. Woody biomass increased by (10%) compared to an overall decrease of 9% indicating a certain level of rainfall-induced resilience in the ecosystem. Further research is needed for quantifying the mechanisms that enhance vegetation recovery in dry land areas (Braimoh and Vlek, 2004). Although the natural vegetation has its own regenerative capacity, that does not appear to be adequate for addressing desertification in the Volta basin and Ghana at large. Human activities have accelerated the rate of desertification and this is compounded by climatic conditions. Desertification and land degradation therefore, remains a development problem affecting the entire country, especially northern Ghana. First desertification expose top soils and make them susceptible to erosion and physical degradation that reduce their productivity in food crop production. Secondly, the lack of thick vegetation (especially in the dry season) combined with degradation of limited available grazing lands has limited access to fodder and grazing opportunities. This undermines the development of the livestock sector in the basin and northern Ghana.

2.3.2 Geology, soil erosion and physical degradation

The geology of Ghana is predominantly characterized by the pre-cambrian rocks comprising the Dahomeyan and Birimian formations (Bates, 1962). The Birrimian formation is predominant and underlies nearly all the forest zone and the entire areas of

Northern, Upper West and Upper East regions of Ghana. The Birimian formation consists mainly of granites made of geosynclinals sediments and partly granitized volcanic rocks. These granitic rocks are the source of most of the minerals of Ghana. These different geological formations (Map 2.2) have given rise to different parent materials. The different parent materials then gave rise to the development of the different soils on Ghana's landscape (EPA 2002: 30-33). The Ministry of Food and Agriculture (MoFA), Ghana, classify soils for agricultural production into seven groups based on ecological zones. These soils per discussion developed over different parent rock materials but other factors such as climate, vegetation, topography and organisms influenced their development. By the classification, the soils of the Guinea Savannah comprise Lixisols, Acrisols, Luvisols and Gleysols (MoFA, 1998). However, the soils of the Savannah are broadly classified into Savannah Ochrosols and Laterites. In the *Atankwidi* basin and KND as a whole, these two kinds are predominant – Savannah Ochrosols and Ground Water Laterites (See van der Geest, 2004). The Savannah Ochrosols cover about 40% of the district and are found in the northern and eastern parts where a larger part of the *Atankwidi* is located. These soils are well drained, porous and loamy soils found over granites, Birrimian rocks and sandstones. The Ground Water Laterites (Laterites) are formed over granites and shales, and become waterlogged during the rainy season. These soils also dry out and form cemented layers of ironstone called hard pans during the dry season (EPA, 1999; Yaro, 2004). Most soils [including soils of the Savannah] developed on thoroughly weathered parent rock materials. The soils are old and have been leached over a long period of time. As a result, their organic matter content is generally low. They therefore, have low inherent soil fertility. They are most deficient in nitrogen and phosphorous because of the very low organic matter content. Meanwhile build-up of organic matter is further constrained by anthropogenic factors such as burning and overgrazing. Desertification exposes the soils and makes them susceptible to erosion during the rainy season. All these factors in turn, make low fertility worst. Extensive areas of shallow concretionary and rocky soils with low water holding capacities are common (EPA, 2002:33-34). High temperatures also cause rapid decomposition, which lead to low organic, matter content.

Map 2.2: Map showing geology of Ghana and desertification hazard areas



Source: EPA (2002:32)

In general, soils in the KND have an extreme moisture relationship associated with the alternation of wet and dry seasons. This leads to intense leaching of nutrients out of the top soils and the formation of laterites and iron pans that are unsuitable for agriculture (Yaro, 2004). Most soils in the district are also exposed to soil erosion although majority of the soils are on gentle sloping surfaces. The immediate cause being torrential rains while the remote causes are overgrazing, burning and improper cultivation practices that lower organic matter content (Adu, 1969; in Yaro, 2004). Two rivers drain the district surface and in the process cause erosion. These rivers include the *Asebeillika* and the *Atankwidi* rivers, which have *Tono* and *Anayere* as tributaries respectively (Yaro, 2004).

I would like to explore further the issue of soil degradation in Ghana with a focus on the northern Savannah given the importance of soil quality in food crop production. According to the EPA (2002), there are three forms of soil degradation in Ghana. These include physical, chemical and biological types of soil degradation. Physical degradation has to do with the deformation of the physical structure and composition of soils in a manner that undermine their ability to support plant growth. In Ghana, soil erosion is the commonest degrading factor affecting soil productivity (Oldeman et al., 1991). The causative agents of erosion are water and wind although the latter is less significant. In areas where desertification is pronounced such as in the Savannah Zone of northern Ghana, soil erosion is also pronounced especially on farm lands. In this case, both water and wind are effective causative agents of erosion because of the occurrence of bare land and exposure of top soils (EPA, 2002: 44). As a result, large tracts of land have been destroyed by water erosion (Quansah et. al., 1991). Studies show that 70,441 km^2 of Ghana's landscape was susceptible to slight to moderate sheet erosion dating back to the late 1980s. An estimated 103, 248 km^2 was susceptible to severe sheet and gully erosion while 54,441 km^2 was susceptible to very severe sheet and gully erosion. Specific to the UER, an estimated 4574 km^2 was subject to slight to moderate sheet erosion then. In addition, 3774 km^2 was subject to severe sheet and gully erosion while 964 km^2 was subject to very severe sheet and gully erosion (Asiamah, 1987; in EPA, 2002; Coffie and Penning de Vries 2002). By implication, nearly 96 % of Ghana's total landscape was susceptible to soil erosion. The onslaught of soil erosion however, had already affected the entire landscape of the UER then. Given that desertification increased between then and now, the intensities of severe soil erosion should be higher now and affecting much higher proportions of the landscape of the region. The northern Savannah (Guinea and Sudan) are the most vulnerable to soil erosion. The UER being the most degraded northern Savannah (area of the country) is also the most susceptible to soil erosion (EPA, 2002:45). Soil lost to sheet and rill erosion in this region was 90cm. Some severely eroded lands lost all the 120 cm thickness above the unweathered parent rock (Adu, 1972; in EPA, 2002). A study was conducted by Senayah et al. (2005) in the Bawku area (Sudan Savanna, Upper East Region) to understand the physical factors affecting soil degradation in six communities. Soil texture, topography and rainfall were identified as the physical factors affecting soil degradation (land degradation) using data collected along transects. The soils were found to have developed over granite and Birimian phyllite with varying particle size distribution (Table 2.5). In the granitic areas soil texture is an important causative factor of soil erosion while in the Birimian area, the topography (steep terrain) is the dominant influencing factor of erosion.

Table 2.5: Particle size distribution of top soils of granite profiles around Bawku

Soil type	Depth (cm)	%Sand	%Silt	%Clay	Texture
Varempere	0-11	93.0	6.0	1.0	Sand
(Ferric Lixisol)	11-20	85.0	8.0	7.0	Loamy sand
Tafali	0-8	-----	91.0	6.0	Sand
(Ferric Lixisol)	8-12	-----	85.0	9.0	Loamy sand
Tanchera	0-12	91.0	7.0	2.0	Sand
(Haplic Lixisol)	12-32	78.0	12.0	10.0	Loamy sand

Source: Senayah (2005: [3])

The particle size analysis of three soils (Table 2.5) shows that topsoil (0-30 cm) sand contents are exceed 80% for all soil categories. The predominant textures of the soils are sand and loamy sand. These predominant sandy top soils are highly susceptible to erosion especially in the absence of much land cover in the area. This has lead to significant reduction in topsoil thickness by over 30% within a 24 years period (1969 -1993) (Table 2.6). Although annual rainfall has generally been low (< 1000 mm), it falls intensely. This then has the effect of breaking down soil aggregate and accelerating erosion

(Senayah et al., 2005). The analysis (Table 2.6) show that top soil thickness of the three major soil types decreased from a range of 35-75 cm to 20-45 cm from 1969 to 1993. This implied a percentage reduction of over 35% (Senayah et al., 2005). The percentage could be higher now after over a decade of further soil erosion.

Table 2.6: Changes in topsoil thickness of within a 24-years period in the Bawku area

Soil type	Topsoil thickness (cm) in 1969	Topsoil thickness (cm) in 1993	% Change
Varempere	35	22	37
Tafali	50	32	36
Tanchera(1)*[14]	75	20	73
Tanchera(2)*	75	45	40

Senayah et al. (2005:[3])

As already mentioned, erosion of soils of the Birrimian phyllite are much more associated with the topography. These soils developed over hilly terrains and slopes with gentle rolling slopes of 10-15% and steep slopes exceeding 30%. These soils are clayey and more cohesive than the sandy soils over granite. However, their surfaces are rocky, compacted and sealed in the lower slopes due to their heavy textures. Thus, erosion is accelerated by high –run off over the steep slopes, rocky and sealed surfaces (Ibid). As the discussions show, such severe erosion gives rise to shallow soils. This combined with high rainfall intensities and poor surface drainage arising from the general low topography cause water logging. Localized water logging is commonly experienced every rainy season in the Guinea Savanna and Sudan Savannah zones. Peak season floods and associated water logging are major cause of recurrent crop failures and food shortages in northern Ghana, especially in the Oncho-freed zone (EPA 2002: 47). Aside soil erosion, inappropriate use of tractor ploughs (tractorization) in the early 1960s resulted in the removal of topsoil, subsoil compaction and exposure of clay subsoil. This caused severe soil physical degradation. Thus, most soils in the Guinea and Sudan Savannah have predominantly high textured surface horizons with clay pans appearing at

[14] *Refer to the same soil type with two different soil profiles examined

shallow depths. This has given rise to formation of iron pan[15] (petroplinthite) within the soils. It is estimated that over 96,000 km^2 of the country's land contain such iron pan. Most of it can be found in the Guinea and Sudan Savannah and Transition zones which pose additional risk to soil productivity (FAO, 1976; EPA, 2002). In the Bawku area of the UER for instance, sealed and compacted top soils, concretions and iron pan have been observed as additional indicators of land degradation (Senayah et al., 2005).

Soil chemical and biological degradation are also associated with Ghana's soils, especially the Savannah Ochrosols and Laterites. According to GLASOD, soil chemical degradation is second to soil erosion as causative factors of soil degradation (Sherr, 1999; in EPA, 2002). Nutrient loss including organic matter is the key contributor to chemical soil degradation. Such nutrient depletion occurs primarily through crop absorption, leaching, erosion and nitrogen (N) volitatility (EPA, 2002). However, such processes of nutrient losses are only partially compensated for by leaving crop residues on the field, manure and fertilizer application besides atmospheric inputs (Stoorvogel and Smaling, 1990). Nutrient depletion is widespread in all agro-ecological zones with nitrogen and phosphorous being the most deficient nutrients. Deficiencies in these nutrients are much more pronounced in the Guinea and Sudan Savannah where organic matter content (Quansah et al., 2000). High losses of organic matter are of particular concern for various reasons. First, mineral fertilizers are far less effective on soil with low organic matter content (Swift, 1997). Secondly, organic matter is the main source of nitrogen, phosphorous and sulphur for plants in less input subsistence farming systems (Acquaye, 1990). Thirdly, eroded sediments have been observed to contain higher concentrations of organic matter and plant nutrients than the soil from which these were lost (Quansah et al., 2000). Fourthly, the loss of soil organic matter also represents physical soil degradation (EPA 2002: 47).

[15] Iron pan is the result an irreversible hardening of plithite, a kind of soft subsoil material. Currently over 54 % of the country's agricultural land contains plithite which can harden into iron pan when the soil is not well managed (Asiamah and Dedzoe, 1999).

The overall impact of soil degradation is – poor soil fertility, which has adverse implications for soil productivity. As the discussion show, both physical and anthropogenic factors account for the poor state of soil fertility in the northern Savannah of Ghana. Many researchers acknowledge that there is considerably low soil fertility in northern Ghana, especially in Upper East Region (eg., Boateng, 1966; Songsore, 1996; Blench, 1999; EPA, 2002; Van der Geest, 2004; Braimoh and Vlek, 2005; Senayah et al., 2005). I will examine the issue of low soil fertility by looking at the broader regional distribution of soil fertility with a focus on the UER (Table 2.7).

Table 2.7: Soil fertility status of the different regions in Ghana

Region	Soil pH	%Organic matter	%Total Nitrogen	Available phosphorous (mgP/soil)	Available calcium (mg/kg soil)
Ashanti :					
Offinso- Ejura	5.3-7.8	1.5-3.0	0.2-0.3	0.12-12	50-100
Kwadaso-Juaso, Obuasi	4.3-7.0	1.5-3.0	0.1-0.2	0.12-12	50-100
Western	3.8-7.1	1.03-5.7	0.06-5.4	0.35-11.25	28-420
Brong Ahafo	3.5-6.7	0.34-1.69	-----	0.12-64.25	16-140.3
Greater Accra	5.4-8.2	0.1-1.7	0.05-0.9	0.8-144	14-470
Upper East	5.1-6.8	1.1-2.5	0.06-0.14	1.75-14.75	43.5-151.5
Upper West	6.0-6.8	0.5-1.3	0.01-0.07	2.0-7.4	52-151.5
Northern	4.5-6.7	0.6-2.0	0.02-0.05	2.5-10.0	45-90

Source: MoFA (2002:5)

Generally, soils are rich in fertility when in addition to organic matter, good structure and drainage, large amounts of top soils; they have a good pH[16] and some minerals (nitrogen, phosphorous and potassium) necessary for basic plant nutrition. Organic matter content of soils has generally been low for most regions and ranging from 1.1-2.5% for the UER (Table 2.7). The analysis shows a pH range of 5.1-6.8 for the UER. Although this has supported crop production for a long time, it does not compare favourably with optimal pH range (6.0 to 6.8) and optimum pH (7) for most crops. Acceptable soil pH generally

[16] Soil pH is a measure of the soil acidity or soil alkalinity. An acid solution has a pH value less than 7. A basic solution has a pH of more than 7, an alkaline solution (i.e., a solution with positive acid neutralizing capacity). Many plants and soil life forms have a preference for either alkaline or acidic conditions, affecting the choice of crop or plant that can be grown without intervention to adjust the pH. The pH can affect the availability of nutrients in the soil.

range from 6.0 to 6.8 and majority of food crops prefer a neutral or slightly acidic soil (pH 7) (Wikipeadia, 2010). The lack of adequate nitrogen, phosphorous and calcium in soils can cause deficiencies in plants. Nitrogen[17] (N) deficiency for instance is more likely on light soils and those low in organic matter (Ibid.). Since top soil thickness in the UER have been reduced (light) and low in organic matter, they are susceptible to nitrogen deficiencies in much the same way as most other regions of Ghana (Table 2.6). In the study on soil degradation by Senayah et al. (2005) in the Bawku area of the UER, data from 14 cultivated sites reveals low levels of some of these soil nutrients. These include organic matter (OM), nitrogen (N), phosphorous (P) and potassium (K). Soil nutrient data on 8 out of the 14 sites are presented (Table 2.7).

Table 2.7: Chemical analyses of soils from 8 selected farms in the Bawku area

Parameter	Depth (cm)	1	2	3	4	5	6	7	8
OM	0-10	0.7	1.3	0.9	0.8	0.8	2.0	1.4	0.4
(%)	10-30	0.6	1.1	1.0	0.8	0.4	1.3	0.8	0.3
N	0-10	0.02	0.02	0.01	0.01	0.01	0.02	0.02	0.01
(%)	10-30	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.01
P	0-10	3.10	3.10	1.25	0.70	1.55	1.50	11.00	5.08
(mg/kg soil)	10-30	3.87	3.87	0.65	0.30	0.30	0.50	3.60	0.77
K	0-10	20.00	32.50	35.00	32.50	55.00	27.50	45.00	20.00
(mg/kg soil)	10-30	15.00	22.50	22.50	15.00	22.50	25.00	45.00	7.50

Source: Senayah et al. (2005: [5])

Drawing on their findings (partly in Table 2.7), they observed that with the exception of few farms with moderate levels (2.0 – 3.0%) OM in the top 10 cm, most of the farms have very low (<1.0%) levels within a 30-cm depth. They also assert that P (3.0-6.5 mg/kg soil) and K levels (<50 mg/kg soil) are very low for most of the sites and reflect low OM. This is because OM is the main source of nutrient supply in most subsistence farming systems (Senayah et al., 2005). This problem of soil fertility in the UER and

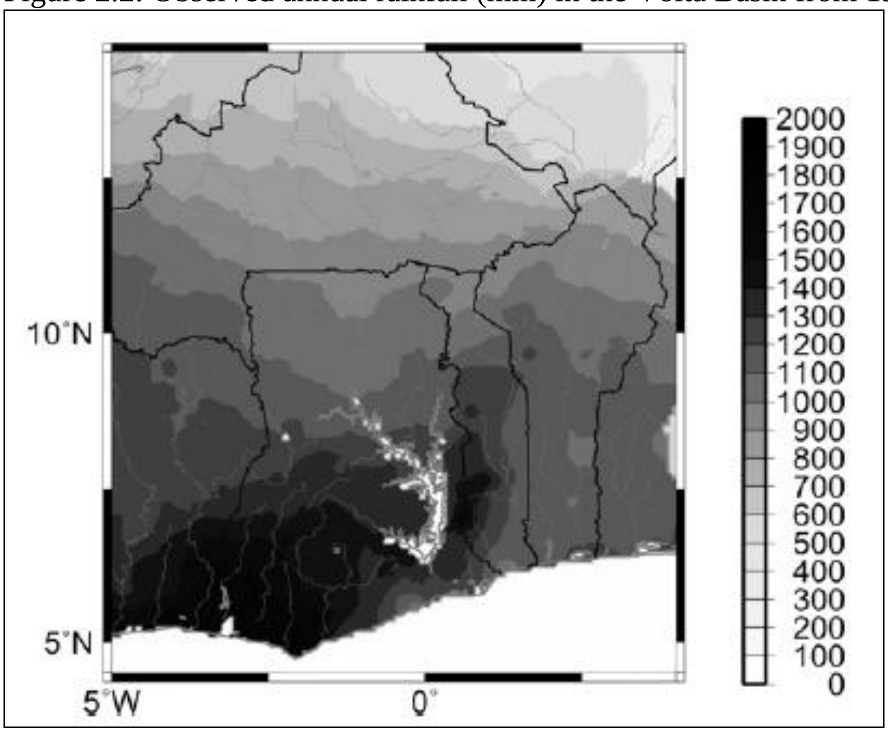
[17] Nitrogen (N) deficiency in plants can occur for instance, when woody materials such as saw dust are added to the soil. Soil organisms will utilize any nitrogen in order to break this down, thus making it temporarily unavailable to growing plants. All vegetables apart from nitrogen fixing legumes are prone to this disorder. Poor plant growth and pale green or yellow leaves are some symptoms.

Ghana is part of a larger continental and global problem. Globally, only an estimated 16% of agricultural soils are free of significant constraints, such as poor drainage, poor nutrient status, difficult to work, salinity or alkalinity, or shallowness. Out of these favourable agriculture soils, 60% are in temperate areas and only 15% lie within tropical areas (Wood et al., 2000). Agricultural land in Africa is poor in soil fertility and quite a significant proportion is degraded to extents where recovery is uneconomical. Most soils therefore, require careful management and investments to maintain or raise productivity for supporting crop production (Coffie and Penning de Vries, 2005). This is the situation with the northern Savannah of Ghana, especially the UER as illustrated in my discussions. A decrease in soil quality along the continuum of land-use intensity in northern Ghana and its adverse implications for subsistence agriculture is observable (Braimoh and Vlek, 2005). Earlier on, they estimate that about 3% of the landscape in northern Ghana was abandoned cropland and that this was probably driven by a decline in soil fertility (Braimoh and Vlek, 2004:14). In this context, the EPA maintains that sustainability of food crop yields is closely linked with the careful management of soil fertility, especially soil organic matter and control of erosion (EPA, 2002).

2.3.2 Climate and climate change

The climate of the *Atankwidi* basin and Ghana falls within the Tropical Continental Climatic Zone (Dickson and Benneh, 1988). It is part of the larger climatic conditions of the Volta Basin and West Africa. In the *Atankwidi* basin, the climate is characterized by semi-arid climatic conditions. It is characterized by pronounced wet and dry seasons, because of the influence of two oscillating air masses, the Northeast trades and the South-West monsoon winds. Originating from the Sahara Desert, the Northeast trade winds blow over the area and the entire West African sub-region, reaching its maximum southwards extent in January. During the entire period of its influence known as the 'Harmattan', it brings a dry, cold and dusty wind, which brings dry conditions to the area. On retreat of the North East Trade winds, the South –West monsoon winds originating from the Atlantic Ocean blow over the sub-region bringing with it moist, humid and wet conditions. They reach their maximum northern extent in August bringing along heavy rainfall. The influence of these air masses has resulted in a single rainy season with monthly totals increasing gradually from March and peaking around August or September and thereafter starts falling (DGRD, 1992; Yaro, 2004). Mean daily temperatures have an annual average of 28.6°C but may be as high as 32.8°C in April. Annual rainfall varies between 700-1200 mm in the region with an average of 986 mm for Navrongo[18] between 1961 and 1990 (Kranjac-Brisavljevic et al., 1999). Annual rainfall for the Guinea Savannah of the Volta basin is estimated at around 1200 mm per year (Kunstmann and Jung, 2005). See Figure 2.2 for map showing observed annual rainfall distribution in the Volta Basin in the rainy season (May- October).

Figure 2.2: Observed annual rainfall (mm) in the Volta Basin from 1992-2000



Source: Kunstmann and Jung (2005:2)

Unlike the southern part of the country, which has a bimodal rainfall pattern, northern Ghana generally, has a unimodal rainfall season annually. This has given rise to only a single major agriculture production season in northern Ghana since most agricultural

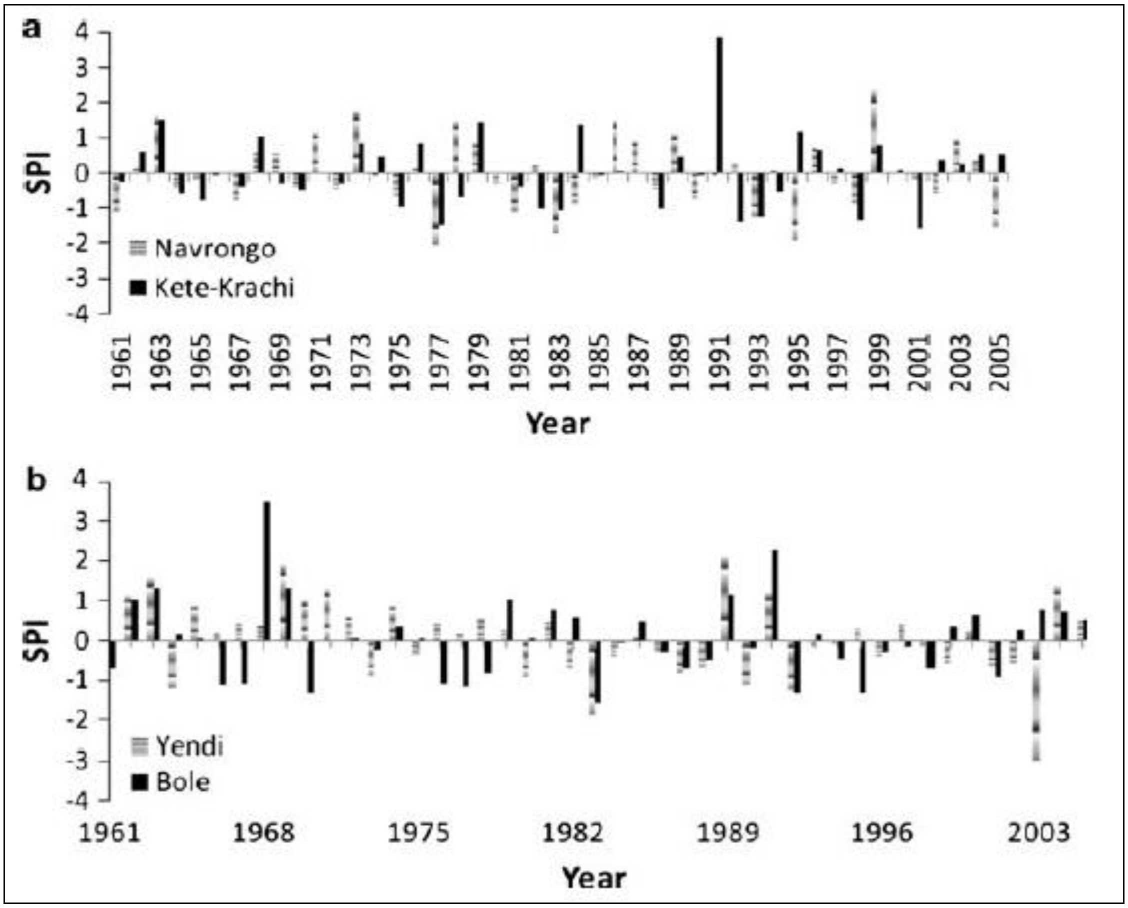
[18] District capital of the Kassena-Nankana District (KND).

production is rain fed. Given that farming is a major livelihood and irrigation infrastructure is limited, underemployment in the dry season is high among the local populace and this has adverse implications for livelihood vulnerability. Furthermore, rain fed agriculture is adversely impacted by climate change and variability. For instance, rainfall is described as erratic and changes occur from year to year. This makes predictability of rainfall and appropriate timing of planting difficult exposing crops to risk of failure (Laube, 2007). Given my interest on livelihood vulnerability, I will explore the phenomenon of climate variability in the Volta Basin with a focus on northern Ghana. Patterns of climate variability are similar across the entire Guinea Savannah zone of the Volta Basin within which the *Atankwidi* lies. The rationale for this exploration is that climate variability gives rise to peculiar risks (vulnerability) that rural people confront in their livelihoods in the *Atankwidi* basin.

The impacts of global environmental change (Turner et al., 1990; Kasperson et al., 2001, Chapter 1) vary from region to region. According to the IPCC (2007), more droughts will occur in drier areas such as in West Africa. Aside the IPCC, many researchers acknowledge the incidence of regional 'climate change' or preferably, climate variability in West Africa (e.g., Jung and Kunstmann, 2007; Van de Giesen et al., 2008; Kasei et al., 2010). In discussing climate variability, I will focus mainly on rainfall. This is because my empirical discussion on livelihood vulnerability (Chapters 3 and 5) are centered on rainfall. I will however, draw on changes relating to temperature and evapo-transpiration where appropriate because of their interconnectedness with rainfall in shaping local climate. A distinction between inter- annual variability and intra-annual variability is a suitable starting point. One of the most pronounced features of rainfall variability in the Volta Basin of West Africa is its inter-annual variability. Since the historic droughts of the 1970s, West Africa has been described predominantly as drought prone although a mixed scenario of dry, normal and wet years exists. Such patterns are correlated with larger scale global oceanographic and atmospheric circulation but also land surface properties of the Volta basin (Jung and Kunstmann, 2007). The 20th century has shown a large variability in rainfall patterns in West Africa (Neumann et al., 2007; Oguntunde et al., 2006). The 1930's and 1950's were wet decades, while the 1970's and 1980's were very dry decades. In particular, 1983-1984 were drought disaster years during which large parts of the rainforest including farmlands in Ghana got burnt. This dry period lead to widespread hunger in the country. Since 1990, mixed scenarios (above and below average) annual rainfall years comparable to that in the 1940's and before 1930 have been recorded (Oguntunde et al., 2006). The post 1970 witnessed a significant decline in average annual rainfall. From a mean of 1100 mm/year over the period (1901 -1969), it declined to 987 mm/year over the period (1970-2002). Once this single 'outlier' is accounted for, no clear trend remains of rainfall pattern in the Volta basin (Oguntunde et al., 2006; see also Van de Giesen et al., 2008). While some research suggests a recovery of the rainfall in the sub-region (Nicholson 2005), a decline in rainfall amount and duration is observed by others for the Volta Basin. Rainfall deficiency has increased since the early 1970s, and moderate to severe drought years have occurred with a return period of approximately 9 years. High impacting droughts with areal extents of 50 % or more in the basin occurred in 1961, 1970, 1983, 1992 and 2001 (Kasei et al., 2010:89). Although rainfall is characterized by the occurrence of a mix of dry and wet years, an overall [tendency] towards a decrease in rainfall has been observed since the discontinuities of the 1960s and 1970s (Oguntunde et al., 2006). This decrease in rainfall ranged from 15 to 30 % (Kasei et al., 2010) with the 1980s being the driest period of the 20th century in West Africa (Nicholson and Palao, 1993). At this point, I will draw extensively on drought (rainfall) analysis for the Volta basin by Kasei et al. (2010) using Standardized Precipitation Indices (SPI)[19]. This is because their analyses extensively focus on meteorological data on northern Ghana (including *Navrongo*, *Atankwidi* basin) (Figure 2.4). Regional climate simulation for the Volta basin by Kunstmann and Jung (2005) is also drawn on to support my discussions rainfall variability. The SPIs (Figure.2.3) show the mix trends of dry and wet years that characterize the rainfall pattern in Ghana (Volta Basin) per my earlier discussions. In Figure 2.3 (a), the SPI for *Navrongo* (including *Atankwidi*) in the KND is presented together with SPIs for *Kete-Krachi,* southern Ghana.

[19] The Standardized Precipitation Index (SPI) is a probability index that was developed to give a better representation of abnormal wetness and dryness in patterns of rainfall (Guttman, 2007). For example, severely-extremely dry year for the Volta basin (including analysis in Figure.6) will have an SPI< -2.5 and severely-extremely wet year an SPI > 2.5 (Kasei et al., 2007).

Figure 2.3: (a) SPI for the north (Navrongo) – south (Kete Krachi) and (b) SPI for the north –west (Bole) – east (Yendi) gradients.

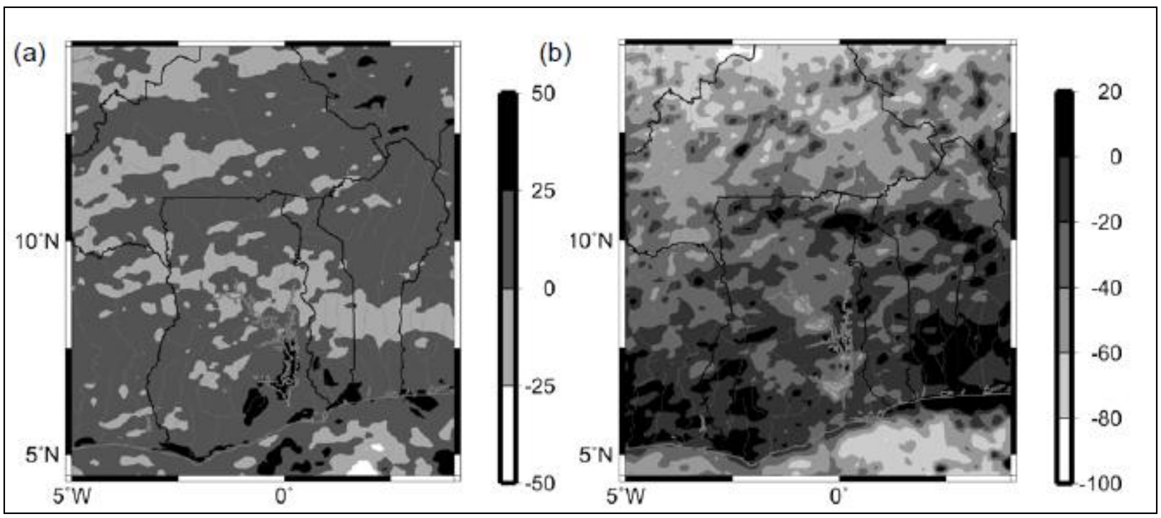


Source: Kasei et al. (2010:93).

Normal rainfall years are represented by SPI values 0±0.5 between 1961 and 2005. Beyond this, SPI values towards -2.0 and +2 represent extreme dryness or wetness respectively. For instance, SPI of -2.0 represent extreme dry conditions (drought) and that of +2 represent extreme wetness (heavy rainfall). The SPIs for *Yendi* and *Bole* (Figure 2.3 b), both located in northern Ghana show similar mixed trends of dry and wet years, although according to Kunstmann and Jung (2005), most significant trends are negative for the Volta basin. The analysis (Figure 2.3) clearly shows that rainfall in northern Ghana and the Volta basin at large is characterized by significant inter-annual variation. Future projections about rainfall and climate change in the Volta basin based on different ‘regional climate models’ present similar mixed scenarios of dry and wet years ahead.

As my discussion show, some researchers predict a drying trend in the rainfall situation moving forward (eg., Oguntunde et al., 2006; Kasei et al., 2010). On the other hand, Kunstmann and Jung (2005) project a slight increase in total annual rainfall of 5%, but also a significant decrease (up to 70%) for April, which marks the transition from the dry season to the rainy season. They used a high resolution regional climate simulation model (IS92a ECHAM4 global climate scenario) based on “future climate” (time slice 2030 – 2039) and “recent climate” (1991-2000). Their predicted changes in precipitation show strong spatial variation (Figure 2.4).

Figure 2.4: Change in (a) annual and (b) April precipitation 2030-2039 vs 1991-2000(%).



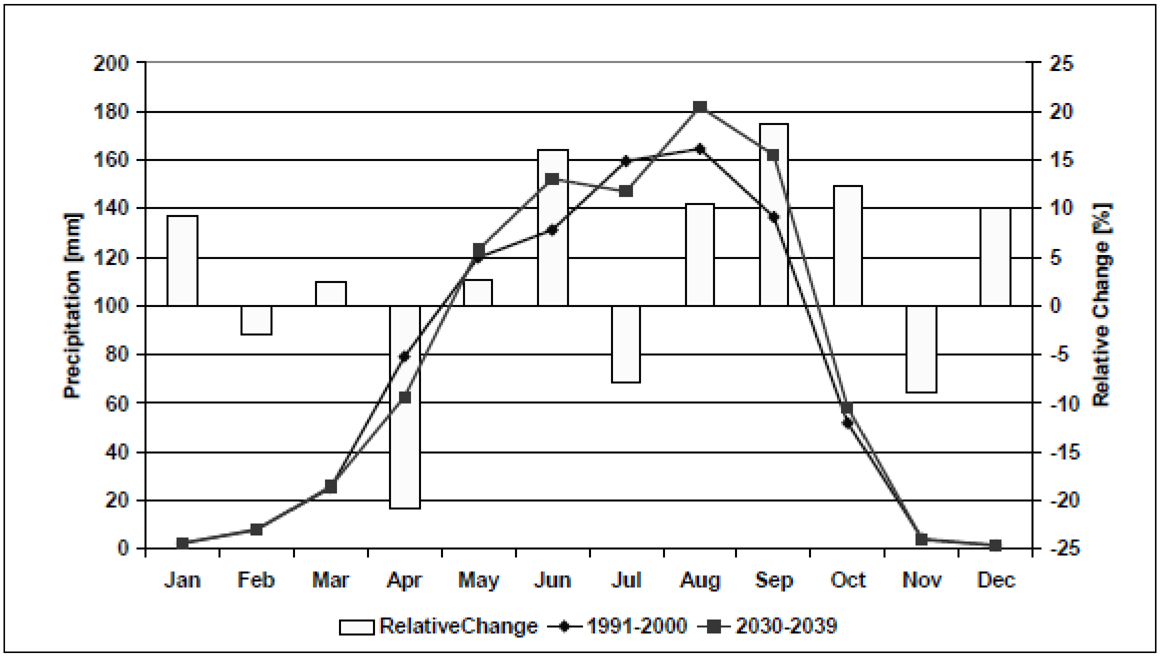
Source: Kunstmann and Jung (2005:8)

The spatial distribution of annual rainfall change is shown in Figure 2.4 (a). A rough rainfall increase of +20% appear throughout the basin although spots of relatively less rainfall increments also dot across the basin. In April (Figure 2.4 (b)), a dramatic rainfall decrease of up to 70% over the entire Basin is predicted but this is also the time farmers typically start seeding (Kunstmann and Jung, 2005).

As already stated, the second domain of rainfall variability I intend to discuss is intra annual rainfall variability (ie. emerging patterns of change in annual distribution of rainfall). There are three issues of change associated with intra annual rainfall distribution. These include shifting onset of the rainy season, ‘discordant’ annual rainfall distribution giving rise to intermittent droughts and or high rainfall intensities and shortening rainfall seasons. The sowing season in the north of Ghana some few decades back started in April. However, the onset of the rainy season is shifting forward. Atmospheric modeling results by Jung and Kunstmann (2007) suggest that this trend will continue into the near future. The onset of the rainy season is anticipated to shift roughly from April to May. In the 1990s, the sowing season already started in May, implying a shift (Kasei and Sallah, 1993; in Kasei et al., 2010:90). What makes the onset of the rainy season problematic is that it has also become difficult to predict with precision for better timing of sowing. According to Van de Giesen et al. (2008), there are regularly “false starts” of the rainy season. Spurious early rains deceive farmers into planting and thereafter expected follow up rains fail to sustain crops. Although farmers apply various risk management strategies losses are still major. In addition, farmers’ experiences point to shifting trend in the onset of the rainy season in the year. In relative terms, farmers claim to sow 10 to 20 days later than their parents did. Laux et al. (2007) find statistical evidence to support the argument that the onset of rainy season is shifting forward. They find that the onset of the rains moved forward by 0.4 to 0.8 days/year in several components although the end of the rainy season and rainfall amounts remained largely unchanged. This also gives rise to high rainfall intensity within the rainy season with sometimes adverse implications for farming. What makes the shifting forward of the rains worst is the projection by Jung and Kunstmann (2007) that mean monthly rainfall for April will fall by 70% (Figures 2.4 and 2.5). If this projection is correct, it will likely affect the entire period within which the rains usually set in. This will have dying consequences for food crop farming.

Another feature of intra-annual rainfall variability is the ‘discordant’ distribution of rainfall over the rainy season. This gives rise to occurrence of intermittent drought spells and high rainfall intensities that are often not in harmony with plant water requirements. After the rains set in, the distributions over the rainy season greatly influence the growth and development of the crops (Kasei and Sallah, 1993; in Kasei et al., 2010:90).

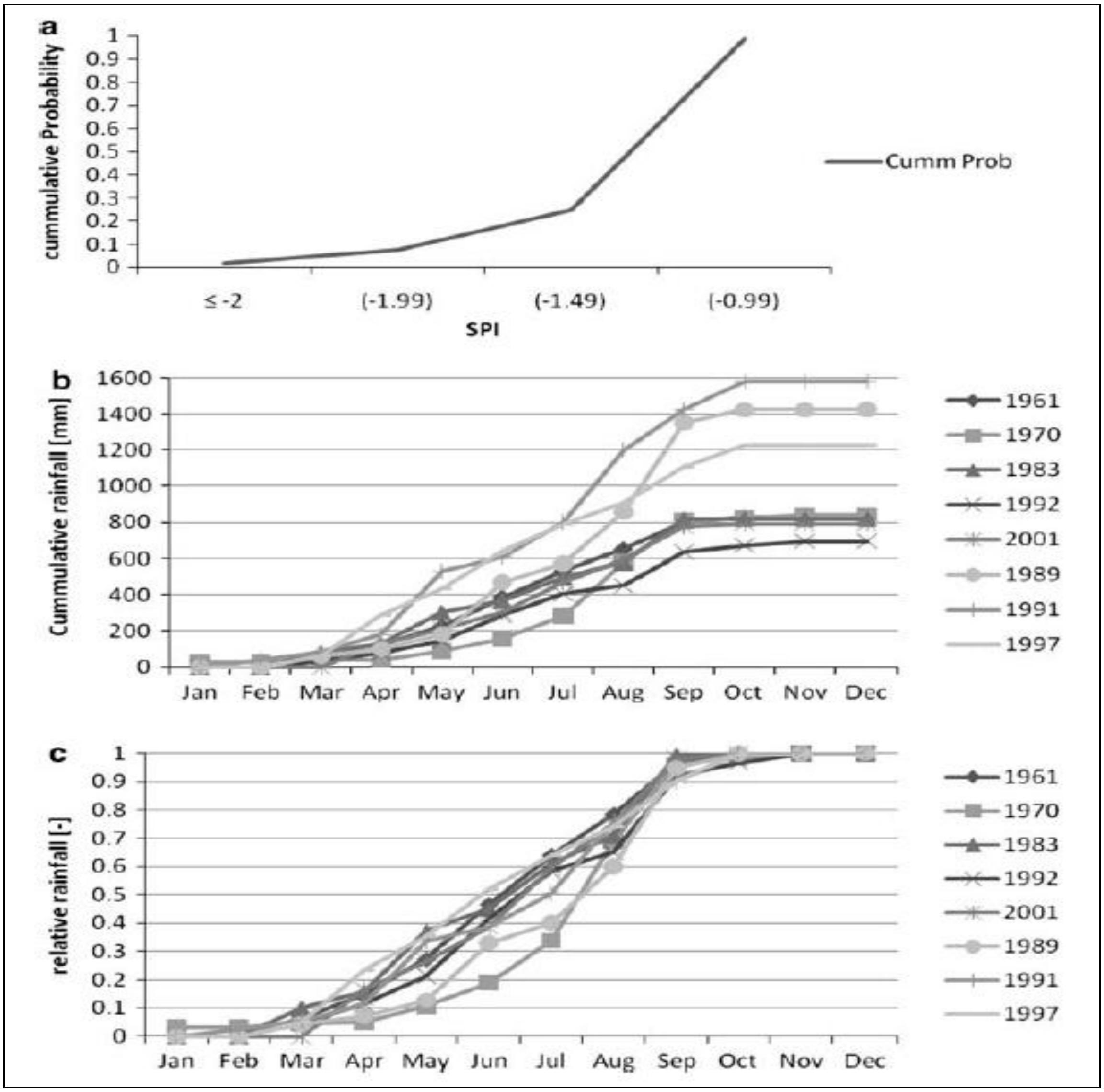
Figure 2.5: Change in mean monthly precipitation 2030-2039 vs 1991-2000



Source: Kunstmann and Jung (2005:8)

However, within season dry spells (drought) are also common in northern Ghana and the Volta basin as a whole (Laux et al., 2007; Jung and Kunstmann, 2007, Kasei et al., 2010). In northern Ghana (around Tamale), "a dry spell of 7 days can be expected to occur once a year in June and once in every 4 years in September at the peak of the rains" (Kasei and Sallah, 1993; in Kasei et al., 2010:90). In the context of drought spells in the Volta basin, "a later sowing date than presently done is associated with better yields. This is because, on average, the impact of drought spells are less when sowing is done later (Sultan et al., 2005). On the other hand, there can also be high rainfall intensities and sometimes this also adversely affects plant growth and development. For instance, more rainfall is expected in the peak months of August and September in the Volta basin (Van de Giesen et al., 2008) but intensities can go to an extreme inimical to plant growth. Figure 2.6 shows relative drought frequency curve and intra-annual rainfall distribution for the Volta basin for 1961-2005. I will draw on this analysis for further illustrations.

Figure 2.6: Relative drought frequency curve and intra-annual rainfall distribution for the Volta basin for 1961-2005



Source: Kasei et al. (2010:94).

Figure 2.6(a) shows relative drought frequency curve for the Volta basin for 1961-2005. Hence, drought intensity and frequency for the Volta basin (as earlier mentioned), shows an average return period of about 10 years for a moderate drought of probability 0.06 – 0.18 for the 44-year rainfall record (Kasei et al., 2010). This relates more to and or supports the discussion on inter-annual rainfall variability as discussed already. The analysis (2.6 b, c) relates to intra-annual rainfall distribution which is my focus here. While (Figure b) shows monthly rainfall distributions of selected dry and wet years in

Tamale, (Figure c) shows the distribution functions of relative rainfall of selected years with 1997 as a normal rainfall year. Reference to Figure (b), the usual pattern of rainfall distribution is one in which rainfall amounts ‘pick up’ in May and peaking in August and September. This is the normal year rainfall distribution pattern that supports optimal crop yields. Farmers expect this pattern of distribution as represented by the ‘normal’ rainfall years of 1989, 1991, and 1997. However, when the rainfall fails to ‘pick up’ well between May and July, and rainfall amounts fall below 800mm during the expected peak period (August – September); then the rainy season is impacted by drought. Such drought years as shown by Figure (b) are represented by the remaining five years (1961, 1970, 1983, 1992, and 2001). In general, the length of the rainy season remains same for both dry and normal years. Early rains start around March, ‘picking up’ from May till September with late rains occurring in December. The rainfall season therefore, typically last 5-6 months during which about 80% of the rain falls (Kasei e al., 2010). In Figure (c), relativities in the distribution functions of the selected years (with 1997 as a normal rainfall year) are illustrated.

As the discussions show, climate variability, especially rain fall variability is a reality in northern Ghana and the Volta Basin of West Africa at large. Rainfall change manifest in both ‘inter-annual’ and ‘intra-annual’ variability. This makes rainfall unreliable and exposes farmers to multiple ‘stresses’ and ‘risks’ that create difficulties in food production and agro-related rural livelihoods. Climate variability exposes rural households to the risk of livelihood failures. Thus, the ensuing discussions address the impact of both land and soil degration, and climatic variability in the economic wellbeing of the populace in Ghana with a focus on the *Atankwidi* basin and northern Ghana.

2.4 Economic environment and poverty

In Ghana, and the entire continent of Africa, agriculture remains the mainstay of national economies. It is a major source of livelihood for the rural population who are in the majority. In Ghana, the agricultural sector dominates the economy in terms of its share of GDP, employment, foreign exchange earnings and provision of food. The sector employs about 70% of the rural labour force, contributes 45% of GDP and accounts for over 55% of the foreign exchange earnings. It provides over 90% of the country's food needs. It is also an important source of raw materials for the manufacturing industry, especially agro-processing industries. However, the agricultural sector has not grown as expected due primarily to low investments. The overall growth rate of 2.8% in the sector does not compare favourably with growth targets of 5-6% as enshrined in Ghana Vision 2020, a policy target for transforming the country from a poor to a middle income status by the year 2020 (GOG, 1995). This low growth rate (2.8%) vis- a- vis 2.6% population growth rate (GSS, 2000) poses serious risks for food security, employment, rural incomes and overall national economic development (EPA, 2002). There is a significant commitment by the GOG to accelerate agricultural production as reflected in its development programmes. However, multiple-stressors arising from environmental degradation pose a serious challenge to this development agenda.

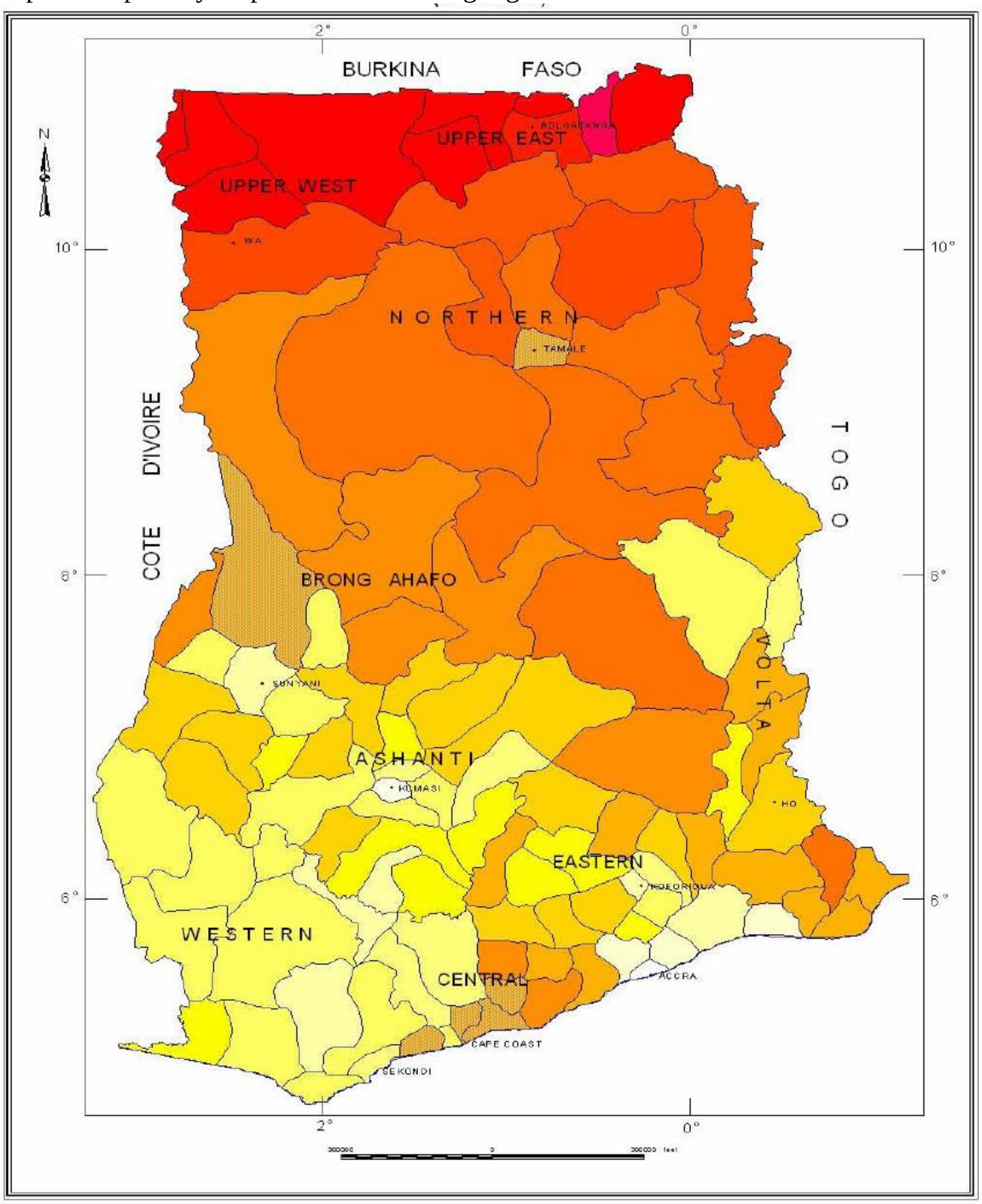
Amongst the major forms of degradation, soil fertility decline is recognized as the major constraint to accelerating agricultural sector growth rates for meeting increasing demands for food in the country (MoFA, 1998). The top soil loss to erosion is usually the most fertile part of the soil containing most plant nutrients, organic matter and where possible applied fertilizers (Bonsu and Quansah, 1992). Hence, the loss of such top soils gives rise to economic costs. For instance, estimates of the effects of soil degradation on the economy of Ghana show productivity losses of 2.9% per year for all forms of crops (Alfsen et al, 1997). This loss in productivity resulted in a 1% decline in economic growth even with increased fertilizer use. In a recent study, the seasonal cost of NP and K lost through erosion per hectare under a maize monocrop grown under excessively tilled land was estimated at US $7.1 (Quansah et al, 2000). Thus, gross annual economic loss to erosion ranged from 2 to 5% of Agricultural Gross Domestic Product (AGDP) in Ghana (Bojo, 1996). In monetary terms, Convey and Tutu (1990) estimate the cost of annual production loss to erosion and nutrient depletion at US $166.4 million in Ghana. This is about 4-5% of AGDP (See EPA 2002:58-60). Most agricultural production is done by subsistence farmers who practice low input farming. A majority of subsistence farmers do not apply chemical fertilizer in farming because of the inability to afford. This is so despite the fact that large quantities of fertilizer may be needed to maintain crop yields where soils are less productive. For instance, Ghana ranks amongst countries where fertilizer usage is lowest. High cost due to privatization of fertilizer trade, poorly developed market distribution mechanisms, limited access to credit and subsidies, land tenure insecurity and in recent times limited access to government subsidies are to blame. Fertilizer usage declined from 4.5 to 2.9 kg ha^{-1} between 1990 and 1996. In 1996, per capita use was estimated at 0.73 kg/person. Soil mining in food production is therefore, a major feature of subsistence farming systems in rural Ghana and in most parts of rural Africa. According to the EPA (2002), farming in desertification-prone areas in Ghana is largely characterized by low input technologies. It is also characterized by the cultivation of marginal lands and reductions in fallow periods in the northern Savannah due to population pressure. Thus, nutrient mining is a common feature of the farming systems in northern Ghana. These characteristics of subsistence farming systems, combined with environmental change have lead to low crop yields and increased livelihood vulnerability for many rural folks.

An overwhelming majority of 'subsistence farmers' in the Volta Basin cultivate under either a 'unimodal' or bimodal rain fall regime. For the Guinea Savannah area of Ghana and the Volta basin (West Africa), farmers largely depend on 'unimodal' rain fed agriculture. Nearly 90% of the Volta Basin is under rain fed farming (Kasei et al., 2010). Indeed, rain fed agriculture is the most important economic activity within the Volta basin (Van de Giesen et al., 2008:2). It's a major source of livelihoods for the highest population concentrations of the Savannah zone in West Africa. These include the UER of Ghana including the *Atankwidi* basin, northern Côte d'Ivoire, southern Mali, the Mossi plateau in Burkina Faso, and the Jos Plateau in Burkina Faso. As a result, rainfall variability and the wide fluctuations that occur over the basin adversely affect crop yields and livelihoods of many people. A mix of droughts and heavy precipitation has undermined agricultural production in the basin as a reflection of climatic variability in the past. For instance, the major droughts of 1968-73, 1982 -85 and 1990-92, particularly that of 1983 caused serious hydrological imbalances that adversely affected crop production and the natural vegetation. The results were shortages in food production, famine and a general decline in human livelihood (EPA 2002). High variability of rainfall account for fluctuations in food production in the Volta basin, especially, in northern parts of the basin (Kasei et al., 1995). In the drought year of 1983, Ghana's food production was considerably below normal (PPMED 1987) and this lead to hunger in several parts of the country. Similarly, 14 out of 18 households in the village of Oualaga in the Sanmatenga Province of Burkina Faso experienced food deficit exceeding 50 % as a result of the early 1980s droughts (Broekhuyse, 1983). In Senegal, rice yields reportedly decreased rapidly in response to rainfall falling below average over a 10-year period (Elston 1983). See Kasei et al. (2010). As my previous discussion show, more of such climatic stressors, especially droughts can be expected in the future as part of the effects of global climatic changes. These trends will likely impact harshly on agricultural production and undermine food security for majority of subsistence households if adaptive capacity is inadequate. For instance, increases in droughts and floods are projected to adversely affect local crop production, especially in subsistence sectors at low latitudes (IPCC, 2007). The IPCC further estimates that by 2020, between 75 million and 250 million people will be exposed to increased water stress due to climate change. If coupled with likely increased demand, this will undermine livelihoods of many small producers. Thus, agricultural production, including access to food, is projected to be severely compromised by climate variability and change in many African countries. The area suitable for agriculture, the length of growing seasons and yield potential, particularly along the margins of semi-arid and arid areas, are expected to decrease. This would adversely affect food security and exacerbate malnutrition in the continent. In some countries, yields from rain-fed agriculture could be reduced by up to 50% by 2020 (IPCC, 2007). Studies show that Africa remains one of the most vulnerable continents to climate variability and change because of its exposure to multiple stressors and low adaptive capacity. Although the studies acknowledge that some adaptation is taking place, it may be insufficient for dealing with future climatic changes (IPCC, 2007).

Low agricultural productivity and declining production arising from environmental change have culminated into high incidence of poverty in the *Atankwidi* basin and northern Ghana as a whole. There is an on-going discourse as to whether its environmental change that causes poverty or it's poverty that causes environmental change. To illustrate this issue pertaining to northern Ghana, the EPA (2002) in one breadth asserts that poverty is the main underlying socio-economic cause of land degradation. It maintains that poverty limits farmers' ability to invest and adopt sustainable farming practices although they may be aware of the necessity to do so. In another breadth, the EPA maintains that poor people, particularly, poor women, often depend on the most fragile areas and resources for their livelihoods because they lack access to the best land. By implication, low productivity and production arise from cultivation of marginal lands and make such people poor. Rather than take side in this debate, a holistic view of the debate better supports my interest in this study. The use of 'vulnerability' as a research concept in this study enables me to analyze the interactional relationship between the two (environment and poverty) and the consequences for livelihoods in a holistic manner. In effect, the two matter in livelihood vulnerability and sustainability if poverty is understood as a multi-dimensional phenomenon that embodies issues relating to income, knowledge, education and health. At this point however, my discussion focuses on poverty in northern Ghana with a focus on the *Atankwidi* basin, UER. Although Ghana has made some strides in poverty reduction over the past two decades, poverty levels remain unacceptably high. Statistics based on the GLSS suggest that the share of people living in poverty reduced from 51.7% in 1991/92 to 39.5% in 1998/99. This further reduced to 28.5% in 2005/2006. However, the spatial distribution of poverty shows clear spatial inequities in the state of development in the country. Geographically, the incidence of poverty is highest in northern Ghana comprising the UER, UWR and NR. In this northern half of the country, 68% of the populations live in poverty compared with the national average of 28.5% as of 2006. According to Coulombe and Wodon (2007), the northern-southern divide in the analysis of poverty seems more important than the urban-rural divide. This is because there is increasing concern and overwhelming evidence that the northern part of the country is being left behind in the growth process. Both urban and rural savannah areas of the north remain very poor and the poorest in the country. While rural areas of the coastal and forest zones experienced large poverty drops over the past two decades, the drop was negligible for the rural Savannah. This increased the poverty gap between the northern half and the southern half of the country. This resulted in an increase in the share of the poor living in the rural Savannah areas from 32.2% in 1991/92 to 36.6% in 1998/99 and further to 49.3% in 2005/06. Thus, while the rural Savannah area in 2005/2006 accounted for only one fourth of the population, it accounted for half of the poor (Coulombe and Wodon 2007). See Map 2.3 for a poverty map of Ghana showing the regional distribution of poverty. From the map, the three northern regions, including the NR (southernmost fringes), the UWR (northwestern part) and the UER (north-eastern part) occupying the northern half of the country are represented as the poorest regions of Ghana. The extent of poverty is represented by light to dark red shadings, with the worst areas of poverty represented by the dark shadings. Thus, with the exception of *Wa* and *Bolgatanga* (capitals/metropolitan) represented by light red shadings, the entire stretch of rural UWR and UER are the poorest regions as represented by the dark red shading.

In the *Atankwidi* basin and the entire UER, consumption poverty manifest in hunger, malnutrition and in its severest form, famine. Hunger arising from food shortages in the 'lean season' (June-July) has come to be institutionalized in the local seasons as '*kom taam'*, meaning the lean season. According to the EPA (2002), low crop yield in areas worst affected by soil degradation result in seasonal food shortages (hunger-gap) and occasionally, widespread famine in northern Ghana. Degradation impacts negatively on nutritional status and increase malnutrition and nutrition related diseases such as kwashiorkor among children. Children are the most vulnerable as they very often suffer from malnutrition and stunted growth in northern Ghana but also in other degraded parts of the country (EPA, 2002). In Ghana, malnutrition among children between the ages of 0-5 years in communities with severely degraded soils increased from about 50% in 1986 to 70% in 1990 (DGRD, 1992). In the UER including the *Atankwidi* basin, hunger and famine intermittently give rise to food relief programmes supported by the GOG, international relief agencies and NGOs. For areas affected by drought increases such as in the *Atankwidi* basin, the IPCC (2007) projects that there will be increased risk of food and malnutrition.

Map 2.3: A poverty map of Ghana showing regional distribution



Source: Coulombe and Wodon (2007:35)

It further maintains that climate change increases the number of people at risk of hunger relative to status of socio-economic development. Globally, 820 million people are undernourished today. Projections based on some scenarios of socio-economic development (without climate change), estimate that between 100-240 million people will be undernourished by 2080 while another scenario put the figure at 770 million in 2080. Thus, climate change and socio-economic conditions combine to alter the regional distribution of hunger, with large negative impact on Sub-Saharan Africa (IPCC 2007).

Another dimension of poverty in the *Atankwidi* and UER in general is low incomes. This situation arises from a combination of factors. First, the majority of the rural population depend on low productivity farming[20] for their incomes. This implies 69% of the population for KND and 66% for the UER as a whole (GSS, 2002). See Appendix 2.4 for details on occupational distribution. However, low productivity and production arising from environmental degradation has meant that little is available for sale as source of income. This is so for food crops but also poultry and livestock. Declining yields have impoverished local farming households (Laube et al., 2008). Findings from my fieldwork show that many farmers lose their poultry to diseases while livestock (goats, sheep, and cattle) fare poorly because of the lack of adequate feed and water especially in the dry season. That apart, hunting as a source of livelihood is rare because of the collective disappearance of wildlife and forest cover. In many communities, hunting has virtually become an 'extinct' livelihood. According to the EPA (2002), low crop yields and reduced agricultural productivity result in low family and individual incomes. This limits the ability of households to raise money to buy food for meeting deficit consumption requirements arising from low own production. It also limits opportunities for savings, capitalization and leads to further increases in the level of poverty and unfulfilling livelihoods. Although lacking in the *Atankwidi* basin, improved economic production is important for poverty reduction. For instance improved economic conditions in the country helped improve household consumption by 20.5% in urban areas and 38.9% in rural areas between 1991 and 2006 (Coulombe and Wodon 2007).

