Food and nutrition insecurity risk mapping (FNIRM) in urban and periurban areas in West African cities

(Tamale and Ouagadougou)

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Dedication

To my parents Tobias and Esther Chagomoka who spend many years doing agriculture in and outside cities in Zimbabwe.

And

My caring and loving family; Reginah Chagomoka (wife), Morevictory Chagomoka (son) and Greatness Baraka Chagomoka (daughter).

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List of abbreviations

BMI	Body Mass Index
CARE	Cooperative for Assistance and Relief Everywhere
CSA	Climate-Smart agriculture
CSI	Coping Strategies Index
FANTA	Food and Nutrition Technical Assistance
FAO	Food and Agriculture Organisation
FGD	Focus Group Discussion
GIS	Geographic Information Systems
GIZ	German Federal Enterprise for International Cooperation
GPS	Global Positioning System
HAZ	Height-for-age
HDDS	Household Dietary Diversity Score
HFIAS	Household Food Insecurity Access Scale
HLPE	High Level Panel of Experts
ICN2	Second International Conference on Nutrition
IDDS	Individual Dietary Diversity Score
IFAD	International Fund for Agricultural Development
IFPRI	International Food Policy Research Institute
INSD	Institut National de la Statistique et de la Démographie
IWMI	International Water Management Institute
MANOVA	Multivariate Analysis of Variance
MDG	Millennium Development Goals
NRI	Natural Resources Institute
TMA	Tamale Metropolitan Assembly
UA	Urban Agriculture
UPA	Urban and Periurban Agriculture
UN	United Nations

UNDP	United Nations Development Programme
UNFPA	United Nations Population Fund
UN-HABITAT	United Nations Human Settlements Programme
UNICEF	United Nations International Children's Emergency Fund
URBANET	Urban Agriculture Network
USAID	United States Agency for International Development
VRA	Volta River Authority
WARDA	West Africa Rice Development Association
WAZ	Weight-for-age
WDDS	Women’s Dietary Diversity Score
WFP	World Food Programme
WHO	World Health Organization
WHZ	Weight-for-height

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Abstract

Food and nutrition insecurity remains a global challenge, with sub-Saharan Africa bearing a large share of this burden. Women, mostly of reproductive age (15 – 49 years) and children under five years are at the pinnacle of this problem. It has traditionally been looked at as a problem of rural areas taking in consideration that urban households are better placed than their rural counterparts in terms of infrastructure, especially in sub-Saharan Africa. Nevertheless