A further dimension of poverty is the low educational status of the *Atankwidi* basin population which limits their scope of job opportunities. From the survey of 131 farmers, 72% (95 out 131) did not have any form of formal education. This is a reflection of poor

[20] Farming refers to food crop cultivation, poultry and livestock rearing including fishing and hunting

educational situation in the region and the country at large. A greater part of the population aged 6 years and older has not had formal education at both the district and national levels. Educational statistics reveal that about 64% of the population in KND have not had any form of formal education. In the case of females, the percentage is higher and estimated to be about 69%. The lack of formal education at the district level mirrors the situation at the regional and national levels (Appendix 2.2). The statistics show that more people (about 70%) at the regional level do not have formal education. The figure for females without formal education is higher (74%) at the regional level. At the national level, the picture of formal educational attainment is relatively better than it is in the study area and this further reflects higher incidence of poverty in the latter. For the country as a whole, 38.8% (33.1% males and 44.5% females) have not had formal education (Appendix 2.2). The gap in educational attainment between the country and region is still very wide. This has been attributed to many factors. The lack of education is partly attributed to the incidence of widespread poverty and late introduction of formal education in northern Ghana. However, there have been some improvements in formal educational attainment in the region since 1984. In 1984, 82.3% of the population aged 6 years or older had never attended school and this proportion dropped to 69.4% in 2000. For males, 75.6% had never attended school in 1984 but this reduced to 64% in 2000. For females, the proportion reduced from 88.1% in 1984 to 74.4% in 2000 (GSS, 2005). The lack of formal education among the population presents many implications for livelihoods of people. For instance, many people are stacked with low productivity farming and agro-processing under difficult conditions. They lack ‘occupational mobility’ – as they cannot easily switch jobs because of the lack of skilled training obtainable through formal education. For instance, higher paid formal and private sector jobs require some level of formal education which majority of the population in the study area lack. In pursuance of their livelihoods, access to important information and knowledge that may be important for their livelihoods may also be limited to localized informal interactions and specially designed education and extension programmes. This is because the use of English language dominates most systems of formal documentation and communication in support of innovations in livelihoods. In general, formal education improves people’s wellbeing as illustrated by Coulombe and Wodon (2007) in their analysis of consumption poverty at the country level (Ghana) between 1991 and 2006. They find that an increase in the education level of households' heads and their spouses lead to gains in consumption of 7.8% in urban areas, and 2.0% in rural areas. In the absence of good job opportunities within the basin, many people, especially the youth have resorted to migration – a subject I will discuss in details in Chapter 3.

2.5 Socio-cultural space of vulnerability

2.5.1 Household composition, size and dependency

The composition of households in the district shows relatively higher household sizes and high proportion of dependants (Appendix 2.3). From the analysis, about 70% of households are classified as medium to large size households with household memberships ranging from 3 to 8 persons. From this, large size households (6-8 persons) alone constitute 31% of households as of the 2000 population census. On the part of relationships in households, about 70% of household memberships are dependants including children, parent in-laws, son/daughter in-laws, grandchildren, other relatives and sometimes non-relatives. From this, children and other relatives alone account for approximately 42% and 16% of dependant relatives respectively. The KND has an age dependency ratio of 87.8 and a dependant population of 40.5% (below 15 years) and 6.1% (above 65 years old). At the regional level, the dependency ratio is 99.2 and the depenedant population (43.4% under 15 years old) and 6.4% (aged 65 and above). These dependeccy rations imply that 100 economically active persons have responsibility for sustaining 99 dependants at the regional level. At the the district level, this means that 100 economically active persons are responsible for for sustaining 88 dependants. The age dependency ratio[21] is influenced by the birth rate. As such, the high age dependency ratios result from high population growth rates. This has resulted in a large proportion of

[21]The dependency ratio is defined as the ratio of the sum of the population aged below 15 years and above 64 years to the population between 15 and 64 years expressed as a percentage.

children 0-14 in the population. These observed ratios imply that there is roughly one dependent person to every economically active adult in the district (GSS, 2005). The large household's sizes and high dependency ratios have a bearing on household vulnerability. Large household sizes and dependents imply that heads of households and their spousal counterparts (28%) have to meet the basic needs of a large number of dependants (70%) under their care in a context where poverty is widespread. In the area of food for instance, this simply means more mouths to feed. See GSS (2005). In the analysis of poverty trends between 1991 and 2006, Coulombe and Wodon (2007) find that changes in household sizes had a bearing on poverty. For instance, they assert that a reduction in household sizes yielded a gain of 7.9% in consumption in urban areas, and 1.4% in rural areas of the country over the period. Given such evidence, it is reasonable to assert that large household sizes and high depency ratios increase household livelihood vulnerability in the *Atankwidi* basin.

2.5.2 Traditional funeral rites and social expenditures

Traditional funeral rites are expensive and affect household vulnerability in the study area. For an adult to be accepted into the ancestral world when he or she dies, or to qualify as an ancestor, his or her funeral has to meet a three-phase funeral ritual requirement. These stages include – (1) *Kuum Nyoka*, (2) *Bŭŭka and* (3) *Kuure*. In order to illustrate what it takes to go through these stages, I will centre my discussion in reference to a case, the case of *Atugba* who performed the *Kuure* of his late *Yidaana* (Landlord) as the present *Yidaana* of the *Yire* during my fieldwork in *Yua.* I personally attended this funeral and made some observations. These observations later proofed useful when *Atugba* granted me an interview a few days after the funeral on the subject – funeral rites celebrations. According to *Atugba*, his Uncle who was the *Yidaana* passed away three years ago. As the current *Yidaana*, he had responsibility to perform the funeral rites of his late *Yidaana* in order that the deceased can be accepted by the ancestors – for him to qualify as an ancestor him self. This is usually dream and value held in high esteem for any person who led a meaningful life in the entire basin.

The first rite he organized was the *Kuum Nyoka*, that is, the burial ceremony that is often described as a 'fresh funeral'. This rite is essentially a burial ceremony that is associated with offerings, sacrifices, and the provision of food and drinks for key players in the ceremony. The ceremony lasted for about three days with key actors playing key functions. The first group of key players are the grave diggers/undertakers. He offered several 'gifts' to them in honour of the deceased. These included slaughtering two (2) sheep and two (2) goats, and the provision of food and drinks. Another key group of players are the drummers who play and dance to traditional music during such occasions. Five of such groups participated in the *Kuum Nyoka*. Several guinea fowls and fowls were also slaughtered for preparing meals for drummers and dancers. Alcoholic drinks were added to motivate them wake to perform well during the funeral. For the *Pokima*, that is, sympathizers who kept wake outside the compound, another goat and several fowls were slaughtered for preparing meals for their refreshment. Atugba received several donations of fowls and grains from relations, neighbours and friends from within and without the community to support feeding of the guests.

The second rite *Atugba* performed was the *Bŭŭka*. This ceremony is also a blend of traditional rituals, sacrifices and social activities usually lasting about 3 days. In all four key activities are associated with this ceremony. These include (1) traditional offerings, sacrifices and spiritual diagnosis of the cause of death; (2) merry making over food and drinks and; (3) the war dance. First, the *Bŭŭka* is meant to diagnose the cause of death. A *Bakolgo* (soothsayer) and elders meet and after a series of rituals and spiritual consultations of the ancestral world lead by the *Bakolgo*; the cause of death is pronounced and made public. Is death a natural call to join his ancestors or somebody caused the death? Prior to this, the *Yidaana* would have done earlier consultation of a *Bakolgo* on the cause of death but this information is meant only for circulation among key family members. The essence of this second consultation is to confirm cause of death and to make cause of death public. A different *Bakolgo* presides over each stage of consultation. If it is established that he died a natural death, they make offereings and sacrifices to the ancestors to thank them. If it is established that somebody caused it, they still take it in good faith and make offereings and sacrifices to facilitate the deceased acceptance into the ancestral world (Photo 2.1).

Photo 2.1: Sacrificial cow as offering during *Bŭŭka* for Atugba's late *Yidaana*

Source: Field Photo 2009.

The diagnosis of cause of death is usually accompanied by traditional offerings to the deceased first as tribute to his 'great' legacy and second as a symbol that the deceased left behind a family of good economic standing. In the case of *Atugba*, this meant slaughtering a number of animals including one (1) cow (photo 2.1), eight (8) goats, three (3) sheep and several fowls and guinea fowls. The extended family contributed to buy the cow. In addition, individual family members presented goats and sheep and contributed several quantities of grains. Friends and neighbours contributed fowls and guinea fowls as well as grains to support the process – lots of numbers in in-kind grain contributions are often involved. The fowls were used for preparing food for guest. As custom demands, the family was only entitled to the head and skins of the livestock that were slaughtered as offerings. The remaining portion of the meat is shared among the elders who came for the *Bŭŭka*. *Pito* (Sorghum beer) is brewed for ritual purposes and for entertaining guest (Photo 2.2).

Photo 2.2: 'Pito' brewed outside a compound in funeral rites of an old woman in *Yua*

Source: Field Photo 2009

There are variations in the *Bŭŭka* depending on whether the deceased is regarded as elderly (man/woman) or young (man/woman). The *Bŭŭka* of a young man or lady is not made a big function. The *Bakolgo* is invited and a small group does the *Bŭŭka*. The *Bŭŭka* of an elderly person is made a big function. An old woman for instance will likely have many children and grandchildren, and all of them will attend the funeral. For both elderly deceased men and women, the sorghum beer (*Pito*) that is brewed is done outside because large volumes and many people are involved (Photo 2.2). Such people turn to have a large family and social following who will participate in the funeral rites so that there is no enough space for accommodating this activity indoors. On the contrary, that of younger men and women is done in the courtyard because no large volumes and people are involved. Such people do not have a large family and large social following that will give rise to a large gathering for the funeral rites.

An important cultural activity during the *Bǔǔka* is the *Diia* (war dance) especially if the deceased was regarded a warrior. This may entail different groups of war dancers dressed in war regalia (bows and arrows), singing, and dancing to war songs (Photo 2.3). This performance is known as the ‘war dance’. In the case of an elderly woman, the *Diia* is not performed but all other activities associated with the *Bǔǔka* are done. As part of social change driven by the interest of the youth, hired services of modern musical bands that play modern systems of music are organized alongside *Diaa* (Photo 2.4). It is common to have a noisy environment arising from the mix of these traditional and modern systems of music, although from time to time one system gives way for the other. For most of the youth, this hired modern musical system is what keeps them awake and active throughout the funeral rites. It has indeed also become a major attraction to the youth and fast becoming a standard to be measured by the youth of every family in every funeral rite. Cost is involved and has become a newly emergent additional social expenditure that is footed by the youth. In the case of *Atugba,* it was the youth; specifically the children within the extended family hired the band that provided the music at the funeral (Photo 2.4).

The third and final rite is the *Kuure*, referred to as ‘the funeral’. This stage is associated with some rituals and merry making over food and drinks. An important traditional practise at this stage is that the elders come together, pour libation and make some traditional offerings and sacrifices by slaughtering fowls. A deity is then moulded in the house to represent the deceased and is symbolic that the deceased is an ancestor. For the rest of the life of the *Yidaana*, and subsequent generations of *Yidaama,* they will pour libation and make offerings to this deity, to seek his mediation and the interventions in the ancestral/spiritual world for the general wellbeing of the family.

Photo 2.3: *Diaa* during a *Bǔǔka* at the funeral ground by war dancers

Source: Field Photo 2009

This last funeral rite is very important because it qualifies the deceased as an ancestor to which everybody in the society seeks to be after death. It is believed that if somebody dies, until this final funeral rite is performed, even if it takes 100 years, that person will not be accepted by the ancestral world and will therefore, not qualify as an ancestor. During the final funeral rite, a lot of food and drink is prepared for consumption during this ceremony. Family members, neighbours and friends contribute a wide range of grains - sorghum for brewing ‘pito’, beans for making bean cakes, millet for preparing TZ and the boiling of Bambara beans – all for consumption and merry making. Smoked guinea fowls are used for preparing food for important guest.

Photo 2.4: Modern musical system organized by the youth at the funeral ground

Source: Field Photo 2010

The case of *Atugba* illustrates the typical funeral rite in the community and shows that a funeral in the community is an expensive business. These funeral rites with the exception of the *Kuum Nyoka* (burial) are often organized during the off farm season (November to April). Many families strive to maintain standards in order to honour the deceased and to maintain family prestige and social status in the community. However, this comes with it high social spending and this adversely affect the capability of households involved to meet their basic needs especially food thereafter as subsequent discussions (chapters 4 to 5) will reveal. This is particularly so given the high incidence of poverty in the area. There is the option of celebrating funerals at lower cost but even the poor find it difficult to finance such costs. The fact remains that funerals are generally expensive for all categories of people and this contributes to the state of vulnerability after such expenditures have been undertaken. Financing funerals and funeral rites requirements of livestock, poultry and a wide range of foodstuff reduces household food stocks and savings among a large number of households.

2.6 Policy planning and regional development

In the domain of policy planning, both colonial and postcolonial development policies have partly shaped the present state of development (underdevelopment) in northern Ghana. At independence, Nkrumah's CPP government inherited an exploitative-based economy marked by significant spatial disparities in development between northern and southern Ghana. Colonial development policy emphasized development of places in [southern Ghana] where cash crops such as cocoa, coffee, timber, rubber, palm oil and various kinds of mineral resources including gold, diamond, and bauxite were mined for export (Bening, 1975, 1990; Kuu-ire, 2009). Economic and social infrastructure such as roads, railway lines, schools and health services were also concentrated in these areas to support the exploitative-based economy. Thus, development in terms of infrastructure and services came to be concentrated in the area between *Accra*, *Kumasi* and *Takoradi* described as the 'Golden Triangle'. The northern territories comprising today's northern Ghana [north of *Kintampo*] was largely deprived of the investments needed for its development. This neglect of investments in the northern territories was partly a deliberate discriminatory colonial development policy that supported its designation as a 'labour reserve' to service the exploitative economy south of *Kintampo* (Songsore, 2001; Saaka, 2001). This set in motion a 'north – south' labour migration stream involving movements of the northern active labour force to work on cocoa farms and mines south of *Kintampo*, southern Ghana. Due partly to these policy interventions, northern Ghana became impoverished and underdeveloped relative to the southern part of the country. Successive governments since independence have made efforts within the total endeavour of national development, to accelerate the rate of national development, especially northern Ghana. Not much has been achieved to date. The development gap between northern and southern Ghana remains. In some areas of development, the gap has widened. Efforts at bridging the gap through postcolonial development policy have produced dismal results. The enormity of poverty remains unacceptably high (Ghana, 2003; Dittoh, 2008; Kuu-ire, 2009) and worsened by contemporary development policy and macro-economic conditions.

I will discuss postcolonial development policy and their impact on development (with focus on northern Ghana) around the past two governments (eras), the Rawlings and Kuffour regimes. The first era represents a period of liberal economic reforms and social development programmes under the Rawlings regime. Rawlings first took over power in a 1979 military coup but it was short lived as it handed over to a democratically elected government. The overview of policies and development programmes here spans two separate but continuous eras. First was the PNDC military regime under the leadership of Rawlings from 1981 to 1991. Second was the NDC constitutional government from 1992 to 1999 also under the leadership of Rawlings. The Rawlings regime embarked on an ERP under the support of the World Bank and IMF in 1983. The overall objective of the ERP was to reduce Ghana's debt and to improve upon its trading position in the global economy. The specific objectives included many specific policies: lowering inflation through prudent fiscal, monetary and trade policies; increasing foreign exchange flows into priority sectors; restructuring the country's economic institutions; rehabilitation of economic infrastructure for enhancing production and export; and increasing the availability of essential consumer goods (Berry, 1994). The implementation of economic reforms lead to initial expenditure cuts, improved tax collection and reduced budget deficits. A series of cedi devaluations also boosted exports. The reforms saw a remarkable shift towards liberal economic and structural adjustment policies that saw a shrinking role of the state in economic development. Many state owned enterprises were put on divestiture and many workers were retrenched. The state however, maintained its role in the provision of social infrastructure and services that also saw the introduction and or increment of user fees for a wide range of social services in health and education. By the end of 1991, ERP had improved the country's international financial standing and ability to service loans (Ibid.). Critics of the reforms however, maintained that it had failed to bring about fundamental transformation of the national economy. Therefore, the economy still heavily relied on cocoa and some agricultural commodities mainly produced in the southern part of Ghana. The export economy therefore, mainly developed south of *Kintampo* with virtually no participation or very limited participation of northern Ghana in the export trade. Structural adjustments came with it significant hardships because some Ghanaians were retrenched in the wake of divestiture of state owned enterprises. Trade liberalization policies had made Ghanaian products and their prices uncompetitive. Importation of cheaper food products exposed domestic producers to unfair competition and tended to serve as disincentives for production. Agricultural subsidies were removed. Fertilizer was affected and production cost was high. Many farmers could not simply compete for the market at high production costs. After a decade of adjustment, studies revealed growing poverty and widening inequality (GSS, 2002; Kuu-ire, 2009). From an ailing economy in the late 1970s, results of adjustments began to show positive signs of economic recovery in the 1980s right through to the 1990s. Many Ghanaians still suffered from the impact of adjustment policies. Some social protection measures such as PAMSCAD and user-fee exemptions in health delivery were introduced to ameliorate the sufferings of Ghanaians. These special programmes helped but achievements were modest as the incidence of poverty still prevailed and loomed in northern Ghana in particular.

When Ghana returned to constitutional rule in 1992, the National Democratic Congress Government (NDC) under the leadership of Rawlings launched the 'GHANA –VISION 2020' that expressed the long term vision of the country as - *"to become a middle income country by the year 2020"* (Ghana, 1995: iv). Ghana Vision 2020 was a comprehensive National Development Policy Framework (NDPF) that articulated long term, 25 –years (1996 -2020) perspective for Ghana's socio-economic development. It outlined medium to long-term co-ordinated programmes of economic and social development policies in the context of decentralization of local governance. Under this comprehensive policy framework, northern Ghana witnessed some significant improvement in economic and social infrastructure and services during the 1990s.The extension of relatively stable hydro-powered rural electrification for the first time, tarred roads especially in the northeastern corridor, and the expansion of health and educational infrastructure resulted in the extension of some social services to new frontiers. The establishment of the University for Development Studies (1992) and the Tamale Polytechnic extended higher education to northern Ghana for the first time. In the 1990s, Ghana Government in collaboration with IFAD initiated spatially targeted schemes to enhance agricultural production, food security and reduce poverty in the three northern regions. IFAD provided most of the funding with counterpart funding from the Government of Ghana. These initiatives culminated into three IFAD projects for the three northern regions: LACOSREP for the UER; UWADEP for the UWR; and NORPREP for NR. LACOSREP for instance had five objectives and components: (a) increase food production and household incomes of rural families; (b) establish mechanisms for environmental protection and improvement; (c) strengthen formal and informal beneficiaries' organizations; and (d) improve the economic status of women through credit support (IFAD, 2010). Through this programme, many dams in the region had been rehabilitated or constructed providing reservoir capacities by the close of 1998 to support irrigation of about 463 ha. Nineteen dam site nurseries were established and about 631,000 seedlings of various kinds of trees planted for catchment area protection. To the end of 1997, 43 trials involving crop varieties, soil fertility and crop husbandry practices had been carried out. Since the project inception, the Crop Service Department has controlled four major pest outbreaks covering 600 ha in a range of crops involving sorghum, millet, maize, rice and onion. Assisted and supervised seed growing, marketing, and training of about 600 groups with 9000 farmers on safe insecticide use and handling. In the area of credit financing, the ADB disbursed a total of 2 billion cedis (68 % of the credit) to 8150 beneficiaries across five districts in the region while other banks disbursed the remaining credit (IFAD, 2010). Although all these interventions increased dry season production and thereby increased agricultural production in the UER and in the other regions, food security and poverty is still a major challenge as evidenced by the statistics on poverty. This suggests that many measures did not affect poverty reduction in a significant way although it opened up certain investment opportunities. The need for effective implementation through possible review of implementation strategies in possibly subsequent phases of these programmes were echoed by IFADs own evaluation teams (ibid.). Economic recovery strategies such as fees in social services, removal of agricultural subsidies and cutting back on government subventions to state enterprises tended to affect the poorest the most. These constraints also affected the implementation of IFAD supported agricultural programmes. The three northern regions have remained the poorest throughout the 1990s until date (GSS, 2003).

The Kufour administration embarked on poverty reduction through an economic growth strategy when it took over power in 2001. They implemented the Ghana Poverty Reduction Strategy (GPRS I – 2003 to 2005) (Ghana, 2003) and the Growth and Poverty Reduction Strategy (GPRS II – 2006 to 2009) (Ghana, 2005). The government accessed the Highly Indebted Poor Country (HIPC) debt cancellation support package from the donor community. The HIPC initiative was conditionally tied to poverty reduction and this made more resources available for supporting the implementation of poverty reduction programmes in the country. The LACOSREP programme continued to be supported by Government under MoFA and in respect of GPRS. The GPRS II sought to increase access to irrigation and mechanized agriculture, access to credit for agricultural inputs, develop selected crops, increase access to extension services, improve agricultural marketing and increase access to the global export market. Similarly, implementation of the US funded MCA programme as a growth oriented development package disadvantaged northern Ghana. The north was largely excluded in the selection of beneficiaries except for two districts in NR. The Upper East and West regions with the highest incidence of poverty did not benefit from this programme. The export base of the economy was not developed and the north continuous to be at the fringes of the export sector till date. Some other development programmes were introduced during the Kufour administration. These include the SFP, NHIS, Capitation Grants, LEAP and MASLOC aimed at improving education, increasing access to micro-finance and improving the ability of poor households to meet basic needs. Although the national economy grew and some significant investment went into the social sector under GPRS, the manner in which these programmes were implemented did not transform northern Ghana in particular. This is partly because there were no targeted schemes aimed at poverty reduction in northern Ghana, so that although economic gains were made under GPRS, the poorest of the country did not benefit much from this growth. For instance, a poverty survey revealed that although national poverty reduced from 36 to 18 % between 2000 and 2005, trends remained higher for northern Ghana (Kuu-ire, 2009: 186-187).

The outcomes of some of these policy interventions affect livelihoods, and thus vulnerability at the local level. Given the predominance of farming as a livelihood, the removal of agricultural subsidies as part of macro-economic policy reforms combined with high inflation rates have largely lead to high prices of agricultural inputs since the early 1980s. In the context of poverty, majority of peasant farmers lack economic access to inputs such as fertilizer, seed and chemicals for production. Although the current government re-introduced subsidies for fertilizer in 2009 in recognition of this problem, the level of subsidy is minimal and such interventions are yet to benefit the very poor. The activities and 'hijacking' tendency of commercial farmers and some other implementation bottlenecks have so far deprived peasant farmers from benefiting from fertilizer subsidies. Thus, they still lack economic access to fertilizer even though soil fertilities are known to have declined considerably over the years. Aside these factors, trade liberalization has resulted in the importation of cheap agricultural products (eg., rice, canned tomatoes) crowding out peasant farmers in the competitive access to local markets. In this respect, peasant farmers have limited access to good local markets for their products. Second, they are not well integrated into the national economy. These structural constraints have secluded them from mainstream processes of globalization (integration) and the benefits of participating in global economic production. Because of the lack of adequate investments in economic infrastructure, access to irrigation as an alternative to rain fed agriculture is limited. Poor road infrastructure and transportation networks have further held back the economic production potentials in northern Ghana. This further limits the opportunities that exist in northern Ghana, and for that matter in the study area for viable economic production.

From the discussions so far, the *Atankwidi* basin itself, presents unique risks that households have to deal with in the pursuit of their livelihoods. These risks factors arise from multiple domains and collectively make household livelihoods susceptible to vulnerability. Physical environmental change presents unique set of physical risks that households have to deal with in their livelihoods. As the discussion show, such environmental change is driven by both human factors at the basin level and global environmental change. For instance, while desertification and land degradation is partly attributable to population pressure and land use change in agriculture, such changes are reinforced by climatic changes linked to global climatic changes. Risk factors arising from environmental change are multiple and adversely affect economic production in the *Atankwidi* basin. The overall impact has been low economic production, especially agriculture and excruciating poverty that undermine ability to meet basic needs in the basin. Beyond physical factors, some social characteristics of the population predispose them to increased livelihood vulnerability. Social expenditures on funeral rites and care for high levels of dependants at household levels also contribute to livelihood vulnerability. In addition, discriminatory colonial development policies against the 'Northern Territories' partly contributed to the state of underdevelopment in the area. This led to a wide developmental gap between the northern half and southern half of the country to the disadvantage of the former. Although successive governments have made efforts to accelerate development, commitment to investments has been low so that the entire north continues to experience chronic poverty.

2.7 Summary and emerging issues

In the beginning of this chapter, I stated that certain variables of the wider environment within which households strive to make a living contribute to their vulnerability in the *Atankwidi* basin. These variables, including population change and density, environmental degradation, economic underdevelopment and poverty, high dependency and customary funeral rites and national policies have contributed to the current state of livelihood vulnerability among households in the basin.

Population change and density: The population of the KND (including the *Atankwidi* basin) has increased consistently from 1960 (93, 397) to 2000 (149, 491). This also led to increasing population density for the KND, increasing from 37.2 per square km in 1960 to 91.0 persons per square km in 2000. This increasing trend of population growth and density has brought pressure to bear on natural resources, especially arable land and the natural vegetation for supporting the livelihoods of the increasing population in the basin. As a result, population has been a key anthropogenic factor causing deforestation, land and soil degradation in the *Atankwidi* basin and the KND at large. Given the young population structure of the district, population will continue to increase over the next few decades due to the population momentum effect although growth rate is declining. This will further increase pressure on the available land and other natural resources to meet the needs of the increasing population. This population –natural resources dynamics in the *Atankwidi* basin mirrors the situation at the wider level – regional and national levels.

Physical space of vulnerability: In my discussions, I have shown that (1) desertification of the natural vegetation; (2) the geological formation and degradation of productive soils; and (3) climatic variability, especially rainfall combine to 'shape' the physical space of vulnerability. This undermines livelihood sustainability in the Atankwidi basin. In my discussions, I have shown that conversion of the natural vegetation into croplands due to increasing demand for food is a major cause of desertification. I have also shown that continuous cultivation (land mining) and limited fallows have led to significant soil fertility decline. In respect of soils, the discussions show that there is an element of 'poor inherent soil fertility' arising from the geological formation and parent rocks. However, these soils have been fertile enough to support crop cultivation for generations. Nonetheless, continuous cultivation combined with soil erosion facilitated by exposure of land due to desertification has led to significant degradation of productive top soils. This has resulted in poor soil fertility. In addition to these physical constraints is climatic variability, especially rainfall variability. I have shown in my discussions that inter-annual and intra-annual variability in rainfall have resulted in a mix of dry and wet years and months although many researchers agree that a drying trend is observable. I have illustrated that such rainfall variability adversely affect crop yields in the basin. Indeed, the overall impact of all these physical constraints is low agricultural production, including both food crop and livestock production.

Economic environment and poverty: Given that majority of the population (69%) engage in subsistence farming for their livelihood, degradation of the very natural resource base that is put to cultivation has resulted in widespread poverty in the *Atankwidi* basin. As subsistence farmers, they predominantly depend on their own production for food and income. Given low agricultural productivity arising from environmental constraints, the harvest is often low and inadequate for household consumption. Secondly, none or only a little may be available for generating an income. In fact, sale of own produced staple grains are rare among households in the basin. Due to low production and incomes, malnutrition, hunger and starvation is common across the entire basin. Given the lack of formal education for a majority of the population, occupational mobility is lacking. Many people are stacked with low productivity subsistence farming that perpetuates poverty and livelihood vulnerability among households.

Socio-cultural space of vulnerability: Two socio-cultural variables of the environment, (1) high dependency ratios and (2) customary funeral rites contribute to livelihood vulnerability in the basin. Medium to large household sizes (3-8 persons) account for about 70% of household sizes in the KND. This has lead to a disproportionately large number of dependants that place a heavy burden on few household heads and their spouses who have a responsibility for meeting the needs of the former. Such burdens have undermined the economic wellbeing of many households and rendered them vulnerable to livelihood failures. In addition, customary funeral rites, which are held in high esteem, are expensive. Funeral rites often involve offerings involving poultry, small ruminants and sometimes cattle. Staple grains are drawn from household stocks for making offerings and for preparing food to entertain guests. In all instances, this practise is not limited to the household organizing the funeral rite. Many relations, neighbours and friends also draw on their respective household food stocks for supporting such funeral rites. For a single funeral rite, many households compromise some quantity of their food stocks. Since their food stocks are very often inadequate for all year round consumption, this increases their vulnerability to hunger and livelihood failure.

Policy planning and regional development: In my discussions, I have pointed out that both colonial and postcolonial development policy have had various impacts on the state of development (underdevelopment) in northern Ghana. Historically, the neglect of colonial development policy has had adverse implications on the state of development (underdevelopment) in northern Ghana. The north of Ghana was deprived of necessary investments in economic and social infrastructure in favour of investing in such infrastructure in southern Ghana to support exploitation of raw materials for export. In addition, northern Ghana was designated a labour reserve to provide labour requirements for the extractive industries south of *Kintampo* (southern Ghana). In the postcolonial era, successive governments have tried to address the poor state of development in northern Ghana within the framework of national development programmes. Through such interventions, some improvements in economic and social infrastructure have been achieved. However, poverty remains a major problem confronting the people of the north. Northern Ghana remains the poorest part of the country and the gap in poverty between the southern and northern half is widening. Investments have been low relative to the magnitude of the development challenges and many policies lack commitment to geographical targeting for addressing this development imbalance in the country.

2.8 Conclusion

In this chapter, I have discussed how environmental variables contribute to livelihood vulnerability among households in the *Atankwidi* basin. The discussion show that population change and density, physical environmental degradation, poverty, high dependency, customary funeral rites and national policies all affect people's livelihoods. As a result, these multiple variables have contributed individually and collectively to the current state of livelihood vulnerability among households in the *Atankwidi* basin in the UER, Ghana. Many households have had to devise innovative ways of adapting to these multiple stressors in their livelihoods. In Chapter 3, I will discuss livelihood diversification as part of local knowledge for reducing livelihood vulnerability to environmental change in the *Atankwidi* basin.

Chapter 3

3.0 Livelihood Diversification and Change under Environmental Change

3. 1 Introduction

In this chapter, I discuss household livelihood diversification in the context of environmental change in the *Atankwidi* basin. The discussion considers livelihood diversification as an embodiment of the tacit local knowledge of households for adapting to environmental degradation in the basin. The main argument I will attempt to illustrate is that livelihood diversification reduces livelihood vulnerability to environmental change in the basin. The discussion takes cognisance of how environmental factors drive emerging patterns and change in livelihood portfolios at household levels. To illuminate these dynamics, I used a three- generational approach for analyzing household livelihoods. I structure the discussion in five parts. In the first part, I present an overview of environmental degradation and livelihood vulnerability in northern Ghana with a focus on the *Atankwidi* basin. In the second part, I present two case studies on household livelihoods. The case studies involve a three-generational analysis of household livelihoods. In the third part, I discuss the composition, trends and driving environmental factors of livelihood change. The discussion draws on the two household cases and additional results from focus group discussions, the survey and institutional data. In part four, I present a summary of the findings and conclude the discussion in part five.

3.2 Livelihood vulnerability to environmental change

In Chapter 1, I discussed 'vulnerability' as a concept that guides this study. I have indicated that 'vulnerability' has two sides, an external side comprising the risks, shocks and stress posed by a hazard[22] and an internal side consisting of (in) ability to anticipate,

[22] A 'hazard' is a dangerous phenomenon, human activity or condition that may cause harm, loss of life, loss of livelihoods and social or economic disruption (UNISDR, 2008:7). 'Hazard' as used here refers to hazards of natural

cope with, resist and recover from the impact of the hazard (Chambers, 1989:1; Bohle, 2001). The external side of this 'double structure of vulnerability' (Bohle, 2001:119; van Dillen, 2004; Birkmann, 2006; 19), sets the framework for discussion here. The discussion highlights the exposure of livelihoods to risks, shocks and stressors arising from environmental degradation. In northern Ghana, and the *Atankwidi* basin in particular, environmental degradation undermine livelihood security. This is because agriculture, the major source of livelihood for majority of the population is increasingly dependent on a degraded natural resource base. The economic base of northern Ghana hinges on smallholder agriculture with over 80% of the population depending on it for their livelihood (Songsore, 1996:53). In the KND where a larger part of the *Atankwidi* basin is located, subsistence agriculture is the mainstay of the economy accounting for about 68 % of employment. The remaining 32 % are involved in various kinds of non-farm based livelihoods (KNDA, 2001), most of which are also agro-related and depended on a degraded natural resource base. In a survey involving 239 females, all of them were involved in non-farm livelihoods in the district that are depended on agro-related products. These include trade in foodstuff (37 %), shea butter extraction (20%), local restaurant services (18%), brewing local alcoholic beverages i.e *Pito* (14%) and rice milling (8%). Females involved in these non-farm livelihoods are not optimizing the utility function of these non-farm livelihoods for poverty reduction. This is partly because of poor crop yields, limited supplies of food and forest products, and high costs of raw materials arising from the impact of environmental change in the district (Derbile, 2003; Dinye and Derbile, 2004).

Since I have done an extensive discussion on environmental degradation in Chapter 2, my focus here is an overview of the issues. The discussion identified three areas of physical environmental 'harzards' that households confront in pursuit of their livelihoods in the *Atankwidi* basin. These include (1) desertification of the natural vegetation (2) the geological formation and degradation of productive soils and (3) climatic variability,

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origin such as desertification, land degradation and drought linked to long-term human activity. These hazards result from a gradual process of environmental change so that the associated hazards referred to in this discussion are not sudden. Rather, such hazards increase gradually in incidents and intensities ('creeping hazards') over a long period.

especially rainfall variability. The discussion revealed that desertification was a major form of environmental degradation and that conversion of the natural vegetation into croplands for food production was a major driving factor of such change. I have also shown that continuous cultivation combined with limited or no fallows have led to significant soil fertility loss. Soils in the *Atankwidi* and the larger part of northern Ghana developed over granitic rocks underlain by the Birimian geological formation. These soils have an element of 'inherent poor soil fertility' although they have supported crop cultivation for generations. Land mining from continuous cultivation combined with soil erosion has led to significant degradation of top soils. This has resulted in soil fertility decline and low productivity that affect crop yields in the basin. In addition, rainfall variability, as manifested in inter-annual and intra-annual variability have resulted in a mix of droughts and high rainfall intensities difficult to predict by farmers. Such variability has also adversely affected crop yields in the basin.

According to the DGRD (1992), multiple processes of agro-ecological degradation in the UER, has led to a deterioration of the quality and productivity rating of the land. This resulted in the following: reduction of biodiversity, including the stock of plant and animal species; decrease in vegetation cover, increased soil exposure and evapotranspiration; impoverishment of soil in terms of organic matter, soil depth and structure through accelerated erosion, leaching and loss of moisture holding capacity; and siltation of ponds including dams by the deposition of the eroded material. A study dating back to the 1980s revealed that one full day was required to gather 3 days worth of fuel wood and that, women travelled about 8 kms to collect firewood in northern Ghana (Asare 1985). According to Wiggens (1999), there is incidence of deforestation, soil and land degradation and climatic variability in northern Ghana, specifically the UER. Several studies under the GLOWA project (Chapter 2) provide overwhelming evidence of environmental degradation in northern Ghana (Daudze, 2004; Braimoh and Vlek, 2004; Kunstmann and Jung, 2005; van de Giesen et al., 2008; Kasei et al., 2010). What makes the situation precarious are the limited abilities and or declining abilities to deal with the threat of environmental degradation in livelihoods, especially, agriculture. For instance, farmer's traditional knowledge in the prediction of rainfall in the area is becoming less reliable. Similarly, the Meteorological Services Department (MSD) lacks the ability to predict rainfall patterns because of limited resource capacity (Obeng 2005).

The overall impact of these physical constraints is low agricultural production in the basin, including both food crop and livestock production. Non- farm livelihoods have also been adversely affected, especially those that are agro-related and dependent on agricultural and forest raw materials for production. For instance, land degradation has caused deficits in products of the forest, woodlands and trees. These include fuel wood and charcoal, food, building materials, game, meat and raw materials for income generation, artisanal and domestic needs (EPA, 2002). The impact of environmental degradation affects a large proportion of the population in the *Atankwidi* basin because an overwhelming majority depend on 'low input' – 'rain fed' subsistence agriculture for their livelihood. According to the GSS (2002), 69 % of the population depends on farming as a major livelihood in the KND. However, findings from my survey show a higher percentage, 87%. In Chapter 2, I did a more extensive discussion of the economic environment and poverty in northern Ghana. The discussion illustrate that northern Ghana, especially the UER is the poorest region in Ghana (See Map 2.3). Low economic production, especially agriculture arising from the impact of environmental degradation was identified as partly causing poverty in the basin. The environmental risks and shocks that households confront in pursuit of their livelihoods is therefore, a major concern for farmers, researchers and policy makers. This is because the quest for livelihood sustainability will depend on how such vulnerabilities are dealt with. Farmers are knowledgeable about long-term environmental changes in the UER (Dietz et al, 2004), but they are also knowledgeable about their vulnerabilities to such changes. During my fieldwork, farmers often cited multiple environmental factors, i.e., soil fertility decline, drought, rainfall variability and floods as causing poor crop yields. Farmer workshops in the *Atankwidi* basin reveal that loss of soil fertility and declining yields were main problems of rain fed agriculture (Laube & Le, 2007; Laube et al., 2008). Farmer experiences with crop failure are on the increase and this is having an overall adverse effect on food security in the UER (Obeng, 2005: 117). For instance, farmers' accounts in the Bongo District (UER) reveal that droughts led to the following: destruction of crops and an all time hike in the prices of maize in 2001; invasion by armyworms, destruction of crops and hunger in 1999; and poor crop yields and hunger in 1997 and 1998 (Obeng, 2005:103). The GOG and development agencies had to provide food aid to a number of households in 1997 and 1998 (Ibid.). Thus, environmental change, including climatic variability and land degradation undermine agricultural production in the *Atankwidi* basin and northern Ghana as a whole. Crop failure and decreasing crop yields has lead to increased impoverishment and livelihood insecurity. According to Songsore (1996) such impacts of environmental change can lead to human tragedy, especially famine and dislocation in northern Ghana. Beyond the direct impact on crop yields, low agricultural production has adversely impacted on the supply of raw materials for agro-processing livelihoods in rural areas. This compound the problem of seasonal supply of agro-raw materials associated with the climate of the KND (Derbile, 2009).

In Chapter 2, I have done a more detail discussion of livelihood vulnerability arising from environmental degradation. The main issue arising from the discussion was that most people in northern Ghana, especially in rural areas were poor partly because their livelihoods were vulnerable to environmental degradation in the area. My intention is to highlight some pertinent issues arising from that discussion here and to show how they manifest at the district level (KND). I illustrated in the discussion that poverty was multi-dimensional and that in the context of northern Ghana, it manifested in consumption poverty, low incomes and low formal education. I also pointed out that these factors combined to perpetuate poverty among majority of the people living in the northern half of the country. I will focus on nutrition to illustrate how consumption poverty manifests in KND. In the KND, households generally have an unmet need for adequate food and nutrition (Derbile, 2003). This has resulted in under nutrition in children and malnutrition among pregnant women and lactating mothers exacerbating the mortality impact of infectious disease mortality (NHRC, 1999). To address such food supply deficits, 59% of incomes earned by women from non-farm activities go into supporting household food expenditures in rural KND; and this is partly the cause of underdevelopment of SMEs in the area (Derbile, 2003). Malnutrition remains unacceptably high in the district. Adokiya (2010:40) makes startling revelations from a nutrition study on 379 children from the district. The results show that, 6-24 months old children were fed solid foods (24 hour recall) as follows: 48% 2 times; 48% 2-3 times; and 4% 3-4 times daily. For the same age group, semi-solid foods were fed to them as follows: 79% 2 times; 20% 2-3 times; and only 1% were fed 3-4 times daily. This shows an abysmal situation on nutrition for the most vulnerable group (children). The scenario will certainly be worst for adult household members because very often, children have better care due to their vulnerability. An earlier study on food security by Yaro (2004) revealed a similar situation in respect of nutrition in the district. Yaro assessed frequency of meals eaten among households during the normal[23] and the lean[24] seasons in the district. The study involved 598 households across three communities namely *Kajelo, Chiana* and *Korania*. The results show that during the normal season, 2% of households eat once per day while 46% eat once per day during the lean season. In the normal season, 66% eat 2 times daily while 45% eat 2 times daily in the lean season. Again, in the normal season 31% eat 3 times daily while 9% eat 3 times daily in the lean season. For further analysis, a cut-off point of 2 meals per day was used for distinguishing between food secure and insecure households. Hence, 1% of households were food insecure during the normal season but as much as 46% were food insecure during the lean season. This implied that the affected households eat once a day during both seasons. Based on the work of Oshaug (1985:5-13), Yaro classified households by their status of food security into enduring, resilient and fragile households. Among food insecure households, resilient households comprised 44% and fragile households constituted 28%. Resilient households are able to secure food for at least half of the crop calendar year. They engage in non-farm income activities to meet deficit food needs arising from low production. While non-farm income for this group of households is tied to their survival, it is tied to capital accumulation for enduring households (food secured). Fragile households are the worst food in-secure households. They are the very poor whose food reserves last less than four months in the crop year.

[23] The normal season coincides with the harvest season (August-October) during which food is relatively available in the community and for most households.

[24] The lean season often coincides with the planting and early part of the farming season (May – July) during which food stocks are very low for many households and most likely unavailable for some households. During this period many households have to buy grains from the markets for household consumption.

They have low production and low income that increases their vulnerability. They are unable to provide adequately for other basic needs including health, education, potable water, clothing and shelter. All these contribute to worsening nutrition. Very often, they resort to begging within the community as a survival strategy (Yaro, 2004: 229-240).

So far, I have examined livelihood vulnerability to environmental degradation in the *Atankwidi* basin and the KND at large. I will now turn my attention to discussing livelihood diversification as an essential part of local knowledge systems for reducing livelihood vulnerability to environmental change in the *Atankwidi* basin.

3.3 Livelihood diversification and change: dynamics of local knowledge

In this part, livelihood diversification is discussed as part of the response measures of households for addressing the internal side of 'vulnerability', thus for enhancing their abilities to anticipate, cope with and recover from the impact of environmental change on their livelihoods (Chambers, 1989:1; Bohle, 2001). Given that livelihood diversification is *"the processes by which rural families construct a diverse portfolio of activities and social support capabilities in order to survive and to improve their standards of living"* (Ellis, 1998; 1), the discussion underscore that livelihood diversification is an embodiment of the local knowledge of rural households. In this context, local knowledge is what people do to make a living in a changing natural environment in the basin. I assume a pluralistic view of local knowledge in the discussion. Local knowledge refers to 'indigenous knowledge systems' developed by local communities themselves and may have been subject to transformation as a result of influence of 'external' knowledge systems (Blaikie et al, 1997). In addition, local knowledge also refers to the importation and adaptation of new knowledge from external sources to local situations through negotiation between internal and external actors (Long and Long, 1992; Pottier, 2003). By this pluralistic view, local knowledge is a fusion of 'internal' and 'external' knowledge systems in the local context. Thus, the application of 'tacit knowledge' (Nonaka and Takeuchi, 1995) for livelihood analysis in the local context is implied. Nonaka and Takeuchi describe tacit knowledge as deeply rooted in an individual's action and experience, ideals, values and emotions. It has two dimensions – the technical and cognitive. The technical dimension encompasses the informal skills in terms of 'know how' while the cognitive dimension consists of schemata, mental models, beliefs and perceptions that are very often taken for granted although they shape the way we perceive the world around us (Nonaka and Takeuchi, 1995: 8). It is estimated that about 80% of all knowledge is tacit knowledge (Botkin & Seeley, 2001; in Evers, 2008) and that the conversion of knowledge from tacit to explicit remains one of the most challenging domains in knowledge management (Evers, 2008:6). Thus, the best way to transmit tacit knowledge is still by observation, physical contact and learning by doing (Evers, 2008: 6). By describing the nature of household livelihoods in the *Atankwidi* basin, I am attempting to describe their local knowledge systems. The discussion centres on both the diversification of livelihoods and changing trends in household livelihood portfolios as reflecting the dynamic and strategic nature of local knowledge (Sikana, 1994: 82; Gerke & Ehlert, 2009:6).

In order to understand the dynamics in livelihood diversification, I use a *three generational approach*[25] for analyzing livelihood portfolios of two household cases from *Yua*. I also also examine environmental factors as driving forces of livelihood patterns in these cases as well. The cases involve a male-headed household and female headed household. The sample includes these two kinds of households because they are the commonest forms of households in the community although male-headed households are predominant. I have structured each case in three parts. Firstly, I present the background of the household. Secondly, I analyze livelihood composition of the son's generation and how environmental factors have shaped such livelihoods. Thirdly, I analyze the livelihood composition of the father and grandfather's generation and how environmental factors shaped them.

[25] For this study, the first generation is the era of the grandfather(s) of the present generation. The second generation is the era of the father(s) of the present generation. The third generation refers to the present generation as represented by son (s) generation

3.3.1 The case of *Atanga's* household livelihood profile

I. Background of Household

Atanga is a 55 years old head of a polygamous family and household in *Yua*. He has three wives. *Atanga* lives with his three wives and children in their *Yire* (compound). Each wife and her children occupy a *deo* (household) in the *Yire*. The first wife *Apogbire* is 50 years old. In all, *Atanga* has ten children. Two boys completed SHS while two boys are residing with a relative in *Kumasi* where they attend school too. The remaining 2 girls and 3 boys reside with the family and attend school in the community. All the children are grown and offer support in farming activities.

II. Son's generation livelihoods – composition, dynamics and environment

Atanga and his first wife report that as a family, they cultivate food crops as their major occupation. *Atanga* indicates that he cultivates crops the way his father practised crop cultivation. He has two farmlands. These include his *Sammani* (compound farm) and *Moom* (bush farm). He divided the *Sammani* into three smaller plots on which he plants a combination of traditional and new crop varieties. On plot 1 estimated to be 1½ acres, he intercrops *Talenga* (Sorghum), *Naara* (early millet), *Zea* (late millet) and Tɛa (beans). On plot 2 estimated to be about 2 acres, he intercrops yet the same combination of crops. On plot 3, estimated at 1 acre, he crops maize only. The cultivation of cereals is regarded a family tradition meant for the welfare of all household members. As head of household, *Atanga* leads the process in decisions and managing planting, harvesting and seed according to custom. He consults Soothsayers on spiritual matters concerning farming and makes sacrifices to the ancestors in order to enhance chances of securing good harvest. The wives and children support farming activities mainly through their labour contribution although his wives may take independent decisions regarding their own farming initiatives. Aside making decisions regarding their own farms, *Atanga's* wives also intercrop two early maturing sorghum varieties, *Kadaa* and *Agriki*' on the *Sammani* during the sowing of traditional cereal crops on the *Sammani*. They do this on their own accord and as a new initiative during sowing because sowing is customarily their domain. Since these crops are early maturing, they see that these new crop varieties provide grains for family consumption when there are no more grain stocks in the 'lean season' for family consumption. Soon after consuming *Naara* often harvested in August, little quantities of harvested *Kadaa* and *Agriki* new sorghum varieties play a key role in providing the needed grains for family consumption until some other major cereal (*Talenga)* is harvested in early October. Atanga's wives harvest small quantities of the new sorghum varieties because they plant only a little quantity of the seed on the *Sammani* in order to make more room for traditional cereal crops. Besides these personal initiatives of *Atanga's* wives, individual members of the household may cultivate some crops separately but these are cultivated in *Moom* (bush farms) rather than the *Sammani*.

Atanga and his household have three *Moom* (bush farms). The first farm is the *Aoósi* farm located in a nearby fertile river bank within the community; the second is *Agiro* farm located along the Ghana- Burkina Faso border; and the third *Ayelbia* farm located in a forest area of Burkina Faso bordering Ghana. Although the family cultivate cereals as a collective endeavour here, individual members of the household also cultivate their own farms here. At the *Aoósi* farm, *Atanga* with the support of his wives and children plant two new sorghum varieties called – *Agriki* and *Baninga* in the local parlance. Here, his wives also have their own farms. For instance two of his wives cultivate rice here for supporting both household consumption and meeting their personal needs. At the *Agiro* farm estimated at about 6 acres, *Atanga* and his wives cultivate groundnuts on 2 ½ acres as part of a collective family tradition. *Atanga* allocated farms to each of his three wives here to cultivate their own groundnuts. As a norm, individualization of groundnut cultivation is for the dual purpose of meeting household and personal needs of farmers, especially female farmers. When yields are good, *Atanga* can harvest about four bags from the family farm while his wives can harvest between 1-2 bags each from their individual farms. On this same farmland, *Atanga's* first wife started cultivating soya beans on her own the previous year - that is 2007. This marked the beginning of soya bean cultivation in the house. Upon the advice of his first wife, *Atanga* also started cultivating soya beans in 2008.

Environmental change influence *Atanga's* farming decisions. *Atanga* describes how environmental factors are affecting household food crop farming (Box 3.1).

Box 3.1: How environmental factors affect *Atanga's* food crop farming

When my father was alive, rainfall was good for food crop farming. Since my father died, the rains have become unreliable. For instance, two of my wives cultivated rice the previous year but the rains stopped abruptly at tussling stage and this lead to poor yields. These days, I cannot harvest enough *Naara* to support household consumption as my father did because of unreliable rainfall and rainfall variability.

Atanga's first wife, *Apogbire* corroborates her husband's assertion. She recounts her own experience with the environment: *I have 6 years experience cultivating a new rice variety we call 'Saane ki ya' in the local parlance. However, I stopped planting rice at some point in time due to unfavourable rains. I resumed rice cultivation three years ago not because the rainfall situation had improved but because it is increasingly becoming difficult to produce enough grains for household consumption. We simply have no option than to attempt cultivating more and hoping that we will harvest enough to feed our children.* Aside unreliable rainfall, poor soils also affect *Atanga's* household crop production. It was in response to exposure to vulnerabilities arising from environmental factors that *Atanga* resorted to cultivating multiple farms and crops, especially *Moom* (bush farms). In Box 3.2, *Atanga* describes how environmental factors have affected household production, his response strategies and how they vary from practices of his father and grandfather.

Box 3.2: *Atanga's* response strategies to environmental factors in food crop farming

Poor soils on my *Sammani* combined with unreliable rainfall patterns pushed me to acquire my *Ayelbia* farm along the Ghana-Burkina Faso border. My father did not farm at *Ayelbia*. Here, I cultivate mainly *Baninga*, which is a white and long maturing traditional sorghum variety. I also cultivate some other crops. My father cultivated *Baninga* but he did it at *Aoósi* along the riverbank in the community. Three years ago, I cultivated about 1 ½ acres of *Baninga* at my *Ayelbia* farm and the yield was good. You see, this sorghum variety requires better soil fertility to do well and the soils are relatively more fertile there than on my *Sammani*. I also plant *Agriki*, an early maturing yellow maize variety on my *Ayelbia* farm. You can plant this maize variety in July and harvest in September. However, I have to apply fertiliser to have a good harvest. I also plant about an acre of *Tεa* (new bean variety locally named *Wogro*) and an acre of groundnuts. I did not farm there this year due to late start of rains. Two years ago, I harvested 4 ½ bags of *Baninga*, and 2 ½ bags of maize. That year, the rain was too much and that accounted for the poor harvest of maize. The area is clayey and I did not plant early too. Hence, waterlogging at tussling destroyed the crops. In planning, I usually plant my *Sammani*' first before going to *Ayelbia* to plant. As a routine, I usually go there in June, stay for 4-5 working days ploughing the land for planting with bullocks or sometimes by the hoe. I go with my brother and then mobilize additional labour there to support. After ploughing, my wives go to do the sowing. I usually organize additional labour at GH¢1.20 per head per day to support my wives fast track the sowing. In this way, my wives are able to return on time to support weeding the *Sammani*.

Atanga and his household also rear poultry and livestock to supplement food crop farming. In Box 3.3, he describes his household experiences in rearing poultry and livestock as a supplementary livelihood.

Box 3.3: Poultry and livestock as supplementary livelihood

Rearing poultry and livestock is helpful for the sustenance of my family. However, returns from rearing are not as good as they were in my father's era. My father simply had far more poultry and livestock than we have today. As I speak to you, I put a lot of effort to rearing fowls and guinea fowls but I have just a few. For livestock, I have 13 goats, 6 sheep, a pair of bullocks, 2 female cows and a calf. I also have a donkey and its cart for transportation of farm produce. There are few more fowls and goats in the house but I do not own them although customarily, they are mine. My wives and their children also have a fowl or two that they rear and use for purposes of their own choosing. I know that each of my wives own at least a fowl. Some of them have a goat or more, which the children cater for. Even the children also have their own fowls and goats their mothers support them to rear. We are all making the effort to rear but we are not reaping what we deserve for our effort. Fowls are so important to us culturally and in our daily lives but we lose most of them to diseases. My parents did not have such experiences with diseases.

According to *Atanga*, rearing livestock in particular has become more challenging these days and require extra effort for sustaining it as a supplementary livelihood (Box 3.4).

Box 3.4: Challenges of livestock rearing for *Atanga's* household

There is no enough grass for the grazing of animals especially during the dry season. When we harvest groundnuts, I have to store the vines on sheds and ration it as feed to the animals during the dry season. We also harvest rice straws and store as feed for the animals during the dry season. My children often cross over to rice farms in Burkina Faso just to harvest rice straw soon after harvesting for storage as feed for our animals. They will go there with a donkey cart to cart the straw here. We also harvest stalks and keep for many purposes but part of the reason is to feed the cattle. When I was a child, we harvested stalks and put them in the farmyard for organic manure making. Some stalks remained on the farms for animals to graze. Even then, there were enough stalks on the *Sammani* for grazing and for decomposition to support soil fertility. These days, if you leave stalks on the farm, the animals will eat all. Not a single stalk will decompose for enriching soil fertility. Even for stalks we store on sheds, we have to protect them from livestock.

Atanga's household is also involved in a wide range of non-farm activities. *Atanga's* first and third wives are involved in the processing and trade of malt used for brewing *Pito* (local alcoholic beverage). They often buy the sorghum for malt preparation from *Guelwongo* market in Burkina Faso. In addition to processing malt for sale, *Atanga's* third wife also brews *Pito* for sale in the daily *Yua* market and at social events such as funerals. The second wife makes groundnut oil and cakes *('kulikuli'*) for sale in the daily *Yua* market. *Atanga's* first wife *Apogbire* recognizes that environmental factors affect their nonfarm livelihoods in various ways (Box 3.5).

Box 3.5: Effects of environmental change on non-farm livelihoods of *Atanga's* wives

Although we engage in non-farm activities to earn income, we know from experience that they are not profitable enough. The cost of sorghum for instance is so high that it erodes profit from malt sales and *pito* brewing. If you price your products high too, you will not get the market for them. In the days my mother in-law brewed *pito* she made better profits. I was newly married

then. The sorghum was cheaper and one could buy sorghum from *Yua* market or nearby *Sirigu* market. Today, it is uncommon to buy sorghum in *Yua* market because everybody is now keeping their harvest for household consumption. If you go to nearby *Sirigu* market, it is available but prices are higher because every trader is retailing. We are suffering from this problem because poor rains are leading to low production – we do not even harvest enough for consumption. It is for this reason that we go to *Guelwongo* market in Burkina Faso to buy sorghum for our businesses. Prices of sorghum are lower there but we still do not make significant profit. My colleague involved in groundnut oil and cake processing is facing the same problem. Last year (2007), floods destroyed virtually every groundnut farm in this community. No one harvested groundnuts from the fields as a result. This planting season, people do not even have groundnut seed to plant due to last year's devastating floods. So what do you think will happen to groundnut prices in the market? [She asked]. We know these non-farm businesses are not profitable enough, but we are able to earn some income and sometimes buy cereals and ingredients for home consumption. Sometimes we also meet petty personal needs from this income. If we stop these businesses, what will we do? [She asked rhetorically]. We have to do something even if profits are minimal.

Migration is another source of livelihood for *Atanga's* household. Neither *Atanga* nor any of his wives is personally involved in migration. *Atanga's* most senior daughters migrate to Accra during the off-farm season to engage in wage labour commonly known as '*ka ya ye'* (head pottering) or washing dishes in local restaurants popularly known as *'chop bars'*. She usually leaves for Accra soon after harvest (November) and returns during the planting season (June). On her return, she brings with her second hand clothes for some family members. She also brings some money part of which is given to her mother (*Apogbire*) for the purchase of grains for supporting family consumption. Supplementary foodstuff purchases (cereals in particular) from nearby *Guelwongo* market (Burkina Faso) and or *Sirigu* market (Ghana) is an annual practice for meeting part of the consumption needs of the household. According to *Apogbire*, they have to buy foodstuff almost every year to supplement their own production (Box 3.6).

Box 3.6: *Puuliga* for supplementing *Atanga's* household production

> For most years in the past, crop yields were inadequate to meet household consumption needs. We have to buy grains from the market to supplement our own production – a practise expressed in the local parlance as *puuliga*. This year (2008), we have not purchased food because harvest from our *Sammani* was relatively better. Intensified manure application on our *Sammani* paid off. Last year, we bought several bags of *Zea* (late millet) due to poor harvest. Last two years, we bought foodstuff but not as much as we did last year. Our husband provides the money for most food purchases and he raises the money by selling his goats and sheep. When it is critical he has to sell a cow to finance grain purchases. We also help with the little income from our non-farm activities. We buy very little quantities but more frequently.

III. Father's/grandfather's generation livelihoods- composition, dynamics and environment

According to *Atanga*, the major occupation of his parents (father and mother) was food crop farming. His father inherited farmlands, seed variety and knowledge of cultivation from his grandfather whose major occupation was also food crop farming. He recalls from oral accounts that his father cultivated the *Sammani* and the *Agiro* farmlands in Burkina Faso but his grandfather cultivated the former only. He notes that his parents planted traditional crop varieties including – Z*ea* (late millet), *Naara* (early millet), *Kemoliga-menka* (sorghum), *Sumkaam-menka* (groundnuts) and *Tεa-menka* (beans) on the *Sammani*. His father took decisions regarding farming when he was a child. He also recalls that his mother and they the children provided labour in farming activities. This was in the area of sowing, weeding and harvesting. His father set up the *Agiro* farm (a bush farm) for the cultivation of groundnut, which he inherited. Soils at *Agiro* are sandy but have good water retention suitable enough for groundnut cultivation than the *Sammani*. Here, groundnuts were mostly cultivated as a collective family endeavour to support household consumption. However, *Atanga's* mother planted her own groundnuts on a small scale here too. *Atanga* describes the era of his parents and grandparents as good times in food crop production. According to him, they harvested lot of foodstuff to the extent that they had old food stocks at the time of harvesting new crops. They always had surplus production of grains. Soils were relatively fertile then and rainfall was favourable for plant growth than it is now.

Atanga describes his father and grandfather as renowned poultry and livestock farmers in those days. He recalls that his father took poultry and livestock farming seriously. In his opinion, they engaged in poultry and livestock not simply as a livelihood. His father and grandfather had passion for keeping birds and livestock. He describes their involvement in the industry as a success story (Box 3.7).

Box 3.7: Involvement of *Atanga's* father and grandfather in poultry and livestock

> My father was a rare type of outstanding poultry and livestock farmer in the community. He inherited breeding stocks from my grandfather. These included - fowls, guinea fowls, goats, sheep and cattle. Oral accounts of my father reveal that my grandfather was even a more renowned poultry and livestock farmer – that he had passion for livestock and was indeed, blessed with many poultry and livestock. My father had more livestock and poultry than I have now. I put in a lot of effort yet the returns are not good enough these days. At any given time, my father could count at least 15 cattle, 30 sheep, and 20 goats as his possession. His fowls and guinea fowls were simply 'uncountable'. They were so many that he could only count them by their colour groups. If you stole one, he would not know but if you stole many fowls of the same colour, he would notice it. That was the situation during my father's reign. Accordingly, my grandfather built his livestock breeding stock gradually through focus on poultry and barter. He sold poultry to buy breeding stocks of goats and sheep. In other instances, he obtained breeding stocks through barter with grains.

According to *Apogbire* (*Atanga's* first wife), her father in-law was not engaged in any non-farm activity but her mother in-law brewed *Pito* for sale in *Yua* market. At that time, the *Yua* market was a well-patronized market. According to *Apogbire*, the decision to brew *Pito* was a personal initiative of her mother in-law. She explains that women did not have their own farms those days – except groundnut farms. *Apogbire* also reports that *Atanga's* grandmother did pottery but it was mainly for home use.

3.3.2 The case of *Abowine's* household livelihood profile

I. Background of household

Abowine is a 50 years old widow. She has been a female head of household for 15 years. She and her husband returned from southern Ghana (returned migrants) to settle in *Yua* some 25 years ago. *Abowine* has three children. The senior son migrated to southern Ghana where he cultivates maize in a farming village. The junior son also migrated to southern Ghana (Obuasi) where he is a casual labourer. The daughter had just completed JHS and awaiting placement in SHS. *Abowine* lives with her daughter and sometimes her teenage grandson who visits frequently.

II. Son's generation livelihoods – composition, dynamics and environment

Abowine represents the current generation (i.e son's generation) of the household. She reports that her household cultivates food crops as their major livelihood. They cultivate mainly their *Sammani*. She has divided her *Sammani* into three different plots. On plot 1 estimated at about 1 acre, she intercrops *Naara, Zea, Talenga* and some vegetables including Okro and Kenaf. On plot 2, estimated at half an acre, she intercrops yet *Naara, Zea, Talenga* and Okro. On plot 3, estimated at a quarter of an acre, she planted a new groundnut variety *Nigeria'* and intercrops it with *Wogro* (a new variety of beans). *Abowine* intercrops traditional crops with new crop varieties (Box 3.7).

Box 3.7: *Abowine* intercrops traditional and new crop varieties

As you can see on my *Sammani*, some of the crops that we have planted are traditional crops. These include *Naara* and *Zea*. The *Talenga* we cultivate is a new and early maturing sorghum variety. It matures earlier than our traditional sorghum (*ke-menka*). When we returned from Kumasi people advised us to plant *Talenga* because it yielded better than *ke-menka* given shortening rainfall durations. So, I went to my father in *Vea* a village close to *Bolgatanga* and brought the seed for planting. We have been planting it since then. It is also suitable for our local dishes. *Talenga* is very helpful. It matures shortly after harvesting *Naara*. So when the *Naara* fails, the *Talenga* saves the situation. As you can see from the farm, the *Naara* yield is good but that of *Talenga* looks good. Therefore, the *Talenga* will be our major grain for consumption this year. *Talenga* is also good for preparing malt or for brewing *pito*. Soothsayers also accept it as in-kind payment for spiritual consultation. I present it to soothsayers during spiritual consultations to assess my fortune for the incoming farming season. I use its flour to make offering to our ancestors - 'pour libation'. In 'pouring libation', I request support from our ancestors for good health and harvest at the beginning of the farming season.

Abowine also cultivates rice in a nearby *Boo* (riverbank farm). Her narration about rice farming highlights the importance of 'bush farming', for meeting consumption needs of her household and some gender dimensions in farming (Box 3.8).

Box 3.8: *Abowine* cultivates rice in her *'Boo'* to support household consumption

I also cultivate rice on a small farm along the nearby stream you see ahead. River bank farms are richer in organic materials and therefore, called *'Boo'*. I started cultivating a traditional variety called *Mйй kiliga*. I shifted to the cultivation of a new rice variety we call *Sane ki ya* because it is early maturing and yielded better under shortening rainfall duration. When my husband was alive, I used to cultivate rice and still help him cultivate cereals on the *Sammani* for the family. He did not participate in rice cultivation but I did it with the support of the children. You see, my husband focused on farming cereals and this was what every man did. Rice cultivation is very helpful to the family. We eat most of our harvest. Rice complements *Talenga* in our portfolio of food stocks. In the past, I have sold some (1-2 bowls) of rice to buy ingredients for cooking. Rice usually belongs to the women because we cultivate it. Therefore, we sell some of it to meet our personal needs when the need arises. As a woman, you may inform your husband as a sign of respect but it is not obligatory. The problem for me is that my rice output has declined considerably. Last year, I harvested only one basin. I no more have children available to support me on my farm. You know my little daughter was in JHS. She could not provide much support because she had to attend school. Although she helped occasionally, it was not enough. I perform the functions of 'the man' and 'the woman' in farming activities. I have to focus on producing cereals from the *Sammani*. For this reason, I am unable to attend to my rice farm as well. When my husband was alive, we cultivated three farms. These were the *Sammani*, *Boo* and *Daboo*[26].

[26] The *Daboo* is usually the first compound farm of the extended family. Over time, all individuals move out of the compound to start their own households but still maintain their share of the compound farm referred to as the *Daboo*.

Today, I lack the strength to cultivate the *Daboo*. This is partly the reason why I do not harvest enough for household consumption.

Abowine acknowledges that although she puts in a lot of effort in food crop farming, unfavourable rainfall, rainstorm, drought and poor soils are to blame for her poor crop yields every year. She particularly singled out rainstorm as very destructive. She recalls that rainstorm can lead to total crop failure and points to two types of storms. She identifies the windy storm that fells plants including *Naara*, *Talenga* and *Zea*. When this happens at maturity stage, the seeds rot if it is still raining or one may lose seeds to fowls. There is another destructive type of rainstorm. It most likely occurs at mid-day and immediately accompanied by light rainfall and sunshine. This type of disrupts the seed development of *Talenga* in particular. The outcome is that you see the plant, especially *Talenga* looking healthy but no seeds, a phenomenon known as *Sii fŏŏsi* in the local parlance. In her opinion, heavy rainfall and poor soils are factors that cause poor crop yields. She points out that although drought is also a problem, it is not as destructive as the other factors.

Abowine also rears poultry and livestock as a supplementary livelihood for her household. At the time of the interview, she had two hens and no guinea fowls. She lost all her guinea chicks to diseases. She also had one (1) sheep and no cattle. She had no goats as she had sold all of them to buy grains in the past. She recalls that when her husband was alive, they had about five (5) cows, four (4) goats and more poultry than she has now. She also points out that the lack of grass for grazing by animals and the lack of sufficient water bodies for watering animals in the dry season is a problem in the community. She points to the devastating effect of diseases in her attempts to rear poultry. Accordingly, she loses most of her poultry (fowls and guinea chicks) to diseases every year.

The *Daboo* is the exact site of the original compound which is usually cultivated by the landlord (*yidaana*) as a symbol of authority and leader of the extended family.

According to *Abowine*, she cannot rely on food crop farming alone to provide for the food needs of her household. As she puts it, times have changed as unreliable rainfall and poor soils undermine her ability to secure good crop yields. As such, she has to explore supplementary livelihoods (Box 3.9).

Box 3.9: Supplementary livelihoods of *Abowine*

Every year, I do not harvest enough for home consumption. So, I have to find ways of supplementing household food needs. I weave ropes to generate income for purchasing grains in the dry season – Puuliga. Previously, I traded in maize but stopped due to old age. At that time, I bought maize from *Bolgatanga (*regional capital) market and retailed the grains in *Guelwongo* market in Burkina Faso. It was profitable then. These days' traders rather bring maize from *Guelwongo* to sell here. See how things can change.

According to *Abowine*, her senior son who settled to farming in *Abofor* a farming community in southern Ghana some 9 years ago with his family, has been very helpful in supporting her meet food needs. She does not migrate herself but she gets support from her migrant son in her narration (Box 3.10).

Box 3.10: Remittance as a source of livelihood to *Abowine*

My senior son is a maize and tomatoes farmer in *Abofor*. He pays us annual visits during which he supports us to buy foodstuff. He brought us a bag of maize during his last visit in March this year. Sometimes he sends money (about GH¢ 40.00) to enable me buy foodstuff. My junior son does not give me any support. I believe he will when he is in a position to do so. I wish they were living with me here but it is difficult here too. I am not alone. Other people are in a similar situation but what can we do? , She asked rhetorically.

Food purchases are important for sustaining the family of *Abowine.* The practise, referred to as *'Puuliga'* in the local parlance, has become an annual activity for this family. Since the harvest is often inadequate to meet consumption needs, *Abowine's* migrant son continuous to support. Last two years her son sent her some money. She used it to buy a bag of *Baninga* (a local sorghum variety) suitable for preparing *Tuo-zafi*. When it finished, she sold a goat to buy some more food to supplement. She often buys food on her own to supplement. For instance around *Naa pumolga* (pollination season of *Naara*), she bought GH¢ 10.00 worth of late millet (*Zea*) to support consumption through the sale of a goat. This served as a bridge in for consumption till *Naara* was harvested. She often sells a goat when in dire need of buying grains. That explains why she does not have a goat remaining at the time of interviews. She also sells fowls to finance such purchases but poultry diseases have stripped her of poultry over the past few years.

III. Father's/ grandfather's generation livelihoods – composition, dynamics and environment

According to *Abowine*, her father in-law and mother in-law cultivated food crops as their major livelihood. They cultivated traditional crop varieties – including *Naara* (early millet), *Zea* (late millet), *ke-menka* (traditional sorghum), *Tεa-menka* (beans) and *Sumkaam-menka* (groundnuts). She notes that in the era of her father in-law and mother in-law, they cultivated three farms. These included the *Sammani*, *Boo* and *Daboo* farms. Her mother in-law also planted *Mǔǐ kiliga*, a traditional rice variety in *Boo* along nearby river *Akulaa* in the community. *Abowine* also recounted oral accounts that show that the grandparents of her late husband cultivated food crops as their major livelihood as was the case with most households at the time. She notes in a narration that the era of second and first generations households were good times in food crop farming (Box 3.11).

Box 3.11: *Abowine's* narration of farming among second and first generation

They planted only traditional crop varieties most of which no more strive well under current shortening rainfall regime. They were serious farmers. Farming has been the tradition of the family and this knowledge is passed on from generation to generation. The eras of my father in-law and beyond were good times. They harvested enough food for consumption. They even had surpluses from their Sammani alone. The duration of rainfall was longer and favourable to plant growth. The soils were more fertile than they are these days too. So they were self sufficient in food crop production.

Abowine recalls that her father in-law was also rearing poultry and livestock. He focused mainly on poultry – fowls and guinea fowls. He also reared small ruminants including goats and sheep. According to *Abowine*, her father in-law had far more poultry and small ruminants than what she and her late husband had. She however, recalls that her late husband's grandparents did not have cattle. In that regards, the rearing of cattle started with she and her late husband. Environmental factors were generally favourable for livestock farming even then. Animals had more fodder to graze on because there was enough grass and vegetative cover. Poultry was not affected by diseases, as is the case today. She also points out that unlike her who sells her poultry and livestock to buy food, the generation of her husband's parents and grandparents used theirs mainly for cultural purposes such as dowry, sacrifices and kept them for family prestige. As she puts it, she understands the father in-law sold his poultry and livestock but such sales were not linked to the need to purchase foodstuff for the family. They produced enough food for household consumption. According to *Abowine*, her late mother in-law did pottery but this was mainly for home use. Aside this, both father and grandfather's generation households of the family did not engage in any other form of nonfarm livelihoods. They were mainly food crop, poultry and livestock farmers.

In my discussion, I have analyzed the household profiles of *Atanga* and *Abowine* according to a three generational analytical framework. The case of *Atanga* and *Abowine* are a representative sample of the two kinds of households in the community, male and female-headed households respectively. The livelihood profiles of these two households reflect the general pattern among households in the community and serve as an entry point for considering additional data for further discussions. Thus, the ensuing section entails further livelihood analysis that draw on these two household cases together with additional results from focus group discussions, survey and institutional data.

3.4 Livelihood analysis: composition, trends and driving environmental factors

3.4.1 Food crop farming as primary household livelihood

Smallholder crop farming is the primary livelihood for majority of households in the *Atankwidi* basin. In both the livelihood profiles of *Atanga* and *Abowine*, food crop farming was the major livelihood of the household. The survey of 131 heads of households across three communities in the basin revealed that 80% cultivated food crops as their major source of livelihood. The respondents covered in the survey are the third generation peers of *Atanga* and *Abowine* (i.e son's generation colleagues). In livelihood analysis, it is common to examine the contributions of various livelihoods to total household expenditure as a way of understanding the relative importance of each livelihood to the household. See van der Geest (2004) and Yaro (2004). From the description of livelihood portfolios of *Atanga* and *Abowine*, I have pointed out that food crop farming remains the main source of grains (food) for most part of the year. In order to understand the role of food crop farming to livelihood sustenance in a broader context, I asked seven female focus group discussants from *Yua* to prepare and analyze a calendar that shows the period within which most households are dependent on their own food crop production for consumption (Table 3.1). In the analysis (Table 3.1), the empty cells and the period of planting represents the period for which households no more have their own produced food stocks for consumption. In this case, the period between September (harvest season) and April (onset of the next planting season) is the period households depend on their 'own produced grains' for consumption. This corresponds to eight (months). Yaro (2004) classified this period as a 'food secure' period in his analysis of individual food security situations in *Chiana,* a village in the KND. The availability of food stocks over this period (September to April) vary according to crop type. From the calendar, May to August is the period most households resort to buying grains from market centres to support household consumption.

Table 3.1: Household food consumption calendar for common crops in *Yua*[27]

Crop/month	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Naara/millet					PL	PL		H/C	C			
Kadaa/sorghum					PL	PL			H/C	C		
Talenga/sorghum	C	C	C	C	PL	PL					H/C	C
Zea/millet	C	C			PL	PL					H/C	C
Gerigo/potatoes					PL	PL			H/C	C		
Sane ki ya/rice	C	C	C	C		PL			H/C	C	C	C
Mŭŭ kiliga /rice	C	C			PL				H/C	C	C	C
Puuliga/buying					P*	P*	P*	P*				

Source: Focus Group Discussion, 2008

Most households exhaust their 'own produced' food stocks by this time. For most households, June to July is the most critical period. Yaro (2004) describes this period in relation to individual livelihood cases as the period of 'critical food insecurity'. For this period, households resort to buying grains to support consumption using income generated from secondary livelihood sources – a phenomenon referred to as *Puuliga* in the local parlance. Aside its contribution to sustaining most households, food crop farming is the rallying point for synergies of individual members in the household production system. Individual members of the household, including husbands, wives, children and sometimes brothers, grandparent(s) play similar and varying roles in sustaining farming as part of their culture, knowledge system and an important component of their ancestral heritage. Food crop farming takes precedence over all other forms of livelihoods in the household. There is higher value placed on food crop farming than poultry and livestock rearing and this reflects in the local literature of the people. For instance, the head of household will tell you *maam de la Kaara*. Although this literally means he is a farmer, it mostly refers to food crop farming. The same person will tell you

[27] Explanatory notes for abbreviations in Table 3.1: 'P' for planting; 'H/C' for harvesting and consumption; 'C' for consumption and; 'P*' for *Puuliga*.

maam po ugra me. This means he is also a poultry and livestock farmer. This shows that food crop farming is primary in their livelihood portfolios.

Some major features of food crop farming in the basin include multiple farmlands, defragmentation of the *Sammani* and mixed cropping. The main farm asset is the *Sammani* (compound farm) which is often the immediate surrounding farmland around the homestead. Different households within a compound usually have their own *Sammani*. The *Sammani* is divided into several smaller plots for the cultivation of crops as in the cases of *Atanga* and *Abowine*. The next category is the bush farms (*Moom*). *Moom* has two categories - nearby bush farm called *Boo* and mostly located along streams, riverbanks or in a valley and long distant bush farms simply referred to as *Moom.* For most farmers in *Yua* their *Moom* are located in Burkina Faso. In the case of *Atanga's* household, they have one S*ammani* and three *Moom* one of which is a *Boo*. In the case of *Abowine's* household, they had a *Sammani* and a *Boo*. Planting and managing multiple farms is a complex task requiring careful planning. Findings from focus group discussions show that cropping decisions in the context of multiple farms follow a carefully thought out order (Box 3.12).

Box 3.12: Order in planting of multiple farms

When the rains start, households plant the front part of the *Sammani* facing the main entrance to the homestead first. Given proximity, and easy visibility, this enables them to drive away animals and protect the plants from destruction by animals. This is necessary because at the early stage of cultivation most livestock are often not tethered. The next area most people plant either is the part of the Sammani behind the homestead or a little further from the house. After this, the next farmlands they plant are the *Boo* and then finally the *Moom*. These distant farms are planted in later stages by which time most livestock are tethered.

Mix cropping occurs at two levels. From the cases of *Atanga* and *Abowine*, these two forms of mix cropping include (i) intercropping cereal crops with leguminous crops and (ii) intercropping traditional cereals crops with early maturing new cereal crops. These forms of mixed cropping are typical of household practise as the evidence from focus groups and survey show. These mixed cropping patterns enhance adaptation to rainfall variability (see Chapter 5).

In food crop farming, individual household members perform varied and similar roles. Heads of households irrespective of their gender take major decisions concerning food crop farming as part of their leadership responsibilities. Drawing on the cases of *Atanga* and *Abowine,* these leadership roles include meeting customary, religious and spiritual requirements associated with farming, taking cropping decisions including types of crops, timing of farming activities and seed management. In polygynous households, wives may contribute to cropping decisions by providing advice to their husbands. For instance, *Atanga* started cultivating soya beans upon the advice of his first wife. However, their roles essentially entail providing labour in farming activities. Women are quick to say that *maam songre la N Sira ta koora* and this literally means 'I assist my husband to farm'. In the cultivation of traditional cereal crops[28], men provide both leadership and labour, while the women and children provide labour. In the case of non-traditional cereal crops[29] and leguminous crops (groundnuts, soya beans) women are the decision makers because they see immense benefits to the household. They decide on planting, harvesting and consumption. For instance, *Atanga's* wives started intercropping some new sorghum varieties, *kadaa* and *Agriki* with traditional cereal crops on their own because of the benefits to the household. When food is most lacking during the rainy season, these new crops provide the grains for consumption. Female focus group discussants describe such intercropping decisions as an emergent phenomenon in the community (Box 3.13).

Box 3.13: Women intercropping new crops with traditional cereal crops

Female discussants at focus group sessions confirm that this is a common response to unreliable rainfall among women in the community. They point out that men focus on traditional cereal

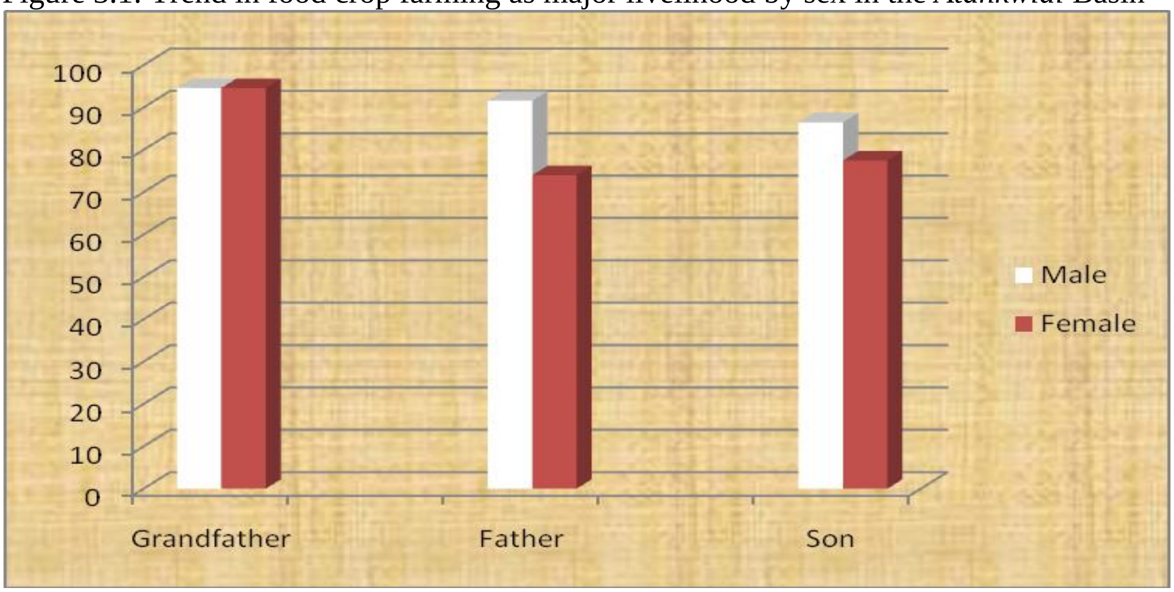
[28] Traditional cereal crops are the inherited indigenous sorghum varieties which include *Naara*, *Zea* and *Talenga*. *Talenga* is relatively new but it is classified as such because it has been cultivated for some time now.

[29] Non-traditional cereal crops are new and early maturing cereal varieties including such sorghum varieties as *kadaa*, *'Agriki'* and new rice variety such as *Sane ki ya*.

crops to the neglect of other crops. Since they the women have realized the importance of these new crops, they intercrop small quantities with traditional crops on their own accord during sowing which is predominantly their domain. In the evaluation of the discussants, the men have now seen the benefits of these crops in providing food when it is most needed. Hence, men are appreciative of these decisions and initiatives although they are still not very much involved.

There are changing patterns in food crop farming practices at the household level partly due changing environmental factors. These trends include (1) declining trend in the number of households engaged in food crop farming as a primary livelihood and (2) declining trend in the farm sizes that households cultivate. Results from household survey[30] show that household members (spouses) involved in food crop farming as their main livelihood is declining from generation to generation (Figure 3.1).

Figure 3.1: Trend in food crop farming as major livelihood by sex in the *Atankwidi* Basin



Source: Field Survey, 2008

[30] The survey covered 131 households across three communities (*Yua, Mirigu and Pungu*) in the *Atankwidi* Basin. The target respondents were 131 heads of households comprising both male and female heads. The survey gathered information on the major livelihoods of respondents and their spouses (living or deceased). The survey also gathered information about major livelihoods of the first generation (grandfather) and second generation (father) of the same households (Figure 3.1).

The analysis (Figure 3.1) shows a declining trend in the percentages of household members (spouses) involved in food crop farming as their major livelihood. From 90% for the grandfather's generation, the percentage declined to around 80% for son's generation. The decline of involvement in food crop farming across three generations has been more dramatic among females (spouses) than males (spouses). Declining crop yields because of rainfall variability and poor soil fertility are partly to blame for this trend. Food crop farmers continue to make efforts in the cultivation of crops, but poor and unstable yields resulting from environmental factors are a disincentive to investments. Apart from being a primary livelihood, historically, food crop farming has been part of the culture of the people and part of their ancestral heritage. Thus, a declining trend in the number of spouses engaged in food crop farming as a major occupation does not only indicate a change in household economic structure but also underpins social change. There is also a declining trend in farm sizes between earlier generations and the latter generation and this is driven by declining soil fertility and rainfall variability. In the case of *Atanga*, it is clear that he has not been consistent in cultivating his *Ayelbia* bush farm every year over the past five years. From the results, the first generation concentrated most farming activities on their *Sammani* and this is understandable. Soils were relatively fertile at the time and as the findings suggest, they harvested enough for consumption. Oral accounts show that immediate surroundings of houses were thick forest and one could not see the next house from another. There were wild animals that prohibited free movement. It might well have been safe for the grandfather's generation households to farm around their homes. However, poor soil fertility became more of an issue of concern among the father's generation households. As a response, they began to expand their farm sizes by seeking bush farms especially bush farms in Burkina Faso. This worked for them as they also harvested enough for home consumption and indeed had surpluses too. However, son's generation households are withdrawing gradually from cultivating bush farms partly due to redirection of some labour to soil fertility improvement on the *Sammani* and unreliable rainfall patterns. Late start of rains is making it impossible to cultivate multiple farms at the same time especially in the light of labour shortages – hence, focus on *Sammani* and to a lesser extent, *Boo*.

3.4.2 Migration as a major secondary household livelihood

Migration is a major secondary livelihood among majority of households. In the cases involving *Atanga* and *Abowine*, migration featured in their livelihood profiles as an important source of livelihood. Through migration, *Atanga's* daughter supports her family to meet their household needs for food and clothes. *Atanga's* two children are also away in *Kumasi* (a southern city) attending school and this is helpful to *Atanga* in a number of ways. In the first place, the host will contribute significantly (in most cases total responsibility) towards the education of their children. Secondly, the absence of the children at home means mouths to feed have reduced by two and this helps reduce pressure on household food stocks. In a thesis[31] submitted to the University of Bonn, Schraven (2010:161) asserts that seasonal migration is prominent in the *Atankwidi* basin and that such migration reduces the pressure on limited household food stocks. This allows available food stocks to last a bit longer for meeting consumption needs of the household. This benefit is equally associated with the seasonal migration of *Atanga's* daughter. Anytime she is away, the numbers of mouths to feed are reduced by one and this reduces pressure on household food stocks. In the case of *Abowine*, she receives annual remittances to buy foodstuff during the lean season from her senior son who migrated to southern Ghana. From the two cases, it is the young men and a spinster who are the migrants. They are involved in both seasonal and permanent migration. The cases of *Atanga* and *Abowine* represent the 'tip of an ice berg'. Their experiences with migration are a reflection of a common phenomenon across many households in *Yua* and the *Atankwidi* basin in general. Results from focus group sessions show that migration,

[31] Schraven (2010) conducted a survey covering 150 households and 1003 respondents on irrigation and migration in the *Atankwidi* basin in 2007. From the survey, the share of households who had seasonal migrants in 2007 was 31.5 % among 'irrigation households' and 29.5 % among 'non-irrigation households'. He also reviews two surveys conducted (one 2006 and the other 2008) on shallow ground water irrigation in the *Atanwidi* basin under the GLOWA Volta Project. His analysis show that for 2006, 15.7 % of 'irrigation households' had seasonal migrants while that for 2008 was 15.5 % among 'irrigation households'. The seasonal migration for 2007 was unusually high and he attributes the phenomenon to market failure in 2007 for irrigated crops, especially tomatoes for which many farmers made losses. To compensate for their losses, most irrigation farmers, migrated to southern Ghana after the tomatoes harvest season to engage in income earning activities to help meet food needs of their families.

especially migration to *Kumasi* (southern Ghana) is a major secondary livelihood in *Yua.* Results from household survey corroborate this assessment on migration. From the survey, 98% of households were involved in migration as a livelihood. Out of this, 76% of migrants migrated to *Kumasi*. The results also show that 58% of the migrants were young men (married/unmarried), 25% spinsters and 12.3% were the wives of heads of households. The importance of migration is corroborated by the NDSS[32] age-specific net migration rates[33] for KND (Table 3.2).

Table 3.2: Net migration rate by age for Kassena –Nankana District (per 1000)

Age group	2000	2003	2005	2007
0-9	18.3	12.9	-0.43	-17.8
10-19	-3.4	-4.9	-12.4	-14.3
20-29	24.6	23.6	12.2	8.0
30-39	26.1	33.0	20.3	14.0
40-49	10.7	13.4	10.8	4.4
50-59	7.3	7.4	9.8	2.8
60-69	0.9	5.2	2.6	0.5
70 –79	3.1	6.4	4.6	2.0
80 +	1.8	7.2	10.1	0.2
Total	11.7	11.0	2.5	-6.0

Source: NHRC (2009).

From the analysis (Table 3.2), in- migration was the predominant form of migration in the past but an increasing trend of outmigration has led to a reversal of this pattern. For instance, more people came into the district than went out between 2000 and 2005 given

[32] The Navrongo Demographic Surveillance System (NDSS) is the bedrock of all research carried out by the NHRC located in Navrongo, Ghana. The NHRC is a field station of the Health Research Unit of the Ghana Health Service and a reputable health research institute in Africa. With funding from the Rockefeller Foundation, the NDSS is a continuous population registration system, which assesses demographics of the entire population of the KND. In every 90 days, all 14,500 compounds in the district are visited to update vital events such as migration, births, deaths and pregnancy.

[33] The age specific net migration rate is an indicator for comparing out-migration and in-migration for specific age groups. The source data on migration for computation of the net migration rates was drawn from the NDSS database (Appendix 3.1) and the net migration rates as presented, computed by the Research Officer of the NDSS. I will draw on other data and computations sourced from the NDSS/NHRC in ensuing discussions.

the total net migration rates. However, this declining trend of net migration rates also meant an increasing trend of outmigration within the same period. This scenario eventually reversed in 2007 with more people going out of the district than the numbers coming in with net migration rate of -6.0%. There has been consistent rise in the migration rate for 10 – 19 age group rising from -3.4% in 2000 to -14.3% in 2007. This clearly shows that for this age group, more of them have migrated out of the district than they have returned for the years under consideration. Another remarkable phenomenon is the migration trend for the youngest age group (0-9). The migration trend for this group shows that for 2000 and 2003, more children came into the district than the number that went out by as much as 18.3% for 2000 and then reduced to 12.9% in 2003. However, this trend changed for 2005 and 2007. More children within this age group went out of the district than they came in by -0.43% in 2005 increasing to -17.8% in 2007. It is important to observe that since children of that age cannot migrate on their own, intensified migration of mothers between the ages of 20 and 49 accounts for this phenomenon. The migration rates for the 20 to 49 age group show a consistent decline from 2003 to 2007. This implies a consistent increase in the number of people within this age group who joined in the out-migration stream over the period. More women most likely constituted the majority of increased migrants for this age group. As mothers with normative care roles for their children, they went along with their children driving migration rates for the 0-9 age group into the negatives for 2005 and 2007. The decision to migrate is associated with the search for work and income earning opportunities. From the household survey, 98% of migrations were closely associated with the search for employment and income earning opportunities. In a similar study, Schraven (2010:170) found that people within the *Atankwidi* basin migrated for purposes of economic gains. This mainly includes the search for employment and income earning opportunities for family upkeep, acquiring farm inputs and for housing construction.

Another important aspect of migration is its seasonal dimension closely associated with livelihoods. Migration patterns show seasonality associated with farming activities in the community. Focus group sessions reveal that migration is lowest during the farming season and peaks during the off farming season. In both outmigration and in- migration, decisions to migrate are closely associated with the search for livelihoods. Hence, migration destination decisions are based on perceptions of where better income earning jobs exist. Southern Ghana generally referred to as *Kumasi* in the local parlance is the preferred destination in the search for jobs (Table 3.3).

Table 3.3: Out migration by sex and destinations for KND (%)

Destinations	2000		2003		2005		2007	
	Male	Female	Male	Female	Male	Female	Male	Female
Kassena-Nankana District	31.1	38.5	36.7	29.7	28.1	35.1	36.6	40.1
Within Upper East Region	XX	XX	19.5	18.5	5.7	8.6	6.1	8.4
Outside Upper East Region	66.1	58.5	40.4	49.3	63.2	53.0	54.5	48.2
Burkina Faso	XX	XX	3.0	2.1	2.7	3.0	2.5	3.1
Other	2.8	3.0	0.4	0.4	0.3	0.3	0.3	0.2

Source: Navrongo Demographic Surveillance System (NHRC, 2009).

From the analysis (Table 3.3)[34], majority of migrants prefer destinations within Ghana but outside the UER. The percentages range between 40% and 66% of migrants for both sexes and for all years. However, the percentages for male migrants are higher than that of their female counterparts. This corroborates the assertion that most migrants prefer *Kumasi* as a destination – meaning southern Ghana including the Brong-Ahafo, Ashanti and Greater Accra regions because these are the areas where better job opportunities are perceived to exist. See Appendix 3.2 for monthly migration by destinations for 2007. An interesting phenomenon is that migration within the district is substantial and female migrants are in the majority for all years except for 2003. The percentages range from 28% to 40% for both sexes for the years under review. For instance, about 28% of all 'out-migrants' (10,808) in 2005 were males who migrated within the district but their female counterparts constituted 35% of all 'out-migrants' who migrated within the district. The evidence on migration shows that irrespective of the form, characteristics of migrants and destinations, migration is generally a source of relief to many households.

[34] See Appendix 3.1 for total number of out-migrants and in-migrants for KND for 2000, 2003, 2005 and 2007. The computations were done relative to the total statistics on out-migrants and in- migrants for the district. For instance total out-migrant population for 2005 was 10,808 while that of in-migrants was 11,164.

3.4.3 Other secondary household livelihoods

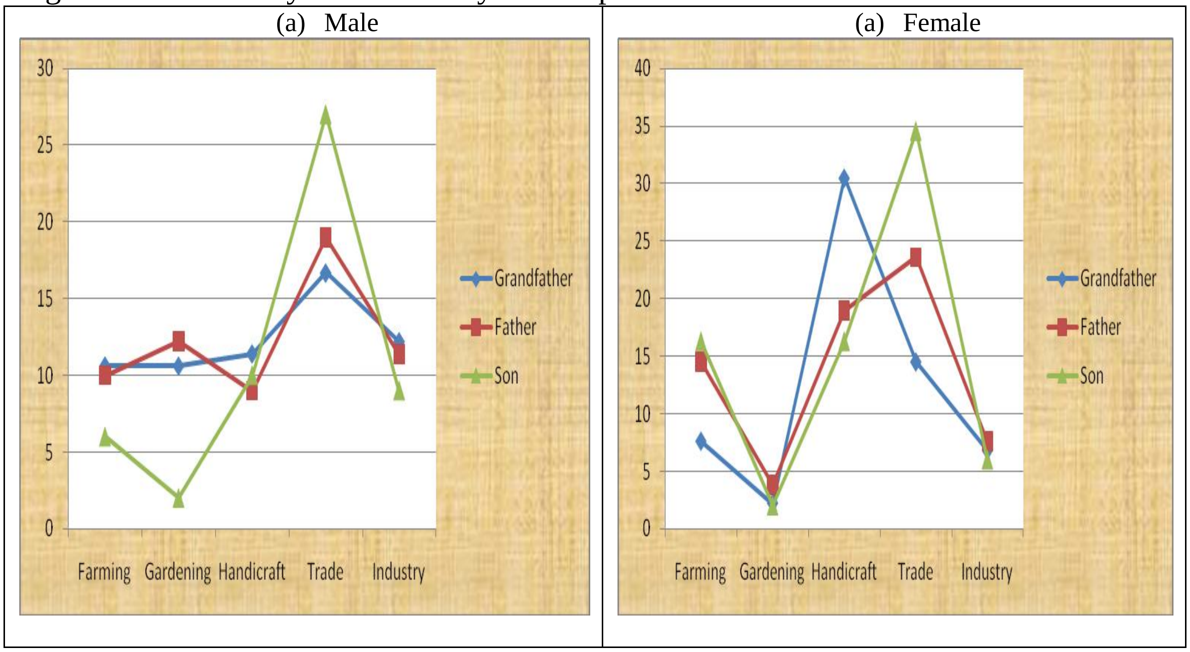
Aside migration, the findings reveal a wide range of other secondary household livelihoods that are important for the sustainability of households. These include poultry and livestock rearing, food crop farming (as secondary livelihood), gardening, non-farm activities and grain purchases. Poultry and livestock farming is a secondary livelihood organized within the framework of mixed farming among households. The industry is a very important livelihood for many households except that diseases have undermined its progress among son's generation households. In the cases of *Atanga* and *Abowine*, keeping poultry and livestock is an essential part of their household livelihood portfolios. In the category of poultry, fowls and guinea fowls are the commonest as typified by the two cases. Poultry is associated with a wide range of varied household types irrespective of economic standing in the community but it is also the hardest hit by diseases. In the category of livestock, goats and sheep are the commonest as exemplified by the two cases. Although cattle are common in the community, cattle rearing are commonly associated with few wealthier households such as in the case of *Atanga.* However, cattle and livestock rearing is hard hit by the lack of adequate vegetative feed due to desertification. Many livestock farmers have to store harvested and imported plant residue, which they ration as supplementary feed in the dry season. As a result of this and coupled with the sale of livestock to meet household food needs, many son's generation households lag behind their grandfather's and father's generations in livestock possessions. The commonest scenario among cattle owners now is that, they have two to three cows, one to two calves and a pair of bullocks. *Abowine* does not have cattle although she and her late husband had cattle in the past. However, more households strive to keep at least a pair of bullocks and/or a donkey for farming purposes (ploughing and transportation) even if they do not rear as in the case of *Atanga.* Poultry and livestock keeping is an important supplementary livelihood for many reasons. In the first place, poultry and livestock have constituted an important part of the assets and savings of families across generations. A cursory examination of trends in value placement show that while livestock keeping among grandfather's generation was more of a prestige and essential for dowry and other cultural reasons, the emphasis of value today is economic.

Although son's generation households still keep livestock for cultural reasons, they are considered more as household savings and insurance against uncertainties in food supply and emergencies. As is the case with *Atanga's* household, they have to sell small ruminants in order to purchase foodstuff to supplement their food needs. Under more serious food shortage situations, *Atanga* sells a cow, which has higher economic value in order to meet his household's food needs. In the case of *Abowine*, she relied on sales of goats to finance food purchases in the recent past because of which she no more owns a single goat. However, she has held on to a sheep. The sheep has both higher cultural and economic value than the goat and she must still be holding on to it as her last asset. An important aspect of keeping poultry and livestock is the dynamics in the ownership. Customarily, men are the leading actors in this domain. Among grandfather and father's generations, poultry and livestock in particular were often in a pool and owned by the *Yidaana* (head of the extended family). The *Yidaana* had under his domain a number of households who lived together in the same *Yire* (compound). In the event that a *Yidaana* is deceased, ownership is transferred to the next *Yidaana* who most likely will be the next senior male in the family who may be a brother, cousin or nephew of the immediate past *Yidaana*. In this system, custodian right and ownership of livestock kept moving from one *Yidaana* to another *Yidaana* and this meant from one household to another household. The *Yidaana* held the livestock in trust for the benefit of the entire extended family. This practise has not been sustained due to succession related conflicts. In the son's generation, ownership of poultry and livestock is customarily vested in heads of households who are mostly men. However, women and children are participating in the rearing of poultry and livestock at the household level. This is so in the case of *Atanga* but also for *Abowine*. The participation of women is driven by the desire to meet household food needs although some personal gains may also be the motive. It is perhaps due to this orientation that male heads of households are supportive or indifferent about the participation of women and children in poultry and livestock rearing. By entrusting ownership of livestock to their children, women have gradually negotiated their way and rights to participation in rearing and ownership of poultry and livestock. The commonest type of poultry and livestock women and their children keep are fowls and goats, although sheep may also be kept as in the case of *Abowine*. Female ownership of cattle exists but this is rare.

Non-farm livelihoods constitute the most varied and largest number of secondary livelihood options for households in *Yua* and the basin at large. In the case involving *Atanga's* household livelihood profile, his three wives are involved in agro-processing activities namely – malt processing, *pito* brewing, groundnut oil extraction and groundnut cake making (*kulikuli*). In the case of *Abowine*, she currently weaves ropes for sale and previously traded in maize. Focus group discussants list additional nonfarm livelihoods commonly associated with households (Appendix 3.3). These include sale of plant stalks, pottery, weaving, blacksmithing, carving, butchering, trading, head pottering, transport services, commercial bullock ploughing and wage labour. Although the results show a wide variety of secondary livelihoods for household members, there are mixed trends closely associated with environmental factors. Findings from the household survey[35] show that involvement of males in secondary livelihoods has generally declined relative to increments among their female counterparts across the three generations (Figures 3.2). From the analysis, some spouses practise food crop farming as a secondary livelihood. This practice is lower among sons generation than their grandfathers and fathers generations by a 5-percentage difference. In contrast, there is a consistent rise in the number of females taking to farming as a secondary livelihood within the household. From less than 10% among grandfather's generation females, the percentage doubled to 20% for the father's generation and again doubled to almost 40% for the son's generation (Figure 3.2b). The incidence of handicraft has stagnated among males (Figure 3.2a) but has consistently risen among females (Figure 3.2b).

[35] The survey covered 131 households across three communities (*Yua, Mirigu and Pungu*) in the *Atankwidi* Basin. The target respondents were 131 heads of households comprising both male and female heads. The survey solicited information on secondary livelihoods of respondents and their spouses (living or deceased) – the third generation (son's generation). The survey also solicited information about secondary livelihoods of the first generation (as represented by grandfather) and second generation (as represented by father) of the same households (Figure 3.2).

Figure 3.2: Secondary livelihoods by sex of spouse in the *Atankwidi* Basin



Source: Field Survey, 2008

From 30% among grandfather's generation, female involvement rose to 50% and 65% for father and grandfather's generations respectively. Trade is the commonest secondary livelihood of all times among males (Figure 3.2a). However, more sons' generation males engaged in trade than in grandfathers' and fathers generations. The graph shows a remarkable leap in the number of males who trade among sons generation households. The number of females involved in trade has seen the most phenomenal changes. From 15%, it more than doubled to 40% for the fathers' generation and then doubled again for the sons' generation peaking at a little over 70% (Figure 3.2b). Male involvement in industrial activities as secondary livelihood consistently declined from generation to generation. Although female involvement in industry rose consistently, inter-generational increases have been insignificant (Figure 3.2b).

The results on secondary livelihoods show that rural households are gradually drifting away from farming and agro-processing livelihoods. In place of this, migration, trade and handicrafts are preferred livelihood options. Unfavourable environmental factors are part of the driving factors for this phenomenon. While poor soil fertility and rainfall variability has negatively affected crop yields in farming, poor yields from farming has undermined community-based access to raw materials for agro-processing activities. Many women import raw materials from Burkina Faso in order to stay in agro-processing businesses not so much for the 'negligible profits', but to address underemployment. As a response to the impact of environmental change on agriculture, many household members have resorted to migration, trade, handicrafts, and a combination of these activities for supporting household livelihoods.

3.4.4 *'Puuliga'* – making for the household food deficit

Food purchases to make up for household food deficits have become an annual affair for many households. This phenomenon has been 'institutionalized' in the local seasonal calendar and in the local literature. This practise is serious business and worth discussing as a secondary livelihood. The scale and significance of this practise to social sustainability is enormous among households. Many households depend on grain purchases to supplement their own production for household consumption. This underscores the close interrelation between 'grain purchases' and the wide range of income generation initiatives of household members. In the cases of *Atanga* and *Abowine*, both depended a lot on food purchases to meeting food requirements of their households during the *'lean season'*. In the seasonal calendar, the lean season occurs approximately between May and July. This is referred to as *koom taam* while the practise of purchasing food for consumption during the period is called *Puuliga* in the local parlance. Thus, the development of local literature for describing the phenomenon underscores the importance of food purchases for sustaining households. Poultry and livestock sales are the main source of finance for *Puuliga* in *Atanga's* household. Non-farm activities of his wives and migration of her daughter are additional sources. In the case of *Abowine*, there seems to be a fair balance between remittances from her migrant son and the sale of livestock for financing *Puuliga*. The weaving of ropes is yet another source of finance while trade in foodstuff was previously another.

Overall, the discussion shows that livelihoods of a typical rural household in the *Atankwidi* basin comprise multiple livelihood portfolios. Of these, food crop farming is a primary livelihood but often goes in hand with poultry and livestock rearing. Aside these, households are involved in a wide range of secondary (supplementary) livelihoods. These include poultry and livestock. The rest include migration, a range of non-farm livelihoods, wage labour and trade. Through such diversified livelihood portfolios, households are able to reduce their vulnerability to multiple environmental stressors. The discussion underscores that such diversification is part of the local knowledge of households and that this knowledge dates back to their grandfathers' generations. This knowledge was passed on from generation to generation as part of tradition through informal teaching and learning mechanisms and practices at household level. However, the forms of livelihood diversification are gradually changing from generation to generation and a gradual process of (de)agraniazation is observable.

3.5 Summary and emerging issues

In this chapter, I used 'vulnerability' for analyzing livelihoods and local adaptation to environmental degradation in the *Atankwidi* basin, UER of Ghana. In conceptualising this investigation, I have pointed out that vulnerability has a double structure – an external side comprising exposure to risks and stressors and an internal side related to the ability to cope or adapt to such risks and stressors (See Chapter 1). Drawing on this structure for analyzing qualitative and quantitative empirical evidence, the discussion illustrates that livelihood diversification is part of the local knowledge of households for adapting to environmental change in the *Atankwidi* basin.

First, the discussion addressed the external side of livelihood vulnerability in the *Atankwidi* basin. In this discussion, I illustrated that households face multiple risks arising from environmental change in the pursuit of their livelihoods. These include physical risk factors arising from desertification, soil and land degradation and climatic variability, especially rainfall variability. Each of these domains of environmental change presents a unique set of risk factors that affect livelihoods, especially agriculture production in the basin. Collectively, these risks constrain livelihoods, especially subsistence agriculture production in the basin. As a result, crop yields are characterized by declining trends, fluctuations and uncertainties.

To reduce vulnerability to environmental risks, I have argued that households have depended on livelihood diversification as part of their local knowledge systems handed down from generation to generation. This helps build capacity to deal with the 'internal side' of vulnerability, that is, minimizing the risks of inability to adapt to environmental shocks. The discussion underscore that: (1) livelihood diversification at the household level reduces vulnerability to environmental change; (2) that livelihood diversification is dynamic and reflected in changing patterns that enhance adaptation (coping) in response to on-going processes of environmental change and ; (3) that the principle of livelihood diversification is part of the local knowledge of households and that although it may change in patterns, this knowledge dates back to the era of grandparents.

I organized in-depth discussions on livelihood dynamics around three themes – livelihood composition, primary livelihoods and secondary livelihoods. First, typical livelihoods of a household comprise a set of multiple livelihood portfolios undertaken jointly or individually by household members. All such livelihoods enable household sustenance. Livelihood diversification has a long tradition among households. Thus, it was a common phenomenon across three generations considered in this study. Its practise has been handed down from generation to generation as part of tradition, culture and hence, local knowledge of the people. The multiple livelihood portfolios essentially comprise food crop farming, poultry and livestock rearing, gardening, migration, wage labour, trade, and series of agro- processing related industries. Through diversification, households have reduced their exposure to risks arising from environmental degradation. That apart, they have enhanced their ability to adapt (cope) with risks and stressors associated with environmental change in the pursuit of their livelihoods. Through diversification, they have made strides towards environmental and social sustainability in livelihoods (Chambers and Conway, 1992).

Secondly, food crop farming is the primary livelihood and a major component of smallholder agriculture. However, food crop farming is practised alongside poultry and livestock rearing and this is so across all three generations. Farming strategies such as multiple farms and or defragmentation of farms, different rounds of seeding and intercropping traditional and early maturing crop varieties have been useful in supporting adaptation to environmental change. However, a decline in the number of spouses engaged in food crop farming as a primary livelihood is observable since the grandfather's generation. This is partly due to the adverse impact of environmental degradation on food crop production. While shifts in employment from agriculture to industry in the industrial economies of the world were because of structural changes in the economy, this is not the case in the *Atankwidi* basin. Food crop farming remains the prime driver of the local economy although a gradual process of 'deagraniazation' is observable.

Thirdly, secondary livelihoods provide the largest number of livelihood options to households. Although non-primary, they are essential for social sustainability of household livelihoods. Secondary livelihoods generally include poultry and livestock rearing, a wide range of nonfarm activities and migration. The findings suggest that migration is the major secondary livelihood among son's generation. Although migration existed among grandfathers generation, migration has increased tremendously among fathers and particularly sons' generations as a livelihood option. The study also revealed mixed inter generational trends among other secondary livelihoods. In the area of poultry and livestock for instance, few households had small numbers of livestock among grandfathers' generation. As such, it represented the stage of stocking livestock breeds. Fathers' generation households built on this foundation by increasing stocks and production. It represented an era in which livestock spread widely among households. However, stocking levels and production have declined drastically among son's generation. This is partly due to environmental factors and livestock stripping arising from sales for food purchases. In the domain of nonfarm livelihoods, there is a gradual shift from agro-processing activities towards commerce. Trading in foodstuff has become important and dominated by women for very good reasons. First, women have direct access to food for home consumption, especially during the lean season. Secondly, such trade generates income for meeting other household needs but this includes purchasing grains for household consumption as well.

3.6 Conclusion

In this chapter, I have discussed household livelihood diversification as an embodiment of the tacit local knowledge of households for reducing their livelihood vulnerability to environmental change in the *Atankwidi* basin. In their quest to attain environmental and social sustainability of livelihoods, households have resorted to reducing their vulnerabilities to environmental change by developing a portfolio of livelihoods. These generally include food crop farming, livestock and poultry, non-farm livelihoods, migration and commerce. However, food crop farming is the primary livelihood for majority of households across all three generations although a gradual process of 'deagraniazation' is observable. Secondary livelihoods are essential for social sustainability of household livelihoods, but also useful for supporting environmental sustainability. Since food crop farming is the primary livelihood for most households, Chapter 4 is devoted a discussion on the role of local knowledge in soil conservation for sustaining food crop production under environmental change in the *Atankwidi* basin.

Chapter 4

4.0 Reducing Vulnerability of Food Crop Production to Land Degradation through Local Knowledge

4.1 Introduction

Farmers in the *Atankwidi* basin generally report that poor soil fertility arising from land degradation is a major impediment to food crop production. As a result, households have resorted to the use of local knowledge systems of soil conservation in food crop production. To explore this subject, I used 'vulnerability' as an analytical concept for explaining the outcomes of local soil conservation measures on household food crop production. Hence, this chapter entails a discussion of the role of local knowledge systems of soil conservation for reducing vulnerability of food crop production to land degradation in the *Atankwidi* basin. I have structured the discussion in four parts. In the first part, I discuss vulnerability of food crop production to poor soil fertility. In the second part, I discuss how local knowledge systems of soil conservation reduce vulnerability of food crop production to poor soil fertility. The third part entails a summary of emerging issues while part four entails the conclusion.

4.2 Vulnerability to land and soil degradation

In Chapter 3, I described food crop farming as a primary livelihood of the people in the *Atankwidi* basin. Although many households depend on food crop farming, soil and land degradation pose a serious risk to production. As a result, household food crop production is susceptible to soil degradation. The concept 'vulnerability' as used in this analysis denotes a precarious situation of food crop production arising from land degradation. Vulnerability refers to defencelessness, insecurity, and exposure to risk, shocks and stress and the difficulty in coping with them (Chambers, 1989:1; 2006). Thus, *vulnerability* has two sides, an external side and an internal side. In this context, an external side comprising the risks, shocks, and stress posed by degraded soils to which the household is subject and an internal side comprising the household's (in) ability to anticipate, cope with, resist and recover from the impact of poor soil fertility. It is this distinction between the exposure to external threats and the ability to cope with them that is described as the 'double structure of vulnerability' (van Dillen, 2004; Birkmann, 2006; 19). Drawing on this double structure in his research on famine, Bohle (2001:119) underscore that 'vulnerability' is the outcome of interaction between exposure to external stressors and the coping capacity of the affected household. By implication, the response of the household, in terms of its capacity to cope with the external threats determines its extent of vulnerability to the external threat. It is this understanding that van der Geest (2004) illustrates in the point that although a flood may occur, varied characteristics (eg., social and economic) of households can result in differential impacts on household livelihoods across households. The UN/ISDR underscores the multi-dimensional nature of 'vulnerability'. It emphasizes that 'vulnerability' embodies physical, social, economic and environmental factors. In an applied sense, 'vulnerability' according to UN/ISDR arise from the peculiar characteristics and circumstances of the household food crop production system that predispose it to the damaging effects of degraded lands and poor soil fertility (UN/ISDR, 2009:12). This definition brings to the lime light that 'exposure' to risk also occurs on the 'internal side' side of 'vulnerability' that essentially deals with coping with a hazard. Birkman (2006:19) illustrates this in his explanation that 'exposure' in social vulnerability debate goes beyond physical exposure and embodies features related to the entitlement theory and human ecology perspective. Hence, exposure also deals with social and institutional processes that may increase defencelessness (Ibid.), or increase coping or defence capability. Hence, such processes alter exposure of the household to risk (Cannon et al., 2003; in Birkman, 2006: 19). In totality, the conceptual framework that guides the analysis in this chapter draws on the 'double structure of vulnerability'. Vulnerability requires examining both exposure to risks and coping capacity to 'hazard' (Birkman, 2006:19).

In the *Atankwidi* basin, every farmer I spoke to cited poor soil fertility as a major environmental factor hindering food crop production. In a survey covering 131 farmers in the basin across three study communities *Yua, Mirigu and Pungu*, I decided to find out how they rank[36] poor soil fertility relative to four other environmental factors that affect crop production. The majority of farmers agree that poor soil fertility adversely impacts on household food crop production the most. Low soil fertility can result from low inherent soil fertility, but it can also result from land degradation due to intensive land use combined with inadequate conservation measures (van der Geest, 2004:66). Farmer perspectives on the causes of poor soil fertility generally conform to the latter school of thought. Most farmers recount good times of fertile soils and harvest during the era of their fathers and grandfathers. They recount that soils were relatively more fertile then and surplus production was possible. In the *Nandom* area of the UWR, van der Geest reports of similar findings among farmers (Ibid.). This widespread perception among farmers that soils were more fertile in the past suggests that poor soil fertility today is the outcome of land mining. However, the geological formation and development of top soils in the area [UER] suggests that there is an element of low inherent soil fertility although soils may have been more fertile in the past than they are now. According to Kranjac-Berisavljevic et al. (1999), the parent rock material of the area are granites and that soils that developed over them have a low inherent fertility status. Soils formed from granites are characterised as sandy, moderately acid and infertile, and very often the most weathered and infertile soils in tropical savannahs (Tropical Savannahs CRC, 1998). These features tend to inhibit penetration of roots and plant growth, especially trees (Duadze, 2004). Much of the Upper Regions of Ghana [UER and UWR] have 'granite' parental soil and that ground water laterites and patches of savannah ochrosols developed as the top soils (van der Geest, 2004:82). Thus, van der Geest cites Boateng as having characterized these groundwater laterites as:

> *Pale coloured, sandy or salty loam with a depth of up to two feet underlain by a mottled clayey layer rich in iron. The soils harden to form an ironpan on exposure because of the rich iron content. The soils have a poor drainage and tend to easily saturate causing water logging during the raining season and dry out during the dry season. These soils,*

[36] The results show that 34% of the farmers (45 out of 131) ranked poor soil fertility as impacting crop yields the most. This was followed by 29% of farmers (40 out of 131) citing heavy rainfall and 23 % (30 out of 131) citing drought as the most impacting factors causing poor crop yields.

> *especially those developed on the Voltain shales, are considered among the poorest soils in Ghana* (Boateng, 1966:60; in van der Geest, 2004:83).

Similarly, MoFA describes soils in the Upper East Region as:

> *Predominantly, light textured surface horizons sandy loams that are very poor in organic matter content. They have lower soil horizon and slightly heavier textures varying from coarse sandy loams to clays. Heavier textured soils occur in many valley bottoms which are suitable for rice cultivation. Many soils contain abundant coarse material either gravel and stone, or concretionary materials which affect their physical properties, particularly their water holding capacity* (MoFA, 2008).

In Chapter 2, I have done a more detail discussion on the geological and soil formation in northern Ghana. Although low soil fertility may be inherent in the soils of the study area, soil fertility has declined considerably over time due to human activities. For the entire northern Ghana including the *Atankwidi* basin, a combination of intensive cultivation, inadequate soil conservation, bush burning, over grazing, tree felling, charcoal burning and soil erosion have all lead to land degradation and poor soil fertility (Songsore, 1996; Blench, 1999; van der Geest, 2004; Laube, 2007).

Poor soil fertility and unreliable rainfall lead to poor crop yields in the *Atankwidi* basin. In the survey, 76% of farmers reported that their annual harvest is inadequate to meet annual household consumption needs. Poor soils and unreliable rains often top the list of causes from the perspective of farmers. A majority of farmers (76%) reported 'decreasing' trends in household food crop output while (24%) reported of 'mixed trends' (increases and decreases) in output experiences. Perceptions of 'output declines' among farmers are not peculiar to farmers in the *Atankwidi* basin. According to van der Geest (2004:66), farmers in the *Nandom* area of the UWR attribute declines in crop yields to soil infertility and worsening climatic conditions. The relation between poor soil fertility and poor crop yields is undisputable. A comparative analysis of crop yields (maize and guinea corn) between the *Sissala* District and *Lawra* District in the UWR revealed that yields were lower in the former because of poorer soil fertility there (Ibid.:83-84). In

Malawi over-exploitation of the natural soil fertility in the production of a hybrid, maize variety throughout the early 1990s eventually resulted in soil fertility mining. Hence, soil fertility declined to levels that could no longer support crop output at a rate required to feed the growing population (Tchale et al., 2005). Poor resource endowments including poor land quality and an inappropriate policy environment undermine agriculture development (World Bank, 2000; in Rosegrant et al, 2001:37). This has been a major cause of inadequate food production in the Developing World. In general, Sub-Saharan Africa finds itself with high population and food demand growth exceeding modest production growth (Byerlee and Eicher, 1997). Also, see Rosegrant et al. (2001: 37).

In the ensuing discussion, I will examine how households use local knowledge systems of soil conservation for reducing vulnerability of food crop production to land degradation and soil infertility in the *Atankwidi* basin.

4.3 Reducing vulnerability through local knowledge on soil conservation

In Chapter 1, I have done a more detail discussion on local knowledge and its role in sustainable development. My intention is to do a brief review here. Local knowledge embodies a fusion of both 'indigenous knowledge' and 'scientific knowledge' at local levels (Long and Long, 1992; Pottier, 2003). Scientific knowledge is external and originating from formal research influenced by Western Sciences. The ensuing empirical discussion draws on this holistic view of local knowledge. Hence, local knowledge comprises a combination of both 'indigenous knowledge' unique to the people of the study area and all other forms of 'external knowledge', that is, knowledge drawn from external sources and adapted to local soil conservation. Local knowledge is an embodied practise and its production negotiated within the context of knowledge interfaces (Ibid.). The processes in local knowledge production involve the interaction between local communities who have their own practices and discourses, and external agents of change, who have their own practices and discourses (Pottier, 2003). Localization of knowledge, that is, allowing in and adapting knowledge from external sources to local situations is therefore, done through the mediation of established cultural parameters. Local knowledge is therefore not strictly local and not accessible by verbal communication alone (Ibid.). Indeed, local knowledge is dynamic and ever-changing (Sillitoe, 1998; Sikana, 1994) giving rise to diverse knowledge and practices (Pottier, 2003). Knowledge production is "embedded in social and cultural processes imbued with aspects of power, authority and legitimization; the act of producing knowledge involves social struggle, conflict and negotiation" (Pottier, 2003:2).

In my review so far, I have shown that local knowledge is a strategic resource in community development. I have also shown that vulnerability has an external side that comprises exposure to risks arising from poor soils and the difficulty in coping with the situation. In the ensuing section, I will discuss empirical findings to support the argument that households are reducing vulnerability of food crop production to poor soil fertility and land degradation (i.e., extent of risk exposure and risk of inability to cope) through local knowledge systems of soil conservation. This contributes to ethnopedology,[37] an integrated discipline that emerged over the past few decades encompassing both natural and social science perspectives on soil and land use knowledge systems of rural populations. Given my understanding of farmer's perceptions about the quality of their soils, I asked *Adoko,* a male farmer this question: 'How would you describe the quality of your soils and how have you managed to make a living from cultivating it?*'* See Box 4.1 for his response.

Box 4.1: How *Adoko* makes a living from his degraded farmland

Continuous cultivation of the same land has led to considerable soil fertility decline over the years. My parents and grandparents cultivated this same land. I am doing the same. Poor soil fertility is one of the biggest problems faced by every household in food crop production in this community. To be able to feed my family, I have had to step up efforts to improve upon soil fertilities on my compound farm since ever my father passed away. I do not have money to buy

[37] Ethnopedology is one aspect of indigenous knowledge. "Ethnopedology is a hybrid discipline between the natural and social sciences that encompass the soil and land use knowledge systems of rural populations from most traditional to the modern". (Barrera-Bassols and Zinck, 2003: in, Mikkelson and Langohr, 2004: 13). Ethnopedology has gained importance over the past few decades for a numbers of reasons:1) a general in-crease in the interest for social sciences; 2) a growing interest in preserving local soil knowledge before it is partly or completely lost and; 3) the aim to achieve a better understanding of local communities for improving success rates on development projects (Ibid).

chemical fertilizer for application on my farm. I apply local manure prepared from my *Nandeene* (Kraal) and *Tampugerɛ* (refuse dump). Through concerted effort in manure application, I have transformed infertile soils on portions of my compound farm into near loamy soils – referred to as *Pu'usego zeɛ* in the local parlance. Through this, I have halted a declining trend in food crop production. I have even increased my output in recent years. Although it is not enough to meet consumption needs of my household, it contributes significantly to meeting a chunk of my household food requirements annually.

Source: In-depth Interview, Yua, 2008

This response from *Adoko* shows his understanding of the risk that poor soils pose in his effort to produce food crops for household consumption. His choice of manure prepared from traditional methods to improve soil fertility illustrates his commitment to local knowledge systems for addressing his household's vulnerability to soil infertility. The case of *Adoko* reflects the experiences of many farmers in the basin. The survey revealed that 97% of farmers apply some form of local organic manure in food crop production as a means to improving soil fertility. In the ensuing section, I will discuss qualitative results around local manure, the methods, and sources of knowledge, materials and participants in the preparation process. The discussion also examines the role of local knowledge for reducing vulnerability to soil infertility.

4.3.1 N- yaaba ɛtigo – renewed commitment to traditional manure

The results from in-depth interviews and focus group discussions show a renewed commitment among households to the use of indigenous forms of organic manure for improving soil fertility. Households applied two indigenous forms of organic manure in food crop farming. These forms of manure include *Nandene Pu'usego* and *Tampugerɛ Pu'usego* in the local parlance. *Nandene Pu'usego* is manure produced mainly from the decomposition of cow dung and plant residue. At harvest, plant residues including groundnut vines and early millet stalks (*Naara*) are deposited in the *Nandeene* (kraal). The cattle lie, urinate and deposit their dung on the residue. Over time, partial or complete decomposition of the organic materials takes place. The *Nandeene* is usually located within the homestead. Household members are encouraged to bath and or pour wastewater on the organic materials in the *Nandene* to provide moisture for decomposition. The decomposed organic material, *Nandene Pu'usego* (Photo 4.1) is then applied to the *Sammani* at the beginning of the farming season. The photo shows a typical *Nandeene* with deposits of plant residues including groundnut vines, rice straw and millet stalks that have partially decomposed. This *Nandeene* is not rich in cow dung but darker portions are a blend of decomposed dung, plant residues, urine and moisture.

Photo 4.1: *Nandene Pu'usego* in a homestead in *Yua*

Source: Field Survey, 2008

The second form of indigenous manure, *Tampugerɛ Pu'usego* is produced through the decomposition of a wide range of organic materials from a refuse dump. A *Tampugerɛ* literally means a refuse dump in local parlance and is usually located within the immediate surroundings of the homestead. Since this kind of manure is produced from a refuse dump, a wide range of organic materials including kitchen wastes, ashes, plant residues, animal droppings, tree stumps or branches are deposited and preserved for decomposition. An important material in the *Tampugerɛ* is the remains of cow dung particles used for trapping termites by farmers. Termites are an important feed for poultry and cow dung is the main material for trapping termites. The dung is crashed into small earthen pots. The opening of the pot is then secured over the hole of the termites to attract them over night. The termites move up into the pots during the night to feast on the crashed dung. The farmers turn over the pot early in the morning trapping the termites together with partially eaten crashed dung for feeding chicks during the day. The residue after feeding chicks (particles of partially eaten dung) is deposited in the *Tampugerɛ,* forming a heap of organic materials (Photo 4.2). Poultry production is intensified during the off- farm season. As such, significant quantities of this kind of residue can accumulate in the *Tampugerɛ* over the dry season. The *Tampugerɛ* is watered with wastewater from domestic activities periodically to provide moisture for decomposition. However, a conscious regime of watering is emerging among households drawing on practises from Burkina Faso.

Photo 4.2: A *Tampugerɛ* with a heap of organic materials outside a homestead in *Yua*

Source: Field Photo, 2008

The photo (Figure 4.2) shows a *Tampugerɛ* located within the immediate surroundings of a homestead in *Yua*. The heap of organic materials includes stalks, stumps and largely particles of dung residues after feeding chicks with termites. It is this heap of organic materials partially or completely decomposed that is called *Tampugerɛ Pu'usego*. The photo also shows a conscious effort to secure the organic materials with logs and broken pieces of earthen pots. This illustrates the importance of this type of manure.

Results from both survey and in-depth interviews reveal that most farm households combine both *Nandeene Pu'usego* and *Tampugerɛ Pu'usego* in food crop production. From the survey, 70% of households combined both *Nandeene Pu'usego* and *Tampugerɛ Pu'usego* for improving soil fertility. Minority households, 17% applied *Nandeene Pu'usego* only while 8% applied *Tampugerɛ Pu'usego* only. Although the current generation make more effort to produce manure, the immediate past generation of households applied more manure than the former mainly because of resource constraints. For instance, 74% of respondents reported that their parents had more livestock (especially cattle) and so had more cow dung an important organic material in making manure. More farmers (84%) agreed that their parents applied more manure than they currently do in farming practises although they put in more effort than their parents did. The combination of *Nandeene Pu'usego* and *Tampugerɛ Pu'usego* is a major part of local knowledge on manure. This knowledge was inherited as part of the ancestral heritage of the people. The current generation is also transferring this knowledge to their children through informal methods of teachings. In the ensuing discussion, I will examine how 3 households employ indigenous forms of manure in food crop production to reduce vulnerability to poor soils. In the first case, I will describe *Akolbire*'s use of organic manure, the context, materials and processes of knowledge transfer from generation to generation and how such knowledge reduce vulnerability to poor soil fertility (Box 4.2).

Box 4.2: *Akolbire* - Combining *'Nandeene'* and *'Tampugerɛ Pu'usego'* for reducing vulnerability of household food crop production to poor soils

Akolbire is a 55 years old farmer in *Yua*. He is a male head of a polygamous family. He lives with his three wives and six children. *Akolbire* inherited the practice of combining *Nandeene* and *Tampugerɛ* manures from his father just as his father inherited the practice from his grandfather. As a child, he supported his parents in manure preparation through which he saw and learnt what they did. His children, both boys and girls are also learning from him daily by supporting him in manure related activities and so, they see what happens annually. His wives equally learnt how such indigenous manure is prepared when they lived with their parents as children. As such, his children also learn from whatever his wives do in support of manure preparation.

Akolbire applies *Nandene and Tampugerɛ* manure to the production of grains including *Naara* (early millet), *Talenga* (sorghum), *Zea* (late millet) and *Mŭŭm* (rice). The process of manure preparation typically starts after the harvest of *Naara* in July/August. *Akolbire* and his wives and children will gather *Naara* stalks from the *Sammani* and deposit some in the *Nandeene* and others in the *Tampugerɛ.* The cattle, which sleep in the Nandeene, deposit their dung and urine on the stalks in the *Nandeene* gradually increasing quantity of organic materials. He adds groundnut vines and rice straw to the organic residues in the *Nandene* as and when they are harvested. From this point onwards, there is no significant addition of materials to the *Nandeene* except overnight dropping of dung by cattle. Rainfall, bathing in the *Nandeene* by children and urine from cattle provide the moisture for decomposition of the organic materials overtime. While the family makes effort at producing *Nandeene Pu'usego*, further effort is also made to mobilize more organic materials for *Tampugerɛ Pu'usego* concurrently**.** Everyone in the house deposits whatever organic materials they can lay hands on in the *Tampugerɛ* on a continuous basis because every one knows this is how things are done. A wide variety of organic materials such as kitchen waste, vegetable residues, grass and ashes from burning wood are deposited in the *Tampugerɛ* routinely and periodically as and when they are available. Remnants of cow dung generated after feeding chicks are an important component of organic materials used for *Tampugerɛ pu'usego* (Photo 4.2). These chicken feed residues continue to be deposited in the *Tampugerɛ* throughout the dry season and *Akolbire's* children; both boys and girls are involved in this process. *Akolbire* and his family add ashes and water to the materials because it facilitates decomposition of the organic materials into manure. Unlike the past, they make a conscious effort to water the organic materials with wastewater occasionally based on their knowledge of new practises among relations in communities of neighbouring Burkina Faso. The manure from both sources are applied to the farms at the beginning of the rainy season. Manure is heavily applied to limited areas of the *Sammani* requiring soil improvement, which is also a departure from past practise of spreading manure widely. From experience, *Akolbire* learnt that concentration of manure application and rotating areas of application annually has a more positive impact on crop yields than spreading the manure widely. Here again, *Akolbire's* children are directly involved in the process through which they are learning this technique. To protect their investments in manure, *Akolbire* plants hedge plants locally called *Saasi* around their *Sammani* to check soil erosion and to conserve soils for production. According to *Akolbire* it is as important as applying the manure itself because there is no point applying manure and not protecting it from erosion.

Akolbire understands the risk that poor soil fertility poses in his efforts to enhance household food crop production. He identifies poor soil fertility as having a more adverse impact on crop yields than any other factor. It is this understanding that has increased his commitment and effort at manure application in food crop production. However, he admits that unlike the generation of his parents who produced enough for household consumption, he and his household are unable to produce enough food for household consumption annually. Although they have increased their crop yield from their *Sammani* through increased effort and application of manure, ouput is still inadequate to meet household consumption needs. Rainfall is also a risk factor in food crop production and *Akolbire* understands from experience that more application of manure also increase water retention capability of the soil, which he says, is important for sustaining plant growth during dry spells or droughts. He admits that although his parents produced manure in the past, he and his family had taken it more seriously now because with shorter rainfall regimes, crops needed suitable soil conditions to mature quickly before the rains stop. Although *Akolbire* and his family put in more effort, his parents produced and applied more manure than he does now because they had acess to more organic materials. His father had more cattle and so he produced more *Nandeene Pu'usego*, which was richer in cow dung. At the time of the study, he had three (3) bullocks only but his father had more than 10 cattle. His father also had more stalks from his *Sammani* because plants yielded better then due to better soil fertility. *Akolbire* describes his current crop output as modest. In a normal year, he can harvest 6 baskets of *Naara*, 12 baskets of *Talenga*, 8 baskets of *Zea* and 10 baskets of paddy rice (Photo 4.3).

For *Akolbire*, current crop output levels meet household consumption needs for 8 months, usually from August when *Naara* is harvested to April when land preparation for the next farming season begins. Household grain consumption needs from May to July have to be met through *Puuliga, which* is financed through livestock sales and or non-farm incomes of his wives.

Source: Compiled from in-depth interviews, Akolbire, Yua, 2008 and 2009.

In the case of *Akolbire* (Box 4.2), improving soil fertility through the application of indigenous manure is central for sustaining and or increasing crop yields for household consumption. Akolbire understands the risk that poor soil fertility poses to his household food production. Failure to sustain and or increase household crop production can increase the 'food deficit' and expose the household to risk of livelihood failure. It is this understanding that underscores the commitment to indigenous manure for improving soil fertility and increasing crop output.

Photo 4.3: Basket of freshly harvested rice from Akolbire's rice farm

Source: Field Photo, 2008

The lesson learnt from *Akolbire'*s case is that he has been able to sustain a certain level of annual crop output (in normal years) although it is insufficient to meet household consumption requirements. They have to buy grains to supplement what is produced. Nonetheless, the household depends on its own production for consumption for most part of the year. For instance, household food production is the main source of grains for household consumption for approximately 8 months. Poultry and livestock sales are main sources of funds for purchasing supplementary grains but *Akolbire* is faced with depletion of his stocks. Thus, crop failure will have a major devastating impact on the household livelihood and render it vulnerable to failure. This also explains why this household tries to use manure as an important strategy for either sustaining or increasing output in an effort to fill the household's 'food supply deficit'. *Akolbire* combines *Nandeene* and *Tampugerɛ* manure, a tradition he learnt as a child and later inherited as an adult. Just as he learnt from his parents, *Akolbire* is bequeathing this knowledge of manure making to his children (both boys and girls) by involving them directly in the process of manure preparation and application. In response, to the risk of crop failure arising from degraded soils, *Akolbire* and his household make more conscious effort in mobilizing, managing and utilizing organic materials for making organic manure than his parents did. This increased commitment to organic manure is driven by the need for addressing a major problem of soil infertility through scarce organic materials. In the practise of these traditional methods, *Akolbire* and his household introduced innovations. First, by introducing a routine watering regime in preparing *Tampugerɛ Pu'usego* inspired by practise learnt from relations in neighbouring Burkina Faso. Secondly, a change from thinly spreading manure widely to concentrated application on parts of his *Sammani.* Finally, *Akolbire* was also innovative by checking soil erosion.

I will now turn my attention to the second case of traditional manure practise. In this case, I will show how *Aminga*, a female head of household explores innovation in the preparation of *Nandeene Pu'usego* for improving soil fertility in the context of her peculiar circumstances (Box 4.3).

Box 4.3**:** *Aminga* – Innovations in 'Nandeene Pu'usego' for improving soil fertility

Aminga is 50 years old, a widow and a female head of household. Her husband passed away – 25 years ago. She has a 27 years old son who lives and farms maize in a village in southern Ghana. She also has a 23 year old daughter who is married and living with her husband in a neighboring community called *Soe*. She lives mostly by herself and sometimes with an 8 year old grandson who visits her frequently.

Aminga depends solely on *Nandeene Pu'usego* for sustaining cereal crop farming on her *Sammani*. In preparing *Nandeene Pu'usego,* she uses mainly crop residues. At harvest, *Aminga* will gather and deposit *Naara* stalks, groundnut vines and rice straw from her farms in her *Nandeene*. *Aminga* knows that by practise, cow dung is added to plant residues for preparing *Nandeene Pu'usego***.** However, she has no cattle although she has a *Nandeene*, which is often part of the architectural design of traditional homesteads. As such, she only adds a few pieces of cow dung she personally handpicks from open grazing fields. *Aminga* relies on both rainfall and waste domestic water for providing moisture for decomposition. In the dry season, she baths on the crop residues in the *Nandeene* to provide moisture for decomposition. She does this through out the entire dry season until early rains start. At this point, she will turn the organic materials – swapping positions of top and lower layer materials to facilitate quicker and complete decomposition of the materials. She turns the organic materials few days after every rainfall during the early part of the rainy season. Early rains and wastewater from bathing continue to provide the moisture requirement for decomposition. She will then scoop the manure and apply to portions of her *Sammani* and rice farm requiring fertility improvement when she starts ploughing to plant. She has learnt how to prepare *Nandeene Pu'usego* the traditional way first from her parents when she was growing up as a child. She has also practised it with her husband when he was alive and cow dung was a major component of the materials then because they had cattle then. Her circumstances have changed and so she has had to think through and experiment innovative ways of manure making suited to her conditions.

Aminga's innovations in the preparation of *Nandeene Pu'usego* were inspired by her knowledge of '*pit method'* of compost making in Burkina Faso (Photos 4.7 & 4.8). The family of *Aminga's* Aunt in *Bungu*, a community in Burkina Faso practise the *'pit method'* of compost. *Aminga* observed this during a number of social visits. She recalls that agricultural staff of the Burkina government taught her relations there how to dig pits, cement them and use the pit for composting. She notes that plant residues and cow dung are the main materials that are used and that the latter is particularly a requirement to have good compost in the '*pit method'*. She also observed that the need for turning the materials and watering the organic materials routinely facilitates decomposition. She compares the '*pit'* and *Nandeene* methods and notes that the '*pit method'* is better because it is more effective in increasing crop yields. The method is however, labour intensive and expensive. She does not have the physical strength or resources to employ labour to dig a pit. The *'pit method'* of compost also requires the addition of cow dung in order to facilitate decomposition and good quality compost materials, which she does not have. In the *Nandene* method, one can add cow dung but her experience shows that it is not a strict requirement for producing manure good enough to support plant growth. Given resource constraints, *Aminga* decided the *Nandeene* method was most suitable and workable for her. She also plants *Saasi* as hedging plants to check erosion on her farm.

Amorigiziire has not been able to increase crop yields through manure except that she has managed to halt a declining trend in yields experienced in the recent past. She has fairly stabilized output levels, which she describes as a significant achievement. Although her crop yields are low, she thinks relaxing in manure application will make crop yields worst even if rainfall was favorable because her *Sammani* has lost soil fertility considerably. In 2008, crop yields for *Aminga* were as follows: *Talenga* (3 baskets*)*, *Naara* (2 baskets), *Zea* (4 baskets) and Mŭŭ (4 basins). In Photo 4.4, a woman is carrying a basin of harvested paddy rice – the standard measure that *Aminga* used to describe her rice yield.

Amingas's crop output over the past 5 years has not varied much from what she harvested in 2008 except in 2007 when floods generally destroyed most of her crops. The current crop output level is inadequate to meet household consumption requirement. Current output levels of grains meet her household consumption requirements for approximately 7 months, that is, from September to March when early land preparation for the next farming season begins. *Aminga* has 'household food supply deficit period' of averagely 5 months and she has to fill this gap mainly through *Puuliga* because she does not receive remittances from her migrant son. She depends on the sale of poultry and small ruminants to finance food purchases. At the time of the study, she had loss all her poultry to diseases, sold all her goats over the years to buy grains and left with only a sheep. Given the extent of poultry and livestock stripping, failure in food crop production will spell out disastrous consequences for her livelihood.

Source: Compiled from in-depth Interviews, Aminga, Yua, 2008 and 2009.

In the case of *Aminga* (Box 4.3), sustaining current crop output level through the application of manure is an important achievement for sustaining her livelihood although current output is insufficient for meeting household consumption requirements. Depending on household production as the major source of grains for 7 months is a significant achievement because at least anything short of that will increase the household's vulnerability to livelihood failure. *Aminga* is aware and appreciates new ways of making compost that make a difference in her livelihood. However, she continuous to depend on *Nandeene Pu'usego* due to her peculiar circumstances - the lack of labour and the lack of adequate organic materials especially cow dung. At least, her strategy works for her in so far as production level is sustained to support household consumption of a certain level. However, *Aminga* has been innovative in the way she prepares *Nandeene Pu'usego.* First, *Aminga* learnt about the traditional methods of preparing this type of manure from her parents when she was growing as a girl but she has also practised the method together with her late husband. Her innovations in manure making were driven by changing circumstances. First, given the scarcity of organic materials, *Aminga mainly* focused on preparing *Nandeene Pu'usego* although the 'norm' is to combine at least two methods. This helped her concentrate her efforts in manure production in a meaningful way. Secondly, she also prepares *Nandeene Pu'usego* without adequate cow dung although by norm significant quantities are often included. To compensate for this, she introduces routine turning of organic materials and supports this process with continuous watering in both wet and dry seasons drawing on new practises she learnt from her relatives in Burkina Faso. By these innovations, *Nandeene Pu'usego* has worked for *Aminga* to the extent that she has been able to stabilize her output to support household consumption.

Photo 4.4: A female farmer carrying a basin of paddy rice harvested from her rice farm

Source: Field Photo, 2008

In the third case, I will describe how *Aputire*, a female head of household acquired and applied knowledge of indigenous manure production to improve soil fertility and to increase crop production to support household consumption (Box 4.4).

Box 4.4**:** *Aputire* – How learning the art of manure as a 'girl' can reduce vulnerability to poor soil fertility later in life

Aputire is a female head of household. She was 30 years old at time of the study and the only child of her parents. Customarily, she did not marry in order to remain in her paternal home to cater for her aging parents and to guarantee continuity of the family. *Aputire* has a boy friend and they have three boys from the relationship. Since *Aputire* is not married, the children customarily belong to her household – a customarily sanctioned practise that ensure generational continuity of the household. *Aputire* lives with two of her children and a 70 years old Aunt as a household.

Aputire learnt how to use manure in farming from her parents when she was growing up as a girl. During the lifetime of her parents, *Aputire* learnt four (4) organic manure-farming methods by observing and practising with her parents. In preparing farmlands for the farming season, *Aputire* together with her parents will gather stalks on portions of the *Sammani* that have relatively poor soil fertility. They will burn the stalks and the result is then a heap of dark soils that is spread during ploughing and weeding. *Aputire* notes that the crops did well on such dark soils. She also observed that her parents avoided stockpiling and burning stalks on waterways. Her father told her burning on waterways could block water channels and lead to the erosion of soil nutrients produced from the burnt organic materials. *Aputire* also learnt how to prepare *Tampugerɛ Pu'usego* and *Nandeene Pu'usego* by participating in the process with her parents as a teenager. Her father often invited her to join him when he went trapping termites to feed chicks - a process that generated substantial dung residues for *Tampugerɛ Pu'usego* preparation. Her narration of all other processes and materials associated with *Tampugerɛ Pu'usego* and *Nandeene Pu'usego* generally corroborates the cases of *Akolbire* and *Aminga* (Boxes 4.2 and 4.3). Aside these methods, *Aputire* also identify weeding as an important organic farming practise that her parents bequeathed to her. She narrates that as a girl, she weeded alongside her father and mother using a hoe – copying how they weeded. Her father taught her that controlling weed through weeding facilitated crop growth. Her father told her of the need to shake grass during weeding to separate soils from roots in order to ensure that the grass did not survive even if it rained soon after weeding. Better still, she also learnt from her father the practice of picking and heaping grass during weeding at various points to ensure that grass did not survive to undermine plant growth. Some times, she played this role together with her mother during weeding – picking and heaping grass while her father did the weeding. Once the grass dried up through exposure to sunshine, and once heaps of dry grass was watered from rainfall, they eventually decomposed to enrich soil fertility on the farm. *Aputire* also leant about organic farming by listening to the conversations of her parents. Her parents had lots of conversation about a wide range of farming issues and *Aputire* was exposed to this. As she puts it: *'I leant a lot by listening to daily conversations between my father and mother or between them and their friends about farming activities. When you are close to your parents as a child, you will always learn through their conversation and from what you see them do. In many instances, my parents did not tell me to do this or that. Once you see them do it in certain ways – it beholds on you to learn and do it the same way when you have to fern for yourself. I have been farming on my own for about ten (10) years since my mother also passed away. Through my personal experiences in farming, I have also leant other farming tricks on my own' (Aputire, Yua, 22.01.09).*

In her ten years experience as a farmer, *Aputire* has observed a correlation between manure application and crop yields. She has practised all forms of manure she learnt from her late parents. Currently, she produces and applies more *Tampugerɛ Pu'usego* to her *Sammani*. Manure from the other methods are in small quantities and complementary mainly because of the lack of organic materials, especially cow dung since she does not own cattle. *Aputire* observed that manure has been a decisive factor in influencing her crop yields over the years. She observed that anytime she puts in much effort in applying more manure, her crop yields increase even if rainfall was only good. Similarly, she has observed a decline in crop yields anytime she relaxed in her effort to apply more manure. From this experience, *Aputire* has committed to maximum effort in the application of manure in household food crop production and she protects such investments from soil erosion through the planting of the hedging plants called *Saasi. Saasi* is also used as broom for sweeping. Through manure application, *Aputire* has been able to increase her production significantly over the past 6 years. Her output levels are still susceptible to fluctuation but output levels of grains have not fallen below household consumption requirements of 9 months except in 2007 when floods destroyed crops. Even for years she has been able to increase her output significantly; it is often insufficient to meet household consumption requirements for 12 months. This keeps her under pressure to make more manure because she thinks that relaxing in her effort can degenerate into a worst situation and lead to a huge food deficit that she will find difficult to cope with. She continuous to depend on various forms of organic manure in her effort to increase output and or at worst sustaining current production levels to support household consumption.

Source: Compiled from in-depth interviews of Aputire, Yua, 2008 and 2009.

The main strategy for *Aputire* (Box 4.4.) has been to increase crop output by addressing soil infertility through her knowledge of various types of indigenous manure. Although her crop output fluctuates, she has been successful at stabilizing her output level for meeting at least 9 months household consumption requirements for grains for most years. *Aputire* predominantly relied on traditional methods of manure she learnt from her late parents by doing and observation. She also recognizes the need to check soil erosion. She plants *Saasi*, a common hedging plant used for checking soil erosion in the community. This case highlights heavy dependence on indigenous methods of manure production and their utility in increasing crop yield to support household consumption.

4.3.2 Moving beyond tradition - *Tanuku* and *Na'ambɛa Pu'usego*

Results from in-depth interviews and focus group discussions reveal that some local forms of manure for improving soil fertility in food crop farming evolved overtime because of changing circumstances. These in the local parlance include *Tanuku Pu'usego* and *Na'ambɛa Pu'usego*. The *Tanuku* and *Na'ambɛa* forms of organic manure are practised by few farmers and inspired by new information. In preparing *Tanuku Pu'usego*, a pit (*Tanuku*) usually located within the immediate surrounding of the homestead is used. Originally, *Tanuku* (pit) is created through digging for moulding bricks for housing construction. As such, it is typical for every house to have one. Although it is not dug for making manure, a few households are resorting to its use for such purposes. In practice, a combination of crop residues and animal droppings are the materials used for preparing *Tanuku Pu'usego*. *Na'ambɛa Pu'usego* involves the direct on farm application of cow dung. In my next case (Box 4.5), I describe how *Atanga* has adapted new information from external sources to the preparation of *Tanuku Pu'usego* for improving soil fertility on his farm for sustaining crop production.

Box 4.5**:** *Atanga – Tanuku Pu'usego* as innovation for improving soil fertility

Atanga is a 50 years old male head of household. He has four wives and ten children. Six children live with him while two have migrated. This household represents a case in which wide diversity of methods are used for producing manure for farming. These include the two traditional forms of manure (*Tampugerɛ Pu'usego* and *Nandeene Pu'usego*), two evolved traditional forms of manure (*Na'ambɛa* and *Tanuku*). In addition, the household also makes compost from a 'pit', which is a new mode of compost production (See Photos 4.7 and 4.8). Although the diversity in this case is unique, I intend to show how *Atanga* adapted new information to producing *Tanuku Pu'usego*. I pay attention to the form of manure, sources and processes of information flows, materials and participants in manure making.

Atanga started preparing *Tanuku Pu'usego* some six years ago following advice by Agriculture Extension Officers. These officers went round compounds advising farmers to dig pits in which organic materials can be dumped for making compost for improving soil fertility. These officers did not return to the community since their initial contacts. Around the same time, the Information Service Department was also disseminating information asking farmers to stop burning their farms as a bush fire prevention measure. Following these interventions, *Atanga* decided to deepen a *Tanuku* he inherited from his father. *Atanga* and his household members will gather and deposit a wide variety of crop residues and animal droppings into the *Tanuku*. He stopped the practise of burning crop residues during land preparation. Rather he will deposit all plant stumps generated during land preparation into the *Tanuku (pit)* at the beginning of the rainy season (April). *Atanga* also dumps remnants of chicken feed, that is, cow dung particles used for trapping termites for feeding poultry in the *Tanuku*. *Atanga* has 5 cattle (comprising a set of bullocks, two heifers and a calf) and these provide some cow dung, which he also adds to other organic materials in his *Tanuku*. The organic material is left in the *Tanuku* throughout the raining season so that rainwater provides moisture for decomposition of the materials. The manure is collected at the beginning of the next rainy season for application on the *Sammani* thus, creating room for starting the process anew. *Atanga* also plants grass strips *Saasi* and makes 'stone bunds' for checking soil erosion and conserving soils on his *Sammani*.

*Atanga'*s involvement in *Tanuku Pu'usego* was also inspired by social contacts with his Uncle in Burkina Faso, specifically in a community called *Ziko*. *Atanga* visits his Uncle very often and returns the same day except on special occasions. When he is there to mourn with the family during a funeral, he spends between two and four nights. He recalls that a government department in Burkina Faso advised his Uncle and other farmers in *Ziko* to make compost from pits. According to him, the Burkina government officials educated and supported farmers over there to dig pits to some specific measurement standards, line the pits with stone and concrete, and use cement provided by the government to plaster the pits. Water channels are factored into the construction design to allow free flow of water into the pit during the raining season to facilitate decomposition. *Atanga's* Uncle also told him that sprinkling salt in the pit accelerates decomposition of the materials. Although *Atanga* has learnt about digging the pit to specific measurement standard and cementing it for compost making, he has not cemented his *Tanuku* because he lacks money to buy cement for the purpose. He has not dug his *Tanuku* to any given specification but provided channels to aid flow of water into the pit. Atanga also has no money to buy salt for compost making. However, Atanga occasionally goes to the *Sirigu* market with his children to sweep and collect the top soils of sections of the market from which salt is sold. These top soils often contain some salt particles that drop on the ground and mix with the soils during trade activities. *Atanga* and his children will then carry these soils home and sprinkle it over his compost materials in his *Tanuku* to aid decomposition.

Through *Tanuku Pu'usego*, *Atanga* has been able to improve soil fertility on his *Sammani* and increased his crop yields over the past few years. He had this to say in support of his assertion: *I have observed a difference since I started applying 'Tanuku Pu'usego'. My harvest has increased. I cannot easily estimate by how much my harvest has gone up for all crops that we produce. What I can say is that I could not harvest more than 4-5 baskets of 'Naara' (early millet) previously. Now, I harvest between 9 to 10 baskets of 'Naara' and this makes me believe that these new ways of making manure really makes a difference in improving soil fertility. That is the reason everyone in my family is serious and committed to making manure in new ways. As I speak to you, my children and I have started digging to specification the type of pit that is used in Burkina Faso. I invited 'Nsoh' to take the measurement for us. We plan to start with the new pit type of compost making this year.* Over the past five years, *Atanga* and his family have been self sufficient in food production through commitment to traditional and new forms of making manure. They have combined this with checking soil erosion. *Atanga* and his first wife attest to self-sufficiency in household production despite the unreliability of rainfall. They harvest enough to meet all year round consumption needs except in 2007 when floods destroyed most crops.

Source: In-depth Interviews (*Atanga* and *Apogbire*), Yua, 2008 and 2009

In this case, (Box 4.5), *Atanga's* strategy has been to increase crop yields for household consumption through the application of manure using new methods of making compost. The results show that *Atanga* has been able to increase total household production through innovations in compost making and they have attained self-sufficiency in household production even though this is also a large family. However, it is important to underscore that *Atanga's* innovations were inspired by first, the interventions of some external agencies, that is, the agriculture officers who advised that farmers dig pits for compost making. Secondly, bush fire prevention education conducted by the Ghana Fire Service Department around the same time - discouraging burning of crop residues on farms most probably gave an additional impetus inspiring *Atanga's* receptivity to new technology. Along the way, *Atanga* learnt about the pit method of compost making from his Uncle in Burkina Faso and adapted new information about this method to improve the quality of manure that he produces from his *Tanuku*. For instance, the use of salt as a facilitating agent of decomposition was inspired by new information he gained from his Uncle in Burkina Faso.

Na'ambεa Pu'usego evolved alongside increasing participation of households in rice cultivation in the community. Although cereal crops remain the staple crops in the community, the cultivation of rice is increasingly becoming an important and widespread activity among men and women, especially the latter. The challenge that most rice farmers face is poor soil fertility. In most instances, grazing lands are being turned into rice farms and these are not suitable enough for cultivation or fertile as valley rice fields. In response, some farmers have resorted to direct application of cow dung (*'Na'ambεa'*) as a means to improving soil fertility for rice cultivation. In the *'Na'ambεa'* form of organic manure (Photo 4.5), farmers hand pick cow dung from grazing fields and stock pile the dung directly on the farms during the off farm season.

Photo 4.5: Stockpile of *'Na'ambεa'* on a rice farm in the dry season in *Yua*.

Source: Field Photo, 2009

The pile of cow dung on this rice farm in the dry season is in preparation for the next farming season. The onset of rainfall will soak and facilitate break down of the dung and this is mixed with the soil during plough and weeding to improve soil fertility. This is a new form of organic farming practise that is particularly useful and practiced by non-cattle owning households although the practice is not exclusive to them. I will now examine a case invoving *Anseem*, a female rice farmer (Box 4.6). The case explores *Anseem's* use of *Na'ambɛa,* the context and factors that inspired her innovation in the use of this organic manure type in rice cultivation.

Box 4.6: *Anseem – Na'ambɛa* for soil fertility improvement in rice cultivation

Anseem is a 22 years old female farmer who lives together with her husband, two children and father in-law. *Anseem* cultivates a small rice farm located on a large grazing land that is increasingly, put into rice cultivation by community members. The portion on which she cultivates is part of their family land. She cultivates rice on her own. Rice cultivation is increasingly becoming important in the community and many more women are resorting to rice cultivation because of its benefits for household consumption and income generation potential. *Anseem* started cultivating a new rice variety called *Sane ki ya* in the local parlance some four years ago. She obtained the rice seed from *Guelwongo* market in Burkina Faso. She learnt about this rice variety from rice farmers in a neighboring community, *Yorogo*, in Burkina Faso.

From her interaction and observation of *Yorogo* rice farmers, she knew that the new rice variety could yield very well but only if chemical fertilizer was applied. *Anseem* knew soils on her farm were not fertile but she did not have the money to buy fertilizer. So she resorted to the use of *Na'ambɛa* (cow dung) to sustain the cultivation of the new rice variety. She will go around grazing fields to pick cow dung and stockpile them on her rice farm during the dry season. Her household had only two cattle and the dung that they produce are used to support cereal crop production on the *Samani*. When she starts cultivation of her rice farm in the rainy season, the rainfall combined with tilting of the land help breakdown the cow dung into smaller particles that mix with the soils. This mix of cow dung and soil particles over the years has improved soil fertility on her farm.

Anseem has also resorted to bunding her rice farm as a water conservation measure, but also as a means of conserving soil fertility that she is investing time and resources to improve. Rice field 'bunding' is a departure from past practices of non- bunding. *Anseem* learnt about rice bunding from her friend *Apogbire* who is a native and rice farmer in *Yorogo*, Burkina Faso. *Anseem* also learnt about 'bunding' rice fields by observing the practices of other rice farmers in *Yorogo*. The rice fields of *Yorogo* are located along the Ghana-Burkina Faso border. Given proximity of the *Yorogo* rice fields to *Yua*, *Anseem* is able to observe farming practices through daily interactions with the *Yorogo* rice farmers.

Through the application of *Na'ambɛa*, *Anseem* has consistently increased her rice yields to supplement cereals produced for household consumption. The first year she cultivated rice, it was without *Na'ambɛa* and she harvested one basin of rice (Photot 4.4). She attributed the low harvest to poor soils and poor rainfall. The second year she planted, she applied *Na'ambɛa* and did 'bunding' of her rice field. She harvested three basins of rice from the same size of farm. For the next two years, she harvested approximately 4 basins of rice per year and she attributes the increase in yield to the application of *Na'ambɛa* combined with 'bunding' of her rice field. Although total crop output is insufficient, increased yields from rice cultivation supports household consumption budget and this is significant in reducing livelihood vulnerability.

Source: In-depth Interviews, Yua, 2008/2009.

The main strategy of *Anseem* (Box 4.6) has been to increase the yields of her rice through application of *Na'ambεa*. Her first experiment with *Na'ambεa* in rice cultivation yielded positive results and served as a source of motivation for manure application. Based on her success in increasing rice yields through manure application, *Anseem* even plans to increase her farm size. This suggests that *Anseem* perceives manure as an important decisive factor in her crop yields. *Anseem's* decision to experiment with *Na'ambεa* was based on her knowledge that rice farmers in neighbouring *Yorogo* community in Burkina Faso apply chemical fertilizer in order to have good yields with the same variety of rice that she plants. Since she does not have the money to buy chemical fertilizer, *Anseem* joined in the 'open competition' of picking cow dung from open grazing fields in the community to support her rice cultivation. Although total crop production for *Anseem's* household is insufficient to meet all year round consumption needs, the increase in rice cultivation would have helped reduce the food 'deficit supply gap' because the rice supplements grains in household consumption. This achievement of *Anseem* with *'Na'ambεa'* has enabled the household reduce its vulnerability to poor soil fertility.

From the discussions so far, four different traditional forms of organic manure are identified in household food crop production practices in *Yua* in particular and the *Atankwidi* basin in general. However, most households combine their application in various ways. In *Yua* for instance, every household uses *Tampugerε Pu'usego* and nine (9) out of every ten (10) households use *Nandene Pu'usego* in crop production. *Nandene Pu'usego* is commonly associated with cattle owning homes although it is not exclusive to only cattle owning households. As a 'rule', households generally combine *Tampugerε Pu'usego* and *Nandene Pu'usego* in crop production and in few other instances also practice a third form – either *Na'ambεa Pu'usego* or *Tanuku Pu'usego.* The choices that households make depend on the extent of commitment to organic manure in production and access to organic materials especially given that organic materials have become scarce. In a study on local farmers' knowledge of soils and traditional crop management in *Dalun* in northern Ghana, Mikkelson and Langohr found a Farmers' Soil Classification (FSC) system as revealing two hierarchical levels comparable to soil profiles of the ISSS/ISRIC/FAO (1998) 'World Reference Base for Soil Resources' (Mikkelson and Langohr, 2004:1). Drawing on their analysis, they observe that "the FSC is strongly based on the requirements for optimal crop production as a function of the climatic conditions of the area, and its application is oriented towards a traditional and sustainable form of agriculture" (Ibid.:1). Despite the subordination of African science and knowledge system in general, as facilitated by decades of implementing the 'Technology Transfer Model' even after independence, the African knowledge system persists albeit marginally and has sustained many lives over a long period (Millar, 2004). Among the *Frafra* ethnic group in the UER, several traditional soil and water conservation techniques including stone lines, contour tillage, ridging and border grasses have been practised for sustaining farming in the context of unfavourable land conditions (Millar et al., 1996). Although water conservation techniques have not been sufficient to counter land degradation, (van der Geest, 2004), they have been vital for sustaining livelihoods of many small-scale farmers who cultivate under difficult environments. The utility of traditional forms of organic manure for reducing vulnerability to land degradation and soil fertility in *Yua* and in the *Atankwidi* basin feeds into the on-going discourse and indeed, re-kindled interest in the relevance of indigenous knowledge to sustainable development. Many researchers are increasingly acknowledging the advantages of the efficiency of small-scale farmers and their ability to use land resources in carrying out their livelihoods in a sustainable way (Baker, 2000; Corbeels et al., 2000; Millar, 2004; Mikkelson and Langohr, 2004). Local farmers' knowledge show features of innovation[38] so that their resource management strategies are described as 'indigenous sustainable approaches' that takes cognizance and great care of the specific needs of plants and is closely adapted to fluctuating physical environmental conditions at the local level (Baker, 2000; in, Mikkelson and Langohr, 2004:1). It is also in this context that the works of Paul Sillitoe is relevant to the discourse on indigenous knowledge[39] and development. He

[38] As stated in my discussion, households generally combine *Tampugerɛ Pu'usego* and *Nandene Pu'usego in foodcrop farming. These are* indigenous forms of manure. I have also described some 'evolved forms' of local manure as innovations inspired by self experimentation, changing circumstances, new information and the need for sustaining livelihoods as illustrated by the cases of *Anseem* (Box 4.6) and *Atanga* (Box 4.5). This corroborates the assertion that indigenous knowledge is innovative, dynamic and relevant for development (Sillitoe, 1998; Pottier, 2003 Aluma, 2004) and that innovation is driven by the need for sustaining livelihoods (Nuffic and UNESCO, 1999).

[39] There is a large discourse on indigenous knowledge that underscores its utility for local level development. However, it is important to caution that some indigenous knowledge may also become obsolete over time due to changing circumstances. An example from the *Atankwidi* basin will illuminate this issue. Among first generation households, the commonest form of organic farming practice was to leave plant stalks on the farm after harvest. The

argues that indigenous knowledge is holistic and can therefore; facilitate interdisciplinary research towards accelerating development and addressing poverty in the Developing World (Sillitoe, 2004).

4.4 Agencies support but farmers shape a 'new dawn' of composting

The study revealed the introduction and gradual adoption of two new methods of composting, the *Zaï*[40] and the 'pit' composting models. External practises and agencies inspired the introduction of both methods. However, farmers opted for the 'pit' method over the *Zaï* model in a new dawn of compost making for addressing soil infertility. In the ensuing section, I will describe the introduction of new compost methods in three stages. In the first stage, I will discuss the effort of MoFA to introduce the *Zaï* compost model and why it did not gain general acceptability among farmers in the community. In the second stage, I will examine the case of *Nsoh Asakote*, an innovative farmer who was first to adopt the 'pit compost' model in the community and the factors that facilitated early adoption. In the third stage, I will examine how two community-based organizations (one external and the other internal) collaborated to accelerate the adoption of pit compost among farmers in the community.

Stage 1: The *Zaï* model of compost making fails the test of adoption

intent was for the stocks to decompose for improving soil fertility. Today, this practice has become virtually 'extinct' although the knowledge still exists among the present generation households. Competing uses for stalks is on the ascendency and this arises from desertification, reduced crop and stock yields and increased population. Annual household stocks cannot even meet annual livestock grazing requirements. Thus, leaving stalks on the farms will mean that all stalks will be consumed within a short period. No single stock will decompose on the farms. Aside, increasing demands for use of stalks for burning as source of energy, material for weaving door mats/doors and as tradable goods for income generation all increase pressure on the already scarce resource.

[40] Zaï is a traditional soil conservation technique that originated in Mali in the Dogon area. Zaï was adopted and improved by farmers in Burkina Faso after the drought of 1980's. Farmers here have since appreciated this technique, which is a plant-pit system. Farmers apply the Zaï technique to recover crusted land or barren land. Zaï is a traditional planting pit with diameter of 20-40 cm and a depth of 10-20 cms. The dimesions may vary according to soil type. The pits are dug in the dry season and stocked with organic matter at a recommended rate of 0.6 kg/pit. The pit is then covered with a thin layer of soil and the seed placed in the middle of the pit after the first rain. Zaï fulfils three functions - soil and water conservation and erosion control for encrusted soils. The application of the Zaï technique can increase production by about 500 % if well executed (World Bank, 2005:1-2).

The Ministry of Food and Agriculture (MoFA) in Ghana under the LACOSREP programme introduced the *Zaï* model of composting to the community some three years ago. MoFA introduced the *Zaï* compost model'[41] through a demonstration project in the community (Photo 4.6). The *Zaï* demonstration project is located on the compound farm of a subsistence farmer located in the centre of the community. The *Zaï compost* demonstration structure is rectangular with three different chambers of varying sizes. An Agricultural Extension Officer (AEA) supervised the construction while the community provided labour and the materials. The men were involved in digging soils, preparing mortar and building the structure. The women were responsible for fetching water and doing the plastering. The farmer hosting the demonstration project provided the organic materials for the training. The chief and elders mobilized farmers in the community attend two demonstration trainings provided by the AEA.

Photo 4.6: The Zaï compost demonstration project in *Yua*.

Source: Field Photo, 2008

[41] The MoFA *Zaï* model seems to be a compost model that it set out to promote. It differs from a planting pit, which the Zaï technique originally refers to although it adopts the name and some principles of Zaï. It appears the ministry was more interested in promoting compost application – rather than an on farm pit planting method.

In the MoFA *Zaï* model, organic materials are deposited layers, routinely watered and periodically turned to facilitate decomposition in the largest chamber. As the organic materials begin to decompose, the quantity of the materials decrease in size and are transferred into the second largest chamber for further decomposition. Continuous watering and turning regimes aid further decomposition. The organic material is further transferred into the smallest chamber. This is the final stage, where decomposition is completed and the compost is collected for application on the farm. By transferring organic materials from chamber to chamber, space is created for making more compost - hence multiple and varied stages of compost making can occur concurrently. Focus group discussions with farmers revealed that farmers have not adopted the *Zaï* model. It became clear that the only farmer who adopted this type of compost making was the farmer who has the demonstration project located on his farm. In this case, the farmer is utilizing the infrastructure on his farm. Focus group discussants attributed non-adoption of the *Zaï* compost to some unfavourable features associated with the method. The method was considered costly because it required the use of bricks for construction and plastering with bitumen or cement. It was also considered labour intensive requiring routine watering and turning of the materials. Given these perceived unfavourable conditions, innovative farmers are resorted to the pit type of compost making instead. The Management Information System Officer (MISO) of the District Agricultural Directorate for Kassena-Nankana East District recognized this preference among farmers:

> Farmers are becoming more familiar with the pit type of compost making although we have made the effort to promote the *Zaï* model. We have initiated a number of demonstration projects in the area but there is no uptake of the method. Farmers prefer the pit type but it also has its shortcomings. Too much rainfall can impair decomposition. However, cost seems to be the main reason why farmers are not adopting the Zaï model that we are promoting (MISO, 15/07/08).

Although the interventions of MoFA may not have induced the expected community response, the compost demonstration project probably pushed education on the need for making manure in a new and more effective way than has been the case in the past. Around the time that MoFA initiated its *Zaï compost* demonstration project, there was general awareness in the community about the ‘pit’ method of compost and its practice in neighbouring communities in Burkina Faso. The two sources of knowledge probably had a significant impact on community awareness and education leading to increasing orientation and commitment towards new methods of compost making in the community. These conditions gave momentum to the rise of a new era in composting. In this new era of compost making, *Nsoh Asakote*, a farmer himself played a leading role in the adoption and spread of the ‘pit’ compost in the community. His contributions are twofold. First by being, an innovative farmer and the first farmer to adopt the pit compost around the same time that the *Zaï* model was introduced in the community. Secondly, he also facilitated the adoption of the ‘pit’ compost method through technical support to farmers groups in the community. I will focus on his personal adoption of the ‘pit’ compost for household production in the ensuing stage, while his role in community wide adoption is discussed in the next stage.

Stage 2: Early adoption of ‘pit’ compost by *Nsoh Asakote*

Nsoh is about 60 years old. He has two wives and eleven children. Most of his children are adults who have migrated. He lives with two teenage daughters, a son and two wives in the *Barigabisi*, a section of Yua (See Map III) which shares boundary with Burkina Faso. *Nsoh* and his household have been making pit compost for the past two years. In this case, I will explore how *Nsoh* obtained information on pit compost, the kind of information he obtained, how he adapted this to making compost and the general context within which his innovation evolved.

Nsoh first learnt about the pit compost from his Uncle in *Bungu*, a community in Burkina Faso through social visits three years ago. He learnt more about this method of compost making through subsequent visits. He recalls that his Uncle dug a rectangle pit to some standard specification directed by Burkina Faso Government officials. He then used concrete to cement the floor and the sides of the pit. His Uncle dumps various kinds of organic materials including crop residues into the pit soon after harvest. He will dump millet stalks, groundnut vines and even weeds uprooted during weeding in the rainy season. His Uncle will also scoop out cow dung from the *Nandeene* and add them to the organic materials in the pit. Sometimes they added the remnants of cow dung particles used for trapping termites as feed for poultry. They will occasionally pour water into the mixture of organic materials. He will encourage his wives and children to pour ash into the mixture. He will periodically turn the organic materials with the help of his children. This will involve scooping out the organic materials and separating them into top and lower layers. He will then put back the organic materials in layers but this time swapping the organic materials. This process combined with continuous watering of the materials facilitates even and complete decomposition of the organic materials for application by the next rainy season.

Nsoh was also inspired by his observation of how his neighbours on the Burkina Faso side of his community took up to the production of pit compost. *Nsoh* lives in the *Bargabisi* section of *Yua*, is ‘split’ into two parts – one side is in Ghana and the other side in Burkina Faso. The international borderline passes through *Nsoh’s* homestead. In fact, the entire *Taribisi* community though technically belonging to two different countries show a continuum of homesteads as one moves from the Ghana section to the Burkina Faso section of the community. Therefore, one can see from *Nsoh’s* house, homesteads in Burkina Faso. This enables daily interactions (See Map III). It was in this context that *Nsoh* observed the adoption of pit compost among his neighbours on the Burkina Faso side, which further inspired him.   In his personal remarks, *Nsoh* notes that:

> After first learning about pit compost from my Uncle, I later realized that many other families on the Burkina Faso side of my community starting doing same’. [While pointing to some houses, Nsoh intimates that], “all those houses you see on the Burkina Faso side are now involved in compost making using pits”. Can you see the house next to my house? [He asked]. “He is my neighbour on the Burkina Faso side of our community. I personally observed him cart three donkey cart loads of pit produced compost to his farm at the beginning of the farming season this year”.

In adopting the pit compost, *Nsoh* went to his Uncle in *Bungu* with a rope woven of ‘kennef’ fibre. He then took the standard measurements of his Uncle’s pit and tying knobs on the rope to mark the points of measurement. He returned to *Yua* and with the support of his children, dug a pit on his *Sammani* to the measurement specifications he took of his Uncle's pit. From right to left (Photo 4.7) are *Nsoh*, my research assistant (Patrick) and *Nsoh's* son standing by the pit he dug. The background shows his *Naara* (early millet) on the *Sammani*. In this photo, *Nsoh* showed us his stocked compost pit with partially decomposed organic materials on the top layer. At the time, *Nsoh* was preparing to excavate his compost for application on his maize farm on his *Sammani.* After harvesting crops, *Nsoh* starts the process of preparing pit compost in the dry season (Photo 4.8). As can be seen, *Nsoh* had already stocked his pit with organic materials and covered it with soils for making compost towards the next farming season. As can be seen, the pit is not full and this is because of a general problem of limited organic materials in the community. On the immediate background is *Nsoh's* house. The distant shining roofs are the roofs of *Nsoh's* immediate Burkina Faso neighbours.

Photo 4.7: *Nsoh's* compost pit containing organic materials in the rainy season, *Yua*

Source: Field Photo, 2008

Photo 4.8: *Nsoh's* stocked compost pit during the dry season in *Yua*

Source: Field Photo, 2009

In practice, *Nsoh* integrates both *Nandeene* and *Tampugerɛ Pu'usego* into his pit compost production because the latter is more effective in decomposition. Such well-decomposed organic manure support plant growth much better. A wide range of organic materials including *Naara* and maize stalks, groundnut vines and cow dung mobilized from his farm and grazing fields are used pit compost making. Organic manure from the *Nandeene* and *Tampugerɛ* are transferred into the pit for complete decomposition. The pit compost has the advantage of facilitating complete decomposition because of good management practices associated with the method. The organic materials in the pit are turned periodically to facilitate good decomposition but *Nsoh* admits the process is strenuous and requires more hands. He also waters the organic materials intermittently. His wives and daughters fetch water from a community dam to water the organic materials. The decomposed materials, organic manure are scooped out at the beginning of the rainy season and applied to his *Sammani* for improving soil fertility.

Nsoh observes that he has increased his production significantly through the application of pit-produced compost. He points out that although new crop varieties are good for adapting to shortening rainfall regimes, increased yields were because of compost application. Since he resorted to pit compost, he has rarely bought grains to supplement his farm output except last year (2007) when rains/floods destroyed crops.

Source: Compiled from in-depth Interviews, *Nsoh*, *Yua, 2008 and 2009*.

Although *Nsoh* was the only early adopter of pit compost, his innovation improved awareness beyond the *Barigabisi* section of the community. *Nsoh* recalls that several neighbours and other distant community members made inquiries about pit compost. In this case *Nsoh*, served as a culturally acceptable 'demonstrator' being an indigene and local farmer himself. Many farmers who inquired from him expressed interest of trying the method and *Nsoh* was an example to guide them. Many of such farmers according to *Nsoh* are beginning to experience increased crop yields since they adopted the method of compost making. Similar to the role of *Nsoh*, two farmers played a key role in the dissemination of the original *Zaï* technology in the *Yatenga* Region of Burkina Faso. These included *Yacouba Sawadogo* and *Ousseni Zorome* who both got involved in experimenting with Zaï. Their experimentations lead to some innovations. They both got involved in training other farmers on their innovations. *Yacouba Sawadogo* made this impact living in the village of *Gourga* close to the regional capital *Ouhigouya*. *Ousseni Zorome* also lives in the village of *Somyaga*, which is also close to the regional capital *Ouhigouya* (Kaboré & Reij, 2004). Beyond the initial and innovative role of *Nsoh* in the adoption and dissemination the pit compost, it took the instrumental efforts of CBOs to upscale efforts targeted at community wide adoption of the method. Here again, *Nsoh* was a key part because of his knowledge and experience. I will now tend my attention to the third stage, which is a discussion of the roles of CBOs in the uptake of the pit compost method in the community.

The *Nemogre Farmers Group* and the Sirigu Ecological Initiative for Sustainable Development (SEISUD) are two community-based organizations that have collaborated to accelerate the adoption of pit compost among farmers in *Yua*. Established in 2001, SEISUD started operation as a community based organization focusing on a basic schools organic garden project in a neighbouring community, Sirigu. SEISUD moved the idea of collaborating with the *Nemogre Farmers Group* to promote new methods of composting in food crop production in 2007 in *Yua*. The Executive Director of SEISUD, Peter Anoah, is very instrumental in the running of the organization. At the time of the interview, he was in the process of registering SEISUD as a non-governmental organization in the country. The *Nemogre Farmers Group* was already in existence haven been formed in 2000 and comprising both male and female farmers. These farmers organized themselves into a large farmers group in order to meet conditions for accessing development support packages, such as credit facilities of government and non-governmental agencies. Mr. *Patrick Akanlisi*, a resident Teacher in *Yua* who volunteers as a coordinator of the *Nemogre Farmers Group* is very instrumental in supporting the functioning of the group. SEISUD chose to work with the *Nemogre Farmers Group* because of its commitment to function as a group and its goal of improving upon farming as a livelihood for its members. In the ensuing section, I will examine the roles of these two community based organizations in the adoption of pit compost in four areas: initial consultations and reorganization of the farmers group; community based education; implementation strategy; and finally, trainings.

SEISUD started its operations with the *Nemogre Farmers Group* through several preparatory meetings and consultations in 2007, with the coordinator of the *Nemogre Farmers Group* liaising between his organization and SEISUD. Through these meetings, the group reached a consensus on promoting improved compost making for its members. However, the group reached a consensus to adopt the pit compost method that was practised in Burkina Faso. Initially, SEISUD advocated for the *Zaï* model but many farmers and groups at later stages expressed preference for the pit method based on cost considerations. SEISUD then focused its attention on how to reorganize the *Nemogre Farmers Group* to make it more effective to deliver on this common agenda. Given the history of poor functioning of large groups, SEISUD recommended that the group should be split into smaller groups to enhance effective functioning. At the same time, SEISUD pushed for screening group members before they were registered as members of the new splinter groups. This was to avoid registration of uncommitted members. The screening took into consideration commitment to a series of line up preparatory meetings, age (one needed to be active) and respectability in the community. The number of women was very small at the initial stage. A decision was taken by the executives to recruit hard working female farmers into the groups. The response was good and many invited female farmers became very committed and eventually met the criteria to register as group members. In the end, women outnumbered their male counterparts in the splinter groups.

The coordinator of the *Nemogre Farmers Group* together with the executives of the group over saw the screening and registration processes in a transparent manner that was fair and acceptable to all group members. In the end, the *Nemogre Farmers Group* was split into four smaller farmers groups namely: *Zɛke-zoole* comprising 15 members (all females); *Zigi-bisi* also comprising 15 members (6 males and 9 females); *Nemogre,* the mother group comprising 16 members (6 males and 10 females); and *Beere-yelum* comprising 14 members (3 men and11 women). At this point, each group met and elected their executives and decided on their own ways of conducting meetings and their activities. Patrick, the volunteer coordinator of the defunct large *Nemogre Farmers Group* continued to coordinate activities of the splinter groups. He organized and participated in meetings involving all four groups. In his role, Patrick acted as a liaison – liaising between the farmers groups and SEISUD in the dissemination of information and organization of activities. After the groups were re-organized, the Executive Director of SEISUD was invited to give a talk on group formation and functioning to further support the activities of the groups.

In the next stage, SEISUD organized a community workshop by contracting a resource person from TRAX to train the farmers on compost making using the Zaï model for the purposes of demonstration. A training session was done for all the four groups during the time of the research. I sat through some of the training sessions (Photo 4.9). The photo shows a cross section of farmers during a community based compost-training workshop organized for some members of the splinter *Nemogre* farmers groups. The resource person, Solomon, a staff of TRAX Bolgatanga is taking farmers through the process of preparing compost using the *Zaï model*. The training focused on the construction of the three-chamber structure and mobilization of local organic materials. The training also emphasized the use of ash and water for aiding decomposition, importance of aeration and turning of organic materials to aid decomposition. SEISUD and the resource person used the *Zaï* demonstration project as reference for the training. As a policy, SEISUD and the resource person advocated for the groups and farmers to adopt the *Zaï* compost model.

Photo 4.9: Community workshop on compost training for farmers groups in *Yua*

Source: Field Photo, 2008

In a subsequent meeting organized by the farmers groups to decide on the way forward, the groups expressed preference for the pit method of composting which most of them had seen in neighbouring Burkina Faso citing cost considerations. Opposition to the *Zaï* model had already started at the smaller group level and this was brought up in the general meeting of all groups for discussion. After long deliberation of the issues, the farmers groups reached a consensus to adopt the pit compost rather than the *Zaï* model, which was being advocated by SEISUD. SEISUD eventually agreed to the proposal of the groups after initial policy resistance. Further discussions were held and a common implementation strategy for starting the process of constructing pits for their members was agreed upon. However, the discussions revealed the need to engage someone who was knowledgeable on pit compost making to provide technical advice and support in the construction of the pits. *Nsoh Asakote*, a member of one of the groups presented himself as having the measurement dimensions of the pit he took of his Uncle's pit in Burkina Faso. The group agreed that he should support the process with the measurements that he had taken. *Nsoh* agreed to provide the needed support to all farmers groups. The farmers then decided on an implementation strategy for all groups. In this strategy, group members will help each other in the construction of the pits for compost making one after the other. In dealing with the details, each group agreed that the beneficiary of the pit would provide food during the construction process. While other groups made the inclusion of alcoholic beverages compulsory, it was optional for others. The groups also varied in their planned schedules of construction (market day cycles, weekly schedules, every two weeks, no planned schedules) but they were often obstructed by social events particularly funeral rites. The groups also varied in the selection criteria for choosing the next beneficiary farmer for pit construction. The criteria varied from group members reaching consensus, to the individual beneficiary expressing readiness for construction and to simple and transparent random sampling methods. Once a group settled on a day to construct a pit, *Nsoh Asakote* will be informed and he will be there to mark out the right standard measurement for the group – cross checked to be 10 feet square by 4 feet depth. He will then leave while the group digs to the measurement specification. The construction of pits was ongoing during the time of the study and Nsoh continued to provide technical support. By February 2010, farmers groups had constructed a number of pits for their members. *Zigi-bisi*, a mixed sex group had dug 9 pits for its members out of a planned target of 15 pits. *Zɛke-zoole*, an entire female farmers group had dug only 2 pits out of a target of 15 pits. *Nemogre,* a mixed sex group had dug 5 pits out of a target of 16 and *Beere-yelum* had dug 3 pits out of a target of 14 pits. Individual farmers were responsible for mobilizing organic materials for compost making and this was one of the conditions for selecting the next beneficiary farmer in most groups.

As part of the implementation strategy, SEISUD agreed to support the farmers with demonstration training in 'pit compost' making in the 'localization'[42] of this new knowledge in the community. Four planned demonstration trainings were agreed upon between SEISUD and the farmers groups with each group benefiting from one training session. Under the agreement, each group will select a farmer whose pit and organic materials were ready and could be used for the demonstration training. Each of the four farmers chosen for the demonstration training came from four different sections of the community to spread the training sessions across the community and to make the maximum impact in the community. These demonstration trainings were open to all farmers in the community (Photo 4.10). In the photo, the resource person, *Solomon* is taking *Bere-yelum Farmers Group* (mixed sex group) through demonstration training on pit compost making. The training session emphasized a combination of issues – ordering organic materials in layers; turning organic materials, watering the materials intermittently; and aeration to facilitate decomposition. I observed the training session, which was organized in the *Barigabisi* section of the community. The training was open to all farmers and many farmers from within and outside the section took the opportunity to observe the demonstration process. About 30 farmers from the community witnessed and participated in the demonstration training. The beneficiary farmer of the compost demonstration training had mobilized his materials including rice straw, stalks, cow dung and ashes for the exercise. Female members of the groups also brought in basins and buckets of water to support the process. A close look at the photo shows a display of all these items. An interesting scene is also the curiosity of children. By observing what was

[42] It is this process of adopting new knowledge from external sources and adapting it to local conditions and application such as in the case of the 'pit compost' technology that is referred to as 'localization' of knowledge in my analysis. See Cohen and Levinthal (1990) and Evers (2003).

going on, children are learning an innovation. They will most likely practice and pass on this knowledge to the future generations.

Photo 4.10: Pit compost demonstration training for *Bere-yelum Farmers Group*

Source: Field Photo, 2009

The general acceptance of ‘pit’ compost among farmers in *Yua* suggest that although indigenous knowledge systems on soil conservation exist, they are inadequate for addressing the problem of soil infertility. In the quest to find answers to this problem, farmers opened up to new ways of doing things to adapt[43] to conditions of the times. This search for ways of adapting predisposed them to new knowledge from external

[43] Farmer Soil Classification (FSC) in *Dalun* of northern Ghana is oriented towards traditional and sustainable forms of agriculture. However, population growth combined with physical environmental change has brought the current sustainable land-use practises in *Dalun* under pressure giving rise to the need for adaptation. Adaptation may ultimately lead to a more intensive land-use based on mechanisation, application of chemical fertiliser and cultivation of new crop types. Such changes represent a risk of the farmers losing their traditional knowledge about the local soils, traditional management procedures, including crop rotation and fallow systems (Mikkelson and Langohr, 2004:1).

sources and lead to the adoption of ‘pit’ compost as an addition to the portfolio of existing local knowledge on manure. In the introduction of ‘pit’ compost, the *Nemogre Farmers Group (NFG)* and SEISUD have been the key actors. SEISUD initially promoted the *Zaï* model but farmers negotiated their preferred choice, the ‘pit’ compost. This underscores the assertion that knowledge production processes are underpinned by the social context, power relations and emerge as a product of social interaction and dialogue between specific actors (Pottier, 2003). Although farmers are now adopting ‘pit’ compost, they still rely on indigenous forms of manure. For instance, *Nsoh*, an early adopter of ‘pit’ compost uses the pit method to complete decomposition of indigenous manure, specifically *Nandeene* and *Tampugerɛ Pu’usego*. This underscores the relevance of knowledge interfaces[44] in the discourse on local knowledge systems (Long and Long, 1992; Millar, 2004). Many other farmers who are now adopting the ‘pit’ compost are likely to follow in the footsteps of *Nsoh* when they learn about the advantages[45] of the ‘pit’ model.

To sum up, household food crop production is vulnerable to soil and land degradation in the *Atanlwidi* basin. Vulnerability manifest in variability of crop yields partly attributable to poor soil fertility in *Yua* and the *Atankwidi* basin in general. In response, households have resorted to local knowledge on soil conservation for improving soil

[44] David Millar uses ‘Cosmovision’ as a concept that capture the African worldview and ways of thinking as a discourse that represents a “rich combination of spirituality, materiality and the social”…and that “this worldview co-exists with western worldviews and systems of thinking, in various shades and combinations of both, as several parallels within the same continuum” (Millar, 2004:1). Drawing on examples from Ghana and Zimbabwe, Millar notes that in the traditional worldview, land, water, animals and plants are not just production factors of economic significance. They have a place within the sacred nature. Such African knowledge systems, thus, indigenous knowledge systems persist despite numerous interventions/interruptions by dominant post-independence technology transfer models shaped by western knowledge systems in the development milieu. After several decades of experimentation with this dominant development paradigm, envisaged benefits have not been realized. This gives rise to the need for an alternative development paradigm. In this respect, Millar recommends an endogenous development process that blends the two knowledge systems (Ibid.:1).

[45] According to *Nsoh*, an early adopter of ‘pit’ compost, the method is effective in completing decomposition, efficient management of organic materials, effective in increasing crop yields and associated with minimal weed growth.

fertility. Such local knowledge systems are dynamic and changing over time in response to changing circumstances. Farmers heavily depend on indigenous forms of manure – inherited from the previous generations. These include *Nandeene* and *Tampugrɛ* forms of manure. However, new forms of organic manure have emerged in response to changing circumstances. These include *Tanuku* and *Na'ambɛa* forms of manure. Farmers are also checking soil erosion by planting 'grass strips' as complimentary soil conservation measures. Collectively, these measures have helped reduce vulnerability of food crop production to poor soil fertility arising from land degradation. Through these soil conservation measures, some households have stabilized crop yields but others have increased yields over the past few years.

4.5 Summary and emerging issues

In this chapter, I drew on 'vulnerability' as a research concept for discussing the role of local knowledge systems of soil conservation for sustaining food crop production under land degradation in the *Atankwidi* basin, northern Ghana.

The discussion shows that household food crop production is vulnerable to land and soil degradation in the *Atankwidi* basin. Vulnerability essentially understood in terms of risk at two levels – exposure to poor soil fertility and difficulty in addressing challenges associated with soil degradation in food crop production. This has contributed to variability in crop yields among households over the past few decades.

Farmers and their farm households understand the nature of risk that poor soil fertility poses in their food crop production. As a result, they have resorted to local knowledge on soil conservation for improving soil fertility and enhancing environmental sustainability of their farmlands. Local knowledge systems on soil conservation have been dynamic, evolved and changed over time in response to changing circumstances. In the application of local knowledge, farmers depend on indigenous forms of manure, which the previous generations bequeathed to them. These forms of manure include *Nandeene* and *Tampugrɛ* forms of manure inherited as part of their ancestral heritage. In response to changing circumstances, farmers evolved additional forms of manure in farming practices. These include *Tanuku* and *Na'ambɛa* forms of manure. To conserve their investments, farmers are combining manure application with measures that check soil erosion. These local measures include planting 'grass strips' and bonding in paddy rice fields.

Through these local soil conservation methods, farm households are reducing their vulnerability to poor soil fertility arising from land degradation. For some households, this has lead to halting a declining trend in crop yields and hence, stabilizing yield levels. For other households, this has lead to increased crop yields to support household consumption. Following these positive results, many more households have become committed to the application of manure in crop production and this is driving innovation in soil conservation practices in the basin.

New information has been a catalyst in driving the process of innovation in soil conservation practices. Through new information from government agencies, the role of community based organizations and communities in Burkina Faso, a new era of manure *'the compost making era'* emerged. This new era is witnessing a revolution in 'pit' compost production and application for improving soil fertility in household production. The 'pit' compost has assumed a 'strategic status' among farmers for sustaining crop production. Compost among early adopting households has resulted in positive gains as reflected in increased crop yields. Such positive results encouraged the adoption of compost in food crop farming in *Yua* and the *Atankwidi* basin at large.

4.6 Conclusion

In the beginning of this chapter, I set out to discuss the role of local knowledge in soil conservation for reducing 'vulnerability' to land degradation and poor soil fertility in household food crop production in the *Atankwidi* basin. Vulnerability was defined as risks that poor soil fertility and land degradation posed in household food crop production. This vulnerability resulted in a mix of declining trends, fluctuations and uncertainties in crop yields. In response, farmers are utilizing local knowledge on soil conservation for reducing vulnerability of food crop production to soil degradation. The gains from these measures have been positive and impressive. Some households have stabilized crop yields but others have increased their crop yields. These successes and interventions of development agencies encouraged the adoption of compost in food crop production. As a result, local organic manure has become strategic local knowledge for enhancing environmental and social sustainability in household food crop production in *Yua* and the *Atankwidi* basin at large.

Chapter 5

5.0 Adapting Food Crop Production to Rainfall Variability through Local Knowledge

5.1 Introduction

In Chapters 3 and 4, I pointed out that unreliable rainfall is a major environmental factor that adversely affects household food crop production in the *Atankwidi* basin, and northern Ghana as a whole. For many households in this area, food crop production is vulnerable to rainfall variability and this is a major issue in the search for sustainable household livelihoods. In this chapter, I will attempt to examine how households[46] in *Yua* and the *Atankwidi* basin at large are reducing vulnerability of food crop production to rainfall variability through existing local knowledge systems of adaptation. The discussion is in four parts. In the first part, I examine the vulnerability of household food crop production to rainfall variability in the *Atankwidi* basin. In the second part, I discuss local knowledge systems used by households for reducing vulnerability to rainfall variability. The third part consists of a summary and emerging issues arising from the application of local knowledge systems. The final part entails the conclusion.

[46] The discussion draws on data generated from two levels of sampling households. In the first level, nine (9) households were sampled in *Yua* for in-depth studies and case studies through purposive sampling technique. The discussion draws heavily on these case studies for shedding light on the adaptation of households to rainfall variability in food crop farming. In addition, a survey was conducted among 131 households across three communities in the *Atankwidi* basin. The survey was conducted in *Yua*, *Mirigu and Pungu* with the aid of a standardized interview schedule – often times referred to as a 'questionnaire' in ordinary parlance. The households and respondents (heads and spouses) were selected through a combination of systematic and simple random sampling techniques. Focus group discussions were conducted among farmers.

5.2 Vulnerability of food crop production to rainfall variability

In Chapter 4, I pointed out that farmers in the study area often cite the 'twin problem' of poor soil fertility and unreliable rainfall as major constraints to food crop production. The discussion essentially attributes the incidence of low crop yields to these two factors. My intention is to discuss rainfall variability and its effects on household food crop production. In Chapter 2, I discussed rainfall variability in the Volta basin of Ghana and West Africa. The discussion reveals two main disturbing features of rainfall variability that affect food crop production. These include inter-annual and intra-annual rainfall variability. I do not intend to repeat that detail discussion here. Rather, I will do an overview of the issues relating to the experiences of farmers and the situation in the *Atankwidi* basin.

To understand how farmers think about rainfall variability, I asked 131 farmers across three communities[47] to identify and rank[48] environmental factors that adversely affect crop production in the basin. The environmental factors that farmers identified themselves included poor soil fertility, heavy rainfall, drought, rainstorm and floods. Poor soil fertility was ranked first. Heavy rainfall (high rainfall intensity) and drought were ranked as the second and third most imposing variables that cause low crop yields respectively. Overall, 52 % of the farmers (68 farmers) asserted that rainfall variability is a major constraining factor in food crop production. Farmers say that the current rainfall regime makes rain fed farming problematic. Their accounts reveal many unfavourable rainfall patterns. This includes shifting patterns in the onset of rains making prediction and timing of planting problematic. There is also unfavourable intra-annual distribution often leading to dry spells and drought in some months and high rainfall intensities in other months during the rainy season. In addition, farmers have observed a shortening duration of the rainfall season. All these factors are unfavourable for crop production. Several studies corroborate farmer perceptions of rainfall variability at the local level.

[47] The sample communities included *Yua, Mirigu and Pungu in the Atankwidi basin, KND, UER*

[48] The ranking was done according to which factor adversely impacted their crop yields the most.

Yaro (2004) observed variability in annual rainfall in the KND between 1961 and 1997 drawing on rainfall data from the Meteorological Service Department, Navrongo. The 1980s and 1990s recorded the highest variability. In addition, intra-annual rainfall distribution from March to October over the same period was variable and sometimes affecting crop production. Such intra-annual variation is implied in the estimated planting or growing period in Ghana. Growing periods in Ghana according to the Soil Research Institute (SRI), Ghana, range between 120 to 150 days, but can be between 150 and 180 days in valley bottoms where moisture is retained for longer periods (SRI, 1999; in Duadze, 2004). Laube et al. (2008) describe rainfall in the *Atankwidi* basin as seasonal, erratic, and variable in patterns and that droughts occur frequently. Considerable variations existed in the rainfall pattern, in terms of its distribution, onset and amount from year to year since the 1980s (Dickson and Benneh, 1988). An analysis of climatic data from 1931 to 1990 revealed rising temperatures and decreasing rainfall for northern Ghana (Kranjac-Berisavljevic et al., 1999). From the analysis of both inter-annual and intra-annual climatic data (1961-1997), Yaro makes some key observations about rainfall variability and its implications for livelihoods around Navrongo (Box 5.1).

Box 5.1: Rainfall variability and livelihoods implications around Navrongo (1961-1997.

- That there is a correlation between total annual rainfall and number of rainy days;
- That the years with lower annual rainfall also registered lower than average number of rainy days required to create enabling moisture conditions for production;
- That between 1961 and 1997, 18 years (out of 36 years) registered lower than expected rainy days required for creating the enabling moisture conditions for production;
- That 1983 registered the worst or highest deficit of -16 rainy days when the area experienced the worst drought and water shortage required for plant growth;
- The situation after 1985 has not been good either – alternating 'droughts' and 'wet' years characterize rainfall;
- For some years that registered adequate rainy days, distribution was concentrated in the peak (July/August) while the early farming season (April/May) in which crops needed moisture to grow experienced dry spells and droughts resulting from lack of rainy days;
- Droughts have a potential of usually crippling other sectors of the economy too, thereby leading to falls in general economic well-being. The withdrawal of subsidies for

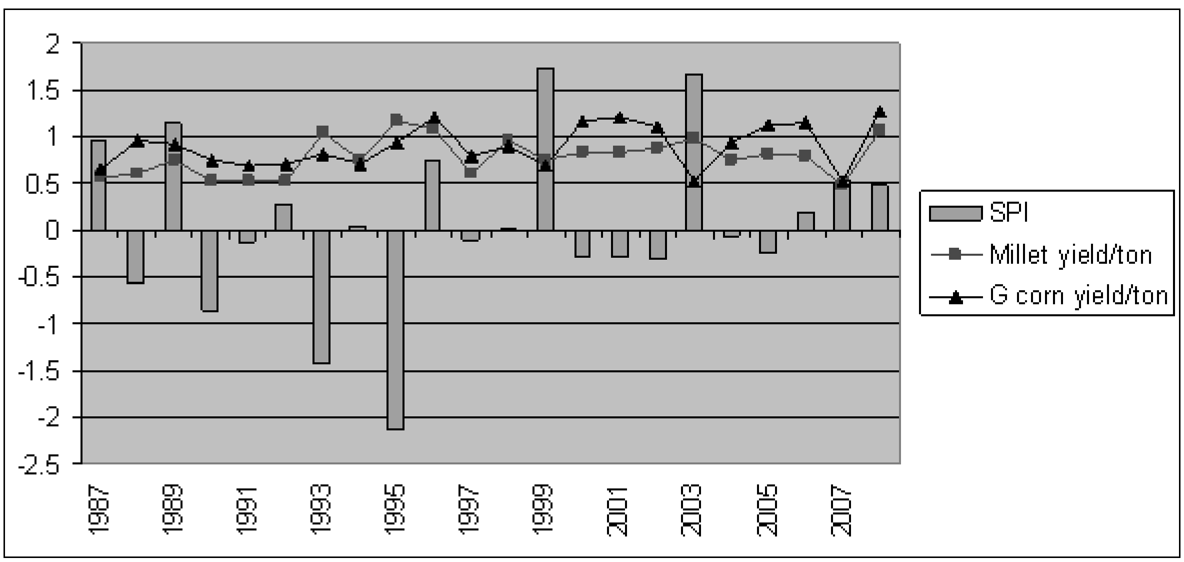
agriculture under structural adjustments policies further turn's the incidence of average rainfall into catastrophic events because most villagers are unable to invest in the needed inputs, which would have otherwise helped improve the situation

Source: Yaro (2004:178 -180).

These observations about rainfall variability are not unique to the study area. They conform to the general situation in respect of northern Ghana and the entire Volta Basin of West Africa (See chapter 2). Farmer perceptions in Ghana are said to reveal hotter climate, decline in rainfall and a shift in the timing and a reduction in the duration of the rainy season (Dinar et al, 2008). Studies under the Glowa Volta Project confirm climate changes and reveal increased risk associated with extreme climatic events in the Volta Basin of Ghana and West Africa (Kunstmann & Jung, 2005).

The overall impact of rainfall variability in crop production is a good basis for assessing vulnerability of crop production to rainfall variability in the study area. This is because majority of the populace (69 %) depend on rain fed cultivation as their primary livelihood (See Chapter 3). According to Yaro (2004), rainfall variability is the single most important vulnerability-imposing variable of the climate in the KND. The survey reveals that 76% (99 out of 131) of farmers experienced 'decreasing' trend in household food crop output while 24% (31 out of 131) experienced 'mixed' trends (increases and decreases). From the perspectives of farmers, rainfall variability is a major cause of yield declines and or fluctuations among many households. Such impacts of rainfall variability occurred in the past. A long period of drought occurred from 1981 to 1984. This led to stunting, drying up and destruction of the vegetation and crops in KND. This spelt out hardships of enormous proportions for the human population leading to starvation and outmigration of many people from the area in order to survive. Official response in terms of food aid was simply inadequate to deal with the crisis because of its magnitude and the number of people involved (Yaro, 2004:178). Such events continue to occur in recent times. In 2007, two different extreme climatic events disrupted livelihoods in the UER and most parts of northern Ghana. A dry spell occurred in May badly affecting yields of early millet. High rainfall intensities and floods occurred in August and September destroying late crops such as guinea corn, rice and groundnuts. A large number of homesteads was destroyed by the floods. Together, both events resulted in crop failure for many households that year. This necessitated the GOG and other development agencies to provide food aid to the populace in many parts of northern Ghana including the *Atankwidi* (Laube et al, 2008). An analysis of rainfall and crop productivity for the UER between 1987 and 2008 provide additional evidence of how rainfall variability affects food crop production. The results show that both inter-annual rainfall extremes, that is, heavy rainfall (wet years), and drought (dry years) lead to low cereal crop productivity for the region (Derbile and Kasei, n.d). In Figure 5.1, I present this comparative analysis of annual rainfall using the SPI index and productivity for millet and sorghum for the region from 1987 to 2008. See Chapter 2 for detail explanatory use of SPI[49] index for the analysis of drought in the Volta Basin of Ghana.

Figure 5.1: Annual SPI and crop productivity for UER from 1987 to 2008 (tons/ha).



Source: Derbile and Kasei (n.d:3).

[49] SPI values range from -2.0 to +2 with -2.0 representing extreme dry, +2 representing extreme wet and 0±0.5 representing normal rainfall.

In general terms, productivity for millet and sorghum in wet and dry years are lower than that for normal years (Figure 5.1). At a quick glance, productivities hover around 0.5 tons/ha for the wet years of 1987, 1989, 1999 and 2003. This compares to a productivity range of 0.7 – 1.2 tons/ha for normal years as exemplified by 2000 to 2002. In general terms, dry years (drought) as exemplified by 1990, show similar lower patterns in productivities but productivities for dry years has been relatively better than that of wet years. This suggests that food crop production in the UER may be more vulnerable to wet conditions than dry conditions. A comparison of average[50] productivities for millet and sorghum between wet years and normal years will illustrate this point clearer (Table 5.1).

Table 5.1: Wet years and corresponding productivities for selected crops (ton/ha) in UER

Year	State of wetness	Output per ton		
		Millet	Sorghum	Groundnuts
1987	Moderately wet	0.56	0.64	0.64
1989	Moderately wet	0.75	0.96	0.91
1999	Very wet	0.75	0.69	0.69
2003	Very wet	0.98	0.53	0.53
	Average	0.76	0.70	0.68

Source: Derbile and Kasei (n.d:9); originally derived from MoFA, UER (2009).

The corresponding productivity of millet and sorghum is analyzed for the wet years of 1987, 1989, 1999 and 2003 (Table 5.1). In general, the analysis shows that productivity for millet, sorghum and groundnuts is relatively lower in wet years than in normal years. The productivity for millet for 1987, 1989 and 1999 fell below the average productivity of 0.79 tons per hectare for millet in normal years. The only exception is 2003 for which the productivity of millet outstripped the average output by 0.22 tons per hectare. This may be related to a favourable rainfall distribution for 2003. The average productivity for millet per hectare for wet years is 0.76 tons/ha compared with 0.79 tons/ha for normal years. For sorghum, productivities for all years fell below the average output (0.99 tons per hectare) for normal years. The average productivity for sorghum per hectare is 0.70 for wet years compared with 0.99 tons/ha average for normal years (Derbile and Kasei, n.d). The effects of rainfall variability on crop yields lends credence to the IPCC assertion

[50] Average output for normal years for millet = 0.79ton/ha; sorghum = 0.99ton/ha; groundnuts = 0.88 ton/ha

that agricultural production and access to food in many African countries risk being compromised by climate variability and changes, especially when extremes such as excessive rainfall occur (Parry et al, 2007).

The view that unreliable rainfall is a major cause of declines in food crop production is not unique to the *Atankwidi* basin. Farmers blame climatic conditions for declines in crop yields across all regions in Ghana, including the UER except Greater Accra Region (Dinar et al, 2008). In the *Nandom* area of the UWR, farmers attribute declines in crop yields partly to worsening climatic conditions (See van der Geest, 2004). The choice of crops among farmers in the UWR is restricted to those that can thrive in soils of low soil fertility and under erratic rainfall patterns. This has resulted in the predominant cultivation of millet, sorghum and groundnut (Duadze, 2004). This suggests that farmer's response strategies are based on their understanding of climatic conditions and how they affect different types of crops. The ability to address vulnerability arising from rainfall variability is crucial for sustaining household livelihoods. I will now examine how households are reducing vulnerability of food crop production to rainfall variability through local knowledge systems of adaptation.

5.3 Reducing vulnerability through local knowledge systems of adaptation

Households are adapting household food crop production to rainfall variability through multiple local knowledge systems of adaptation. The discussion here draws on multiple household cases. The discussion also draws on findings from focus group discussions and a survey of 131 farmers across three communities in the *Atankwidi* basin. The discussions on local knowledge systems centre around four themes. These include multiple farms and staggering seeding, cultivation of drought resistant traditional crops, adoption of early maturing crops and multi-cropping strategies.

5.3.1 Multiple farms and different rounds of seeding - adapting to rainfall anomalies

The findings from in-depth studies show that farmers cultivate multiple farms and employ different rounds of seeding for adapting to drought, excessive rainfall and rainstorms in household food crop production. Through a combination of such farm management measures, farmers reduce their risk to rainfall variability at three stages of planting. These stages include: (1) planting stage associated with sowing and first weeding; (2) growth stage associated with second weeding; (3) maturity stage associated with final weeding, tussling of crops, maturity and harvest. In the ensuing analysis, I will examine cases of how farmers employ multiple farms and stagger planting regimes in a holistic effort to adapt crop production to rainfall anomalies – draughts and or excessive rainfall. In the first case (Box 5.2), I will examine the case of how a male farmer relies on fragmentation of his *Sammani* and staggering planting for adapting to rainfall anomalies.

Box 5.2 *Akolbire*: Fragmentation of *Sammani* for adaptation to rainfall anomalies in *Yua*

Akolbire is a 60 years old male head of household. He lives with his three wives and six children. This case shows how Akolbire fragments his *Sammani* into multiple small plots coupled with different rounds of seeding to adapt crop production to rainfall anomalies.

Akolbire divided his *Sammani* into four (4) plots based on a careful analysis of soil properties. He then plants similar and different plants on the four plots. On plot one (1) estimated at an acre, he intercrops *Naara*, *Zea* and *Talenga*. This plot contains gravel soils locally called *Zika*, and have good water drainage and soil fertility to support the growth of cereals. He plants these cereal crops on this plot because he thinks these crops do not require much water to do well. In this case, if it rains too much, the crops will still do well because of the good soil drainage of *Zika*. On plot two (2), he intercrops *Naara* and *Talenga*. Here, the land also contains *Zika* but he slightly varies the sowing time from plot one in order to increase chances of benefiting from favourable rainfall. On plot three (3), estimated at ¾ of an acre, he intercrops yet *Naara*, *Zea* and groundnuts. This plot contains *Biziga* (sandy soils) which have good drainage characteristics. Since these crops do not need much water to do well, he asserts that he can still have a good harvest even if intermittent drought spells occur. Sandy soils can preserve moistures under intermittent rainfall patterns or during short droughts to support plant growth. Plot four (4), estimated at half an acre contains clayey soils locally called *Yaka.* He plants Maize, *Talenga*, Soya Beans and Sweet Potatoes because in his assessment, these crops need more water and clay soils have better water retention ability to support their growth. However, he intimates that one also needs to plant early on clay soils before it starts raining too much. Once crops are grown before it starts raining heavily, the crops will still do well even if the soils are somewhat saturated with water. The only problem is when there is drought. Clay cakes and plants can easily wilt and die. The good side of this is that heavy rains in July or August don’t adversely affect crop growth on clayey soils once they are grown at that stage.

Akolbire recalls his encounter with two droughts during the early part of the raining season and how he managed the situation. On plot 4 which contains *Yaka* (clay), he initially planted *Naara* very early when the rains started but the plants wilted after germination because of a dry spell. As a result, he planted *Talenga* as a replacement. This is what *Akolbire* had to say about his encounter with drought and planting decision that year: *Initially, I planted early millet (Naara) on my fourth plot but they wilted and died because the rains were not forthcoming. So, I decided to plant 'Talenga'. I had no 'Naara' seed left by that time. You see, even on my first plot on which I planted 'Naara', I did the first planting but they also wilted and died earlier on because of an earlier dry spell. I then replanted, and this time they survived because the rain had become favourable*.

Good traditional seed management practices are also central to *Akolbire's* adaptation to rainfall anomalies. He summarizes his worldview on seed management. As follows: *You see. The most important thing you do at harvest, as a good farmer is to select good cereals as seed. In doing this, you preserve a reasonable quantity as seed. In this way, you ensure that when you sow, there is surplus seed to cater for any eventualities that may require filling in or replanting. Even when you buy seed from the market, it has to be treated as seed customarily. There is always a traditional ritual such as pouring libation associated with whatever you designate as seed. You keep the surplus even after sowing. Customarily, you can only consume surplus seed only after germination is good and the crops are doing well on the farm. Otherwise, seeds are seeds and managed as such. This is how my father and our ancestors went about seed management and this is the tradition I have also inherited. Therefore, you see that tradition is helping us even today but some young people do not have that foresight*.

Source: Compiled from In-depth Interviews, 2008/2009

From the case of *Akolbire* (Box 5.2), four adaptation strategies to rainfall anomalies are discernable. The first strategy is the fragmentation of his *Sammani* into smaller farms coupled with different rounds of seeding to increase possibility of matching planting with good timing of favourable rainfall distribution. The second complimentary strategy is sticking to the traditional norms of seed management that guarantee surplus seed for replanting and or filing in when the need arises. The third strategy is fragmentation of *Sammani* based on soil characteristics and planting similar crops on varied soils to vary the impact or moderate the impact of rainfall anomalies on crops. Finally, an additional strategy is the allocation of plots to planting crops based on an assessment of the water requirements of the plants and the suitability of soils with corresponding water holding characteristics that will support their growth.

In my next case (Box 5.3), I will show how *Aputire*, explores the use of multiple farms (*Sammani* and *Boo*) for adapting crop production to rainfall anomalies.

Box 5.3 Aputire: Combining *Sammani* and *Boo* for adapting to rainfall anomalies in *Yua*

Aputire is a 30 years old female head of household in *Yua*. She lives with her two children (8 and 11 years old) with a 70 years old Aunt. In this case, I will show how *Aputire* combines *Sammani* and *Boo* farms coupled with different rounds of seeding to adapt to rainfall anomalies in farming.

Aputire has two separate farms – one her *Sammani* and the other her *Boo* located along the banks of nearby River *Akulaa*. *Aputire* inherited these two farms from her late parents and has since sustained the cultivation of the two farms because combining the two helps her overcome challenges posed by rainfall variability. As a custom, *Aputire* plants her *Boo* first before planting her *Sammani*, a practise she inherited from her parents. When the early rains start, she intercrops three crops *Naara* (early millet), and two new varieties of sorghum (*Kadaa* and *Talenga*) on her *Boo*. After approximately two weeks, she starts planting her *Sammani*. She has divided her *Sammani* into five smaller plots and staggers planting of these plots too. Here, the time interval for planting between plots could range from just a few days to a week. She intercrops – *Naara* and *Zea* on plot 1; *Naara* and *Talenga* on plot 2; *Talenga* and *Kadaa* on plot 3; Maize and Soya beans on plot 4; groundnuts (locally called *'Nigeria'*) and sweet potatoes (*Gerigo*) on plot 5. She also plants beans (locally called Wogro Teɛ) across most plots as a cover crop.

The experiences of *Aputire* shows that cultivating multiple farms and staggering planting can have some benefits in relation to rainfall variability. In 2008 for instance, *Aputire* reports that she had a good yield of *Naara* from her *Boo* but that *Naara* from her *Sammani* did not yield well. This is because a dry spell adversely affected tussling and seed development on two out of three plots on which she cultivated the crop on her *Sammani*. She intimates that planting of the *Naara* on her *Boo* was timely as rainfall distribution supported growth of the crops. Besides, she observed that early planting at the *Boo* is also most appropriate because early rains are often not consistent and easily characterized by intermittent dry spells. Given better soil fertility of the *Boo*, soils under conditions of dry spells are able to provide better moisture to support plant growth than will be the case on the *Sammani*. Better soil fertility of the *Boo* explains faster plant growth and maturity there. To support her assertion, *Aputire* said: *As I speak to you, we started harvesting 'Naara' from the 'Boo' today and the yield is good. While pointing to crops on her Sammani she said 'but as you can see the yield for Naara on the Sammani is poor and not yet ready for harvesting.* From my observation, *Aputire* was right on her assessment that *Naara* on her *Sammani* was poor and not yet ready for harvest while harvest from the *Boo* was ongoing. The crops mature early on the *Boo* because of several factors: First, because of early planting. Since this is a riverbank farm, it is prone to floods, which can adversely affect plant growth when plants are still young. When plants are already grown and floods occur, it does not adversely affect plant growth much as when plants are still young ; Secondly, the soils of *Boo* are more fertile than that of the *Sammani* and this facilitates fast plant growth; Thirdly, to avoid floods during early stage of plant growth.

Early harvest from the *Boo* provides the family with food that is vital for household sustenance during the lean season/early phase of the farming season. According to *Aputire*, all that she is doing is keeping to a family tradition (cultivating the *Boo* first) and this has proven to be useful in adapting to rainfall variability and providing food for the family during the lean season.

Source: Compiled from In-depth Interviews, 2008/2009

The experience of *Aputire* shows that by combining *Sammani* and *Boo* farms, she adapted household production to rainfall anomalies and securing food supply in various ways.

First, planting the *Boo* first is a family tradition but also informed by the suitable characteristics of the soils there to better adapt to intermittent dry spells associated with early rains. She makes the point that soils on her *Boo* are loamy soils and relatively more fertile than soils on her *Sammani*. This makes soils of the *Boo* better at moisture retention for supporting plant growth during dry spells. Secondly, because the soils are also fertile there, the crops grow very fast. This also helps avoid any adverse impacts of excessive rainfall that may lead to floods later on. As she observes, plants still do well even if floods occur at a stage when plants are already grown. Besides these benefits, early planting combined with fast growth of plants provide the household vital food during the lean season. According to *Aputire* the planting of *Naara* on the *Boo* coincided with a good rainfall distribution in 2008 leading to good yield. However, rainfall distribution did not favour *Naara* planted on her *Sammani* and this lead to a poor yield.

I will now turn my attention to another case (Box 5.3). In this case, I will show how *Aminga* staggers planting between her *Sammani* and *Moom* for adapting crop production to rainfall anomalies.

Box 5.3 *Aminga*: Combining *Sammani* and *Moom* for adapting to rainfall anomalies

Aminga is a 50 years old female head of household who lives with her daughter, a teenage grandson and an aged Aunt. *Aminga* and her household own a *Sammani* and a *Moom*. The *Moom* is actually a *Boo* because it is located along the banks of a river but because it is located outside the community, it is locally called a *Moom. Aminga* and her household have easy access to their *Moom* because it is only about 2 kms away and located in *Yorogo* a community in Burkina Faso. The people of *Yua* share border with the people of *Yorogo*.

Aminga and her household combines the cultivation of their *Sammani* and *Moom* through a carefully thought planting regime that supports adaptation to rainfall anomalies. She divided both her *Sammani* and *Moom* into four small plots each to enable different rounds of seeding. What is peculiar about *Aminga's* case is the way she staggers the planting processes of both her *Sammani* and *Moom* in three phases. At the beginning of the raining season, *Aminga* plants *Naara* and *Zea* first on her *Sammani* in the first phase. Then, she plants *Naara* and *Talenga* on her *Moom* in the second phase. Then she returns to plant *Zea* and *Talenga* on her *Sammani*. *Aminga* also plants rice and *Talenga* on her *Moom*, which she has divided into four small plots. On plot 1, she plants a drought resistant traditional rice variety locally called *Mĭŭ kiliga* and on plot 2 she plants, a new and early maturing rice variety named *Mĭŭ Bonga* in the local parlance. On plot 3, she intercrops the two different varieties of rice and finally on plot 4, she intercrops *Naara* and *Talenga*.

Aminga, staggers planting this way for many reasons. First, by staggering planting, she is able to avoid a complete failure of crops when there is drought or excessive rainfall because plants on the various plots will have grown to different stages with varied capabilities to cope with varied situations. Secondly, *Aminga* plants her *Sammani* first because they can easily protect the plants from being eaten by livestock. This is necessary because livestock are not tattered at the early stages of the raining season.

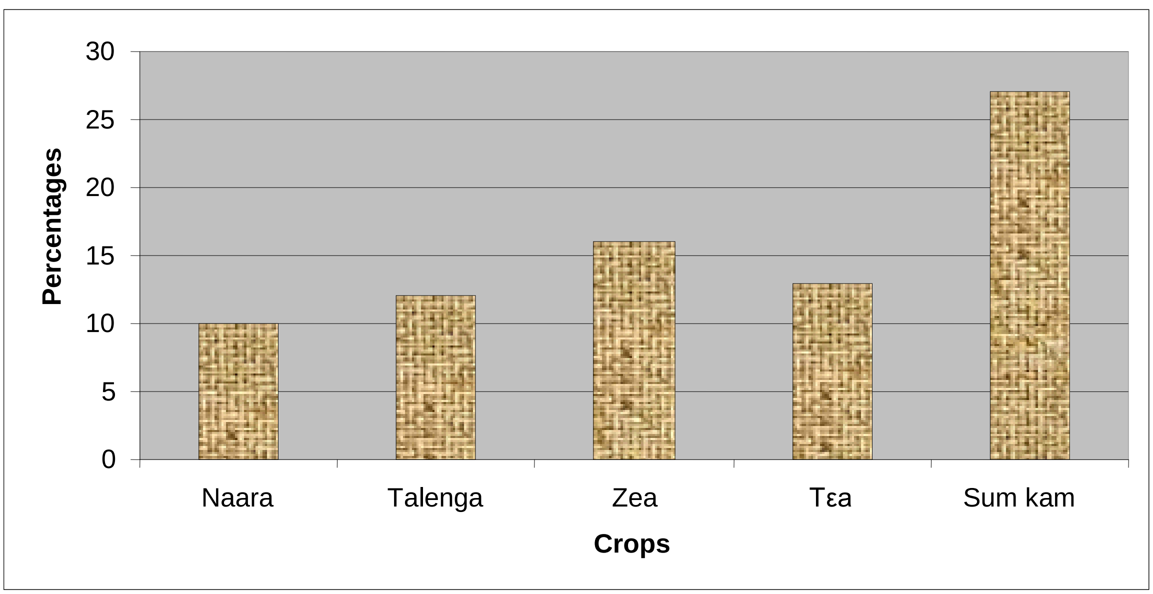
She notes that the best thing to do is to plant the *Moom* before the *Sammani* because the former is actually a *Boo*. This is the practise with cultivating *Boo* when it is within closer reach such as hers. She admits that this was what they did when her husband was alive. At that time, her husband scared away livestock from the *Boo* during the day while rearing poultry on the farm. Although that would be the best thing today, *Aminga* does not have the labour to protect plants from livestock at her *Boo*. She intimates that for the same reason, many farmers are not planting their *Boo* early enough even within the community so that early planting of the *Boo* is becoming a loss tradition. She observes that early planting at *Boo* can lead to good harvest of both *Talenga* and rice. She notes that although early rains are not relaible, *Boo* is able to support plant growth even with dry spells because better soil fertility there. *Boo* are often located in waterlogged areas and contain loamy soils that have good water retention capabilities and as such provide moisture for plant growth during dry spells. This corroborates the assertion of Aputire (Box 5.4). She concludes by observing that Sammani requires regular and good distribution of rain fall for crops to do well because soils are not fertiles enough.

Source: Compiled from In-depth Interviews, *Aminga*, 2008/2009

In the case of *Aminga* (Box 5.3), four identifiable measures enable adaptation to rainfall anomalies in crop production. This includes combining *Sammani* and *Moom* coupled with staggering planting regimes between them to spread risk and reduce vulnerability to rainfall anomalies. Another strategy is fragmentation of both *Sammani* and *Boo* and further staggering of planting at that level for equally reducing risk and vulnerability to rainfall anomalies. Finally, another strategy is intercropping traditional drought resistant and new rice varieties in *Moom* to reduce vulnerability to rainfall anomalies. These adaptation measures are not unique to *Aminga.* They reflect typical adaptation measures among households that cultivate both a *Sammani* and a *Boo* in *Yua*.

From the discussion so far, three forms of farms feature in the local knowledge systems of households for adapting food crop production to rainfall anomalies. The *Sammani* is an important household asset and every household has its *Sammani* that it cultivates. For households that rely on only their *Sammani* for food crop production as in the case of *Aminga*, they rely on fragmentation of the *Sammani* coupled with different rounds of seeding and rationale allocation of plots to the cultivation of different crops based on an analysis of soil properties. Results from the survey show that 34% of households depended on only their *Sammani* for household food crop production. The evidence from observation and focus group discussions show that as a norm or rule, all households are involved in fragmentation of their *Sammani* into smaller farms and staggering of planting for adapting their production systems to rainfall anomalies. Given that only 34% of households depend on *Sammani* only, a majority of households combine their *Sammani* with *Boo* or *Moom*. The survey shows that 37% of households cultivated a *Boo* in addition to a *Sammani* while 31% cultivated a *Moom* in addition to a *Sammani*. In general, most crops that are cultivated in the *Sammani* are also cultivated in *Boo* or *Moom* with the exception of rice. Rice is often cultivated in *Boo* because these are located in waterlogged areas along riverbanks or in valleys suitable for its cultivation. The survey shows that the following crops are commonly cultivated in *Boo* and *Moom* - *Naara* (early millet), *Zea* (late millet), *Talenga* (sorghum), *kemanka* (maize), *Mŭŭ* (rice), *Sum-kam* (groundnuts), Tɛɛ (beans) and *Nanugla* (potatoes). The five commonest crops cultivated in *Boo* and *Moom* in the *Atankwidi* basin are analyzed (Figure 5.2).

Figure 5.2: Crops cultivated in *Boo* and *Moom* among 131 households in the *Atankwidi* Basin



Source: Field Survey, 2008

The analysis shows that *Sum Kam* (groundnuts) is the most cultivated crop in bush farms particularly *Moom* as cultivated by 27% of households (35 out of 131). This is followed by *Zea* (late millet) as cultivated by 16% of households (21 out of 131). This is because most *Moom* (bush farms) are located on lands either within the district, neighbouring districts or in Burkina Faso that have sandy soils suitable for the cultivation of groundnuts and late millet. That apart, farmers plant *Moom* last so that it is too late to plant other crops except groundnuts. This is the case for households that do not have the labour to finish planting their *Sammani* early enough or combine weeding of their *Sammani* with planting their *Moom*. Late millet is planted in *Moom* aside the *Sammani* because it is drought resistant and can strive on sandy soils. Although it is not exclusive, most of the *Naara* and *Talenga* are planted in *Boo* where soils are relatively fertile, waterlogged and loamy. The *Boo* are generally closer and suitable for early planting of *Naara* and *Talenga* in order to get around floods that may occur during the raining season. *Talenga* (sorghum) in particular requires some good soil fertility to do well so that the most rational thing is to plant it on *Boo*. It also strives well in waterlogged areas provided the plants have grown tall enough before floods occur.

5.3.2 Cultivation of traditional crops to adapt to drought

The results show that households are cultivating traditional drought resistant crops as a means to adapting food crop production to droughts. In this section, I will discuss the common practise of 'paring two' traditional drought millet varieties and the cultivation of a traditional rice variety. Most households plant Naara and Zea as a pair of twin traditional crops because of their resilience to drought. These crops have been traditionally the staple crops handed down from generation to generation. *Naara* is an early maturing variety that takes three (3) months to mature while *Zea* often takes five (5) months duration to mature for harvesting. These crops are planted in the *Sammani* and to a lesser extent on bush farms such as *Boo* and *Moom*. Focus group discussants stress the resilience of these two traditional millet varieties to drought as the reason for which households have maintained their production. For the lack of this quality, households ditched the cultivation of *Ke-menka* (*kemolga*), a traditional sorghum variety for a new sorghum variety with drought resistant capabilities. The discussions from a focus group discussion among seven male farmers from *Yua* reflect this assertion:

> We inherited the cultivation of *Naara* and *Zea* from our parents just as they also inherited the seed from our grandparents. Traditionally, this is what we mill into flour to prepare our meals. This is also, what our Gods accept for sacrifices. We use flour from these grains to ‘pour libation’ [meaning to make offerings] to appease our Gods or request support for good health, protection and good harvest. So what we eat is what our Gods also eat. Although we have experienced shorter rainfall periods in the recent past, we still cultivate *Naara* and Zea because droughts are also common and these crops are drought resistant. Once these crops grow to a certain height, they can survive any drought that last from a few weeks to even a month. Although it can affect yields, there will not be a total failure in crop yields. Because of the drought resistant qualities of *Naara* and *Zea*, drought does not necessarily lead to destruction of crops and disruption of livelihood. They express this resilience to drought in the local parlance as *ware ka sangne tinga* literally meaning ‘drought does not destroy the land’ - interpreted to mean drought does not necessarily lead to hunger and crisis.

From the discussions, the drought resistant capability of *Naara* and *Zea* is the driving factor for the continuous cultivation of these crops among households. The paired cultivation of what I describe as the ‘twin drought resistant traditional crops’ is a widespread practise in the *Atankwidi* Basin. The survey shows that 86% of households (113 out of 131) intercrop *Naara* and *Zea* in household crop production. See Figure 5.3 for percentages of households that cultivate three different traditional drought resistant crops – specifically *Naara*, *Zea* and *Mйй kiliga*. From the analysis 92% of households (121 out of 131), plant *Naara* while 91% (119 out of 131) plant *Zea* as part of the portfolio of crops that are produced at the household level in the *Atankwidi* basin. The closeness in percentages of households that cultivate *Naara* and *Zea* suggests the widespread ‘-paired’ practise of planting these two crops in household production system.

Figure 5.3: Number of households cultivating *Naara*, *Zea* and *Mŭŭ kiliga'* among 131 households in the *Atankwidi* Basin.

Source: Field Survey, 2008

In the analysis (Figure 5.3), the cultivation of *Mŭŭ kiliga*, is another important traditional drought resistant rice variety. It is widely planted among households in the basin. The analysis shows that 75% of households cultivate this particular rice variety for its resilience against drought. In the ensuing section (Box 5.4), I will present the case of *Awineboya*, a female farmer in *Yua* who cultivates *Mŭŭ kiliga* and how her decision helps her adapt rice cultivation to drought.

Box 5.4: *Awineboya* cultivates *Mŭŭ kiliga* to adapt to drought

Awineboya is a 40 years old female and head of household. She lives with her 4 sons (ages ranging from 11-20) and her mother. In this case, I will explore how *Awineboya's* cultivation of *Mŭŭ kiliga*, a traditional rice variety helps her adapt to drought.

Awineboya has been cultivating rice for over ten years in her *Boo* located behind her homestead along the banks of River *Akulaa*. In the beginning, she started planting a traditional rice variety called *Mŭŭ Moliga*. *Mŭŭ Moliga* is a long maturing traditional rice variety with reddish grains, which she inherited from her mother. This rice was cooked for home consumption because of the 'unattractive' colour of the grains. The local people did not find it suitable for preparing food to host guests because the reddish colour did not make it attractive and 'befitting' of guest. As such the rice variety was named *Akanduge Saana* literally meaning 'unsuitable for preparing food to host guest'. *Awineboya* cultivated this rice variety for three years after which she ditched it for yet another traditional variety of rice called *Mŭŭ Kiliga* in the local parlance. *Awineboya* ditched the crop because this was the trend in the community. It's unsuitability for hosting guest was yet another factor for ditching the crop. However, *Mŭŭ Kiliga* is a drought resistant traditional rice variety and this is the reason why she adopted it for cultivation. For instance, *Awineboya* has been cultivating *Mŭŭ Kiliga* for six years now although she is aware that many other farmers are cultivating newer varieties of rice namely *Sane ki ya* and *Mŭŭ Bonga*. She has kept to the production of *Mŭŭ Kiliga* because she says it is drought resistant and grows well even if soils are not so fertile. She notes that even when drought occurs, she is still certain of harvesting some rice that supports household consumption although she neither applies fertilizer nor manure. *Mŭŭ Kiliga* as she puts it rarely fails even when drought occurs unlike the new varieties. She also notes that new rice varieties require fertilizer or manure to yield well. Given her resource limitations, she thinks *Mŭŭ Kiliga* is suitable for her although it remains a possibility she could try the new variety in the future.

She compares yields between *Mŭŭ Moliga* and *Mŭŭ Kiliga* and makes some observations. She notes that when she cultivated *Mŭŭ Moliga*, bags were not used for storing or measuring harvest. She remembers that the first year, she harvested quantities that filled three big traditional pots designed for storage. Then she observed that output declined over the next few years. So she adopted *Mŭŭ Kiliga*. *Awineboya* also observes about her yields from cultivating *Mŭŭ Kiliga* over the past three years. This year (2008), she harvested 2/3 of a maxi bag of rice and she thinks the yield was good since she almost got a bag. Last two years, she harvested close to half a bag of rice and she attributes poor harvest to late planting and late weeding. She does not think the problem was with rainfall. Last three years, she harvested a bag of the rice. She notes that her harvest is mainly for household consumption. She does not sell rice. When she needs to meet additional cereal needs of the household or any other need, she prefers to sell groundnuts to raise the money. Her rice yields have become very important for supporting consumption needs of her household.

Source: Compiled from In-depth Interviews, *Awineboya*, *Yua*, 2008/2009

From the case of *Awineboya* (Box 5.4), the resilience of *Mŭŭ Kiliga* to drought is the driving factor behind her cultivation of this traditional variety of rice. For her, the cultivation of this variety guarantees her some harvest even when drought occurs. As such, reducing vulnerability to total crop failure is an objective for its cultivation.

The discussion on the cultivation of traditional crops so far shows that the resilience of *Naara*, *Zea* and *Mŭŭ Kiliga* to drought is central to the continuous cultivation of these crop varieties. This is corroborated by findings from the survey (Figure 5.4) which shows farmers own assessment of how traditional crop varieties perform under the present rainfall regime, including the occurrence of drought. Drawing on the analysis, 57% of farmers (75 out of 131) evaluated the performance of traditional crop varieties under the existing rainfall regime as 'good'. This percentage of respondents is more than half the respondents in the survey already. If those who evaluated the performance of traditional crop performance as ‘very good’ is added, then as much as 60% of farmers covered in the survey agree that these crops perform well under the present rainfall regime.

Figure 5.4: Performance assessment of traditional crops under present rainfall regime among 131 farmers in the ‘Atankwidi’ Basin

Source: Field Survey, 2008

However, this should not give a total impression that traditional drought resistant crops are striving very well under present rainfall regimes. It should be understood in context. First, about 40% of farmers think otherwise and this should bring to the fore the problems of planting even traditional crops under the current rainfall regime. Secondly, most farmers assessed the performance of the crops as ‘good’ compared to only 3% who assessed performance as ‘very good’. The assessment here as good can be understood in the context that both traditional and new crop varieties perform better under varying conditions. When drought occurs, the traditional crops perform better than new crop varieties.

5.3.3 'Moving Beyond tradition' – adoption of early maturing crops

The results also show that farmers are receptive to new crop varieties in order to adapt crop production to rainfall variability. I would examine four household cases to illustrate this assertion. The first case shows the adoption of a new potatoes variety for household production by *Akabote* (Box 5.5).

Box 5.5: *Akabote* adopts *Gerigo* potatoes in response to shortening rainfall duration

Akabote is 25 years old and his wife is 22 years old. The couple has two children – one a toddler and the other in primary school. The young couple live together with *Akabote's* father and mother (who are now old). They also live with two younger brothers of *Akabote*. *Akabote* has adopted different early maturing crop varieties in order to adapt crop production to shortening rainfall patterns. These new crop varieties include potatoes, sorghum, soya beans, beans and groundnuts varieties. In this case, I will show how adoption of a new potatoe variety helps *Akabote* adapt its production to a shortening rainfall regime. The case also shows how local knowledge flows has helped in the 'localization' of this new crop in household production.

Akabote adopted the new potatoes variety called *Gerigo* in the local parlance. He adopted it some three years ago. At the time of interview, *Akabote* was cutting vines of the new variety of potatoes for propagation on his *Sammani*. He had bought the vines of the new potatoes variety from *Sirigu* market (Ghana), a neighbouring community. According to *Akabote, this variety is early maturing. In two to three months after planting, one could harvest to support household consumption. However, the old variety that we inherited from our fathers is sweeter than this new variety. The old variety could also be easily stored for a longer period than this new variety. The old variety is like yam and can be used for preparing pounded TZ ('fufu' or 'sakora'). The problem we are facing with the old variety is that it takes a longer time to mature. Since rainfall durations have become shorter, the old variety rarely strives well. Because the new variety is early maturing, it produces better under the current short rainfall regime. Although it has its shortcomings, we like it because at least we have food to eat. Is it not food we want"*, he asked rhetorically? He continued, saying that *harvesting of the new variety potatoes usually coincides with the harvesting of groundnuts and "peese", another traditional 'potato- like crop' in September. He explained that many more people are planting the new variety of potatoes because they lack groundnut seed to plant on their groundnut fields this year. He explained that heavy rainfall the previous year destroyed so many crops including groundnuts to the extent that many people did not have the groundnut seed to sow this year (2008). Many farmers have bought some seed and have sown smaller portions of their groundnuts fields. Thus, many farmers are resorting to planting potatoes in order to put remaining groundnut farms to use.*

From observation, *Akabote* was cutting the potatoes vines in a thoughtful and very skilful manner for propagation purposes. He would cut vine close to a node so that the upper portion of the vine had in most case 3 leaves. Asked why he was carefully cutting the vines the way he was doing, he had this to say: *I am cutting it the way it is usually done. You see, given the way I am cutting it, it will begin to shoot the potatoes itself once it starts growing. This is what you do when you really* *want to have good harvest. If you make the part that you will transplant long and far from the node, you end up with plenty of leaves but little harvest of the potatoes itself. So, is it the leaves or the potatoes that you want*? He asked rhetorically. I asked him, so how did you learn to transplant potatoes this way? In response, he said: *My father thought me how to plant potatoes this way. For so many years, we had been transplanting the traditional variety of potatoes this way. I have continued to transplant potatoes this way. I have tried the same technique on this new potatoes variety and I have realized that it works. Instead of cutting it the way I am doing, another option is to transplant long vines along the beds but you do this when you have enough vines. As you can see, I do not have enough vines. So I am doing it this way so that it is adequate for transplanting in the ten beds we have prepared for transplanting.*

I also asked *Akabote*, How did you learn about this new potato variety?' In response, he had this to say: *It was my friend 'Apokina' who first tried this variety of potatoes four years ago and I saw. He told me he got the variety from his Uncle in Guelwongo a community in Burkina Faso. That year, I observed that his yield was good and better than the traditional variety that I had planted. So, I decided to try the new potatoes. For my first trial, I went to 'Sirigu' market (Ghana) to buy the vines from farmers who bring it from neighbouring Burkina Faso to sell during the propgagation season.*

According Akabote, Gerigo strives well in many different soils. It does well in clay areas, sandy soils, gravel or loamy soils. It is because of its ability to mature early under varied soils that the community has named this potatoes 'Gerigo', meaning a 'foolish crop' in the local parlance".

Source: Compiled from In-depth Interviews, *Akabote*, 2008/2009

In the case of *Akabote* (Box 5.5), the driving force for adapting *Gerigo* is the shortening rainfall season. His objective is to reduce vulnerability to household food supply by cultivating *Gerigo.* For him, it has the right characteristics to support increased household crop yields under a shortening rainfall regime. A number of issues are discernable from this case. First, *Gerigo* is a preferred crop because it strives better than the traditional potatoes variety under shortening rainfall regime. As a result, it also yields better than the traditional variety under such climatic condition. Secondly, *Gerigo* also strives well under varied soil conditions. It also strives better than the traditional variety under poor soil conditions. A reason for which the new potatoes has been named *Gerigo*, literally meaning 'fool' in the local parlance. A 'fool' presumably does not distinguish between 'good food' and 'bad food'. A fool simply eats whatever food is presented without complain much the same way as this potatoes performs irrespective of soil quality. Thirdly, *Akabote* has pointed out that *Gerigo* is not as 'sweet' or 'tasty' as the traditional variety. It is not also suitable for preparing certain traditional meals and cannot be stored for a longer period like the traditional variety. Despite these shortcomings, *Akabote* has traded quality for quantity. This reinforces the point that reducing vulnerability to household food shortages is a major objective for adopting the crop. Fourthly, *Akabote* cultivates the new potatoes using knowledge of planting the traditional potatoes variety, which his father bequeathed to him. Here, the production of the new crop is localized in the context of indigenous and external knowledge interfaces. Furthermore, *Akabote* first leant about this crop from his friend who is also a neighbour. His friend obtained the new potatoes variety from his Uncle in *Guelwongo*. Beyond this, the case of *Akabote* shows that *Sirigu* market is a major source of the new potatoes for farmers who need it for propagation purposes. *Sirigu* is a neighbouring community located about 4 kms away from *Yua*. The market operates within three days cycle and well patronized by the people of *Yua*. In Photo 5.1, farmers from Burkina Faso are selling bundles of *Gerigo* potatoes in the *Sirigu* market during the propagation season.

Photo 5.1: Farmers from Burkina Faso selling potatoes vines in *Sirigu* market

Source: Field Photo, 2008

The farmers package the vines in bundles, bag them in sacks and transport them by donkey-carts to the market centre for sale. A bundle cost GH ¢50 pesewas. At harvest, there is usually a glut of *Gerigo* potatoes and this leads to low prices. Although households at harvest consume much, yields are so good that it has also become an important source of income to households. Aside, farmers say it cannot be stored for long. These factors culminate into a glut of the potatoes in market centres during the harvest seasons (Photo 5.2). The *Sirigu* market is where most farmers from *Yua* sell their potatoes. In Photo 5.2, women from *Yua* and *Sirigu* are selling *Gerigo* potatoes during the harvest season in *Sirigu* market. A basin as shown in the photo cost GH ¢1.50.00.

Photo 5.2: Women selling *'Gerigo'* (potatoes) in the *Sirigu* market

Source: Field Photo, 2008

I will now turn my attention to a different case highlighting the adoption of a new sorghum variety in household crop production. In this case (Box 5.6), I will show how *Adoko* adopted *Talenga* a new sorghum variety as a measure for adapting sorghum production to shortening rainfall seasons.

Box 5.6: *Adoko* ditches 'Ke-menka' for 'Talenga' to adapt to shortening rainfall season

Adoko is 55 years old and a widower. He has five (5) children. Two of his adult sons live and work on cocoa farms in the *Ashanti* region. A third son lives and farms around Tumu in the U.W.R. The remaining children live with him in the village. The eldest of the two is 25 years old, married with two little kids both under five years, while the youngest son is 16 years old. *Adoko* and his two sons, daughter in-law and two grandchildren live together. In this case, I will examine why *Adoko* adopted this new crop variety and the information flow and initiatives that drove the adoption process.

Adoko adopted *Talenga*, a new sorghum variety for household production ten years ago because it is early maturing. He notes that it was in response to shortening rainfall seasons that he ditched *Ke-menka*, the tradional variety for *Talenga*. The traditional variety did not yield well under shortening rainfall patterns because it is a long maturing variety. *Adoko* narrates how he got involved in planting *Talenga* this way: *The first person I saw plant 'Talenga' was my friend here in 'Yua'. I observed that he had planted a new sorghum variety and had good harvest on his first trial. So I inquired from him how he got the new crop. He told me he got it from his 'Father's Uncle House' in 'Tongo', a community located in 'Tongo' District. So I also decided to visit my relatives in 'Tongo' and got some seed of the new sorghum variety. My late grandfather was a kin to this family. I only know that we are relatives but I do not know exactly how we are related. This family then gave me the first 'Talenga' seed, a small quantity just enough for trail. They did not tell me how to plant the crop. I returned to 'Yua' and started planting it with my previous experience of planting our traditional sorghum variety.*

Adoko shared his experience and knowledge of cultivating 'Talenga'. According to him, *it is early maturing and takes about four (4) months to mature. Hence, it matures before the rains stop under shortenening rainfall regimes. It therefore, strives better under the present rainfall regime than our traditional sorghum variety ('ke-menka'). At tussling, heavy rains can adversely affect seed development and lead to poor yield. At tussling, rainstorms easily blow down the plants and this can adversely affect yields particularly, if storm is severe. At tussling, the crop despises a kind of mild storm associated with 'mid-day rains' immediately accompanied by 'sunshine'. This adversely affects seed development and yields.* The point is that by midday, tussle pods of the sorghum are warm and open up for sunlight, [in what he termed] a relevant process that aids good seed development. However, when this process coincides with this kind of storm (associated with mid-day rains), warm water gets into the pods and destroys the seed development process. The resultant effect is that some pods get rotten and generally lead to poor yields. According to *Adoko*, he acquired this knowledge about the crop through its cultivation.

Source: Compiled from In-depth Interviews, *Adoko*, 2008/2009

The case of *Adoko* (Box 5.6) reveals some pertinent issues related to adaptation of household crop production to rainfall variability. First, a new sorghum variety (*Talenga*) is preferred to the traditional variety (*ke-menka)* for adapting sorghum cultivation to shortening rainfall seasons. This is because *Talenga* strives and yields better than the traditional variety under shorter rainfall durations. Secondly, *Adoko* obtained information or learnt about this new sorghum variety through social and kinship ties. Thirdly, through experimentation and years of cultivation, *Adoko* has learnt a lot about the characteristics of the new sorghum crop.

In the next case (Box .5.7), I will show how a female farmer, *Aminga*, adopted *Talenga* in order to adapt sorghum production to rainstorms that were very destructive of *'Ke-menka'*, the indigenous variety of sorghum.

Box 5.7: *Aminga* ditches *Ke-menka/Kemolga* for *Talenga* to avoid rainstorms

Aminga is a 50 years old female head of household who lives with her daughter, a teenage grandson and an aged Aunt. In this case, I will show that her perception about 'the loss of a community tradition of controlling rainstorms' is a major concern for *Aminga* because it adversely affected production of her *ke-menka*, a traditional sorghum variety. I will also show how *Aminga's* analysis and understanding of this situation led her to adopt *Talenga,* the new sorghum variety for avoiding rainstorms associated with changing rainfall patterns.

According to *Aminga,* the traditional land owners/soothsayers had a way of controlling rainstorms – especially in September in the 'old days'. 'kemen-ka' tussled during this period and despised such storms. She thinks that the community has lost the ability to control these winds today. The *Tindaana* who acts as custodian of the land and spiritual head of the community will bare noise making through an announcement those good days. On order, old stalks of millet stored on top of trees were brought down from trees as a custom to pave the way for fresh stalks from new harvest. When the *Tindaana* did this, he also controlled rainstorms or winds through traditional sacrifices, worshipping and spiritual powers. But now the traditional authorities have lost the capability to control these rainstorms. When asked why it was so, *Aminga* had this to say. *You see, previously, the Tindaana was not supposed to go anywhere, delay and return home at night. But these days, they go anywhere drinking and return very late or even don't return sometimes. They may even be drunk and therefore, be away with the spiritual powers of shrines and community gods. Indeed traditional authorities are not adhering to tradition and taboos strictly these days. They have loss purity and have loss power as a result. Now we even have churches, which were not part of us. So, we have loss our culture and we are now suffering from our deeds. Do you now see why we plant 'Talenga'?* She asked rhetorically. *With 'Talenga', the plants tussle earlier and mature before destructive rainstorms set in mostly in September. So when the rainstorms, particularly the most destructive mid-day rains and sunshine occur, they have no impact on their yields. This is the reason why yields of 'Talenga' are better than that of 'Ke-menka' under the present rainfall regime. I am not even sure if there are any farmers here who still cultivate 'Ke-menka',* she added.

Source: Compiled from In-depth Interviews, *Aminga*, Yua, 2008/2009

A number of issues are deducible from the case of *Aminga* (Box 5.7) pertaining to adaptation to rainstorms. First, according to *Aminga*, the community has loss its powers and ability to control rainstorms as it did in the past because of social change in the community. Secondly, *Aminga* adopted *Talenga* in order to avoid the destructive impact of rainstorms. *Talenga* is early maturing (4 months) and tussles before the September storms set in. Because *Ke-menka* was long maturing (5 months), tussling often coincided with these rainstorms and this adversely affected seed development of the plant. Rainstorm is a community-wide problem that affects seed development in the production of sorghum (Photo 5.3). In the photo, a female farmer assisted by Patrick shows the effect of mid-day rains and rainstorm on seed development of *Talenga* from her *Sammani*.

Photo 5.3: Sii fõŏsi as shown by a female farmer in *Yua*

Source: Field Photo, 2008

As shown in the photo, the plants grow well to the finish except failing to produce seed due to the effect of the rainstorms. This phenomenon is called Sii fõŏsi in the local parlance. Although Sii fõŏsi is a community-wide problem, it does not affect the community evenly for some reasons. First, individual households and sections plant at different times during the planting season sometimes due to differential distribution of rainfall within the community or differential distribution of the nature of soils within the community. This may make it suitable to plant with early rains in some sections but unsuitable for early planting in other sections. For instance, it is possible for a section to start first weeding while another section of the community is actually planting. Secondly, oral accounts during focus group discussions show that these rainstorms often have varied ‘pathways’ and in the process affect farmers differently. Some farmers may be more affected than others may. The nature of rainstorms and its differential impact on individual farmers and sections also helps with adaptation in the community. Those households that are most affected often obtain support from those that are not impacted. This reduces community scale vulnerability to this type of rainstorm.

In my next case (Box 5.8), I will examine how a female farmer, *Abowine* adopted a new rice variety to adapt rice cultivation to shortening rainfall season.

Box 5.8: *Abowine* ditches *‘Mŭŭ kiliga’* for *‘Sane ki ya’* to adapt to shortening rainfall

Abowine is a 55 years old widow and female head of household. She has two sons both of whom have migrated to southern Ghana where they work. *Abowine* lives mostly by her self and sometimes with her grandson.

Abowine planted *Mŭŭ kiliga,* an indigenous rice variety some 20 years ago when she and her husband returned to the village as ‘returned migrants’. At that time, she planted rice on her own with support from her children while at the same time helped her husband to cultivate cereals on the *Sammani*. Her husband did not participate in the rice cultivation because his focus was on millet and sorghum production for the household, which was what every man did. As at now, she cultivates a new rice variety locally called *Sane ki ya in* her *Boo* along the banks of River *Akulaa* behind her homestead. Asked why she now prefers to plant *Sane ki ya*, she had this to say: *When you see that some people are farming a new rice variety, you also make inquiry. If it is good, you also start planting. These days, we plant new crops when they are early maturing and drought resistant. I cultivate Sane ki ya because it is early maturing. Mŭŭ kiliga* is a long maturing traditional crop variety. When you plant it these days, it does not mature before the rains stop. When you plant it these days, you have indeed planted it for livestock to graze on because it stays on the field for long. These days, we are not certain about the duration of rainfall and this creates problems in the cultivation of crops. The rains can start early but also stop earlier than expected or start late and stop early. This is the reason why *Sane ki ya* which is early maturing (3 months) strives and yields better than *Mŭŭ kiliga* (4 months) under shortening rainfall durations.

For 2008, *Abowine* got one basin of *Sane ki ya*. This low output was because she did not have the labour to weed. Previously, she could harvest 2 maxi bags because her daughter lived with her then and supported her on the farm. The rice that is cultivated is essentially consumed at home but a little portion of the harvest may be sold to solve petty problems. Sales according to *Abowine* are rare. If at all, only small quantities 1-2 *‘Alonka’* bowls may be sold. She observed that *rice is* *usually for us the women because we farm it. So if you have a problem and your husband does not have the money, you can consult him and sell some of it to solve the problem'. Presently, I rarely sell some of my rice because I keep it for home consumption.*

Abowine learnt about *Sane ki ya* through her brother's wife in *Vea*, a community located in neighbouring *Bolgatanga* District. She was the one she first saw plant the new crop variety when she visited some four years ago. She obtained seed of this new rice variety from her for trial and has since been planting it. She has planted *Sane ki ya* with her knowledge on rice cultivation in the past but she has also introduced some innovations. *Abowine* applies neither chemical fertilizer nor organic manure. What she does is to sprinkle some little salt on her rice farm. She applies salt at the early stage after the first weeding when she notices that it will rain. She observed that applications of salt that are followed by rainfall facilitate plant growth. The plants become very greenish and turn to grow fast. This in her opinion is because the salt is 'tasty or sweet' for the plants just as it is tasty for humans when it is used for cooking. She buys just about 20 pesewas worth of salt from *Sirigu* market, which is less than a Milo tin for the purpose. She leant this technique of salt application from another female rice farmer, a native of *Tanga-Dooni*, a neighbouring community in the Bongo District. They both cultivated rice along the banks of river *Akulaa* and shared farm boundary.

Source: Compiled from In-depth Interviews, *Abowine, Yua*, 2008/2009

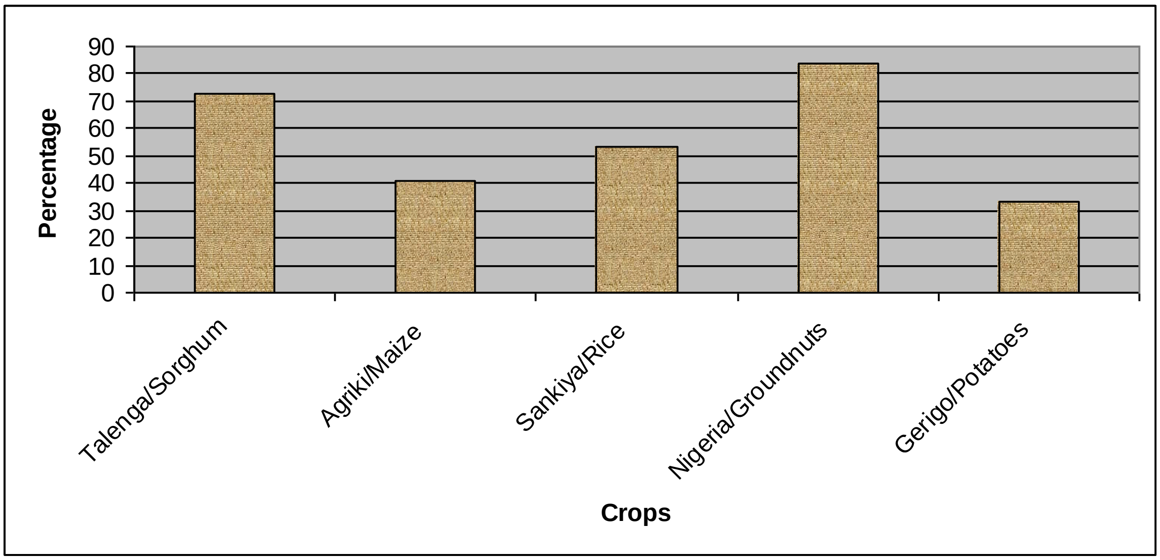
The case relating to *Abowine* (Box 5.8) reveals some pertinent issues relating to adoption of *Sane ki ya* to adapt to shorteneing rainfall season. First, *Abowine* adopted *Sane ki ya* as an early maturing rice variety to adapt household rice cultivation to shortening rainfall seasons. She began to have difficulties in planting *Mŭŭ kiliga* because it was long maturing and sometimes rains stopped when it was not yet ready for harvest. It also required early planting but delays in starting of rains also meant that the variety was no more suitable for cultivation under shortening rainfall patterns. This was a push factor for adopting an early maturing crop variety. Secondly, she cultivates rice mainly for household consumption so that finding innovative ways of sustaining rice cultivation was essential for reducing livelihood vulnerability of the household. Thirdly, *Abowine* learnt about the new rice variety and some farmer innovations through social and kinship ties. Fourthly, she used her knowledge of *Mŭŭ kiliga* cultivation to plant the new rice variety – blending indigenous and new external knowledge.

At this point, I will shift my attention from examining cases to discussing the generality of adoption of new crop varieties for adapting to shortening rainfall durations in the *Atankwidi* Basin. In the broader context of the *Atankwidi* basin, households are adopting new crop varieties mainly for purposes of adapting crop production to shorter rainfall seasons. Female focus group discussants in *Yua* agreed on the importance of new crop varieties for livelihood sustenance at the household level under current rainfall patterns. They generally reached consensus that:

> New and early maturing crop varieties are important in sustaining households under shortening rainfall patterns. They are early maturing and perform better than traditional crops when the rainfall period is short. As such, yields from planting new crop varieties sustain families any year the rainfall season is short.

Results from survey corroborate the assertion that farmers are adopting early maturing crop varieties to adapt to shortening rainfall seasons in the *Atankwidi* basin (Figure 5.5).

Figure 5.5: Five new crop varieties planted among 131 households in the *Atankwidi* basin



Source: Field Survey, 2008

From the analysis, at least 30% of households (39 out of 131) cultivate all the five selected new crop varieties in the basin. However, over 50% of households cultivate *Talenga*, *Sane ki ya* and '*Nigeria'* as new crop varieties. Specifically, 84% of households (110 out of 131) cultivate *'Nigeria'* (groundnuts), followed by 73% (96 out of 131) who cultivate *Talenga* (sorghum) and 53% (69 out of 131) who cultivate *Sane ki ya* (rice). This suggests a high uptake of *Nigeria*, *Talenga* and *Sane ki ya* than *'Agriki'* (maize) and *Gerigo* (potatoes). Maize in particular is not a staple crop and that could explain the reason for lower uptake. However, there seem to be an increasing trend in the adoption of new maize variety because it is early maturing. It is gradually becoming popular among households. The evidence shows that 41% households now cultivate a new crop variety. In the case of *Gerigo* (potatoes), it is relatively new so that its adoption is yet to be widespread among households. Although new, its adoption is phenomenal as evidenced by its cultivation by 33% of households (43 out of 131).

5.3.4 Multi cropping - 'blending traditional and new crop varieties'

Evidence from the study shows that in reality most households generally practice multi-cropping by intercropping traditional and new crop varieties. As a 'rule', every household intercrops *Naara*, *Zea* and *Talenga*, the former two being traditional crop varieties and the latter a new variety. Together, these are the staple grains that are milled into flour for household consumption in every household. Evidence from the survey corroborates this assertion by revealing that high proportion of households cultivates these three crops. For instance, the results show that 91% cultivate *Naara* while 92% cultivate *Zea*. The results also show that 73% cultivate *Talenga* (Figure 5.4). Beyond this, households intercrop a wider diversity of crops. The combinations of crops vary from household to household. See Table 5.2 for the diversity of crops that households inter-crop in the basin.

Table 5.2: Diversity of crops that households intercrop in the *Atankwidi* Basin

Traditional crops	New crop varieties
▪ Naara – early millet	▪ Talenga – sorghum
▪ Zea – late millet	▪ Kadaa - sorghum
▪ Mǔǔ kiliga - rice	▪ Sane ki ya – rice
▪ Sumkam-menka – groundnuts	▪ 'Agriki' Kamenka – maize
▪ Nanugle-menka - potatoes	▪ Gerigo – potatoes
▪ Kaman-menka – maize	▪ 'Nigeria' – groundnuts
▪ Bonga – sorghum	▪ Wogro – beans
	▪ Soya beans

Source: Field Survey, 2008/2009

The analysis shows that households in the *Atankwidi* basin generally have a wide portfolio of crops that they intercrop (Table 5.2). They draw on a wide diversity of traditional and new crop varieties. Multi cropping and intercropping are part of the local knowledge on risk management for adapting to rainfall variability within the basin.

In the discussion so far, I have attempted to illustrate that household crop production is vulnerable to rainfall variability in the *Atankwidi* basin and the larger Volta basin of Ghana. Inter-annual variability leads to a mix of droughts and heavy precipitation. On the other hand, intra-annual rainfall variability occurs in the form of shorter rainfall seasons, dry spells and droughts, high rainfall intensities and floods due to unfavourable distribution. Such variability is not favourable for crop production. Thus, low crop yields in the basin are partly attributable to inter –annual and intra-annual variability of rainfall. As a response, households are employing local knowledge systems for adapting crop production to rainfall variability. These measures include the cultivation of multiple farms, staggering of seeding and cultivation of drought resistant traditional crops. Others include the adoption of early maturing crops and multi-cropping strategies. These strategies comprise both indigenous and new knowledge systems combined in various forms and shades by households. Through these measures, some households have been able to sustain crop production under rainfall variability. Others have stabilized their yields while others have increased their yields. Thus, households are reducing the vulnerability of crop production to rainfall variability through local knowledge systems in the *Atankwidi* basin.

5.4 Summary and emerging issues

In this chapter, I discussed the role of local knowledge for adapting food crop production to rainfall variability in the *Atankwidi* basin. In my discussion, I have outlined that the quest for addressing vulnerabilities of food crop production to rainfall variability is the driving force for the adoption of local knowledge systems of adaptation among households. The discussion captured the ‘double structure’ of vulnerability. On the one hand, households are vulnerable because they depend on rain fed cultivation and thus, exposed to the risk of rainfall variability. On the other hand, this exposure to risk comes with it the difficulty of adapting to rainfall variability in crop production, which can affect livelihoods in the basin. Some emerging issues arise from the discussion.

The discussion shows that household food crop production in the *Atankwidi* basin and northern Ghana at large is vulnerable to rainfall variability. Rainfall variability takes two major forms – inter annual and intra annual variability. For inter-annual variability, some years may be wet and others dry both of which are a departure from normal year rainfall. Intra-annual rainfall variability manifest in shortening rainfall durations, dry spells and droughts, heavy rainfall and floods. Such variability in rainfall contributes to low crop productivity and production in the *Atankwidi* basin. As a result, household crop yield is vulnerable to unreliable rainfall. This vulnerability is manifest in many ways. These include low crop yields, declining crop yields and or fluctuations in crop yields, which have adverse implications for household livelihoods.

In response, farm households are exploring the use of various local knowledge systems for adapting household crop production to rainfall variability. This reduces the vulnerability of food crop production to rainfall variability. These knowledge systems include the cultivation of multiple farms and staggering of seeding. Others are the cultivation of drought resistant traditional crops, the adoption of early maturing crops and multi-cropping strategies. These strategies draw on both indigenous knowledge handed down from generation to generation and new knowledge systems drawn from external sources. Kinship and social networking facilitate such knowledge flows. Interventions of development organizations also facilitate the localization of knowledge.

The overall outcome of applying local knowledge systems is that households are reducing vulnerability of food crop production to rainfall variability. Vulnerability reduction manifest in various experiences for different households. For some households, this has lead to halting a declining trend in yields and stabilizing food crop yields for supporting consumption. For other households, this has lead to an increasing trend in food crop yields for supporting household consumption.

5.5 Conclusion

In the beginning of this chapter, I set out to discuss the role of local knowledge systems for adapting food crop production to rainfall variability in the *'Atankwidi'* basin, northern Ghana. In my discussion, I have shown that food crop farming is vulnerable to rainfall variability. As a result, crop yields are low and or variable. This exposes many farm households to the risk of livelihood failure since food crop farming is a primary livelihood. In the quest to address vulnerabilities of food crop production to rainfall variability, households have resorted to multiple local knowledge systems of adaptation. These include the cultivation of multiple farms combined with staggering planting, cultivation of drought resistant traditional crop varieties and the adoption of early maturing crop varieties. These measures have enabled some households' halt a declining trend in crop yields while others have increased their output to support household consumption. Given the strategic importance of local knowledge systems for sustaining livelihoods, Chapter 6 is devoted to a discussion of local knowledge flows.

Chapter 6

6.0 Local Knowledge Flows and Localization of Knowledge

6.1 Introduction

In this chapter, I discuss local knowledge flows and localization in the context of farm households striving to sustain their livelihoods in Yua and the *Atankwidi* basin at large. In the empirical discussions (Chapters 3, 4 & 5), I have illustrated the role of local knowledge in reducing livelihood vulnerability to environmental change. Thus, local knowledge access is crucial to the efforts of households towards sustaining their livelihoods. In my discussions, I have illustrated that local knowledge is a strategic factor in development. Despite the importance of knowledge in development, local knowledge flows remain a grey area in development research. For instance, Alavi and Leidner, (2001:126) point to large gaps in the body of knowledge transfer. While there has been some progress in research on knowledge transfer in relation to firms and corporate entities in the Western World, such progress in the field of development studies is generally lacking in Developing Countries. Ghana is no exception. The World Bank (1999) underscores that 'wide knowledge gaps' exist between the Developed and Developing Countries and that this gap is much greater in terms of knowledge than GNP. Evers (2003) recommends closing this 'knowledge gap' as a development strategy. Although this recommendation is appropriate, understanding the processes of knowledge flows will be central to bridging this knowledge gap. The essence of this chapter is to contribute to the field of knowledge diffusion by discussing local knowledge flows and the localization of knowledge for enhancing the abilities of households to reduce their vulnerability to environmental change in the *Atankwidi* basin.

The discussion is in six parts. In the first part, I discuss local knowledge diffusion and its impact on vulnerability of livelihoods. In the second part, I discuss patterns in local knowledge flows at the household level as shaped by kinship and social organization. In the third part, I examine the ‘localization’ of external knowledge in household production and the role of kinship and social networking in the process. In part four, I discuss the role of community organizations and external agencies in the ‘localization’ of knowledge. In part five, I present a summary of the discussions and then conclude in part six.

6.2 Local knowledge diffusion and livelihood vulnerability

In my previous discussions, I have illustrated that local knowledge is the ‘life –line’ in household livelihoods in the *Atankwidi* basin in the context of environmental change. In Chapter 3, I discussed livelihood diversification and the inter-generational dynamics in response to environmental change as an embodiment of the local knowledge systems of the people. For generations, rural farm households have largely depended on inherited traditions of livelihoods (‘ascriptive’) although subject to adaptation to new situations. In Chapter 4, the discussions illustrated the importance of local knowledge in reducing the vulnerability of subsistence food crop production to land and soil degradation. In Chapter 5, the discussion illustrates the role of local knowledge for adapting food crop production to climatic changes especially rainfall variability. Overall, these discussions reveal some emerging issues that are relevant for discussing local knowledge flows:

1) That local knowledge is important for reducing vulnerability of rural household livelihoods to risks, perturbations, shocks and contingencies arising from environmental change;
2) That differential levels of livelihood vulnerability are partly depended on the level of commitment and application of relevant local knowledge available;
3) Finally, that the utilization of relevant local knowledge reduces household vulnerability to environmental change. Given such positive results, rural farm households are more than ever, committed to the utilization of local knowledge for sustaining their livelihoods especially under environmental change.

These empirical results give strength to the assertion that knowledge is a strategic[51] factor in development and a driving force of innovation and development (Brint, 2001; World Bank, 1999; Pottier, 2003; Evers and Gerke, 2004; 2005). Drucker and Nissen express this view in comparative terms. They assert that knowledge represents one of the very few sustainable sources of comparative advantage in development today (Drucker; 1995; Nissen; 2002). Much as the role of development experts is central to closing this gap, such experts have a biased preference for implementing scientific-rational knowledge to the neglect of social and cultural considerations (Goulet, 1980; Evers and Gerke, 2005). This brings to the fore the usefulness of anthropological and sociological perspectives, such as kinship and social networking for analyzing patterns of knowledge diffusion.

There are two common patterns of knowledge diffusion in relation to the acquisition of knowledge for economic successes of firms (Singh, 2005:756). First, this include, knowledge flows as geographically localized (Jaffe et al., 1993). Secondly, this includes the easy diffusion of knowledge within a firm than between firms (Kogut and Zander, 1992). These observed patterns are useful and adapted for my discussions on local knowledge flows in the context of rural community livelihoods in the *Atankwidi* basin. The subject of local knowledge flows is particularly important because the capacity to benefit from knowledge derives from two basic elements. First, the ability to acquire and

[51] As the discussions in chapters 4 and 5 show, local knowledge is truly a strategic factor in development because it has helped sustain livelihoods of farm households in the basin. However, some local knowledge become obsolete overtime and no longer useful for sustaining livelihoods in the context of emergent environmental changes. Some examples in relation to *Yua* in particular and the *Atankwidi* basin in general on crop varieties will illuminate this issue. The traditional variety of sorghum, generally known as *kemolga* is virtually an extinct crop variety. This crop variety is no more cultivated among farmers mainly because it had long maturity duration (5 months) and thus, unsuitable for the current shortening rainfall seasons. There are other traditional crop varieties that have been abandoned or are gradually being abandoned for similar reasons. Such crops include *Nanugle-menka* (potatoes) and *Mŭŭ kiliga* (rice). In many of these cases, farmers have willingly traded certain good qualities of these traditional crop varieties for quantity in their endeavour to sustain their livelihoods. For instance, *Nanugle-menka* is reported to be sweeter and easily stored for a longer period of time than the new potatoes variety (*Gerigo*). Nonetheless, virtually every farmer is resorting to the cultivation of *Gerigo* in the basin *because* it is early maturing. This makes it most suitable for cultivation under shorter rainfall seasons. Farmers point to an overwhelming evidence that *Gerigo* yields better than *Nanugle-menka* in current rainfall regime even under poor soils. The strategic nature of knowledge also manifest in the fact that farmers cultivate new crop varieties by heavily depending on their previous knowledge and experiences in cultivating the very traditional crop varieties they abandoned. This is particularly important given limited access to extension services by majority of farmers in the basin.

apply relevant local knowledge that already exists. Secondly, local knowledge flows influence the ability to produce new knowledge relevant for addressing development problems. In the context of knowledge importation 'from one place to another', the importing society ought to be able to acquire, absorb, understand, interpret and adapt it to local needs and situations (Cohen and Levinthal, 1990; in Gerke and Evers, 2005: 82). "Knowledge, therefore, has to be imported and adapted to local requirements, i.e., global knowledge have to be 'localized'." (Evers, 2003; 2005:82).

6.3 Kinship and internalization of local knowledge flows at household level

Kinship and marriage are closely associative and grow out of practical and complex strategies. They constitute the basis for perpetuation of a system of "biological, cultural, and social reproduction" (Bourdieu, 1976:141). In simple terms, kinship is a relationship between entities [people] that share a genealogical origin through biological, historical or cultural descent (see Wikipedia, 2010). Kinship is fundamental to the constitution of social networks and analysis of social action. Social relations, including kinship and exchange are embedded in social relations beyond local networks (Schweizer and White, 1998:1). In the *Atankwidi* basin, kinship shapes the basic social structure of the people. The household and the extended family are the basic units of kinship. The household is the basic family unit providing an immediate learning environment[52] in which local knowledge is transmitted, accessed and internalized for sustaining livelihoods. A typical household (*deo*) in the *Atankwidi* basin comprises father, mother, and children and may include two to three other relations. A typical *deo* does not exist in isolation. It exists

[52] According to Millar (1996: 80-120), the family unit is surrounded by an 'immediate environment' and a 'distant environment' which comprises a combination of locations and functions. The immediate environment is an 'active environment' and its boundaries are defined by markets, drinking bars, farms and forests as locations. In addition, such activities as funerals, hunting, herding of livestock, water and fuel wood fetching, fruit picking, communal activities, marriages, and sacrifices are functions that provide learning opportunities within the immediate environment. Similarly, the 'distant environment' is characterised by functions and locations. "Government institutions, external religious institutions, and formal/non-formal schools are some of the locations; whilst migrant labour and visits to other villages are functions. Migrant labour and visits to other villages are described as functions because of the functional relations that bring people together for sharing. Migration is often generally described as a wage- and a labour-activity but it is also important for its exposure, and particularly providing a milieu for learning" (Ibid.: page).

among one to three other households (*detto*) sharing a compound house (*Yire*) and living together as one extended family. These *detto* are related to each other by patrilineal descent or system of inheritance. This extended family as represented by the *detto* provides an extended immediate learning environment within which local knowledge transmission and learning occurs. The *Yidaana* is the head of the extended family system and doubles as head of his own *deo*. Every other *deo* within the *Yire* usually has a head who take charge of leadership of their respective households. However, these household heads are subservient to the *Yidaana* who is an elder and head of the extended family.

In the household, local knowledge as *'what and how'* the household do for a living is passed on from generation to generation within its immediate learning environment. The pattern of flow is that knowledge flows from 'grandparents to parents' and from 'parents to children' within the household production system. In my discussions (Chapter 3), I have shown that livelihood diversification comprising the portfolios of livelihoods is partly an embodiment of the local knowledge of households and that this knowledge is passed down from generation to generation through various informal ways. Take the example of food crop farming as a primary livelihood. In the livelihood profiles of *Atanga* and *Abowine* (Chapter 3), food crop farming is a primary livelihood across three generations of the households. Poultry and livestock rearing is a secondary livelihood undertaken by all three generations of the same households. These livelihoods have transcended generations through inter-generational inheritance within the household. This suggests that these livelihoods are essentially 'ascriptive' (Chambers and Conway, 1992) given that subsequent generations inherited them as part of family traditions. Although I have pointed out from my three generational analyses (Chapter 3) that there is a gradual process of (de)agraniazation, food crop farming remains a primary livelihood for 87% of households (114 out of 131) among the current generation (sons generation). Subsequent generations do not only inherit family livelihoods, they also inherit a plethora of knowledge practices associated with these livelihoods. These knowledge systems are often passed on by the older generation to the next generation through multiple informal teaching and learning processes and techniques. The learning process[53] starts from childhood and can take various forms – children listening to conversations of parents and their friends, active participation (learning by doing) and in many cases observation. In *Atanga's* livelihood profile, he reveals the knowledge of farming as inherited from his father by expressing that he *'cultivates food crops the way his father practised crop cultivation'* (Chapter 3). These practices include combining *Sammani* and *Moom* farms, defragmentation or miniaturization of the *Sammani* coupled with different rounds of seeding and intercropping. From my experiences during fieldwork, many other farmers make similar references to their parents as the source of knowledge of farming practices. Such references establish a strong link of similarity between their 'farm practices today' and those of their parents and grandparents in the past. Thus, such linkages point to lineage and kinship as a major conduit and mechanism for sustaining local knowledge in household production systems.

The case of *Aputire* (Chapter 4, Box 4.4,) a female head of household, further sheds light on the role of kinship in knowledge transfer at the household level. The case shows that *Aputire* depends largely on organic manure for sustaining farming as a primary livelihood. She learnt four methods of producing and applying organic manure when she grew up as a girl. These include – burning crop residues to improve soil fertility on the *Sammani*; preparing *Tampugerɛ Pu'usego and Nandeene Pu'usego* (manure) and; weeding as an organic farming practice. All these organic farming practices worked for her because they helped her increase crop yields. The key issue is how this local knowledge was transferred to *Aputire*. From the analysis, *Aputire's* parents bequeathed this knowledge by creating an enabling learning environment within the household. She learnt by practising with her parents; she learnt by observing what her parents did; and she learnt by listening to conversations between her father and mother, and between her parents and their friends concerning organic manure and other farming practices in

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[53] The learning process takes into consideration the 'changing environment' because new knowledge is practiced and leant in this context within the household production system. Thus, children are privy to most innovative interventions meant for adapting to environmental change because they are often involved in the innovative processes themselves once they are grown enough to do so. For instance, the case of *Atanga* (Chapter 4, Box 4.5; Chapter 6, Box 6.1) show that his children are involved in the innovative process of producing *Tanuko Pu'usego*, an innovative form of organic manure for countering poor soil fertility arising from degradation of their farm lands in crop production.

general. As is the case with many households [as in the case of *Aputire*], the household head is at the centre of local knowledge transfer at the household level. As the head, he or she exercises power and leadership in the primary livelihood of the household. He or she determines the mode of local knowledge transfer. However, there are other modes of learning that are not executed within controlled settings. Children by doing and observation learn a lot from their parents and sometimes unaware that a lot is learnt. The knowledge that is bequeathed to children is accepted as legitimate knowledge without 'critical questioning' within the immediate learning environment. This is because the household head is respected, trusted and believed to be an 'embodiment' of years of experiential knowledge. Here power within the household plays a role in the learning process. Delbos & Jorion (1984) mirror these learning processes in their book *The transmission of knowledge* in which they show how empirical knowledge was transmitted within family-based communities of fishermen, traditional salt-producers and oyster-breeders in Brittany. Jorion (2008) reviews their findings on knowledge transfer, thus:

> That although sons and daughters renewed the same patterns of occupations generation after generation, there was hardly any knowledge properly transmitted in such traditional environments. Rather, a child was introduced to becoming part of the production process at an early suitable age. Contrary to expectation, the child would not be taken through formal training - by being shown and explained to. The child would be put at a location of strain in the productive process where s/he can play a useful role. Instead of being told what to do, the child would be asked to improvise intelligently. This occasionally led to inadequate behaviour resulting in scolding and very little explanation on the subject of learning. This process is maintained until the appropriate behaviour becomes a habit. The novice [child] would therefore have to re-invent the technique for his/her own purpose, rather than being formally taught it. One day the novice is told that s/he knows all that needs to be known, although s/he feels inadequate. Such mode of teaching would function effectively in the context where sons learn from their fathers and daughters from their mothers. The acquisition of knowledge in this way coincides with the renewal of generations and the *'You are an expert my son'*, would coincide with the *'You are a man'* (Jorion, 2008:8).

In cases like these, the kinship network can be described as carrying information flows in a particular manner and that it is essentially through identification that some knowledge is reproduced generation after generation (Ibid.). Inheritance of for [instance knowledge] is customary and not contentious, and very often based on the needs and contingencies of particular families and sets of individuals (Geertz 1961: 46-54; in White & Schweizer, 1993: 43). Referring to such local farmers knowledge on soils and traditional crop management in *Dalun* (northern Ghana), Mikkelson and Langohr (2004:1) described it as “indigenous knowledge” [..] “based on inherited experience gained over many generations and is passed on verbally from generation to generation”. This observation of ‘verbal transfer’ of knowledge also underpins the active nature of the learning environment as described by David Millar. According to Millar (1996), interactions between people and the immediate environment for purposes of learning are more aggressive and spontaneous than with the 'distant environment'. This is because there is more regular intercourse here, especially for adult learning [but also for children] and that learning occurs in a ‘give and take’ fashion. Information that is available in this environment is considered more trustworthy than information from elsewhere. However, two tendencies arise from this situation. First, that there is a tendency for people to pit this information against other findings but that information from within the immediate environment is given the benefit of the doubt when ‘conflict of information’ arises from such comparisons. Secondly, that people also have a tendency to fall back on this information when that acquired from outside is not delivering as expected.

Local knowledge flows within the household is predominantly ‘closed’ because flows, access and learning easily occur in daily interactions and seasonal livelihoods within the household production system rather than outside it. Thus, individuals within the household have better access because of their direct social connections to the source of knowledge (Sorenson et al., 2006) than those outside the household who may have less such connection. They find robust evidence to support the proposition that “socially proximate actors have the greatest advantage over distant actors for knowledge of moderate complexity” (Ibid.,:1). Millar (1996) draws on a popular anecdote to illustrate one of the general rules of teaching/learning within the household learning environment among the *Dagaaba* of north western Ghana (Box 6.1).

Box 6.1: A legend of keeping the family 'secret' in local knowledge systems among the *Dagaaba* of northwestern Ghana

The legend is told about a famous hunter who went out hunting and met an old bush cow and its calf. He shot and killed the bush cow but the calf escaped. After some time this calf grew up and charged itself with pursuing and killing that hunter who killed its mother. One day the hunter went out hunting and came across a very beautiful lady whom he married and brought home. The hunter's mother was very happy to have such a beautiful daughter in-law.

During the first night together, the young lady told the hunter how she admired his skills, and asked him how he managed to kill dangerous animals which can change their forms, like bush cows. In order to show off, the hunter told his bride that he first shoots at them and then turns into a stone, when they turn into that, he turns into a grass, when they turn into that he turns into a tree, and when they turn into that he lastly turns into............................

Then his old mother interrupted with "fari jog" - meaning 'it is enough - don't let out the family secret. Not even to your new wife'.

The story continued that the next day the wife asked the husband to accompany her to fetch firewood which he willingly did. When they got into the forest, his beautiful wife turned into a bush cow and came at him. He turned first into a stone and she did the same. Then he went through all the stages he had mentioned the previous night and she followed through. Lastly, he turned into a needle and entered the tail of the bush cow. This kept pricking the cow and it kept hitting itself against the trees until it died.

The moral lesson is; never to tell all (especially family secrets), to those outside the immediate environment.

Source: Millar (1996: 82-84).

This legend among the *Dagaaba* of northwestern Ghana (Boxe 6.1) as illustrated by David Millar support my discussion on internal knowledge flows in various ways. First, the legend supports the assertion that knowledge flows much easily within the immediate household environment than between households. As the legend suggest, one day was enough for a bride (newly married wife) to learn a lot about the knowledge (skills and powers) of her husband, the great hunter which she used against him the next day. As a wife, she easily accessed this knowledge as a socially proximate actor within the household. In a typical household setting, children are also socially proximate actors and would easily access or learn about knowledge within the household much the same way as many other household members. Secondly, the "fari jog" interruption by the hunter's old mother turned out to be what saved his son, the great hunter when he was under attack by his newly married wife (who had turned into a bush cow) and attacked him. This also underlines the fact that every household will try to keep some vital knowledge a family ‘secret’ in order to maintain a certain comparative advantage within the environment it operates. The interruption of the hunter’s old mother was timely to enforce a ‘norm’ of confining some key knowledge to only some key members of the household that the hunter had grossed over in his joyful mood with his newly found wife. Women may gain the status and right of holding to such key information but only if they stayed in the marriage for long and contributed immensely to the development of the family do they earn such a respectable status of being ‘custodian’ of some key family knowledge. In Chapter 2, I outlined that an elderly woman who had given birth to many children and probably having many grandchildren earns a reputable status in the family much the same way as a male counterpart in *Yua* and *Atankwidi* basin in general. Such a woman is awarded the highest honours in funeral rites after death (i.e., organizing all funeral rites) that she deserves. At this point, I will like to re-state the point that knowledge flows much easily within the household than between households in much the same way as with firms. Thus, this observable pattern in knowledge flows relative to households is comparable to the observable pattern that knowledge diffuses more easily within a firm than between firms (Kogut and Zander, 1992).

Local knowledge access within the household is not very ‘exclusive’ either to household members only; neither is it the case in relation to the firm. Such descriptions are suggestive of the predominant tendencies and the dominant patterns. In the context of households, social ties and interactions in the extended family system within ‘localized economic spaces’ also provide conduits for ‘leakages’ of knowledge within the household. For instance, in the area of food crop farming, the immediate learning environment extends beyond the immediate household environment. As already discussed, it comprises the extended family setting and its production system. In this case, the household together with its productive assets, family lands comprising *Sammani* and *Moom* and the extended family together provide the immediate environment within which local knowledge is transferred or learnt. People belonging to different households within the ‘compound’ interact among themselves daily and sometimes support each other under ‘labour pooling’ arrangements especially in farming. Consequently, social and economic interactions within the ‘compound’ provide mechanisms for ‘leakages’ of local knowledge within the household. Although local knowledge may be regarded an important household resource or ‘secret’ in order to maintain an advantage, rural dwellers are predisposed to sharing their knowledge with relatives and non relatives in the spirit of oneness and belongingness in their social milieu. Such kinds of ‘leakages’ in knowledge flows also exist among firms. Every firm clearly gains from knowledge spill over when it receives information, but when its own is shared it erodes its competitive advantage. Despite this fact, several studies (e.g., Rogers, 1982; Allen, 1984; Ingram and Roberts, 2000) have shown that firms generally benefit from knowledge spill over and that “informal exchange of information between agents in different organizations is frequent in the innovation process” (Ǿstergaard, 2008:197).

6.4 Kinship, social networking and household localization of external knowledge

The point that local knowledge is dynamic and change over time plays out at the household level. Several factors, including kinship and social networks and organizations (community based and external) drive the processes of knowledge flows that facilitate change in local knowledge. Households are constantly involved in the evolution of local knowledge – herein referring to blending ‘indigenous knowledge’ with new ‘external knowledge’ to address challenges confronting household production. The social structure as shaped by kinship plays a key role in this process. Kinship is a basic institution in society, ordering social interaction, reproduction, and the flow of resources [including local knowledge] (Schneider, 1984), and hence continues to be a central focus of anthropological inquiry (Shimizu, 1991; in, White & Schweizer, 1993). In the context of knowledge evolution, the head of household is at the centre in the uptake of new knowledge and the localization of such knowledge in household production systems. Women are also increasingly contributing to the uptake of new knowledge in household production systems. From my previous discussions (Chapters 4 & 5) this plays out in food crop farming. For instance, I have shown how *Aminga*, a female head of household introduced innovation in the making of *Nandeene Pu’usego* (a traditional form of farmyard manure) in *Yua* (Chapter 4, Box 4.3). The discussions show that she originally, learnt how to make this kind of traditional manure from her parents but also practised it with her late husband. The discussions reveal that cow-dung is a key material in the making of *Nandeene Pu'usego* because it facilitates decomposition. However, *Aminga* has circumvented this practice through some innovation because she lacks cow- dung. In the absence of cow-dung, she uses mainly crop residues but has to supplement this with a routine watering regime and turning of the organic materials intermittently to facilitate decomposition. These innovations were inspired from compost making practices she observed from her Aunt's family in *Bungu*, Burkina Faso during social visits. This is also suggestive of the role of kinship and social networking in facilitating flow of new knowledge to the household. Since *Aminga* introduces her daughter and grandson to practices associated with making *Nandeene Pu'usego* when *cow* dung is lacking, she has invoked multiple processes of bequeathing to them an innovative way of making this indigenous form of manure. Her daughter and grandson will most likely grow to apply this knowledge in making manure when they are confronted with the lack of cow dung. It is also most likely her daughter and grandson will serve as agents of transferring this knowledge to subsequent generations along family lineages. In another example, I have shown that *Atanga*, a male head of household, adopted *Tanuku Pu'usego* , an 'adapted version' of a new form of organic manure for improving soil fertility drawing on inspiration and information from external agencies and distant relations (Chapter 4, Box 4.5). Here, some issues on local knowledge flows and localization in relation to the case of *Atanga* are examined in Box 6.2.

Box 6.2: External sources and local knowledge flows to *Atanga*

Atanga started preparing Tanuku *Pu'usego* six years ago following advice by AEAs. These officers went round compounds advising farmers to dig pits in which organic materials can be dumped for making compost for improving soil fertility. These officers did not return to the community since their initial contacts. Around the same time, the Information Service Department of Ghana was also disseminating information that farmers should stop burning on their farms to prevent bush fires. Following these interventions, *Atanga* decided to deepen a *Tanuku* (pit created from construction activities) he inherited from his father. *Atanga* and his household members will gather and deposit a wide variety of crop residues and animal droppings in the *Tanuku*. He stopped the practice of burning crop residues during land preparation – instead he will deposit all plant stumps generated during land preparation into the *Tanuku* at the beginning of the rainy season (April). *Atanga* also dumps remnants of chicken feed, that is, cow dung particles used for trapping termites for feeding poultry in the *Tanuku* .

Atanga's involvement in *Tanuku* manure was also inspired by his social contact with his Uncle in Burkina Faso, specifically in a community called *Ziko*. *Atanga* visits his Uncle very often and returns the same day except on special occasions. When he is there to mourn with the family during a funeral, he spends between two and four nights. He recalls that a government department in Burkina Faso advised his Uncle and other farmers in *Ziko* to make compost from pits. According to him, the Burkina government officials educated and supported farmers over there to dig pits to some specific measurement standards, line the pits with stone and concrete, and use cement provided by the government to plaster the pits. Water channels are factored into the construction design to allow free flow of water into the pit during the raining season to facilitate decomposition. *Atanga's* Uncle also told him that sprinkling salt in the pit accelerates decomposition of the materials. *Atanga* has learnt about digging the pit to specific measurement standard and cementing it for compost making; but he has neither dug his *Tanuku* to specification nor cemented it because he lacks money to buy cement. In his construction, he has provided channels to aid flow of water into the *Tanuku*. *Atanga* also has no money to buy salt for compost making. So occasionally, he goes to the *Sirigu* market with his children to sweep and collect the top soils of sections of the market from which salt is sold. These top soils often contain some salt particles that drop to the ground during trading activities. *Atanga* and his children will then carry these soils home and sprinkle it over his compost materials in his *Tanuku* to aid decomposition.

Source: Compiled from In-depth-Interviews, Atanga, Yua, 2008/2009

The localization of new and external knowledge at the household level as exemplified by *Atanga* (Box 6.2), show that the processes of information flow and innovations in manure production revolved around the 'leadership' role of *Atanga.* As the head of household, he has the 'power' to exercise leadership as shaped by the social structure in the learning process. *Atanga* himself was the recipient of new information from external sources by virtue of his status and responsibilities in the household. He took the decisions as to what to do with the new information and what he learnt from his Uncle in *Ziko*. He took the decision to have his children involved in the processes of manure production. By the participation of his children in the process, they are also learning the art of making a new form of manure, along the lines described by Jorion (2008). They will most likely apply this knowledge in farming later in life when they become adults. They will most likely pass on this knowledge to their children in a similar fashion and this knowledge may be subject to changes arising from new circumstances and technologies. The experiences of *Aminga* and *Atanga* in learning new knowledge from relations living elsewhere and passing on this knowledge to their children by involving them in the production process also corroborates literature on knowledge exchange among firms. For instance, a significant component of a person's information environment consists of the relationships he or she can tap for various informational needs. Tom Allen of Massachusetts Institute of Technology (MIT) is cited for asserting that engineers and scientist were roughly five times more likely to turn to a person for information than to an impersonal source such as a data file or file cabinet. Research has consistently shown that who you know has a significant impact on what you come to know, as relationships are critical for obtaining information, solving problems and learning how to do your work (Cross et al., 2001:100). Within this context, social and physical proximity as existed between *Aminga* and her children and between *Atanga* and his children within their respective household production systems were crucial in the knowledge learning processes. In the access to knowledge, knowing what someone else knows is only useful if you can get access to their thinking in a sufficiently timely fashion. *Aminga* and *Atanga* created this enabling environment for their children by their direct and 'on the spot' involvement in application of new knowledge in production. Hence, access to knowledge is heavily influenced by the closeness of one's relationship, physical proximity and design of the learning environment (Cross et al., 2001:105). In the evolution of the innovative practices by *Aminga* and *Atanga,* they clearly obtained new knowledge through social interactions with a relative, friend or neighbour. Similarly, their children and other household members actively participated in the processes of innovation through interactions in the household production system. Thus the assertion that the innovation process [in the context of a firm] involves interaction and knowledge sharing between co-workers holds true for households – in which all categories of household members (spouses, children and other relation) are the actors. More importantly, innovation studies (e.g., Lundvall, 1992; Lundvall and Johson, 1994) show that innovation is an interactive process and that the central part of the knowledge required is often difficult to codify. For instance, the most general characteristic of the process of indigenous learning is said to be its contextualization. Thus, indigenous knowledge (IK) is closely tied to specific social, cultural, and economic activities within the household and its learning environment (community). To acquire IK therefore, some form of participation in those activities is essential in the learning process be it in a functional and or ritualistic context (Easton, 2004:10). As such close interaction among actors is important in the innovation process (Ǿstergaard, 2008:197) in all forms of knowledge (ie. indigenous and or local knowledge). These underlying processes of learning, innovation and interaction give rise to the occurrence of informal education[54] within the household learning environment - irrespective of whether what is learnt is 'indigenous knowledge' (IK) or 'local knowledge' as understood in this study (Chapter 1). In this respect for instance, indigenous knowledge [or for that matter local knowledge] presents a model for education in contrast to formal and informal education (Easton, 2004:10). According to Peter Easton, ENDA-Tiers Monde in Dakar, an NGO active in local development, suggest some useful distinctions that are relevant for exploring the multiple connections between indigenous knowledge and education. The NGO suggest three meanings or operational levels of indigenous knowledge (Easton, 2004:10):

- IK as a heritage from the past, including specific bodies of knowledge in botany, medicine, social governance and many other areas;
- IK as the embodiment of a different and particularly African mode of thought as encapsulated in the concept of 'Cosmovision' which learners and teachers apply to the acts of learning and instruction; and
- Ik as a means of expressing what people know now and in the future, creating new knowledge from their capacities arising from the intersection between (the first two senses above) for addressing present day challenges of development.

The creation of new knowledge arising from the interface of a cultural heritage, personal genius, skills and experience of a life-time for addressing pressing challenges of local development (as entailed in the third level of IK) broadens the notion of IK and reveals a proactive dimension (Easton, 2004). "In particular, it makes it evident that much of IK activity is fundamentally educational, for it does not involve people in discovering and preserving existing canons of knowledge – it enables them to "make" new knowledge." (Ibid.:9). Returning to my empirical discussions in chapters 3, 4 and 5, many of the cases illustrate efforts by households "finding ways to recognize, extend and reinvent tradition"

[54] Informal education is taken to mean "the life-long process by which every person acquires and acuumulates knowledge, skills and insights from daily experiences and exposure to the environment – more or less systematic or serendipitous, according to circumstances, but not collectively organized, recognized, and structured" (Easton, 2004:10).

(Easton, 2004:9) for adapting their livelihoods to new challenges arising from environmental change.

Another observable pattern is that knowledge flows are essentially geographically localized (Jaffe et al., 1993). Here again, kinship and social networking are the main drivers that give impetus to this pattern in the flow and localization of knowledge. Households tap into the processes of knowledge flows and localization occurring within neighbourhoods, sections and neighbouring communities within Ghana and in Burkina Faso, which have kinship and social ties. Routine social interactions between *Yua* and its neighbouring communities in Ghana and Burkina Faso overshadow even geographical distances in the scheme of activities within the basin. In the domain of food crop farming, a number of examples discussed in the previous chapters (Chapter 4 and 5) shed light on local knowledge flows and localization within neighbourhoods and the community at large. For instance, in Chapter 4, *Nsoh* was described as an early adopter of 'pit' compost making technology, a new form of manure, which helped his household halt yield declines and even increased production in *Yua*. The method required digging a square pit to some measurement specification. Crop residues and cow dung are the main materials. The materials are deposited in the pit in layers. Ash is introduced into the organic materials. A routine watering regime is introduced and the organic materials are turned intermittently. In the case of *Nsoh*, he blends indigenous forms of manure with the pit method. For instance, he transfers *Nandeene Pu'usego* and *Tampugerɛ Pu'usego*, two indigenous forms of manure as part of the organic materials for pit compost making. This aide's complete decomposition of the materials associated with indigenous manure. Incomplete decomposition of materials is commonly associated with these indigenous forms of manure and *Nsoh* has found a way of dealing with the problem. The discussion show that *Nsoh's* adoption of the technology was partly inspired by his observation of pit compost making practices among neighbouring families living on the Burkina Faso side of *Barigabisi*, the section of *Yua* in which *Nsoh* also lives. In further discussions, I have shown that through *Nsoh*, many other households in his neighbourhood and beyond *Barigabisi* also learnt about the pit compost making method. The neighbours of *Nsoh* also observed what he was doing, made inquiries and further observations through which they learnt about the method and became committed to also experimenting. They were motivated by the impressive results in terms of crop yields, which they had observed from Nsoh's *Sammani*. Similarly, *Akabote* adopted *Gerigo,* a new and an early maturing potato variety through observation and information he obtained from his neighbour. (Chapter 5, Box 5.5). *Akabote* had been planting a traditional potatoes variety till he adopted the early maturing variety as a way of adapting to shortening rainfall seasons. He adopted the new potato variety three years ago following information he obtained from *Apokina*, who is both a neighbour and a friend. After observing yields from *Apokina's* potatoes farm and making inquiries about the new potatoes, *Akabote* bought the starting stock of potato vines from *Sirigu* market (Ghana) acting on a tip off from another friend that farmers from neighbouring communities in Burkina Faso sold the vines of the potatoes there for propagation. Since his purchase of the new potato vines, *Akabote* has been planting it in ways that maximize yields using his previous knowledge of planting the traditional potato variety he learnt from his father. Since his first experimentation, *Akabote* has concluded that planting the new potato with previous knowledge maximizes yields.

Women have also become instrumental in local knowledge flows and localization at community and household levels. They introduce new crop varieties in exercising their 'culturally prescribed' normative roles of sowing in farming. Through this, they have also negotiated legitimization of such new crop varieties in household production systems in the community. Women obtain information about these crop varieties through social interactions in the performance of their daily duties. Within the wider cultural environment in rural areas, women buy ingredients and grains from the market for household consumption. They go to the mills to mill the flour. Fetch water from water points. In performing these functions, women like to move in small groups. They like to converse about the details of life and in the process they easily share information about new crop varieties and news about new developments in the community and elsewhere. In my discussions (Chapter 3), I have shown in the livelihood profile of *Atanga* how his wives on their own accord introduced new sorghum varieties into the household production system. Since planting is the domain of women, *Atanga's* wives intercrop little quantities of *Kadaa* and *Agriki* (new sorghum varieties) with traditional grain varieties during planting of their *Sammani*. Although only little quantities of these new sorghum varieties are intercropped in order to make room for more traditional grain varieties, *Atanga's* wives see the benefits of how harvesting little quantities of these crops 'fill-in' a grain supply gap and provide the needed grains for household consumption at a critical stage during the farming season. *Atanga* equally appreciates the benefits from the initiatives of his wives. This gives legitimacy to the innovation as a household tradition. In further discussion on the subject (Chapter 3), I have also pointed out that this practice has become a common phenomenon in households. The leading role of women in the production of rice, especially new rice varieties in most households also point to the role of women[55] in the introduction of new knowledge in household production. Drawing on female farming practices in *Yorogo*, a neighbouring community in Burkina Faso, many women in *Yua* have taken to rice cultivation in recent times. These rice varieties namely, *Sane ki ya* and *Bonga* in the local parlance are early maturing and strive better under shortening rainfall regimes. Although rice cultivation in the community is not entirely new, there seem to be a revolution in the production of rice in the community currently. Fewer people cultivated rice in the past, but many more people are cultivating rice today and the women outnumber the men in the competition to cultivate rice. Unsuitable and uncultivated lands such as grazing fields are being converted into paddy rice fields. Many more women are seeking and establishing paddy rice fields in neighbouring communities in Burkina Faso to supplement household consumption needs. Rice hitherto was not a staple crop but it is fast becoming so due to the instrumentality of women from *Yua* driven by the knowledge they have learnt from colleagues in *Yorogo* and elsewhere. Women's local/indigenous knowledge plays a role in community development. In

[55] Women have played key roles in the introduction of new and early maturing rice varieties in household production systems as illustrated in my discussions in Chapters 4 and 5. For instance, in Chapter 4 (Box 4.6) I have presented a case in which *Anseem*, a female farmer introduced the cultivation of *Sane ki ya*, a new rice variety into her household production system. The case shows that *Anseem* adopted and learnt about this rice variety from neighboring farmers in *Yorogo*, Burkina Faso. The case shows that *Anseem* resorted to *Na'ambɛa Pu'usego,* an innovative form of organic manure for the production of this new rice variety. She resorted to this innovation because she leant good yields are contingent on fertilizer application for which she lacks the economic ability to finance. In the second case, *Abowine* (Chapter 5, Box 5.8) another female farmer is shown to have equally adopted the same new rice variety that *Anseem* cultivates. She leant and adopted this rice variety from a relative in *Vea* in the *Bolgatanga* district. There are many other women like *Anseem* and *Abowine* who have introduced new rice varieties into the household production systems for adapting to rainfall variability.

Senegal's West Coast region of *Popenguine,* for example, local women have taken a leading role in preserving natural forest and bio-diversity in high-risk and marginal areas through an association that they formed. Working through the involvement of traditional leaders, urban women, and youth, entire communities across the region were encouraged to participate in this bio-conservation agenda. It planted firebreaks with endogenous species around the entire perimeter of their forests, established a cooperative distribution network for wood, charcoal, and gas to regulate fuel consumption. All these initiatives effectively supported local efforts at controlling deforestation which ultimately lead to halting of biodiversity loss and diminishing vegetable stocks which were of paramount importance to them (Ramphele, 2004:14). Women through their local knowledge have contributed substantially to maintaining agro-biodiversity in Africa. In response to droughts, which periodically affect many regions in Africa, often causing widespread famine, women contribute immensely to bringing relief to their households. As principal providers of food, women have devised multiple coping strategies to maintain food security at the household level during food shortages. They often rely on minor crops or semi domesticated plants, more tolerant to droughts and pests, providing a reserve for dealing with extended periods of economic hardship. Simply put, women know which plants can provide emergency meals to help keep their families alive during periods of hunger (Ramphele, 2004:14). The case of women in *Yua* planting small quantities of *'Agriki'* and *Kadaa* early maturing sorghum varieties is a conscious strategy among women meant to 'fill' a critical food (grain) supply gap in the household production cycle as identified by women themselves (Chapter 5). According to Easton (2004), local knowledge, especially indigenous knowledge is usually not gender- neutral. In many cultures, women play key role in conserving prescriptions and understandings, stories, and botanical insights from the reservoir of oral tradition and historical experiences even in male dominated cultures.

The uptake and localization of new knowledge occurs within a local rural environment. From the discussions so far, this environment comprises the household and compound as constituting the immediate learning environment. An extension of the learning environment comprises community sections or neighbourhoods, and the community at large and other neighbouring communities (Ghana and Burkina Faso) together with their socio-economic interconnectedness. Given this, knowledge flows are largely open and geographically localized. The empirical evidence of knowledge diffusion transcending households, compounds and communities within the local environment supports literature on the hypothesis of 'geographic localization' in knowledge flows. Results from the survey (Box 6.3) showing results on sources of knowledge for new crop varieties highlight the importance of kinship and social ties in the diffusion of knowledge.

Box 6.3: Sources of information/new crop varieties in *Atankwidi* basin

Results from the survey involving 131 peasant farmers across three communities, namely *Yua*, *Mirigu* and *Pungu* corroborates the important roles of kinship and social ties as drivers of knowledge diffusion within the *Atankwidi* basin in north-eastern Ghana. Overall, 46% of farmers cited a kin or relative as sources of either information or new crop varieties. A detail breakdown show that 25% cited relatives within their respective community, 18% relatives from neighbouring communities within Ghana and 3% relatives in neighbouring Burkina Faso as the sources. Overall, 26 % cited friends as sources of new information and new crop varieties. For the detail breakdown, 13% cited friends within the community, 9% neighbouring communities within Ghana and 4 % friends resident in Burkina Faso. Market centres within the 'local environment' (within Ghana and Burkina Faso) are also important sources of new information and or new crop varieties. From the survey, 27% farmers cited market centres as their sources of new crop varieties.

Source: Field Survey, 2008

The analysis (Box 6.3) shows that together kinship and social ties account for 72% of sources of new crop varieties for households in the *Atankwidi* basin. Market centres are also an important source but there is a strong element of kinship and social ties, which equally underpin market centres as important sources of exchange for seed varieties. In my earlier discussions, I have shown that some farmers have resorted to the market to buy new crop seeds following the sharing of such information from either a relative or a friend. Since women are also responsible for marketing and purchase of grains, their involvement in commerce in market centres in *Sirigu* (Ghana) and *Guelwongo* (Burkina Faso) have served as important sources of new crop varieties. Interactions at market centres are not only commercial in nature, they are also social and many at times involving networking that transcend relations, friends and business partners. These knowledge transfer mechanisms within the local environment defined, by *Yua* and its neighbouring communities support the view of easy knowledge flows within localized environments. For instance, in the literature on industrial clusters, knowledge and information flow more easily between organizations in a cluster than outside and across its borders. The importance of these knowledge flows is currently the subject of intense discussions in economics and economic geography (Krugman, 1991; Martin and Sunley, 1996; Ǿstergaard, 2008:196). However, kinship and social ties underpin local knowledge flows, access and its geographical localization *Yua* and within the basin in general. This also suggests an element of 'exclusivity' in knowledge flows. Kinship has the capacity to be multi-functional, that is, to shape other domains of social life such as the economy, and thus reflect their function of channelling information flows. The more tightly the kinship network is structured, the better it is able to continue with its function as an information channel and in exercising grip on other domains of social life (Jorion, 2000: 1). Bollig (1998) illustrates how kinship and reciprocal exchanges among the *Pokot* herders of northern Kenya [as illustrative of their knowledge system] help reduce risks of livelihoods against hazards (Box 6.4).

Box 6. 4: Bride wealth and reciprocal exchanges during stress (drought) among the *Pokot* herders of northen Kenya

The Pokot herders of northern Kenyan are a pastoral society. Their social organization rest on dispersed patrilineal descent groups, age sets and generation sets. The *Pokot* largely depend on widespread exchange networks shaped by this kinship structure for protecting their livelihoods against various risks such as droughts, epidemics and cattle raids. Transfers of livestock between two herders are customary and imply long-term relations between them. This invokes future commitments to further exchanges of livestock, the transfers of other commodities, and strong emotional ties. Livestock may be exchanged on many occasions. These include for example, bride wealth exchange, bride wealth distribution, stock friendships, distribution within the descent group, and exchanges between two fixed descent groups and life cycle rituals and compensations. These modes of livestock transfers are the major institutions of reciprocal exchange among the *Pokot* (Bollig, 1998:139-140). Marriage among the *Pokot* is legitimized through the exchange of animals (*kanyoy*) and bride wealth are not rigidly fixed. The average is about 12 herds of cattle, 2-3 camels, and 30 goats in addition to some sheep. Whereas bride wealth payments are borne mainly by the bridegroom or by his father, incoming bride wealth payments are distributed throughout the personal network of the recipient. There is a moral obligation to give away large numbers of livestock received as bride wealth payment to relatives and friends. In 36 bride wealth distributions recorded, at least 8 people participated in the distribution. About 70% of all cattle distributed were given away to members of the partrilineage. From this, 19% remained with the bride's father and 23.7% were given to his brothers, whereas 17.2 % went to the bride's brothers and another 10.7 % to remote paternal relatives. Affinal relatives and friends benefited from the distribution, too, each group receiving 14.7% of all cattle given away.

The opportunity to examine the role of these kinship networks and bride wealth exchanges as a strategy for risk minimization came in the bad years of 1990 and 1991. These years were marked by low rainfall, a dreadful livestock epidemic and flaring up of interethnic hostilities over limited grazing pasture. Animals died of emaciation and many others became sick on heavily overstocked pastures. A few households also lost their cattle to raids. Most of the 37 actors consulted before in the network analysis sustained heavy losses of livestock. Some lost about 50% of their cattle, while others lost only a few heads. For goats, most households lost about 30% but one herd grew by 11%. In 1992 each of the 37 household heads was contacted to find out whether they had appealed to one of the 36 others for help or had assisted any of them. Help had been rendered in various ways: men were invited for meat feasts (*asiwa*); they were presented goats to upgrade the nutritional level of their households (*omisyö moning*); or goats and sheep were donated for the performance of healing rituals (*tapa*). While neither *asiwa* nor *tapa* rituals are necessarily tied to periods of stress, the evidence suggested that the number of such rituals quickly rises during early stages of a drought. Each mode of transaction involves very different kinds of help and, as a result, different modes of food distribution. In the case of *omisyö moning* for example, if a man is short of a goat to sell to obtain maize or to slaughter for family consumption, he can turn to an exchange partner and ask him for *omisyö moning* - literally meaning “food for children.” If he is given a goat or a sheep, he can decide freely how to use it for his family. Donations of this sort rarely result in a debt i.e. somebody given *omisyö moning* will generally not have to return a reciprocal gift in future. The help accorded to actors by their networks between 1990 and early 1992 were substantial. The 37 household heads gave about three (3.24) heads of small livestock (very few donations were cattle) within the local network for ritual and food assistance. Each person additionally donated 1-2 goats (1.68) in meat feasts like the *asiwa*, all goats being slaughtered for public (primary male) welfare.

Source: Bollig (1998:138-147).

The analysis (Box 6.4) shows that local strategies for addressing vulnerability of livelihoods to hazards are built around a patrilineal descent of kinship that shapes and reinforces multiple measures. Bollig (1998:139) describes these measures as herd diversification, dispersal of household herds, spatial mobility and widespread exchange networks. The distribution of bride wealth payments as shown is essential to reinforcing kinship networks of mutual obligation. While affinal kinship is created by bride wealth payment, patrilineal kinship is reinforced by bride wealth distribution. Although the donor cannot directly ask his relatives or friends for equivalent gifts in return, he can well expect the recipient to invite him as a beneficiary to similar distributions in the future. Thus, a person receiving a bride wealth payment is eager to include in his distribution list relatives and friends that are trust worthy (Ibid: 141).

The empirical evidence from the study suggests that knowledge flows between different entities within the 'local environment'. In *Yua* and its neighbouring communities, knowledge flows virtually 'ride' on the strength of regular patterns of kinship and social networking. Such regular patterns of information exchange reveal themselves as social networks, with actors as nodes in the network and information exchange relationships as connectors between the nodes. Just as roads structure the flow of resources among cities, so do information exchange relationships structure the flow of information among actors (Haythornthwaite, 1996:1). Recent studies have shown that knowledge flows between firms through social networks take place and that even firm-specific knowledge is shared through this mechanism (Lissoni, 2001; Dahl and Pederson, 2004; Giuliani, 2007). See Ǿstergaard (2008:196). Jasjit Singh has attempted to analyze whether interpersonal networks help explain geographic localization of knowledge flows and concentration of knowledge flows within firm boundaries using patent citation data. First, intra-regional and intra-firm knowledge flows are found to be stronger than those across regional or firm boundaries are. Second, the existence of a tie is found to be associated with a greater probability of knowledge flow, with the probability decreasing as the path length (geodesic) increases. Third, the effect of regional or firm boundaries on knowledge flow decreases once interpersonal ties have been accounted. In fact, being in the same region or firm is found to have little additional effect on the probability of knowledge flow among actors who already have close network ties. Thus, interpersonal networks are important in determining patterns of knowledge diffusion (Singh, 2005:756).

6.5 Community organizations, external agencies and localization of knowledge

The empirical discussions show that both community based organizations and external development agencies played key roles in the localization of knowledge at the household and community level (see Chapter 4). For instance, the *Nemogre* Farmers Group and its splinter farmer based groups played key roles in the adoption, localization and legitimization of new compost making model i.e the Zaï compost model in *Yua.* These farmer-based groups did this through collaboration with external development agencies such as SEISUD and TRAX. A new crop (soya beans) was introduced through similar collaboration. The discussions revealed that through collaboration and engagement with these external organizations, the *Nemogre* farmers group were able to do the following:

1. Restructured the group to improve functional and organizational performance;
2. Served as intermediary between farmers (households) and external agencies in the negotiation processes leading to the introduction of new farming knowledge in household production in *Yua;*
3. Negotiated support for the adoption and localization of farmers preferred choice of compost making method, i.e, the 'pit' method as opposed to the Zaï model that was promoted by the external organizations and finally;
4. At the time of the fieldwork, was executing an implementation plan to support adoption of pit making compost among its members and to facilitate a community wide adoption of the model for sustaining crop production.

The *Nemogre Farmers Group* was formed in 2000 comprising a large membership of over 80 farmers. It was a mixed sex group. This group was formed around a 'collective interest' of facilitating sustainable farming practices for securing a livelihood for its members. In 2007, the group started a restructuring process in order to enhance its organizational capacity for delivering on its mandate with the support of SEISUD. SEISUD at the time of the study was an external community-based organization based in *Sirigu*, a neighbouring community that shares boundary with *Yua*. Based on technical advice from SEISUD, the farmers split the *Nemogre Farmers Group* into four smaller farmer based groups, embarked on a screening and recruitment drive of committed farmers and elected executives to provide leadership. SEISUD toped this up with educational talks on group formation and functioning. With the re-organization, the farmers groups were poised to deliver on their mandate and were very much open to working with external agencies. At the level of splinter groups, they worked independently but occasionally came together for common programmes such as general meetings or activities involving external agencies.

Prior to restructuring the farmers group, MoFA through its Agriculture Extension Agents (AEAs) had introduced the Zaï compost model to the community, ie. *Yua*. A compost demonstration project was initiated with the participation of the then mother *Nemogre* Farmers Group. The group's contribution essentially included providing - labour, materials and construction of the demonstration structure (See Chapter 4 & Photo 4.6). This project essentially introduced a three-chamber compost making structure to the community. The method required the use of traditional materials, crop residues and animal dung. It also required a routine watering regime, turning organic materials intermittently and transferring the materials from chamber to chamber according to differentiated stages of decomposition. The then *Nemogre* Farmers Group with the collaboration of the traditional authorities organized farmers from the community including a larger segment of the community to witness and participate in the training session of the project. In 2008 when the splinter *Nemogre* farmers groups started working with SEISUD, the latter also organized a compost training session for the farmers groups. This time the training session was done for each splinter farmers group. SEISUD contracted a resource person from TRAX in *Bolgatanga* to train the farmers groups. As a policy, SEISUD supported the Zaï compost-making model and the training was done using the demonstration structure as a reference resource for the training. Upon internal discussions and consultations at the splinter group levels, farmers accepted in principle compost making, but many rather expressed their preference for a different method, i.e the 'pit' compost-making model. They were privy to the 'pit' method of compost making practiced by farmers in neighbouring communities in Burkina Faso following its introduction there by officials of government agencies. The farmers had compared the Zaï model with the 'pit' method and concluded that the latter better suited their situation. In a general meeting, the issue was brought up for discussion. The four farmers groups after deliberations reached a consensus to adopt the 'pit' compost rather than the Zaï model, which was being advocated by SEISUD. Citing cost consideration, farmers concluded that it was cheaper to construct and maintain the 'pit' for compost making than the Zaï model. After some initial policy resistance, SEISUD eventually agreed to the proposal of the groups. An implementation strategy in which each group will support the construction of pits for making compost was agreed upon. SEISUD also committed itself to providing demonstration training on the ‘pit’ method for each group. Each group started constructing pits for their members according to their respective implementation plans as agreed upon. As of 26th February 2009, the four groups had dug 19 pits out of a total target of 60 pits for all groups. Individual members started mobilizing their organic materials for commencing compost making. The compost demonstration training by SEISUD using already dug pits by the farmers groups also commenced alongside the process of digging pits. Four open demonstration projects were planned and executed in four different sections of the community. The training sessions were open and spread out to make the maximum impact on awareness and knowledge transfer to many other farmers’ aside group members (see Chapter 4, Photo 4.10).

Given this analysis, it is clear that the splinter *Nemogre* farmer based organizations played several key roles in ‘negotiating’ the introduction of pit compost making in the community. In the process, they have evaluated different compost models, selected their preference model based on analysis of their situation, and negotiated their way through to have SEISUD support the adoption and localization of ‘pit’ compost in the community. This evidence reflects the view that for imported knowledge to be relevant to development, it has to be adapted to local conditions (Cohen and Levinthal, 1990; Gerke and Evers, 2005) or ‘localized’ (Evers, 2003; 2005:82). Through these institutional processes, the farmer-based organizations have provided the institutional and organizational mechanisms, facilitated the legitimacy and adoption of new knowledge from external sources for improving their livelihoods. This evidence supports the assertion (Chapter 1) that outcomes are shaped in the social construction of local knowledge by ongoing processes and that this can lead to mutual transformations of actor’s projects (Long and van der Ploeg, 1994). Results from the survey further speak to the role of community-based organizations in knowledge diffusion. The survey shows that 83% of farmers (109 out of 131) obtained information about the ‘pit’ compost method through a community based organization [farmers group and or women’s group] across the three surveyed communities. About 6% obtained this information from relations in Burkina Faso and these are the ‘early adopters’ and ‘carriers’ of the innovation from Burkina Faso to *Yua* and its environ.

The role of external development agencies in the introduction and up scaling of innovations and new knowledge in the community is undisputable. However, the expected outcomes were not realized as planned from the policy perspectives of the organizations involved. MoFA and SEISUD were prominent external agencies concerned with the introduction of new knowledge for enhancing livelihood sustainability. The interventions were mainly in the domain of food crop farming. MoFA and SEISUD are policy driven institutions and sources of new formal and legitimate knowledge. In their approach to extension, they worked through and or collaborated with farmer based community organizations for mobilizing the community and reaching out to farm households. As a public sector policy driven service agency, MoFA has been less flexible with their policy on the *Zaï* model. This lack of flexibility combined with inadequate follow up in extension work and unfavourable evaluation outcomes by farmers constrained the adoption of the *Zaï* model in the community. Cost considerations of the *Zaï model* and the lack of flexibility and adaptation by MoFA led to the failure of the model in the community. Although the *Zaï model* failed the adoption test, farmers 'picked up' the basic principles and are working with them in the new dawn of compost making. SEISUD followed up with training of farmers using the MoFA *Zaï* model infrastructure in the community. However, SEISUD was more flexible and adaptive to the preferences and situation of the farmers. By this flexibility, SEISUD made a maximum impact in its support to farmers in the adaptation of food crop farming to soil degradation. This type of knowledge was open to the community in the mode of delivery. More importantly however, the collaborative success in the localization of pit compost making in the community was driven by informal networking that evolved between the general co-ordinator of the splinter *Nemogre* farmers groups (Patrick), the Executive Director of SEISUD (Peter) and the resource person from TRAX (Solomon) who did the trainings. Patrick who is a Public School Teacher, has served as the general secretary to the erstwhile *Nemogre* Farmers Group and still coordinates the activities of the four splinter farmers groups on voluntary basis. In the scheme of events, these three agents fronted for the different organizations that they represented. However, informal networking between these three 'officials' in supporting knowledge extension was central to the success story or revolution in pit compost in *Yua*. This supports the view that knowledge flows between individuals in firm and official settings are more often a result of the employee's personal initiative than formal organizational structures (Allen and Cohen, 1969; Allen et al., 2007; Cross et al., 2002.). Similarly, such literature in sociology (e.g., Ryan and Gross; 1943, Coleman et al., 1966; Rogers, 1995) has also emphasized information flow through interpersonal networks (Singh, 2005:756).

In my discussions so far, I have pointed out that local knowledge is a strategic resource for sustaining rural livelihoods under environmental change in the *Atankwidi basin*. It is therefore, an important factor influencing household livelihood vulnerability to environmental change. This brings to the fore the importance of flows and access to knowledge relevant for sustaining livelihoods at the household level. In the discussion, I have illustrated that local knowledge flows and localization generally occurs within a wider local 'learning environment'. First, this comprises the household and compound as the immediate learning environment. Secondly, it comprises an extended learning environment. This embodies neighbourhoods, the community and neighbouring communities. Within this context, local knowledge flows much easily within the household, compound, neighbourhood and community than between communities. Although local knowledge flows between communities may be limited, they are central for innovation in knowledge systems of the recipient community. Kinship and social networking were discussed as driving forces giving rise to these patterns in knowledge flows in the basin. In addition, community and external organizations were identified as also playing important roles in the diffusion and localization of new (external) knowledge.

6.6 Summary and emerging issues

In this chapter, I discussed local knowledge flows and localization in *Yua* and the *Atankwidi* basin at large. The discussions illustrate that patterns of local knowledge flows and localization occur within a wider environment and virtually shaped by the socio-cultural systems of the people. This integrated view is described and emphasized by Knorr- Cetina (1999:1) as culture that creates and guarantees knowledge in practices, processes, structures and symbols and cannot be separated from other spheres of social life. Also see Muller (2003:1). The empirical evidence and discussions highlight four issues: (1) the relationship between local knowledge and livelihood vulnerability; (2) patterns of local knowledge flows; (3) the role of kinship and social networking in local knowledge flows and localization; and (4) the roles of community based organizations and external agencies in the localization of knowledge.

Local knowledge is a strategic resource in sustaining rural households' livelihoods under environmental change in the *Atankwidi* basin, northeastern Ghana. Hence, it is an influential factor for differential levels of vulnerabilities in household livelihoods. For instance, the lack of relevant knowledge for adapting to decreasing soil fertility or rainfall variability can increase ones vulnerability in terms of exposure to risk and contingencies, and further undermine capabilities of responsive adaptation.

Local knowledge flows and localization generally occur within a wider local 'learning environment'. This comprises the household and compound as the 'immediate' environment. It also includes neighbourhoods, community and neighbouring communities as an 'extended' learning environment. Within the context of the overall learning environment, local knowledge flows much easily within the household than between households. That apart, local knowledge also flows relatively easily within the 'extended family compound', neighbourhood and community than between neighbouring communities. However, local knowledge flows between communities are central for innovation and localization of local knowledge systems at various levels – household, compound, neighbourhood and community levels.

Kinship and social networking are the prime drivers of local knowledge flows and localization within the overall learning environment. Within the household, kinship is central and defines the geographical and social closeness of kin to knowledge sources (heads of households and women) within the household production system. For the uptake and localization of new knowledge from external sources, kinship and social networking facilitate these knowledge diffusion processes. Similarly, the empirical evidence suggest that kinship and social networking are the prime drivers of local knowledge diffusion between neighbourhoods, the community (*Yua*) and neighbouring communities.

Community based organizations, such as farmer groups, and external development agencies played key roles in local knowledge diffusion and localization at the household and community levels. Although a few early adopters had already adopted some new and innovative practices, such as the ‘pit’ compost in food crop production, the collaborative effort of farmer based organizations and external agencies provided a systematic mechanism for accelerating adoption and up scaling of community adoption of the innovation. In the process of collaboration, informal networking between staff that fronted for the various organizations (CBOs and external agencies) was central to the success of introducing new knowledge systems in the community.

6.7 Conclusion

In the beginning of this chapter, I set out to discuss local knowledge flows and localization in the context of farm households striving to sustain their livelihoods specifically, in *Yua* and the *Atankwidi* basin at large. First, the discussions reveal that local knowledge was a strategic resource and that its flows and access was central to reducing livelihood vulnerability to environmental change among households. Secondly, that as a predominant pattern, local knowledge flows much easily within the household than between households. Thirdly, that local knowledge also flows much easily within the ‘extended family compound’, neighbourhood and community than between communities. However, inter-community flows in knowledge drive innovations the most. Fourthly, that kinship and social networking shape these patterns of knowledge flows and localization. Finally, that community based organizations and external agencies play important facilitating roles in the localization of knowledge for sustaining rural livelihoods in the *Atankwidi* basin.

CONCLUSION

I. Introduction

This part brings to a close discussion on the study by way of a summary and a conclusion. From the outset, this study set out to explore how rural households were utilizing local knowledge for reducing livelihood vulnerability to environmental change in the *Atankwidi* basin, northeastern Ghana. In exploring this problem, I was guided by the assumption that *'local knowledge and the localization of knowledge from external sources play a major role in reducing household livelihood vulnerability to environmental change in the Atankwidi basin, north-eastern Ghana*.' A set of specific exploratory objectives were set. These included: (a) to explore the composition and changing composition of household livelihood portfolios across generations and how that reduce livelihood vulnerability to environmental change; (b) how rural households are reducing vulnerability of food crop production to degraded farm lands through local knowledge systems of soil conservation; (c) how farm households are reducing vulnerability of food crop production to rainfall variability through local knowledge systems of adaptation and ; (d) the patterns in knowledge flows and 'localization' of knowledge for adapting household livelihoods to environmental change.

To proceed with the study, an analytical framework based on the 'double structure' of vulnerability was used to explore the role of local knowledge in reducing household livelihood vulnerability to environmental change in the *Atankwidi* basin. Thus, I used 'vulnerability' in this framework for conceptualizing 'environmental change' – 'local knowledge' linkages for analyzing the efforts of households towards reducing livelihood vulnerability in the basin. It conceptualized household response to 'vulnerability' as a sequence of risk management strategies comprising two interrelated cardinal stages of defence. On the one hand (first stage of defence), the empirical analysis explored how households used local knowledge to 'moderate exposure' of their livelihoods, especially food crop farming to risks arising from environmental change. On the other hand (second stage of defence), the empirical analysis considered the capacity of households to cope with environmental shocks, stressors and perturbations when they occur through local knowledge. Overall, the application of local knowledge in household livelihoods have had the ‘dual’ effect of moderating exposure to environmental risk and also enhancing capacity to cope with environmental shocks. Syntheses of the findings from this empirical analysis are summarised in the ensuing section.

II. Summary of findings

Livelihood diversification under environmental change

Households essentially diversify their livelihoods as part of their local knowledge and strategy for minimizing risks of total livelihood failure under uncertain environmental conditions in the *Atankwidi*. Livelihood diversification remains a fundamental part of the local knowledge of households across three generations – grandfathers, fathers and sons generations. In the wake of environmental change, the primary livelihood has remained subsistence crop cultivation but changing trends are observable in the livelihood portfolios of secondary livelihoods. These changes are driven by the need to adapt household livelihoods to environmental changes in the basin in order to minimize the risks of livelihood failure. Although subsistence farming remains a primary livelihood, inter-generational analysis reveal that households are gradually shifting away from farming and some agro-processing activities because of their vulnerability to environmental change. A gradual process of (de)agranization is observable across three generations of the same households. In place of this, there is an increasing emphasis on migration and trade (especially in foodstuff) in the domains of secondary livelihoods, which have proven to be essential for social sustainability of household livelihoods, but also environmental sustainability. Overall, livelihood diversification reduces vulnerability of household livelihoods to multiple risks and shocks arising from environmental change in the *Atankwidi* basin.

Local knowledge on soil conservation for crop production under degraded lands

Rural households are utilizing local knowledge systems of soil conservation for reducing vulnerability of food crop production to the more specific problem of degraded land and soils. These local knowledge systems comprise various forms of traditional organic manure for improving soil fertility combined with planting grass strips for checking soil erosion. In addition, households are applying newly evolved forms of local organic manure for soil fertility improvement. In general, the application of organic manure has resulted in some successes in stabilizing crop yields and or increasing crop yields at the household level in the context of 'vulnerability' to degraded farm lands. This success combined with the facilitating roles of internal and external organizations, has increased commitment to organic farming at the household level. This is manifest in systematic and concerted measures at community wide adoption of compost in a new era of organic farming in *Yua* and the *Atankwidi* basin at large.

Local knowledge and adaptation of food crop production to rainfall variability

Rural households are reducing vulnerability of food crop production to rainfall variability through various local knowledge systems of adaptation in the *Atankwidi* basin. These include the cultivation of multiple farms, staggering seeding, cultivation of drought resistant traditional crops, the adoption of early maturing crops and multi-cropping strategies. These strategies draw on both indigenous knowledge handed down from generation to generation and new knowledge systems drawn from external sources. Through these local measures, households are reducing vulnerability of food crop production to rainfall variability. For some households, this has resulted in halting a declining trend in food crop yields. For others it has enabled stabilization of food crop yields and yet for others it has translated into increased food crop yields.

Local knowledge flows and ‘localization’

The study revealed that local knowledge was a strategic resource and that its flows and access was central to reducing livelihood vulnerability to environmental change among households in the basin. As a predominant pattern, the analyses suggest that local knowledge flows much easily within the household than between households from generation to generation. In addition, local knowledge flows much easily within the ‘extended family compound’, neighbourhood and community than between communities. However, flows between communities were central for the transfer and adaptation of innovations to local production systems for reducing livelihood vulnerabilities to environmental change in the recipient community. Kinship and social networking shaped these patterns of knowledge flows in the basin. Community based organizations and external agencies play important facilitating roles in the ‘localization’ of knowledge for sustaining rural livelihoods under environmental change.

III. Conclusion

The main conclusion from this study is that local knowledge and the localization of knowledge from external sources play a major role in reducing household livelihood vulnerability to environmental change in the *Atankwidi* basin, northeastern Ghana. They do this by employing a wide range of local knowledge measures in livelihoods. These include livelihood diversification, the application of local organic manure in farming, cultivation of multiple farms and staggering planting, blending cultivation of drought resistant and early maturing crop varieties. These measures combine indigenous and new knowledge systems in various forms and shades. These local knowledge systems flow through multiple mechanisms of diffusion that give rise to certain patterns. First, local knowledge flows easily within the household from generation to generation than between households. Secondly, local knowledge flows much easily within the ‘extended family’, the neighbourhood and community than between communities. However, local knowledge flows between communities is a major driver of innovations at household and community levels. For the most part, kinship and social networking shape these existing patterns of local knowledge flows for sustaining livelihoods at household and community levels. Organizations and development agencies, both community and external also facilitate local knowledge flows and the ‘localization’ of knowledge at the community level.

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References

Acquaye, D.K., (1990). *Towards development of sustainable agriculture in Africa: Reflections of a soil scientist.* In: M. A. Zobich ed. 1990. Proc. 11th Annual general meeting, soil sci. soc., Ghana, pp. 19-28.

Adger, W.N., Benjaminsen, T.A., Brown, K. & Svartad, H.,(2001). Advancing a political ecology of global environmental discourses. *Development and Change*, 32, pp. 681-715.

Adger, W.N & Brooks, N., (2003). Does global environmental change cause vulnerability to disaster? In: M. Perlling .ed. 2003. *Natural Disasters and Development in a Globalizing World*. London and New York: Routledge, pp. 19-42.

Adokiya, M.N., (2010). *Complementary feeding practices and nutrition status of young children 06-23 months of age in the Kassena-Nankana District, Upper East Region, Ghana.* Ph.D Kumasi: Kwame Nkrumah University of Science and Technology.

Adu, S. V. (1969). *Soils of the Navrongo-Bawku area, Upper East Region, Ghana*. Kumasi: Soil Research Institute.

Adu, S.V. (1972). Eroded Savanna of the Navrongo-Bawku area, northern Ghana. *Journal of Agric. Science*. 5, pp. 3-12.

Alfsen, K.M., Bye, T., Glomsrob, S and Wiig, H., (1997). Soil degradation and economic development in Ghana. *Environmental and Development Economics* 2 (2), pp.119-143.

Allen, J. T., (1984). *Managing the Flow of Technology: Technology Transfer and the Dissemination of Technological Information within the R & D Organization*. Cambridge (MA): MIT Press.

Allen, J., James A.D, & Gamlen, P., (2007). Formal versus informal knowledge networks in R & D: a case study using social network analysis. *R & D Management*, 37 (3), pp.179-196.

Allen, T.J & Cohen, S.I., (1969). Information flow in research and development laboratories. *Administrative Science Quarterly*, 14 (1), pp.12-19.

Aluma, J. (2004). Sustainable agriculture and rural livelihoods: Local knowledge innovations in development. In: The World Bank, *Indigenous Knowledge; Local Pathways to Global Development.* Washington: Knowledge and Learning Group, Africa Region, The World Bank.

Andah, B.W., (1993). Identifying early traditions of west Africa'. In: T.Shaw, P. Sinclair, B. Andah and A. Okpoko(eds.), *The Archaeology of Africa: Food, Metals and Towns.* London: Routledge.

Antweiler, C., (1998). Local knowledge and local knowing: An Anthropological analysisi of contetsted "cultural products" in the context of development. *Anthropos* 93, pp. 469-494.

Asiamah, R.D., (1987). Soil resources and their agricultural utilization in Ghana. Proceedings of the national conference on resource conservation for Ghana's sustainable development. Accra : Environmental Protection Council. 2, pp. 99-111.

Association of Church Development Projects (ACDEP)(2007).Networking for Development.[Internet].Availableat: http://www.acdep.org/Regions/UpperEastRegion.php. [Accessed 15 May 2009].

Baker, K. (2000). *Indigenous land management in West Africa, an Environmental Balancing Act.* Oxford Geographical and Environmental Studies. Oxford: Oxford University Press.

Bates, D.A., (1962). Geology. In: J.B. Will. ed. 1962. *Agriculture and land use in Ghana*. London: Oxford University Press, pp. 51-61.

Bernard, R. H., (2006). *Research methods in Anthropology: Qualitative and quantitative approaches.* Thousand Oaks, CA: Sage Publications.

Birkman, J., (2006). Measuring vulnerability to promote disaster-resilient societies: Conceptual frameworks and definitions. In: J., Birkman (ed.) *Measuring Vulnerability to Natural Hazards: Towards Disaster Resilient Societies.* Tokyo: United Nations University Press, pp. 9-54.

Blench, R. M. (1999). Agriculture and the environment on Northeastern Ghana: A comparison of high and medium population density areas. In: R. M., Blench (ed.) *Natural Resource Management and Socio-economic Factors in Ghana.* London: Overseas Development Institute, pp. 21-43.

Blench, R., (2004). Cultural and biological interactions in the savannah woodlands of northern Ghana, sacred forest and management of trees. In: M. Sheridan & C. Nyamweru (ed.) *Trees, Rain and Politics in Africa*. Oxford, United Kingdom 29 September – 1 October, 2004: Oxford.

Blench, R. (2006). *Working paper: Background conditions in Upper East Region, Northern Ghana, 2005.* [On-line] Available at: http://www.rogerblench.info/Development/Ghana/IFAD/LACOSREP/Blench%20UER%20working%20paper.pdf. [Accessed 20 July 2010].

Boateng, E.A., (1966). *Geography of Ghana*. 2 ed. Cambridge: University Press.

Bohle, H. –G., (2001).Vulnerability and criticality: Perspectives from social geography. *Newsletter of the International Human Dimensions Programme on Global Environmental Change*, IHDP Update 2/2001, pp.1-7.

Bollig, M., (1998). Moral economy and self- interest: Kinship, friendship, and exchange among the Pokot (N.W. Kenya). T. Schweizer & D.R White. Eds. 1998. *Kinship, networks, and exchange.* Cambridge: Cambridge University Press, pp. 137-157.

Boserup, E., (1965). *The conditions of agricultural growth: the economics of agrarian change under population pressure.* Chicago: Aldine.

Botkin, J. & Chuck, S., (2001). Knowledge management manifesto: Why KM requires community building. *Knowledge management review*, 3(6), pp. 16-21.

Bojo, J., (1996). The cost of land degradation in sub-Saharan Africa. *Ecological Economics* 16 (2), pp.161-173.

Bonsu, M. & Quansah, C., (1992). The importance of soil conservation for agricultural and economic development of Ghana. Proceedings of the 13th annual general meeting of the social science society of Ghana, pp. 77-80.

Braimoh, A.K & Vlek, P. L.G., (2004). The impact of land-cover change on soil properties in northern Ghana. *Land Degradation & Development*, 15, pp. 64-74.

Braimoh, A.K. & Vlek, P.L.G., (2005). Land-cover change trajectories in northern Ghana. *Environmental Management*, 36 (3), pp. 356-373.

Bray, F., (1986). *The Rice Economies: Technology and Development in Asian Societies*. Oxford: Blackwell

Brooks, N., (2000). *Dust –climate interactions in the Sahel-Sahara zone of northern Africa, with particular reference to late twentieth century Sahelian drought.* Ph.D. East Anglia: University of East Anglia.

Brooks, N & Legrand, M., (2000). Dust variability over northern Africa and rainfall in the Sahel. In: S., McLaren and D. Kniveton (eds.) *Linking Climate Change to Land Surface Change.* Dordrecht: Kluwer Academic Publishers.

Bourdieu, P., (1976). Marriage strategies as strategies of social reproduction. In: trans. E. Forster and P. Ranum, eds. 1976. *Family and society*, Baltimore: Johns Hopkins University Press, pp. 117-44.

Buah, F.K., (1998). *A History of Ghana: Revised and Updated*. Oxford: MacMillan:

Byerlee, D & Eicher, C.K.,eds.(1997). *Africa's Emerging Maize Revolution*. [Online] Boulder, Colo., USA: Lynne Reiner. Available at: http://www.rogerblench.info/Ethnoscience%20data/Oxford%20paper%202004.pd [Accessed 10 May 2009].

Canon, T., Twigg, J. and Rowell, J., (2003). Social vulnerability, sustainable livelihoods and disasters. *Report to DFID Conflict and Humanitarian Assistance Department (Chad) and Sustainable Livelihoods Support Office***.**

Casey, J., (1998). The ecology of food production in West Africa. In: G. Connah. ed.1998 *Transformations in Africa: Essays on Africa's Later Past*. Leicester: Leicester University Press.

Chambers, R., (1989). Editorial Introduction: Vulnerability, Coping and Policy. *IDS Bulletin*. 20 (2), pp. 1-8.

Chambers, R., (1999). Sustainable small farm development – Frontiers in participation, In: N. Hudson and R.J Cheatle, eds. 1999.*Working with farmers for better land husbandry*. London: Intermediate Technology Publications Ltd.

Clark, W.C., Jäger, J., van Eijndhoven, J. & Dickson, N., eds. (2001). *Learning to Manage Global Environmental Risks: A Comparative History of Social Responses to Climate Change, Ozone Depletion and Acid Rain.* Cambridge, Mass: MIT Press.

Cofie, O.O. and Penning de Vries, F.W.T., (2002). Degradation and rehabilitation of land and water resources: examples from Africa. 17^{th} WCSS, 14-21 August 2002, Thailand. Paper No. 2287, Symposium no. 46.

Cohen, W.M and Levinthal, D.A (1990). Innovation and Learning: The Two Faces of R & D. *The Economic Journal*, 99(397), pp. 569-596.

COMPAS (2007). Sharing visions on local worlds: community diagnosis for endogenous development. Editorial, *COMPAS Magazine*, September 2004.

Corbeels, M., Shiferaw, A. and Haile, M. (2000). Farmers' knowledge of soil fertility and management strategies in Tigray, Ethiopia. Managing Africa's Soils No. 10. Nottinghan: Russel Press. Available at: http://www.iied.org/pubs/pdfs/7421IIED.pdf. [Accessed 9 July 2010]

Coulombe, H. & Wodon, Q., (2007). Poverty, livelihoods and access to basic services in Ghana. Ghana CEM: Meeting the challenge of accelerated and shared growth. Ghana CEM technical review growth workshop in Accra, May 2-3, 2007.

Cresswell, J.W., (1998). *Qualitative inquiry and research design: Choosing among five* *traditions.* Thousand Oaks, CA: Sage Publications.

Cross, N. & Barker, R., eds. (1992). *At the Desert's Edge: Oral Histories from the Sahel.* London: Panos and SOS Sahel.

Cross, R., Nohria, N., & Parker, A.(2002.). Six myths about informal networks – and how to overcome them. *Sloagan Management Review,* 43 (3), pp.67-75.

Cross, R., Parker, A. & Borgatti, S.P., (2001). Knowing what we know: Supporting knowledge creation and sharing in social networks. *Organizational Dynamics,* 30 (2), pp. 100-120.

Cullen, H.M., de Menocal, P.B., Hemming, S., Hemming, G., Brown, F.H., Guilderson, T. & Sirocko, F., (2000). Climate change and the collapse of the Akkadian empire: Evidence from the deep-sea. *Geology* 28 (4), pp.379-382.

Dahl, M. S & Pederson, C. O. R., (2004). Knowledge flows through informal contacts in industrial clusters: myth or reality? *Research Policy,* 33(10), PP. 1673-1686.

De Bruijn, M and Van Dijk, H.,(1998). Pathways' and 'Habitus': Two Frameworks for the Analysis of Decision-Making in High Risk Environments. *ICCD Internal Paper.* ICCD Workshop, Amsterdam, 25 November 1998.

De Menocal, P. B. (2001). Cultural response to climate change during the late Holocene. *Science* 292 (5517), pp. 667-673.

De Waal, A. (1997). *Famine Crimes: Politics and Disaster Relief Industry in Africa, African Rights and the International African Institute.* Bloomington: Indiana University Press.

Delbos, G. & Jorion, P. (1984). La transmission des saviours, Collecion Ethnologie de la France, Editions de la Maison des Sciences de l'Homme, Paris (2nd Print 1991).

DGRD.,(1992). *A socio-economic survey in the Upper East Region with reference to drought and desertification control in Ghana. Final Report submitted to the Environmental Protection Agency of Ghana.* Accra: University of Ghana, Legon.

Derbile, E.K., (2003). Women in non-farm micro-enterprise development and rural poverty reduction in Kassena-Nankana District of northern Ghana. MSc. Kumasi: Kwame Nkrumah University of Science and Technology

Derbile, E.K., (2009). Spatial organization of small-scale industries in the Kassena-Nankana District of Ghana: Implications for the development planning of the district. *Ghana Journal of Development Studies* 6 (1), pp.30-63.

Derbile, E.K & Kasei, R., (n.d). Impact of heavy precipitation on food crop production and policy implications for adaptation in northern Ghana. [Unpublished Paper].

Diamond, J. (1999). *Guns, Germs and Steel*. New York: Norton.

Dickson, K.B & Benneh, G., (1988). *A New Geography of Ghana*. London: Longman Group, U.K.

Dinye, R.D. & Derbile, E.k., (20049. Reducing rural household poverty in Ghana: A case study of women in non-farm enterprise activity in Kassena-Nankana District. *Journal of Science and Technolgy*, 24 (1), pp. 42-53.

Dolman, A.J & Verhagen, A., (2003). Land use and global environmental change. In: A.J. Dolman, A. Verhagen, C. A. Rovers (eds.). *Global Environmental Change and Land Use.* Dordrecht: Kluwer Academic Publishers., pp. 3-13.

Duadze, S. E. K.,(2004). Land use and land cover study of the Savannah ecosystem in the Upper West Region (Ghana) using remote sensing. In: P.L.G, Vlek, M., Denich, C. Martius and N. van de Giesen (eds.). *Ecology and Development Series*. No.16., Centre for Development Research, University of Bonn, Germany

Easton, P.B., (2004). Education and indigenous knowledge. In: *Indigenous knowledge: Local pathways to global development*. World Bank: Knowledge and learning group, Africa region, Pp. 9-12.

Eguavoen, I., (2008). *The Political Ecology of Household Water in Northern Ghana.* S. Gerke & H-D, Evers. eds.2008. ZEF Development Studies, Vol. 10. Münster: Lit Verlag Dr. W.Hopf.

Elston, J., (1983). Climate potential productivity of field crops under different environments. International Rice Research Institute (IRRI), Manila, pp. 3-14.

Ellis, F., (1998). Household strategies and rural livelihood diversification. *The Journal of Development Studies.* 35 (1), pp.1-38.

Ellis, F & Freeman, H., A. (2005) Conceptual framework and overview of the themes. In: F. Ellis and H.A.Freeman (eds.). *Rural Livelihoods and Poverty Reduction Policies*. London and New York: Routledge., pp.3-15.

Encyclopedia of Global Warming and Climate Change (2008). Risk. SAGE Publications. [Online]Availableat:http://www.sage-ereference.com/globalwarming/ Article_n553.html [Accessed 20/9/2009].

EPA., (1998). *Upper East Regional Profile.* Bolgatanga: Environmental Protection

Agency.

EPA., (2002). *National action programme to combat drought and desertification*. Accra: Ministry of environment and science.

Evers, H-D & Mehmet, O., (1994). The management of risk: informal trade in Indonesia. *World Development*, 22 (1), pp. 1-9.

Evers, -H. D.,(2008). Knowledge hubs and knowledge clusters: Designing knowledge architecture for development. ZEF *Working Paper Series.* No 27. Bonn: Department of Political and Cultural Change, Center for Development Research, University of Bonn, Germany.

FAO., (1976). A framework for land evaluation. *Soil Bulletin.* No. 32, Rome.

FAO/IFAD., (1989). Upper East agricultural intensification project. Preparation Mission, 2 vols. 149/89, IF-GHA. Rome:FAO.

Froot, K. A., Scharfstein, D.S & Stein, J.C., (1993). Risk management: Coordinating coporate investment and finacing policies. *The Journal of Finance*, XLVIII (5), pp. 1629-1658.

Gerke, S. & Evers, H-D.,(2005). Local and global knowledge: Social science research on South-East Asia. In: T., Menkhoff, H-D, Evers and Y.W., Chay (eds.).*Governing and managing knowledge in Asia*: *Series on innovation and knowledge management*, Vol.3. Singapore: World Scientific Publishing Co. Pte. Ltd., pp. 79-90.

Gerke, S. & Ehlert, J., (2009). Local knowledge as strategic resource: Fishery in the seasonal floodplains of the Mekong Delta, Vietnam. ZEF *Working Paper Series.* No 50. Bonn: Department of Political and Cultural Change, Center for Development Research, University of Bonn, Germany.

Giuliani, E., (2007). The selective nature of knowledge networks in clusters: Evidence from the wine industry. *Journal of Economic Geography*, 7(2), pp.139-168.

Goldman, M., (1998). The political resurgence of the commons. In: M. Goldman (ed.) *Privatising Nature: Political Struggles for the Global Commons.*New Bruns: Wick: Rutgers University Press.

GOG.,(1995). Ghana vision 2020. The first step: 1996-2000. Presidential report on coordinated programme of economic and social development policies to Parliament, 6th June 1995. Accra, Ghana.

GSS., (1987). 1984 Population Census of Ghana: Demographic and Economic

(Characteristics Upper East Region). Accra: Ghana Statistical Service.

GSS., (2000). 2000 population and housing census. Provisional results. Pp. 23.

GSS.,(2000). Poverty Trends in Ghana in the 1990s. Accra: Ghana Statistical Service.

GSS., (2005). 2000 Population and Housing Census. Upper East Region – Analysis of District Data and Implications for Planning. Accra: Ghana Statistical Service.

Gutmman, N.B., (2007). Accepting the standardized precipitation index: A calculation algorithm. *Journal of the American Water Resources Association,* 33 (2), pp.311-322.

Hamel, J., Duffour, S., & Fortin, D., (1993). *Case study method*. Thousand Oaks, CA. Sage Publications.

Haythornthwaite, C.,(1996). Social network analysis: an approach and technique for the study of information exchange. *Library and Information Science Research*, 18 (4), pp. 323-342.

Houghton, R.A & Stole, D.L., (1990). Carbon. In: B.L.Turner, W.C. Clark, R.W. Kates, J.F. Richards, J.T. Mathews and W.B. Meyer, eds. 1990. *The Earth as Transformed by Human Action*. Cambridge: Cambridge University Press.

Hulme, M., (1996). Recent climatic change in the world's drylands. *Geophysical Research Letters,* 23 (1), pp. 61-64.

Hunter, J.M., (1967). The social roots of dispersed settlement in northern Ghana. *Annals of the Association of American Geographers*, 57(2), pp. 338-349.

Huntingdon, E., (1924). *Civilization and climate* (3rd edn), New Haven: Yale University Press.

Ingram, P & Roberts, P.W., (2000). Friendship among competitors in the Sydney hotel industry. *American Journal of Sociology* 106 (2), pp. 387-423.

IPCC., (1996). *Climate Change 1995: The Science of Climate Change, WMO and UNEP*. Cambridge: Cambridge University Press.

IPCC., (2007). *IPCC fourth assessment report: climate change 2007*. Geneva: IPCC.

ISSS/ISRIC/FAO (1998). World Refence Base for Soil Resources. World Soil Resources Report 84. Rome, FAO.

Jaffe, A.B, Trajtenberg, M., & Henderson, R., (1993). Goegraphic localization of knowledge spillovers as evidenced by patent citations. *The Quarterly Journal of Economics*. 108 (3), pp 577-598.

Jorion, P.J.M., (2000). Information flows in kinship networks. *Mathematical Anthropolgy and Cultural Theory: An International Journal*, 1 (1), pp. 1-16.

Jung, G. & Kunstmann, H. (2007). High- resolution regional climate modeling for the Volta region of West Africa. *Journal of Geophysical Research*. 112, D23108, doi:10.1029/2006JD007951, pp.17.

Kaboré, D & Reij, C., (2004). The emeregence and spreading of an improved traditional soil and water conservation practice in Burkian Faso. EPTD Discussion Paper No. 114. International Food Policy Research Institute, Washington, D.C.

Kasei, C.N & Sallah, P.Y.K. (1993). Drought evasion in crop production under a monomodal rainfall pattern. In: H. Mercer-Quarshie., K.O Marfo., A.S. Langyintuo & R.K. Owusu. eds. 1993. Proceedings of the third workshop on improving farming systems in the Savanna zone of Ghana, 17-29 April, Pp. 51-62.

Kasei, C.N, Mercer-Quarshie H., & Sallah, P.Y.K., (1995). Identifying probable dry periods in maize production under a monomodal rainfall regime in northern Ghana. 29 May – 2nd June 1995, IITA Proceedings of a regional maize workshop. A WECAMAN/IITA Population.

Kasei, R., Diekkrüger, B. & Leemhuis, C., (2010). Drought frequency in the Volta Basin of West Africa. *Sustain. Sci* 5, pp. 89-97.

Kasperson, R.E., Kasperson, J.X., Dow, K., Ezcurra, E., Liverman, D.M., Mitchell, J.K., Rattick, S.J., O'Riordan, T. and Timmerman, P.(2001). Global environmental risk and society. In: J.X Kasperson and R.E. Kasperson (eds). *Global Environmental Risk*. Tokyo: United Nations University Press/London: Earthscan.

Keys, D., (1999). *Catastrophe: An Investigation into the Origins of the Modern World*. London: Arrow Books.

Knorr-Cetina, K., (1999). *Epistemic Cultures*. Cambridge, MA and London: Harvard University Press.

Kogut, B. & Zander, U., (1992). Knowledge of the firm, combinative capabilities, and the replication of technology. *Organization Science*, 3 (3), pp. 383-397.

Kranjac-Berisavljevic, G., Bayorbor, T.B. and Obeng, F.,(1999). Rethinking Natural Resource Degradation in Semi-Arid Sub-Saharan Africa: Case Study– Dunglaaberuk, East Mamprusi District, Northern Region of Ghana. Tamale: Faculty of Agriculture, University for Development Studies.

Krugman, P., (1991). *Geography and trade*. Cambridge, Massachusetts: MIT Press,

Kunstmann, H. & Jung, G., (2005). Impact of regional climate change on water availability in the Volta basin of West Africa. Regional hydrological impacts of climatic variability and change. Proceedings of symposium S6 held during the seventh IAHS scientific assembly at Foz do Iguacu, Brazil, April 2005. IAHS Pub., pp.295.

Laube, W., (2007). *Changing natural resource regimes in northern Ghana: Actors, structures and institutions.* S. Gerke & H-D Evers.eds.2007. ZEF Development Studies, Vol. 4. Münster: Lit Verlag Dr. W.Hopf.

Laube, W., Awo, M. and Benjamin, S. (2008). Erratic rains and erratic markets: Environmental change, economic globalization and the expansion of shallow groundwater irrigation in West Africa. *ZEF Working Paper Series*, No. 30, Center for Development Research, University of Bonn, Germany.

Laux, P., Kunstmann, H & Bádossy, A. (2007). Predicting the regional onset of the rainy season in West Africa. *International Journal of Climatology* 28 (3), pp. 329-342).

Lissoni, F., (2001). Knowledge codification and the geography of innovation: the case of the case of Brescia mechanical cluster. *Research Policy,* 30 (9), pp. 1479-1500.

Lundvall, B. –A., ed., (1992). *National Systems of Innovation: Towards a Theory of Innovation and Interactive Learning.* London: Pinter Publishers.

Lundvall, B. -A & Johson, B., (1994). The learning economy. *Journal of Industry Studies*. 1(2), pp. 23-42.

Malthus, T.,(1798). *An essay on the principle of population*. London: Macmillan.

Martin, R. & Sunley, P., (1996). Paul krugman's geographical economic and its implications for regional development theory: a critical assessment. *Economic Geography,* 72 (3), pp. 259-292.

Mikkelsen, J.H & Langohr, R., (2004). Indigenous knowledge about soils and a sustainable crop production, a case study from the Guinea Woodland Savannah (Northern Region, Ghana). *Danish Journal of Goegraphy.* 104(2), pp. 13-26.

Millar, D.(2004). Interfacing two knowledge systems: Local knowledge and science in Africa. In: COMPAS, Bridging Scales and Epistemologies: Linking Local Knowledge with Global Science in Multi-Scale Assessments. Alexandria, Egypt, March 2004, COMPAS.

Millar, D., (2009). Traditional African Worldviews from a cosmovision perspective.

[Online].Available at: http://regionalafrica.blogspot.com/2009/02/traditional-african-worldviews-from.html. [Accessed: 7/19/2009].

Millar, D., Ayariga, R. & Anamoh, B., (1996). 'Grandfather's way of doing': Gender relations and the Yaba-itgo system in the Upper East Region, Ghana. In: I., Scoones and C. Toulmin (eds)(1996). *Sustaining the soil: Indigenous soil and water conservation in Africa.* London: Earthscan., Pp. 117-125.

Miller, K.D. (1992). A framework for intergrated risk management in international business. *Journal of International Business Studies, Second Quarter*, 23 (2), pp. 311-331.

MoFA., (1998). *National soil fertility management action plan*. Accra: Ministry of Food and Agriculture.

MoFA., (2008). Regional Directorate, Upper East Region. [Online] Available at: http://www.mofa.gov.gh/UER-RADU.html. [Accessed 4/12/2010].

MoFA., (2002). Agriculture in Ghana: Facts and figures. Accra: Statistics, Research and Information Directorate (SRID), Ministry of Food and Agriculture.

Mortimore, M., (1998). *Roots in the African Dust*. Cambridge: Cambridge University Press.

Mortimore, M.(2000). A profile of natural resource management in the Kano Region, 1960-2000. *Working Paper No. 25*, Drylands Research, Crewkerne, Somerset, U.K. [Online] Available at: http://www.drylandsresearch.org.uk. [Accessed 3/12/2010].

Mortimore, M. & Tiffen, M., (2001). Livelihood transformations in Semi-Arid Africa. Working Paper No. 40, Drylands Research, Crewkerne, Somerset, U.K. [Online] Available at http://www.drylandsresearch.org.uk. [Accessed 3/12/2010].

Müller, C., (2003). Knowledge between globalization and localization: The dynamics of female spaces in Ghana. *Current Sociology*, 51(3/4), pp. 329-346.

Neumann, R., Jung, G., Laux, P & Kunstmann, H. (2007). Climate trends of temperature, precipitation and river discharge in the Volta basin of West Africa. *International Journal of River Basin Management* 5 (1), pp.17-30.

Niarmir, M.(1995). Indigenous natural resource management systems among pastoralists of Arid and Semi –Arid Africa. In, D.M. Warren, L.Jan Slikkerveer, and Brookensha, D. (eds).*The Cultural Dimensions of Development: Indigenous Knowledge Systems.* London: Intermediate Technology Publications. pp. 245-258.

Nicholson, S., (2005). On the question of the "recovery" of the rains in the West African Sahel. *Journal of Arid Environments*, 63 (3), pp.615-641.

Nicholson, S.E & Palao, I.M., (1993). A re-evaluation of rainfall variability in the Sahel. *International Journal of Climatology*, 13 (4), pp.371-389.

Nonaka, I., & Takeuchi, H., (1995). *The Knowledge-Creating Company: How Japanes Companies Create the Dynamics of Innovation*. New York: Oxford University Press.

Norberg – Bohm, V. et al., (2001). International comparisons of environmental hazards. In: J.X. Kasperson, and R.E. Kasperson, eds. *Global Environmental Risk*. Tokyo: United Nations University Press and London: Earthscan.

Nsiah-Gyabaah, K., (1994). *Environmental Degradation and Desertification in Ghana: A study of the North-Western Region.* Hants: Ashgate Publishing Limited.

Nuffic and UNESCO (1999). *Best practices on Indigenous Knowledge.* The Haque: Center for International Research and Advisory Networks and Paris, Management of Social Transformations Programme.

Oguntunde, ph. G., Friesen, J., van de Giesen, N & Savenije, H.G. (2006). Hydroclimatology of the Volta River Basin in West Africa: Trends and variability from 1901 to 2002. *Physics and Chemistry of the Earth,* 31 (18), pp.1180-1188.

Oldeman, L.R., Harkkeling, R.T.A & Sombroek, W.G., (1991). *World map of the status of human induced soil degradation: An explanatory note.* Nairobi: United Nations Environment Programme.

Ǿstergaard, C. R., (2008). Knowledge flows through social networks in a cluster: comparing university and industry links. *Structural Change and Economic Dynamics*, 20 (3), pp.196-210.

Patton, M.Q., (2002). *Qualitative research and evaluation methods*. London: Sage publications.

Pender, J.,(1999). Rural population growth, agricultural change and natural resource management in developing countries: A review of hypotheses and some evidence from Honduras. International Food Policy Research Institute, Environment and Production Technology Division, EPTD Discussion Paper 48.

Power, M.,(2004). The risk management of everything. *The Journal of Risk Finance*, 5 (6), pp.58-65.

PPMED., (1987). Ministry of Finance and Economic Planning, Policy Planning, Monitoring and Evaluation Division, Accra, Ghana.

Quansah, C., Baffoe-Bonnie, E. & Asiamah, R. D., (1991). Soil erosion in Ghana and strategies for conservation. In: R.D. Asiamah. ed. 1991. Proc. workshop on soil conservation strategies for Africa. UNEP regional co-ordination unit of the soils and fertilizer networks for Africa, Accra, Ghana.

Quansah, C., Safo, E.Y., Ampontuah, E.O. & Amankwah, A.S., (2000). Soil fertility erosion and the associated cost of N,P and K removal under different soil and residue management in Ghana. *Ghana Journal of Agriculture Science,* 33 (1), pp. 33-42.

Rain, D.,(1999). *The Eaters of the Dry Season.* Oxford: Westview Press

Ramphele, M., (2004). Women's indigenous knowledge: Building bridges between traditional and the modern. In: *Indigenous knowledge: Local pathways to global development*. The World Bank: Knowledge and learning group, Africa region, pp. 13-17.

Richards, J.F., (1990). Land transformation. In: Turner, B.L., Clark, W.C., Kates, R.W.,

Richards, J.F., Mathews J.T & Meyer, W.B., eds. *The Earth as Transformed by Human Action.* Cambridge: University Press.

Roberts, N., (1998). *The Holocene: An Environmental History*. Oxford: Blackwell.

Rodgers, C., Vlek, P.L.G, Eguavoen, I. and Arntz, C. (eds.)(2007). GLOWA Volta: Phase II Completion Report Period: 01.06.2003-30.05.2006., Center for Development Research, Rheinische Friedrich-Wilhelms-Universität, Bonn, submitted to Bundesministerium für Bildung und Forschung.

Rogers, E.M., (1982). Information exchange and technological innovation. In: Sahal D. (ed.), *The Transfer and Utilization of Technical Knowledge*. Lexington Books, Lexington, MA. pp 105-123.

Rogers, E.M. (1995). *Diffusion of innovations,* 4th ed. New York : Free Press,

Rosegrant, M.W., Paisner, M.S., Meijer, S. & Witcover, J., (2001). Global Food Projections to 2020: Emerging Trends and Alternative Futures. International Food Policy Research Institute.

Rose-Innes, R., (1977). *A manual of Ghana grasses*. England: Land Resources Division, Ministry of Overseas Development.

Ryan, B. & Gross, N., (1943). The diffusion of hybrid seed corn in two Iowa communities. *Rural Sociology*. 8 (1), pp. 15-24.

Rudestam, K.E., & Newton, R.R., (2001). *Surviving your dissertation: A comprehensive guide to content and process*. 2nd ed. Thousand Oaks, California: Sage Publications.

Schneider, S.H & Londer, R., (1984).*Coevolution of climate and life*. San Francisco: Sierra Club Books.

Schraven, B., (2010). Local livelihood adaptation in northern Ghana in response to ecological changes and economic challenges. Ph.D. Bonn: der Rheinischen Friedrich-Wilhelms – Universität.

Schweizer, T. & White, D.R., (1998). Revitalizing the study of kinship and exchange with network approaches: In: T. Schweizer, & D.R. White, D.R, eds. 1998. *Kinship, networks, and exchange.* Cambridge: Cambridge University Press, pp. 1-9.

Scott, R., (1977). Sources for a history of the Builsa in northern Ghana. *Paideuma,* 23, pp. 141-168.

Senayah, J.K., Kufogbe, S. K & Dedzoe, C.D., (2005). Land degradation in the Sudan Savanna of Ghana: A case study of the Bawku area. *West African Journal of Applied Ecology,* 8 (1), [pp.1-9].

Shackley, S. & Wynne, B., (1995). Global climate change: The mutual construction of an emergent science –policy domain. *Science and Public Policy*, 22 (4), pp. 218-230.

Sherr, S.J., (1999). Soil degradation: A threat to Developing Country food security by 2020? Food Agriculture and the Environmental Discussion Paper 27. International Food Policy Research Institute, Washington, D.C. USA.

Shinoda, M., (1990). Long-term Sahelian drought from the late 1960's to the mid-1980's, *Journal of the Meteorological Society of Japan,* 68 (5), pp. 613-624.

Sikana, P.,(1994), Indigenous soil characterization in Northern Zambia. In: Scoones, I. and Thompson, J. (eds). *Beyond Farmer First: Rural People's Knowledge, Agricultural Research and Extension Practice.* London: Intermediate Technology Publications, pp. 80-82.

Sillitoe, P.(2004). Interdisciplinary experiences: working with indigenous knowledge in development. *Interdisciplinary Science Reviews*, 29 (1), pp. 6 -23.

Singh, J., (2005). Collaborative networks as determinants of knowledge diffusion patterns. *Management Science*, 51 (5), pp. 756-770.

SRI., (1999). Report on Land Suitability Mapping of Ghana. GERMP Project.Soil Research Institute, Accra Office CSIR, Accra

Songsore, J., (1996). Population growth and ecological degradation in Northern Ghana:

Myths and realities. *Institute of African Studies: Research Review*, 12 (1 & 2), pp. 51-66.

Sorenson, O, Rivkin, J.W & Fleming, L., (2006). Complexity, networks and knowledge flow. *Research Policy,* 35(7), pp. 994-1017.

Stake, R. E., (2000). Case studies. In: N., K. Denzin & Y.S. Lincoln eds. 2002. *Hand book of qualitative research.* Thousand Oaks, CA: Sage publications, pp. 435-454.

Stoorvogel, J.J. & Smaling, E.M.A., (1990). Assessment of soil nutrient depletion in Sub-Saharan Africa: 1983.2000. Winand Staring Centre. Report 28, Wageningen. Pp.259.

Straus, A., & Corbin, J.,(1990). *Basics of qualitative research: Grounded theory procedures and techniques.* New Bury Park, California: SAGE Publications.

Sultan, B., Baron, C., Dingkuhn, M., Sarr, B and Janicot, S., (2005). Agricultural impacts of large-scale variability of the west African Monsoon. *Agricultural and Forest Meterology* 128 (1-2), pp. 93-110.

Tchale, H ., Sauer J and Wobst, P.(2005). Impact of Alternative Soil Fertility Management Options on Maize Productivity in Malawi's Smallholder Farming System. *Development Policy Discussion Paper No. 98*, Center for Development Research, Bonn, Germany.

Tropical Savannahs CRC (1998). Savannah Explorer. Tropical Savannahs Cooperative Research Centre for Tropical Savannah Management. Charles Darwin University, Australia.[Online].Available at: http://savanna.cdu.edu.au/information/info_savanna_explorer.html

Turner, B.L et al., (1990). Two types of global environmental change: definitional and spatial-scale issues in their human dimensions. *Global Environmental Change,* (1), pp.14-22.

Van de Giesen, N., Andah, W., Andreini, M., Barry, B., Jung, G., Kunstmann, H., Laube, W., Laux, P and Liebe, J.(2008). Adapting to climate change in West Africa. [Online].Available at: http://www.expozaragoza2008.es/ContenidosAgenda/tda/ST0618.pdf

Van der Geest, K.(2004). “We `re Managing!” Climate change and livelihood Vulnerability in Northwest Ghana. Leiden: African Studies Centre.

Van Dillen, S., (2004). Different choices: Assessing vulnerability in a South Indian Village, Studien zur geographischen Entwicklungsforschung, Band 29, Saarbrücken: Verlag für Entwickklungspolitik.

Vlek, P.L.G and Rodgers, C. (2005). GLOWA Volta: Significant Progress towards

Establishing a Scientifically Sound Decision Support System for the Volta Basin. Report Period 01.06.2003 to 28.02.205, Center for Development Research (ZEF), Bonn University, Bonn, Germany.

UNDP., (2004), *A Global Report, Reducing Disaster Risk: A Challenge for Development*, New York, N.Y : UNDP Bureau for Crisis Prevention and Recovery

UN/ISDR., (2009).UNISDR Terminology on Disaster Risk Reduction. [Online] Available at: http://www.unisdr.org/eng/terminology/terminology-2009-eng.html

Wikipedia., (2010). The Free Encyclopedia. Wikimedia Foundation. [Online] Available at:http://en.wikipedia.org/wiki/Traditional_African_religion#Religious_traditions_of_Africa, [Accessed: 5/4/2010].

Wikipedia., (2010).The Free Encyclopedia.Wikimedia Foundation. [Online] Available at: http://en.wikipedia.org/wiki/Kinship.

Williams, M.A.J & Balling, R.C.,(1996). *Interactions of Desertification and Climate, WMO and UNEP*. London: Arnold.

Wikipedia. (2010). The free encyclopedia. [Online] Available at: http://en.wikipedia.org/wiki/Soil_pH. Accessed [23 July 2010].

Wikipedia., (2010). The free encyclopedia. [Online] Available at: http://en.wikipedia.org/wiki/Nitrogen. Accessed [23 July 2010].

World Bank., (2005). IK Notes. No. 8, May 2005**.** [Online] Available at: http://www.worldbank.org/afr/ik/iknt80.htm. Accessed [16 August 2010].

World Bank., (2000). *Can Africa Claim the 21st Century?* Washintong, D.C: World Bank.

Wood, S., Sebastian, K. & Scherr, S.J., (2000). Pilot analysis of global ecosystems: Agroecosystems. International Food Policy Research Institute and World Resource Institute. Washington, D.C, pp.110.

Yaro, J.A. (2004). Combating Food Insecurity in Northern Ghana: Food Insecurity and Rural Livelihood Strategies in Kajelo, Chiana and Korania. Occasional Paper No. 44. PhD Oslo: Department of Sociology and Human Geography, University of Oslo.

Appendix 1: The in-depth study community

Origin of the people of *Yua*

The people of *Yua* are *Nankane* speaking people and generally classified as part of the larger *Mole-Dagbane* speaking people occupying the northern part of the country. According to oral history, the people of *Yua* originated from *Kanpalga*-*Yua* in Burkina Faso to settle in present day *Yua* in north-eastern Ghana. *Ayeboa,* is credited as the founding father of present day *Yua*. The story is told of how a man by name *Atuuya* migrated from present day *Gambaga* in the Northern Region of Ghana to settle at *Tungu* in Burkina Faso. He was named *Atuuya* to reflect the fact that he strayed into *Tungu* where he eventually settled with his family comprising two wives and a daughter. *Ayeboa* later embarked on a migration expedition from *Kanpalga*-*Yua* when he met *Atuuya* in present day *Tungu*, southern Burkina Faso. *Atuuya* invited *Ayeboa* to settle with him in *Tungu* to which the latter complied. *Atuuya* provided him with land to settle. *Ayeboa* was a bachelor and so he made efforts to make *Atuuya's* first wife his *zɛba*[56]. Since *Ayeboa* was a bachelor, the rationale for such friendship was to enable him obtain support from *Atuuya's* wife in terms of grinding flour for preparing food and drawing water which are the domains of women. *Atuuya* welcomed the relationship. *Ayeboa* requested from his *zɛba* a clay pot for storing water. His *zɛba* moulded the pot and asked her daughter *Ayanpoka*, to take it to *Ayeboa* which she complied. *Ayeboa* expressed interest in marrying *Ayanpoka* upon seeing her. *Ayeboa* was badly in need of a wife to cater for household chores such as grinding flour, drawing water and firewood, and cooking. *Atuuya* rejected the expression of interest to marry her daughter, *Ayanpoka.* Not knowing to his father, *Ayanpoka* was interested in the relationship. *Atuuya* exploited the situation, made a secret arrangement with *Ayanpoka* and they fled *Tungu.* They eventually settled in present day *Yua* which was reportedly a virgin forest and bushy area. They named their new settlement *Yua* after *Kanpalnga*-*Yua* of Burkina Faso which is the original place of

[56] In the local custom, this is expressed as *Nyokɛ poga la zɛba,* literally meaning befriending a married woman. This is usually an open and sanctioned special social relationship that is characterised by the exchange of courtesies.

origin of *Ayeboa*. *Ayeboa* has since been accredited as the founding father of present day *Yua*. *Ayeeboa* is a *Moshie* name and has been accepted as the ancestral name associated with important spiritual, funeral and sacrificial rites of the community. *Ayeeboa* is now a community God as represented by a *Tengane,* that is, a sacred grove. *Azulma*, a river God is sacrificed annually and from time to time as the need arises in honour of *Ayeboa.* Fowls, goats, sheep and *pito* (locally brewed sorghum beer) are often used for making offerings and spiritual sacrifices. The sacrifices to *Azulma* in honour of *Ayeboa* are also meant to seek multiple blessings[57] for the community. However, because of the historical conflict between *Ayeboa* and *Atuuya*, the *Tungu* people sometimes go to *Azulma* to do a protest sacrifice with a sheep which the people of *Yua* do not use for their sacrifice. *"So anytime we go to sacrifice and see a sheep, we pick it and throw it away and then make the right sacrifice"* says grandfather *Abusina*. However, the relationship between the *people of Tungu* and that of *Yua* has normalized. People from each of the community's attend each other's social functions such as marriage ceremonies, funerals, installation of chiefs and festivals.

Kinship and spatial organization of the community

With time, *Ayeboa's* family population increased and the number of clans as well as their populations also increased. These factors gradually led to an expansion of the community and shaped the current spatial pattern of the community. First, the founding couple of *Yua*, *Ayeeboa* and his wife *Ayanpoka* gave birth to a baby boy. They named their son *Aserebia* literally meaning 'the pot child' – that is reflective of past events leading to the marriage. *Aserebia* also grew and married his wife from present day *Namoo,* a neighbouring community located in the Bongo District. The couple were blessed with many children from their marriage. Together, they had five sons, and three daughters. The sons were *Atisige*, *Aforega, Akonwem, Akolbire* and *Agerebia*. Their daughters were *Azupoka*, *Azure* and *Adogpoka*. Since virilocality is practiced as the custom, all the sons

[57] In search of blessings that God will help their children and women to marry; that married women will be fertile and bring fourth children; that millet and sorghum yields will be good; and that rearing poultry and livestock will be successful endeavours.

got married and started their families as part of the extended family of their parents. The girls also got married to men in other communities and thus, moved homes. In subsequent chapters (chapters 3 to 6), my discussions will reflect how virilocality in marriage and inheritance plays an important role in knowledge flows and transfers. As custom demands, all *Aserebia's* daughters moved out of their paternal home and community to live with their husbands among their extended families. *Aserebia,* his wife, his sons and daughter in-laws then lived together as one extended family. To date, a typical family is an extended family comprising father and wife, son(s) and daughter(s) in-law(s), teenage daughter(s), and perhaps some other relatives such as a grandparent, divorced daughter or foster children living together in a *yire* (compound house). Sons who get married start their families within the extended family setting by first living in their own *detto* (homesteads) usually within the compound setting. Nuclear families therefore, exist but they do not exist as independent and isolated entities. They exist within the extended family and compound setting and are heavily influenced by what happens in the extended family. The extended family then becomes an amalgamation of different blood related *detto* (homesteads) living together within the compound. The family exists in a larger patriarchal society and inheritance is shaped by this system. *Yua* gradually grew from a *deo* (homestead), to a *yire* (a compound), to *detto* (several compounds) and to *yi-zuto* (sections-five) which collectively make up the community (Figure III). The spatial organization of *Yua* may be appropriatly described as follows: several homesteads (*detto)* based on kinship make up a compound (*yire)*; several compounds predominantly formed on the bases of kinship form a section/neighbourhood (*yi-zuto*); several sections based predominantly on clans collective constitute the community.

As the population of *Aserebia's* family increased and there was the need for more space, some households especially the younger ones moved out of the compound to resettle in the neighbourhood. This was how the original section gradually enlarged into the original settlement/section of *Yua.* *Atisige* was the first son of *Aserebia*. As an honour, this original settlement/section was named *Atisigibisi,* after him. The second son, *Aforega*, moved out to start his family in a newly constructed house in the neighbourhood and this eventually gave rise to the development of another section of *Yua*. This section was

Aforegabisi in honour of *Aforega,* the second son of Aserebia. With time, the indigenous people of *Yua* welcomed migrants into their midst. They allocated land to them for settlement in different parts of the community at different times. Three additional sections of *Yua* evolved this way. These include *Taribisi*, *Bargabisi* and *Gingirigo.* The *Taribisi* people originated from *Adare-Konkone* in Burkina Faso led by their great grandfather, N–yaaba Ata-ɛr*a*. They were migrating further south of *Yua* when the indigenous people of *Yua* invited them to settle with them. As an incentive to entice them to stay and to integrate them well into the community, the indigenous people of *Yua* relinquished the chieftaincy position of the community to the *Taribisi* people. Up to date the chieftaincy of the community resides with the people of *Taribisi.* The people of *Taribisi* still maintain kinship and social relations with their origin – thus, the people of *Adare-Konkone.* The *Bargabisi* people also originally migrated from *Adare-Konkone* in Burkina Faso and settled in present day *Tungu* also in Burkina Faso. They were led by their great grandfather, N-yaaba *Baregabisi.* They later migrated further south from *Tungu* settling in present day *Yua* with the consent and support of the indigenous people of *Yua*. They named their section of *Yua* after their grandfather. They also still maintain kinship and social relations and production relations with their relations in *Adare-Konkone.* The people of *Gingirigo* originally migrated from *Nungu* in Burkina Faso. Before their migration, they lived in a section of *Nungo* called *Gingirigo*. They were led by their great grandfather, N-yaaba *Agobga* who after settling named their settlement here in *Yua* after the name of their original settlement in *Nungu*. They still maintain kinship, social and production relations with their people in *Nungu* to date.

There are other minority clans or groups who have been integrated into some of the main sections or settlements of *Yua.* These include the *Kadaare* people some of whom originally migrated from present day Bongo District (Ghana) while some migrated from present day neighbouring *Sirigu* community (Ghana). So the *Kadaare* people are a mixed group of people who were integrated into *Yua* by the indigenous people. Upon settlement, the *Kadaare* people who migrated from *Sirigu* are commonly reported to have said that *'kadaare yane Sirigu'*, literally meaning *Kadaare* is better than *Sirigu*. The indigenous people here again relinquished the office of *Tindaana* to the *Kadaare* people.

By giving them the opportunity to pour libation in the hope that it will serve as an incentive for them to stay. The pouring of libation and making sacrifices requires that people make in-kind contributions - millet, poultry, livetock and drinks for religious sacrifices. After such sacrifices, the surplus meat, food and drinks is usually the preserve of the *Tindaana*- thus, the *kadaare* people. This incentive package was designed to entice them to stay and this worked allowing them to be integrated well into the community. To date, they still play the roles of *Tindaanduma* and benefit from their roles. There is another minority clan, the *Booɛ* people who originated from nearby present day Bongo District. They were migrating from Bongo across River *Akulaa* in the community when *Aserebia's* son (*Akowem*) invited them them to settle in *Yua*. They are not many – they occupy just about 7 houses in the community. There is yet another minority group, the *Abemzanga Bisi*. These people originated from present day *Kandiga* in the Kassena-Nankana District. They visited their *Ansiba Yire* ('uncle house') in the *Agerebia* family of *Atisigibisi* and simply expressed interest in settlement. Customarily, 'they came to live with their uncles' which is acceptable especially if there are pushing factors in their original home. They occupy about four compound houses in *Gebisi* which is part of the larger *Atisigibisi* section of *Yua*.

The discussions so far show that the people of *Yua* are a conglomerate of different clan groupings. Although they live together as a community, the different clan groupings have maintained social and economic relations with their origins up to date. In chapters 3 to 6, my discussions will show how this has created an enabling environment and facilitated access to knowledge and productive assets (especially arable lands) for adapting to environmental change in farming. Thus, the people of *Yua* live together as a community but their 'territory' does not necessarily correspond to the boundary of the community. In general, settlement patterns [including *Yua*] are dispersed and tend to overlap (Runge-Metzger and Diehl, 1993).

African traditional religion and 'cosmovision'

African Traditional Religion is the predominant religious practice of the people of *Yua* although minority religious groupings exist. While this was revealed in focus group discussions, results from the survey show that 71 % of respondents subscribed to African traditional religion. African traditional religion for most of its existence has been orally and or spiritually (rather than scripturally) transmitted (Wikipedia, 2010) and embedded in the everyday and routine lives of the people. Traditional religion permeates all aspects of the lives of the people, including their livelihoods as espoused by their 'cosmovision'. The notion of cosmovision originates from a culture which has a holistic world view, integrating the world with the cosmos. In the Africa's perspective of cosmovision, the whole of nature is conceived as a living being, like an animal, with all parts interrelated and needing to perform (Millar, 2009:1). "Cosmovision is a social construct that includes the assumed relationship between spirituality, nature and mankind" (Ibid.) and these three overlapping worldviews are found in most indigenous knowledge systems (COMPAS, 2007). Cosmovision describes the role of supernatural powers, the natural processes that take place and the relationship between mankind and nature. It often indicates a hierarchy in divine beings, spiritual beings (especially ancestors), natural forces, man and woman (Millar, 2009:1) and this shapes all domains of life including knowledge, natural resource management, livelihoods and development processes in general.

The practices of African traditional religion manifest at various levels in the community – at the individual, household and community levels and linked to important roles of two office holders - the *Bakolgo*[58] and *Tindaana*[59]. I shall limit my discussion here to spirituality at the individual and household levels as linked to the roles of the *Bakolgo*, while spirituality at the community scale vis-à-vis the role of the *Tindaana* is discussed as part of local governance later in this chapter. As an approach to this subject, my

[58] Bakolgo refers to a Soothsayer and or Spiritual Diviner who via spiritual mediums is said to have capability of communicating with the spiritual world and diagnosing a wide range of problems and offering prescriptive solutions.

[59] The *Tindaana* is the spiritual leader of the community and custodian of communal land, shrines and Gods in most communities of northen Ghana.

discussion on spirituality at the individual and household levels will center on the spiritual role of the *Bakolgo* and how that shapes traditional religious practices at the individual and household levels. There are approximately eight (8) to ten (10) *Bakolduma* (plural) in the community but they are often classified into active and non active types by the community. In my discussion, I will draw more on in-depth interviews conducted with a renowned *Bakolgo* in the community, *Abusina*. At the beginning of my interview, I asked *Abusina*: what work do you do as a *Bakolgo* and how did you become one? *"Maam de la Bakolgo daana"*, says *Abusina*. "*Bakolgo de la yelekirishi."* In the words of *Abusina,* this literally means that he is a soothsayer and that he derives supernatural powers from ferries to function as such. He further describes a *Bakolgo a divine calling in the following way*: "*When you were coming from God, you promised to be a Bakolgo. You sought to be healthy, marry like every other man, farm and keep a family. Keep poultry and livetsock. You sought to help other people so you can be happy together. It is a gift from God."*

How did you become a soothsayer? According to Abusina, he became a *Bakolgo* himself following consultation of another *Bakolgo* to find out why he was facing many problems earlier on in his life. According to him, he experienced a myriad of problems at the time. His crops yielded poorly for successive years. He lost a lot of poultry and livestock to diseases. These experiences brought untold hardship to his family. When these events occurred, he made several religious sacrifices, offering fowls and pouring libation for the intercession of his ancestors but he still did not get any positive results. As is the norm, he decided on a further step – and this step was the decision to consult a *Bakolgo* in the community to find out why these calamities befell him. The consultation revealed that he was possessed by some spiritual powers of a female *Bakolgo* originating from his fathers' *Ansiba Yire* (uncle house). This implied that the *Bakolgo* together with its spiritual powers originated from his paternal grandmother's home in nearby *Guelwongo*, Burkina Faso. The *Bakolgo* he consulted prescribed that the solution to his problems was for him to take steps to have the *Bakolgo* from his father's *Ansiba Yire* installed for him to practice as a *Bakolgo* himself in *Yua*. *Abusina* complied and followed up on the issue to his father's *Ansiba Yire*. Following completion of a series of prescriptive spiritual and religious sacrifices and offerings, it was then possible to have the *Bakolgo* finally installed for *Abusina* in *Yua*. The process was long but I will highlight a few of these activities. These activities included a series of visits he did with his wife to his father's *Ansiba Yire* in *Guelwongo* often carrying with them *Pito* (locally brewed sorghum beer), fowls and guinea fowls which were often used as offerings and for pouring libation. The sacrificial offerings were done first, to thank *Abusina's* grandmother whom the *'Bakolgo'* followed to *Yua* when she married *Abusina's* father and second, as offerings and thanksgiving to the *Tengane* (deity, ie tree) from which the *Bakolgo* originally derives its powers from in *Guelwongo.* This deity is called *Agingre* which seeks to 'protect people from evil spirits'. Sacrifices and offerings at the level of *Abusina's* father's '*uncle house'* were done by the elders and lead by the landlord, but those in honour of *'Agingre'* was often done with the leadership of the *Tindaana* of *Guelwongo*. Another important requirement was that *Abusina* had to present two fowls but these fowls had to be kept at his father's *Ansiba Yire* for reproduction purposes. Once they survived and reproduced, it was an indicator that *Abusina's* claim to the *Bakolgo* was genuine and indicative that he will be a successful *Bakolgo*. Once Abusina passed this test, he was due for installation as a *Bakolgo*. A date was set for the installation at his house in *Yua.*

In readiness for the installation, *Abusina* and his wife brewed *Pito* (sorghum beer) and mobilized food stuff for preparing food. On the day of installation, elders of *Abusina's Ansiba Yire* together with the *Guelwongo Tindaana* came to preside over the installation. They came along with roots of the *Tengane* (deity) from which the Bakolgo derives its spiritual powers from in *Guelwongo*. They stopped at a distance and sat under a tree as they approached the house. They sent somebody to inform *Abusina* that they were in for the installation. *Abusina* described the process of installation as involving a series of rituals (Appendix Box 1.1).

Appendix Box 1.1: Rituals in the installation of *Abusina* as a *Bakolgo* (soothsayer)

So, my wife and I took with us food (Tuozafi), a boiled a guinea fowl and some pito to meet and serve our guest under the tree. I also took with me a hoe as part of the requirement. They ate the food, ate the meat and drunk the pito as well. I did this in appreciation for honouring their promise to come and initiate me, said *Abusina*. They then gave me the roots of the Tengane which I carried on my head and took the lead to the house. They followed up to the house after a few minutes. The *Guelwongo Tindaana* burnt the roots of the *Tengane* into charcoal and grounded them into powdery form. They mixed it with ‘pito’ and asked me to drink the concoction which I complied. After drinking it, I became dazed and felt possessed by some spiritual powers. When that happened, the *Yua Tindaana* who was also in attendance at the installation killed a goat in sacrifice for purifying or cleansing the land. This is was a protocol ritual that will allow the foreign *Tindaana*, that is, the Guelwongo *Tindaana* to use soil of the land to prepare mortar and mould a deity in *Abusina’s* house as representing his newly installed *Bakolgo*. When the *Bakolgo* was moulded or constructed, they took a white fowl which I had provided to make yet another test sacrifice. They slaughtered the white fowl and then threw it to the ground. When they did that, the fowl flew up into the skies and fell back to the ground lying with its stomach facing upwards towards the sky. When that happened, they concluded that the *Bakolgo* had been successfully installed and that the spiritual powers associated with it had accepted the sacrifices and the installation. That marked the end of the first day’s session. There were many other fowls and foodstuff that were donated by relatives and other social relations. These were all used to prepare food for the refreshment of both participating guest and all who had come to be part of the installation process.

Source: In-depth Interview, Abusina, Yua, 2009

To confirm that the *Bakolgo* had powers for interacting with the spiritual world (expressed as ability to “see” ie. to be a fortune-teller), some further rituals were done the next day. The feet of the goat that was slaughtered as offering the previous day was buried in a secret location for which his next assignment was to locate them without assistance from anybody. He was given a symbolic stick, referred to as the *Bakolgo.* They will then say that *"Abaga N Zu ho"* literally meaning, they had stolen from him, *Abaga* – thus, challenging him to find the hidden goat feet. *Abusina* recalls that he was dazed and possessed by spiritual powers of the *Bakolgo* in his narrationes that:

> At that point, I could even see dead people, meaning people of the spiritual world. So when I was challenged, I got up and started running to where the goat feet were buried. When I got there, I removed the buried legs at once and returned, all under the spiritual direction of the *Bakolgo*. This exercise was repeated a number of times even to the extent of hiding a goat feet at the river side. But in all these cases, I found the hidden goat feet. These exercises further confirmed that the Bakolgo had been successfully installed and that I could 'see', that is interact with the spiritual world, diagnose problems confronting the living and prescribe solutions through the mediation of the spiritual world of our ancestors. When they realized that I could "see", the *Guelwongo Tindaana* and his followers then told me to use the *Bakolgo* to enhance the welfare of my family, protect myself, and promote my farming activities. Then they embarked on their return journey to *Guelwongo* (Abusina, *Yua*, 04-03-09).

Prior to using the *Bakolgo* for business, *Abusina* decided to consult the *Bakolgo* that originally diagnosed that he was possessed by the spiritual powers of his newly installed *Bakolgo*. The consultation revealed that *Abusina's Bakolgo* was meant to promote the welfare of people beyond his family – hence, the welfare of all. The consultation revealed that *Abusina* should also use his *Bakolgo* to speak for the *Tindaana* of *Yua* in the spiritual realm. The consultation also revealed a forecast that many people will consult *Abusina* (*Bakolgo*) for assistance on a wide range of issues and that he should be kind to serve the welfare of all his clients. *Abusina* had all accessories concerning his *Bakolgo* in a goat skin leather bag – made from the goat that was slautrered for a ritual in his installation. Since the installation, *Abusina* has been sacrificing his *Bakolgo* and offering consultation services to a wide range of people. On three occasions, I had to wait for *Abusina* to finish attending to a client before he could have time to grant me interviews. He makes offerings to his *Bakolgo* depending on what 'she' wants. He pours libation with *Pito,* water and *Zom-kom* (mixture of flour and water). Sometimes he sacrifices a goat or a sheep as offering. What he offers as sacrifice to his *Bakolgo* is most often prescribed by another *Bakolgo*. He consults another soothsayer to know what to sacrifice to his *Bakolgo*. Abusina continuous to make offerings to his *Bakolgo* as demanded. For instance, the *Bakolgo* demanded that *Abusina* name some of his children after her. *Abusina* complied and named three children after her. His first child *Akolgo,* and two other children, *Adongo* and *Atingane* were all named after his *Bakolgo.*

Since his installation, many people from the community and beyond seek consultation services from him on a wide range of issue including agriculture. In Abusina's own narration:

> They come for many reasons. For some, they come because a child is sick. After consulting my *Bakolgo,* I may for instance, tell the clients to go back home and pour libation to appease his ancestors as a prescription for recovery and good health of the child. When the person does it and the child is better, he might then come back to thank me. He might bring a gift or some money and seek further consultation. In some cases, people consult me because diseases kill their poultry and livestock. So I prescribe sacrifices that they have to do to improve upon their situation. There are many people who also consult my *Bakolgo* because of poor crop yields. From the consultation, the *Tengane* of *Yua* may inform the *Bakolgo* to tell the client that he should go and pour libation to appease for instance a deity (e.g., which could be a tree) on his farm. This tree could have been a deity without the knowledge of the client, or an existent *Tengane* (deity) that the client had neglected in terms of making offerings or sacrifices. When he does this and gets good harvest, he comes back and this time the *Bakolgo* may say he should offer a goat in sacrifice to the *Tengaane* (Abusina, *Yua,* 04-03-09).

In the discussions on local governance later in this chapter, I will explain the role of *Abusina*, the *Bakolgo* in matters relating to dealing with drought or excessive rainfall at the community level.

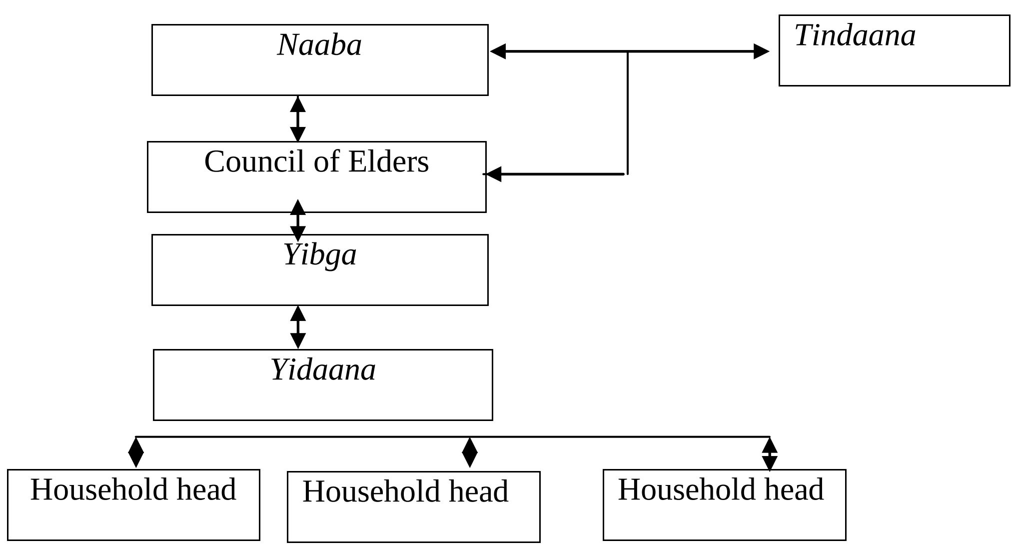
Despite the fact that African traditional religion is the predominant religion in the community, it is important to acknowledge a gradual and an increasing incidence of religious plurality in the community. For instance, a survey revealed that about 24 % of respondents were Christians (with Catholics being the dominant denomination) while 3 % were Muslims. Though these percentages reflect the fact that foreign religions are in the minority, they are indicative of part of the overall social change that is occurring in rural communities within the basin (See Figure III for churches). Given that African traditional religion is predominant, it is important to underscore that many people resort to this faith for spiritual solutions when they are faced with problems in their livelihoods, even if the problems are environmentally related. As part of adaptation measures to climate change among farmers in Ghana and other parts of Africa, the *"more superstitious"* are reported to *"make increased offerings to deities and ancestors"* (Dinar et al., 2008:76).

Local political organization and local governance

Local governance is administered through a dual local political structure comprising (1) traditional political authority and (2) the district assembly within the broader framework of decentralization of local governance in the country. Although the latter has overall legal authority and responsibility in the exercise of local governance, these two systems of governance co-exists, complement each other and sometimes conflict each other at the local level. In my discussion here, I will first, examine the nature and role of first, the traditional political authority and second, the district assembly in local governance at the community level and district as a whole.

The traditional political system of governance in the community revolves around the authorities and functions of the *Naaba* (Chief) and *Tindaana* (Earth Priest). At the apex of the traditional authority structure and system (Appendix Figure 1.1) are the *Naaba* and *Tindaana*. The *Naaba* is the traditional political head of the community while the *Tindaana* is the earth priest and spiritual leader of the community. At the bottom of the structure are the governed - household heads and their members. The *Naaba* takes decisions regarding the community with the support of a council of elders. The *Naaba* identifies sectional heads from each of the five sections of *Yua* and some one or two personal assistants of the *Naaba* to make up this council. Statuses of sectional heads reside with particular families who have played this role dating back to generations but the chief may select different people over time especially when new neighbourhoods or the population increases. In doing this, the chief normally ask sections to nominate their elders for him to work with and most of these decisions are taken by consensus. The most senior in age that is of good character, still strong and active will always be selected by consensus. The council of elders were selected this way as a practice dating back to previous generations and has remained a tradition. When decisions are taken by the chief and his council, each elder transmits these decisions to the people and section he represents on the council. First, the decisions are discussed at the sectional level with *Yibga* here in referring to *brothers* and cousins of the elder who collectively share ancestral heritage. The decisions are further transmitted to the *Yidaama* that is landlords of various compounds in the section and this is then further transmitted to household heads and finally to household members. It is the responsibility of each functionary in the structure to disseminate decisions and information to the next lower level functionaries until it reaches ordinary household members. Any expected feedback from the lowest level such as cash or in-kind contributions reaches the *Naaba* and his council through the same decentralized structure from the bottom up to the top. External development agencies have always utilized this system for mobilization in community development initiatives and it has always worked to a large extent.

Appendix Figure 1.1: Organogram of traditional political structure



Source: Authors construct.

The *Tindaana* is an important ally of the *Naaba* and they are often described as brothers by the local populace. In the particular case of *Yua*, there are as many as three

Tindaanduma. I do not intend to address this issue any further except to comment that this is out of the ordinary but very much related to the evolution of the community. However, there is one *Tindaana* amongst them who is the lead *Tindaana*, and thus the *Tindaana* of the community. The *Tindaana* provides community leadership on matters relating to spirituality and customary land management. He is the 'custodian of communal land and communal *Tengane* (deities) on behalf of the people. The *Tindaana* works in tandem with the *Naaba* and his council of elders on these matters but the *Tindaana* provides the leadership in these domains. For instance, while the *Naaba* and elders may be responsible for mobilizing sacrificial poultry and livestock including flour for making offerings to community Gods, it is the *Tindaana* who leads or does the actual 'pouring of libation' and spiritual offerings on behalf of the community. To distinguish between the *Naaba* and *Tindaana*, it is often said in the local parlance that *Naaba N so nireba*, literally meaning 'the people belong to the chief'. As such, it is the *Naaba* who host guest on behalf of the community. On the other hand, it is often said in the local parlance that *Tindaana N so Tinkobre',* literally meaning 'the land belongs to the *Tindaana'*. In the scheme of things, the *Tindaana* appears most powerful because of his powers over the most important production asset (land) but he works together with the *Naaba* in the spirit of 'brotherhood'. The *Naaba* is however more popular because of his involvement in the public sphere of life. The collective functions of the *Naaba,* the council of elders and *Tindaana* permeate all facets of community life including livelihoods. A summary of this is captured vividly by the responses of the *Tindaana* in an interview he granted me (Appendix Box 1.2). This interactive interview with the *Tindaana* reveals the kind of cooperation that takes place between the *Naaba* (including his Council of Elders*)* and the *Tindaana* in local governance. The important role of the *Bakolgo* (Soothsayer) in community service is also revealed in this interview. These traditional office holders collaborate and undertake routine religious sacrifices to provide spiritual protection for the community and for seeking blessings of the ancestors and God in the area of farming. Prior to the planting season, libation is poured at a Sacred Groove by name *Atalmoa Tengane.*

Appendix Box 1.2: The collective functions of the Naaba and Tindaana in local governance

As T*indaana,* I take custody of all the *Tengane* (sacred grooves). I pour libation and offer sacrifices to these *Tengane* on behalf of the people. I serve as a link between the living in the community and the dead of the community. I pour libation to enable women to conceive babies and deliver successfully. I pour libation to guarantee good yield from farming. I ask for long life for the people. I pour libation to ask for rain during drought. I pour libation and makes sacrifices to ask for peace and good health from the ancestors of the community. When we are affected by drought or excessive rainfall, I offer libation to the biggest *Tengane* (Sacred Groove) called *"Ayua –Nyagre"* to seek the intervention of the ancestors. There are two ways in which the process can be initiated. One way is that the *Naaba* and his elders can consult a *Bakolgo* to find out why there is drought or excessive rainfall. Depending on the findings, the *Bakolgo* will recommend some religious sacrifices that need to be made to address the issue at hand. The chief and his elders will then communicate their findings to me. We will then immediately offer the religious sacrifice to the *Tengane* for his intercession and intervention on behalf of the people. The other option is that few elders from my section together with me may also consult a *Bakolgo* when the community the community is faced with drought or excessive rainfall. The *Bakolgo* will usually make prescription of sacrifices that need to be made. We will also communicate our findings to the chief and elders so that we can collectively take action. The type of sacrifice we make usually depends on the prescription of the *Bakolgo* and this can vary from time to time. In most cases however, it simply entails offering libation. A typical offer of libation involves *'pouring a mixture of water and milled millet flour'*, known as *"Zom- kom"* accompanied by traditional ritual recitals at the *Tengane* (deity), in this case *"Ayua –Nyagre"*. When we deal with drought, the *Bakolgo* may prescribe that dry libation be offered and this means making an offering of flour without soaking it with water. In this case it is symbolic and suggestive that the *Tengane* should provide 'his' own water for soaking the flour and making "Zom-kom". When we offer this kind of libation to *"Ayua –Nyagre"*, sometimes it starts raining before we even get back home. This practice has a long history. We inherited the tradition and we have to follow the traditions that we inherited from our ancestors. We have to follow our gods. They seek our welfare (Tindaana of Yua).

Source: In-depth interview, Tindaana of *Yua*, 2008

Spiritual consultations and pouring of libations continue during the farming season as a community initiative. After harvest, they pour libation and make offerings to thank their ancestors and God for the blessings during the farming season. Sometimes thanksgiving involves the sacrifice of fowls and a cow. In addition, *Pito* (sorghum beer) is brewed. Some of it is used for the libation and the rest is drunk. These sacrifices may be accompanied by drumming and dancing. However, this is not a harvest festival as is the case with some other communities. Besides this community initiative, every *Yidaana* and every household continuously pour libation and offer sacrifices at every stage of farming to enhance their chances of success in farming. This was corroborated by male focus group discussants in the following way:

> As a community, we do not have a harvest festival. However, people thank their ancestors and Gods in the various sections and even in individual homes. People do what we call *Siisia* literally meaning – slashing of millet. This is usually a thanksgiving that is done by every *Yidaana*. A wide range of offerings may be made and this includes slaughtering dogs, fowls, goats, sheep, and using *Pito* for pouring libation as offerings to their ancestors. For female headed household, the boy in the house will do it with the support of the woman. Some women may ask some closely related men to consult a *Bakolgo* on their behalf to find what sacrifice to make. Customarily, women do not consult *Bakolduma* by themselves although a few bold women are beginning to make some inroads in this arena. Any man could actually consult on behalf of a female head of household and then bring the feedback for action. If there is a child in the house; the child does the sacrifice as recommended by the *Bakolgo* on behalf of the female head. The child could be a boy or girl. The man who did the consultation will be the one doing the recitals for the libation, while the child pours the libation on behalf of the woman. In other instances, the female head does the recitals while the child pours the libation. If it involves slaughtering a fowl or animal, it is the child who does it. It is simply a norm that women do not consult or make sacrifices or pour libation by themselves. Any woman who does this 'risk' being tagged a *Poge-naabre* interpreted as an independent woman which has a negative connotation in a patriarchal culture. (FGD, Yua).

As earlier stated, the traditional authority system of governance co-exists with a parallel state supported system of local governance at the district level. The *Kassena-Nankana District Assembly* (KNDA) is responsible for exercising local governance at the district level. The 1992 Constitution of the Republic of Ghana, Chapter 6, 'Directive Principles of State Policy', enjoin the government of the day to make democracy a reality by decentralizing the administrative and financial machinery of government to the regions and districts and to create all possible opportunities for people to participate in decision-making at every level in national life and in government (Ghana, 1992; Asante, 2004). The specific objectives and responsibilities of district assemblies under decentralization as outlined in the Local Government Act 1993 (Act 462) include among others: Deconcentration and devolution of administration, development planning, and management to district assemblies and incorporation of economic, social, spatial, and environmental issues into the development planning process on an integrated and comprehensive basis *(*Ghana, 1992; *Ghana, 1993;* Asante, 2004). In the context of decentralization of governance in Ghana, the Local Government Act 462, therefore, establish the district assembly, thus, the KNDA as the body and authority responsible for overall development planning in the district. It is within this context that the study communities in my study area are under the jurisdiction of the KNDA. A community such as *Yua,* is represented by an elected Assembly Member and a Unit Committee as part of the district assembly's sub-structures. The assembly member of *Yua* sits in district assembly sessions at the district capital (Navrongo) and participates in deliberations and decision-making that affects the entire district. The unit committee of the *Yua Electoral Area* is responsible for engendering participation of their people in decision-making and channelling these as inputs into district development planning for the preparation and implementation of Medium Term Development Plans (MTDPs) for district development. Although these district assembly sub-structures are not functioning effectively because of problems that undermine Ghana's decentralization programme, a fair degree of community participation and collaboration is facilitated by the existing system of governance. At the community level, there is collaboration between the traditional authorities, the assembly member and unit committees in exercise of their functions in local governance. For instance, in exercise of their functions, the assembly member and unit committees seek the support of the chief and his council of elders in mobilization of the community. Similarly, staffs of the various departments under the district assembly seek the support of traditional authorities, especially the *Naaba* and his council of elder's in community entry, communication and mobilization for the planning and implementation of development projects. It is within the framework of the district assembly and support of traditional authorities that departments under the KNDA with specialized technical expertise provide technical and extension services to *Yua* and many other communities in the district. These departments include the District Directorate of Food and Agriculture, Information Services Department, Fire Services Department, District Directorate of Health Services and the District Directorate of Education among others. It is also within the context of a co-ordinating role of the district assembly that external development agencies, such as non-governmental organizations and community based organizations provide complementary extension services and development initiatives to communities in the district. In tChapters 4 & 6, the roles of some of these departments, community-based organizations and non-governmental organizations in the localization of knowledge for adapting livelihoods to environmental change is discussed.

Appendix 1.2: Methodology and field research

This study was carried out through a qualitative research approach. According to Straus and Corbin (1990), qualitative research is the kind that produces findings not arrived at by means of statistical procedures or other means of quantification. They note that it can refer to research about persons' lives, stories, behaviour and organizational functioning, social movements, or interactional relationships. Some of the data may be quantified, as with census data but the analysis itself is qualitative**.** Qualitative research enabled utilization of suitable data collection methods that provided the kind of in-depth insights that was sought in this research. Straus and Baron (1990; 19) observe that "qualitative methods can be used to uncover and understand what lies behind any phenomenon about which little is yet known. It can be used to gain novel and fresh slants on things about which quite a bit is already known. Also, qualitative methods can give the intricate details of phenomena that are difficult to convey with quantitative methods". In my approach to the discussion, I will first do an overview on the research methodology that was employed in this study. This will then be followed by a more detail discussion of sampling, data collection methods, processes and reliability of the study.

As already stated, qualitative methods of data collection were used for data collection and analysis. Data collection was done in three communities within the basin. These included *Yua* and *Mirigu* which are populated by Nankane speaking people. The third community was *Pungu* which is populated by Kassem speaking people. An in-depth study was conducted in *Yua*. This involved a series of in-depth interviews conducted among 9 households with the aid of interview guides. These households were sampled through purposive sampling technique. A total of 41 in-depth interviews were conducted among these sampled households at different times. Each interview built on the previous. The results from these interviews were used to develop household case studies. Aside this, the study also benefited from a triangulation of PRA methods in data collection. These multiple methods include observation, focus group discussions, group interviews and key informant interviews. Focus group discussions were particularly conducted among male and female farmers in *Yua*, but also in *Mirigu* and *Pungu*. At the institutional level, key informant interviews were conducted. The interviews targeted officers of community and external organizations whose activities were a subject of interest in the study. A survey was also conducted among 131 households across all three study communities in the basin to complement qualitative approaches. The survey was conducted through questionnaire administered interviews. In the ensuing discussions, I will show in details how questions regarding sampling, data collection methods, processes and procedures and issues bordering on the reliability of the study were addressed.

When I arrived in the *Atankwidi* basin, I initially sampled three communities, namely *Pungu, Mirigu and Yua* for preliminary assessments on their suitability for the study (See Figures I & II). My choice of communities was partly inspired by some Senior Researchers I spoke to at the Center for Development Research (ZEF), who shared with me their experiences from conducting their Ph.D field research in the same basin under the GLOWA Volta Project. I also had previous research experiences in the first two communities and thus, had a fair understanding and familiarity about their socio-economic settings that would facilitate my field research. Furthermore, *Pungu* is located in the *Navrongo* central sub-district while the other two communities are located in the Kassena-Nankana East sub-district. From observation and literature, these two sub-districts are the worst affected by deforestation and land degradation in the district. Thus, sampling communities from this area was also most appropriate since my study was about adapting livelihoods to environmental change. By my research design, I had to sample one community from amongst the three initial sample communities for carrying out an in-depth study. I proceeded with this task by carrying out some preliminary assessments through focus group discussions with elders (male) and some selected women from each of the communities. I also interviewed the Chiefs and some opinion leaders in each community in my preliminary investigations. The basis of the preliminary investigations was to find out in general terms how each of the communities was exploring local knowledge systems for improving livelihoods in the context of environmental change. My personal evaluation of results from the preliminary investigations showed that all the three communities were generally suitable for my study. However, *Yua* represented the best case for 'fusion of knowledge systems' in livelihoods and this was an interest area in my study. Based on this evaluation, I selected *Yua* on purpose for conducting the in-depth study. Aside, no researcher from ZEF had conducted in-depth studies on *Yua* since the GLOWA Volta Project begun and this was an added impetus for my decision although this reason was secondary to its suitability for investigating my research problem.

The in-depth study community and initial steps in data collection

I began the in-depth study in *Yua* by first focusing my research activities at the community level. First, this was necessary for securing community support for the study. Second, data collection and analysis extensively dealt with happenings in the larger community. This is because what happened in the larger community shaped household activities, which are my focus in the study. I therefore, started with a series of community entry and protocol procedures. These enabled rapport building between me and the the community at large. These procedures involved a series of meetings with traditional leaders, farmers and youth groups to explain my presence and essence of the research in the community. Through these meetings, I presented cola, tobacco and dinks to traditional leaders as part of community entry protocol and in conformity with traditions. After these initial community entry procedures, I first proceeded with some initial PRA methods of data collection and analysis in the community. These include a transect walk and community resource mapping. The others include key informant interviews, focus group discussions and group interviews. I will briefly discuss how the use of these methods facilitated my first steps in fieldwork and how this laddered into household case studies. I began my in-depth studies with a group interview with the chief and elders of *Yua*. The participants comprised 9 discussants. This was actually the third group meeting with the same participants. Earlier on two (2) group interviews were held with them during the preliminary investigations as part of my sampling process. I also conducted a transect walk with three key informants through which a draft community resource map was prepared. This map was later validated and updated at some focus group sessions later on during the study. These initial group interviews and the transect walk [as described] enhanced my understanding of the community. Through these PRA methods, I had a better understanding of the social organization of the people. For instance, I learnt about the five sections of *Yua,* namely, *Baregabisi, Atisigibisi, Taribisi, Gingirigo* and *Aforegabisi* and how they evolved from these sessions (Figure III). I also learnt about their economic assets, activities and the organization of their livelihoods in space. It also afforded me an initial understanding of the knowledge systems they employ in economic production. These initial insights gained proofed to be useful for further research design and field activities. For instance, an important output from the group interview was the formation of two focus groups – a focus group comprising male farmers and other comprising female farmers. I moderated these discussions with the aid of my Research Assistant who was very knowledgeable about the community. The discussions produced a tentative list of 20 farmers, 2 male farmers and 2 female farmers per each section of the community. The elders of each section agreed to confer with female leaders in each section of the community before forwarding to me a final list of proposed participants for the formation of my focus groups. The final list was submitted to me a week later after they had done their consultations at the sectional levels. I then invited each of these groups for a meeting through which I interacted with them and explained the rationale of my study to them. They demonstrated a wealth of knowledge and experience in initial discussions of issues concerning livelihoods and local knowledge at the first meetings. They willingly agreed to be part and to support my research. I was impressed by their level of enthusiasm and knowledge. I therefore, constituted these farmers into two farmers' focus groups – male and female farmers groups for long term engagements in the research. Each group comprised 10 participants. I then conducted a series of focus group sessions with each group. During the entire fieldwork, I conducted 4 focus group sessions with each group at different times aside the initial preparatory meetings with each group. These discussions centred on environmental change, implications for livelihoods and the role of local knowledge in production. The first focus group sessions were informative and enabled me decide on topical issues for consideration in household case studies. This then brought me into the phase of conducting household case studies, which run concurrently with many other methods of data collection, including subsequent focus group discussions.

The multi-household case study and data collection methods

I employed a multi-household case study approach for the in-depth investigation of livelihoods and local knowledge processes at the household level. Theoretically, the case study method involves a systematic gathering of enough information about the case in question. The case could be an individual, household, social setting, event, or group, programmes or organizations (See Hamel et al., 1993; Stake, 2000; Berg, 2001; Patton, 2002). In ethnographic studies, there is usually one unit of analysis. This could be either a community or village or a tribe (Bernard, 2006; also see Patton, 2002). The essence of a case study is to enable the researcher grasp an in-depth and effective understanding of how it operates or functions. Therefore, the case study is not a data-gathering technique. Rather, it is a methodological approach involving using a number of data-gathering methods (Hamel et al., 1993; Berg, 2001). To understand a case, it could be studied analytically or holistically, organically or culturally, and by mixed methods. Whichever way one chooses, one concentrates at least for the time being, on the case or cases (Stake, 2000). In the case of this study, 9 households in *Yua* were the cases. Here too, the households were sampled through purposive sampling technique. First, I determined some guidelines, which I discussed with the female farmers during my second focus group session with them. Second, I asked them to propose fifteen (15) households for conducting in-depth studies according to the proposed guidelines. The guidelines ensured the following: first a spread of the households across the five sections of the community; second, that there was a fair balance between male headed and female headed households; and third, that the proposed sample reflected a fair mix of resource poor and rich households from their own assessments and stand point. I focused on female farmers for this exercise for a reason. My experiences with rural communities in research and development activities show that women are generally more knowledgeable about the details of household and community life than their male counterparts are. My Research Assistant was useful here again not only in the appropriate translation and in explanation of the issues relating to the task to the discussants, but his knowledge of the community aided the process. I conducted initial round of in-depth interviews across the 15 households. The interviews focused on household compositions, their livelihoods and how knowledge was being applied in household production. I then subjected these initial findings to some form of screening after which I reduced the sample size to nine (9) households for case study development. These comprised five (5) male-headed households and four (4) female-headed households. As already indicated, the sampling was purposive. The evaluation and selection of households was based on my impression of which households provided a better opportunity for exploring the research problem. At the same time, I ensured the sample represented a good mix and reflection of the guidelines established for guiding the sampling process.

To collect data for developing these cases, I employed mainly in-depth interviews and observation. For each household, I further conducted a series of four interrelated in-depth interviews. For the first set of interviews, a common interview guide was used to aid the interviews of household heads for all the cases. In the subsequent interviews, interview guides were prepared and tailored to reflect the unique issues arising from the interviews conducted on each household. Thus, the interview guide kept changing in content at each stage in order to enable the interview address the unique issues of each household arising from previous interviews. In this way, each interview conducted built on the other as the study progressed steadily. This allowed for a continuous analysis and reflection of the emerging findings and issues of interest. Since subsequent interviews built on previous interviews, subject leads were easily followed; data gaps were easily filled in the process and on the field analysis was possible alongside data collection. Fortyone (41) such interrelated in-depth interviews were conducted for household case studies. I personally conducted the interviews during which I took field notes. Audio recordings of the interviews was also done and later transcribed to supplement field notes. In conducting the in-depth interviews, the head of household was the target respondent. However, in male-headed households, at least one interview was conducted on their spousal counterparts and this proofed to be useful and complementary in generating data for the completeness of the cases.

These in-depth interviews in household case studies were combined with observation for the collection and analysis of data. For instance, I observed many compound farm

(*Sammani*) practices through such observations. As I advanced with the case studies, preliminary findings were periodically discussed during focus group sessions. I moderated the discussions very often with the objective of seeking further clarifications on findings from case studies. The essence was also to investigate the generality of the findings - to find out if they represented general patterns in the community or were simply unique to the households in question. Case study development and focus group discussions were conducted hand in hand in this alternating scheme of activities and corroboration of findings throughout the fieldwork. These two alternating approaches essentially reflected a continuous process of 'on field' analyses of findings. Patton (2002) describes the case study as an approach to qualitative data analysis, thus:

> The case study approach to qualitative analysis constitutes a specific way of collecting, organizing and analyzing data. In this sense, case study represents an analysis process with the purpose of gathering comprehensive, systematic and in-depth information about the case of interest. The analysis process thus results in a product, that is, the case study. Thus the, case study can refer to either the process of analysis, or the product of analysis or both. There are three interrelated steps or processes for constructing case studies. The first step is to assemble the raw case data. The second step is to construct a case record. This is a condensation of the raw case data organized, classified and edited into meaningful format. The third stage is to write a final case study narrative. This is a readable, descriptive picture of the case studied making accessible to the reader all the information necessary to understand the case in all its uniqueness. The case story can be presented chronologically or thematically or both. It is holistic and presented in its context necessary for understanding (Patton, 2002:447-450).

The community and institutional studies

Although the household is the main unit of analysis, the analysis in this study included certain events within the larger community because these shaped activities within the household. It was therefore, important for the investigation to cover some key community events, actors, organisations and institutions within the larger environ of the in-depth study community and the *Atankwidi* basin whose activities have a bearing on household livelihoods and knowledge systems. For this, additional methods of data collection aside in-depth interviews and focus group discussions were employed as complementary methods of data collection where appropriate. These include additional group interviews and key informant interviews. A series of group interviews were conducted among the leadership of farmer based organizations in the community, for instance, the *'Nemogre'* Farmers Group. Non-office holding members of the groups sometimes joined in the interviews and this generally enriched the composition of the groups and the discussions. The discussions centred on the role of the farmers group in the localization of external knowledge in household crop production.

Key informant interviews were conducted at different levels – community and institutional levels. At the community level, a series of such interviews were conducted among traditional custodian of land (*Tindaana*), a soothsayer and the co-ordinator of all farmer based organizations in the community. The interviews dealt with a wide range of findings concerning environmental change, livelihoods and knowledge for adaptation. These findings were drawn from case studies and focus group discussions. The findings that were subjected to further exploration in each key informant interviews were tailored towards the special domain of knowledge of the key informants in question. For instance, interviews with the *Tindaana* and soothsayer focused on customary land management and religion in farming and the context of environmental change. For the coordinator of the farmer-based groups, the interviews focused on the role of these farmer based organizations in community mobilization and the localization of new and external knowledge. At the institutional level, key informant interviews were conducted amongst officers of external agencies identified through focus group discussions and case studies that had a relationship with *Yua* in terms of promoting new knowledge and livelihood sustainability in the community. At the institutional level, the Executive Director of SEISUD, an external CBO based in *Sirigu,* a neighbouring community was interviewed twice. The interviews dealt with the role of SEISUD in promoting compost as a method of soil conservation for farming in *Yua* through the collaboration of farmer based organizations. In addition, the District Systems Information Officer, the District Director of Agriculture Services and the Agriculture Extension Agent (AEA) were all interviewed as key informants of MoFA. Furthermore, a resource person from TRAX was also interviewed. He was interviewed because he was contracted by SEISUD to undertake training for farmers in *Yua* on compost making. This interview revealed information on the compost technology that was being promoted and how farmers were being engaged to adopt it.

The survey in three communities of the *Atankwidi* basin

This study also benefited from a survey. At the tail end of the fieldwork a wide range of findings relevant to the study were identified. With this knowledge of the study area, I reviewed a questionnaire (interview schedule) that I had earlier on developed for carrying out a survey in the study area. The review was significant in that findings from 7 months of field research informed the review process. This made the questionnaire more focused and relevant to the subject of study and local situation. After minor reviews were done following a pre-test, the questionnaire was administered in a survey conducted in all three communities that were originally sampled for preliminary studies and assessments. These communities as mentioned earlier on include *Pungu, Mirigu* and *Yua*. The essence for extending the survey to cover the basin was to enable testing of the generality of the findings in the basin since communities largely share common characteristics. In all, 131 interview schedules were administered in the survey through a combination of systematic and random sampling of household heads as respondents. A breakdown of the sample by sex shows 82 (63 %) of respondents were males while 49 (37 %) were females. For a breakdown by community, 50 interviews (38 %) were conducted in *Yua*; 41 interviews (31 %) conducted in *Mirigu*; and the remaining 40 interviews (30 %) conducted in *Pungu*.

The analysis of data – from the field to write-up

From the overview so far, a qualitative research approach to data collection and analysis was employed for this study. Within this framework, it benefited from ‘triangulation’ - multiple methods of data collection and multiple sources of data collection. This also allowed for complementary quantitative methods of data collection and analysis. Proponents of both qualitative and quantitative approaches often time, present the unique and appealing features of the approaches they stand for. However, Silverman argues that there is enormous advantage in combining the two approaches as evidenced in his recommendations that “1).... qualitative methods are clearly required for certain types of evaluative research projects and in other cases are useful in combination with quantitative approaches; 2) researchers should use both types of methods” (Silverman, 1990; in, Kunfaa, 1996 : 44). As the overview shows, this study benefited from a combinative research design.

From the overview, this study utilized field analysis of data as a continuous process appropriate for qualitative studies of this kind. Qualitative data analysis is a complex, iterative and continuous process of reflection that runs through all stages of the study design - from conceptualization through the fieldwork process and to final reporting stage. According to Bernard (1994:360), “qualitative analysis – in fact, all analysis – is the search for patterns in data and for ideas that help explain the existence of those patterns. It starts even before you go to the field and continues throughout the research effort. As you develop ideas, you test them against your observations; your observations may then modify your ideas, which then need to be tested again; and so on. Don’t look for closure in the process. If you are doing it right, it never stops”. The analysis of qualitative data requires following up on leads and is a challenging process. Michael Patton notes that “qualitative analysis transforms data into findings. No formula exists for that transformation. Guidance, yes. But no recipe. Direction can and will be offered, but the final destination remains unique for each inquirer, known only when-and if- arrived at” (Patton, 2002:432). Furthermore, he describes the nature of qualitative analysis. Thus:

> Unlike quantitative data in which distinction between data collection and analysis is clear, this distinction is less absolute in the collection and analysis of qualitative data. This is due to the fluid and emergent nature of naturalistic inquiry. During the field work, ideas about directions for analysis will occur. Patterns take shape and possible themes spring to mind. These give rise to the emergence of hypotheses which intend inform subsequent fieldwork. While early stages of fieldwork are data generative in nature, later stages bring findings to closure through confirmatory data collection. This further leads to deepening understanding of issues, and confirming or disconfirming patterns that seem to have appeared (Ibid: 436).

From this review, it is clear that the process and methods of qualitative analysis requires flexibility and should be mainly informed by the field situation. While keeping in mind the need to be flexible, some prior planning of how the data could be analyzed as was the case in this study was a useful exercise. My planned use of multiple methods of qualitative data analysis and reporting as outlined in my discussion was useful. The case study approach to organization, reporting and analysis together with other complementary methods such as description, validity checks, quotes, boxes and tables, frequencies and percentages all proofed to be useful as evidenced in this thesis.

The *household* essentially constituted the unit of analysis for in-depth studies but the analysis was extended to include the *community*. While the household was the main unit of analysis for case studies, the nature of the cases required examining relevant inter-linked community wide and organizational processes. This lead to extending the units of analysis to cover the community and community based organizations. Consideration of the *case community* in the analysis provided the contextual setting within which livelihoods and local knowledge dynamics are occurring. This provided a more holistic and complete understanding of the issues at the household level.

Limitations and validity of the study

A limitation[60] in this study is that the in-depth study was limited to *Yua* as part of the research design for exploring the research problem in the *Atankwidi* basin. At the community level too, case studies were limited to 9 households as part of the research design as well. Small sample sizes of this nature can be expected in qualitative research of this nature although often criticized when pitched against relatively larger sample sizes in quantitative studies. Although qualitative research such as this often provides in-depth insights, validity questions are often raised in much the same way as with quantitative methods. Validity issues are often associated with the research design. In this respect, how trustworthy are the findings of this study on household livelihoods and local

[60] Limitations may refer to restrictions in the study arising from the method that is used. For instance, one may be limited to only a narrow segment of a population targeted for a study (Rudestam & Newton, 2001:90).

knowledge responses to environmental change based on the research design? The limitations of the research design notwithstanding, I have explored long term engagements with subjects of the study and ‘triangulation’ for improving upon validity and overall reliability of the findings. These comprised the incorporation of internal validity and external validity measures in the research design.

Internal validity[61] was enhanced through a number of measures: (1) through long term engagements with households for developing cases studies and (2) through long term engagements with the same discussants in focus group discussions. In the case of household cases, a lineup of at least 4 separate interviews were conducted on each household at different times spanning the entire duration of the fieldwork (12 months). This is aside the first interviews that were conducted for the purpose of screening and sampling households for case development. This is also aside additional interviews of spousal counterparts of male household heads for the purpose of having a complete understanding of household situations. As my earlier discussions shows, this allowed for a continuous analysis and reflection of the emerging findings. Since subsequent interviews built on previous interviews, subject leads were easily followed; data gaps were easily filled in the process and on the field analysis was possible alongside data collection. This provided an opportunity for spending sufficient time with the respondents, understanding their long term experiences in sufficient detail, employing observation as an additional method of data collection and checking for distortions and consistency in responses. By the research design, the same focus group discussants were engaged in long term discussions over the entire period of the fieldwork. This also provided similar internal mechanisms for improving internal validity. By engaging the same discussants in the long term, it afforded me to tap into the long term experiences of discussants. It also enabled me to cross-check for consistency and evaluation of preliminary findings. An important mechanism was the cross tabulation of findings from household cases at focus group sessions for discussions. This allowed for detail

[61] Internal validity refers to the validity of a causal inference. In naturalistic inquiry, credibility is ascertained through structural corroboration. Such corroboration might be accomplished by spending sufficient time with subjects, check for distortions through prolonged engagement and exploring participant’s experience in sufficient detail through persistent observation. It may also be achieved by checking multiple sources of data and clarifying tentative findings with the participants (Rudestam & Newton, 2001:98).

discussions and evaluations of preliminary findings. Overall, findings from households that held true for the community were largely corroborated by focus group discussions.

As already stated, external validity[62] was enhanced through 'triangulation' in the collection and analysis of data. In the in-depth study community (*Yua)*, key informant interviews, observation, group interviews and focus group discussions were employed for complementing in-depth interviews at the household level. In addition, a survey was extended to two other communities in the basin (*Pungu* and *Mirigu*) aside *Yua*. This enabled testing of the generality of findings from *Yua* within the larger *Atankwidi* basin. As the discussions show, the findings from *Yua* were largely corroborated by findings from the survey at the basin level. Thus, through triangulation, findings from household cases were largely corroborated at the community and basin levels.

Overall, internal and external validity measures as part of the research design improved internal and external validities and the trustworthiness of the findings from this study.

[62] External validity refers to the generalizability of the findings of the study. Accordingly, qualitative study emphasizes the "thick description" of a relatively small number of participants in specific setting. The descriptions of participants or settings may be sufficiently detailed to allow for transferability to other settings. Samples can change as the study proceeds, but generalizations to other participants and situations are always modest and mindful of the context of individual lives (Rudestam & Newton, 2001:98-99). However, triangulation may improve external validity (Cresswell, 1998).

Appendix 2.1: Age and sex structure for Kassena-Nankana in national context

Age group	Ghana	Upper East	Kassena-Nankana		
	All sex	All sex	All sex	Male	Female
0-4	2.8	2.4	2.8	49.5	50.5
5-9	11.9	12.3	10.0	50.6	49.4
10-14	14.9	16.7	15.2	53.1	46.9
15-19	12.3	12.0	12.6	51.6	48.4
20-24	10.3	9.1	9.8	47.1	52.9
25-29	8.2	6.6	7.0	44.7	55.3
30-34	7.4	6.7	6.6	41.3	58.7
35-39	6.1	5.5	5.4	41.6	58.4
40-44	5.2	5.1	5.2	42.9	57.1
45-49	4.7	4.5	4.9	46.0	54.0
50-54	4.0	4.3	4.8	41.8	58.2
55-59	3.0	3.5	3.8	47.8	52.2
60-64	2.0	2.4	2.9	43.2	56.8
65-69	1.9	2.5	2.7	49.3	50.7
70-74	1.4	1.8	2.0	51.2	48.8
75+	3.9	4.6	4.2	53.9	46.1
All ages	100	100	100	48.1	51.9

Source: Ghana Statistical Service, 2005

Appendix 2.2: Population (6 years +) by educational status and sex, country and region

School attainment	Total Country			Upper East Region		
	Total	Male	Female	Total	Male	Female
Never attended school	38.8	33.1	44.5	69.4	64.0	74.4
Ever attended school	61.2	66.9	55.5	30.6	36.0	25.6
Pre-school	1.1	1.1	1.1	0.5	0.6	0.5
Primary	21.6	21.9	21.4	16.0	18.0	14.3
Middle/JSS	24.2	26.5	21.9	6.7	8.1	5.5
Secondary/SSS	6.8	8.3	5.3	3.5	4.5	2.6
Voc./Tech./Commercial	2.9	3.5	2.4	1.3	1.7	1.0
Post secondary	2.2	2.5	1.9	1.4	1.8	0.9
Tertiary	2.3	3.1	1.9	1.1	1.4	0.8
All levels	100.0	100.0	100.0	100.0	100.0	100.0

Source: Ghana Statistical Service (2000, 2005)

Appendix 2.3: Household composition (size and relationships) in KND

Household size		Relationship to head	
Category	%	Relation	%
Single (1 person)	6.0	Head	17.0
Small (2 persons)	8.6	Temporary head	0.9
Medium (3-5 persons)	39.4	Spouse	11.5
Large (6-8 persons)	31.2	Child	42.4
Very large (persons or more)	14.8	Parent/parent -in-law	1.9
		Son/daughter -in-law	2.6
		Grand child	6.1
		Other relative	15.8
		Non-relative	1.4
		Group quarters	0.3
Total	100.0	Total	100.0

Source: Ghana Statistical Service (2005)

Appendix 2.4: Main occupation of economically active population (15 years +)

Type of occupation	Upper East			Kassena-Nankana		
	Both sexes	Male	Female	Both sexes	Male	Female
Professional/Technical work	3.0	4.0	2.0	3.5	4.6	2.4
Admin./Managerial work	0.1	0.2	0.0	0.1	0.2	0.0
Clerical and related work	1.5	2.4	0.6	1.4	2.1	0.7
Sales work	9.6	5.8	13.3	9.2	4.8	13.8
Service work	4.0	3.0	4.9	5.6	4.2	7.1
**Farmers	66.4	71.8	61.2	68.7	76.2	61.0
Transport operators/labourers	14.7	11.8	17.5	10.4	6.8	14.2
All others	0.8	1.1	0.4	1.0	1.3	0.8
Total	100.0	100.0	100.0	100.0	100.0	100.0

Source: Source: (GSS, 2000; GSS, 2005)

Appendix 3.1: Total number of migrants by age for KND (2000, 2003, 2005, 2007)

Age group	2000		2003		2005		2007	
	Migration		Migration		Migration		Migration	
	Out	In	Out	In	Out	In	Out	In
0-9	2264	2958	2340	2820	2941	2922	2362	1501
10-19	2879	2763	2929	2757	2994	2582	2381	1940
20-29	2123	2584	2419	2886	2770	2992	2381	2521
30-39	863	1246	866	1328	1001	1277	738	926
40-49	399	541	430	617	620	767	438	497
50-59	205	288	212	294	286	389	203	232
60-69	115	122	129	169	149	167	132	135
70-79	18	28	30	51	45	58	44	49
80 +	6	8	5	12	2	10	5	6
Total	8872	10538	9360	10934	10808	11164	8684	7807

Source: Navrongo Demographic Surveilance System (NHRC, 2009)

Appendix 3.2: Monthly out migration by destination for 2007

Destinations	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Kassena-Nankana District	35.3	42.2	35.6	37.1	37.3	44.0	42.1	47.6	43.9	38.0	31.5	29.3
Upper East Region	6.7	5.5	6.8	8.5	7.8	8.6	7.6	6.2	7.9	7.3	6.4	4.7
Outside Upper East Region	54.3	48.7	54.3	52.0	51.4	44.0	48.3	44.0	44.6	51.3	59.2	63.4
Burkina Faso	3.7	3.6	3.3	2.4	3.5	3.4	2.0	2.2	3.6	3.4	2.9	2.6

Source: Navrongo Demographic Surveillance System (NHRC, 2009).

Appendix 3.3: Common livelihoods reported by focus group discussants

- *Storing and selling plant stalks as sources of energy during the wet season commonly associated with women. Atanga's second wife was organizing stalks for storage at the time of an interview in the house. [Integrate into case].*
- *Pottery involving moulding of earthen pots for storing water and grains commonly associated with women;*
- *Weaving baskets for harvesting crops commonly associated with women; and weaving hats and ropes associated with both sexes;*
- *Blacksmithing – making hoe blades, simple bullock plough and donkey cart accessories and simple instruments. This is also commonly associated with men;*
- *Carving hoe handles, mortars and pestles, and handles of other simple tools. This is also commonly associated with men;*
- *Butchering – processing fresh and boiled meat for sale in market centres and community squares. This is commonly associated with men;*
- *Retail in petty commodity provisions such as soap, matches, sweets, kerosene and petrol for energy. This is commonly associated with men;*
- *Harvesting and processing of wild vegetables ('vonka') for sale in Yelwongo market commonly associated with women but also men in Taribisi section;*
- *Trade in grains between Yelwongo and Sirigu markets. This is a widespread activity commonly associated with women;*
- *Head pottering tradable commodities between Yelwongo and Sirigu markets and homes. This transport business services mainly foodstuff traders and is commonly associated with women;*
- *Intermediate technology transport services involving the transportation of market commodities between Yelwongo and Sirigu markets and homes by the use of donkey carts and bicycles. This activity is commonly associated with boys;*
- *Trade in poultry and livestock in market centres commonly associated with men;*
- *Use of bullocks for commercial ploughing commonly associated with bullock owners (men) and their sons or boys;*
- *Farm wage labour during the rainy season (especially weeding) within the community commonly associated with both men and women and ;*
- *Wage labour at construction sites – commonly associated with both sexes.*

Source: Field Survey, 2008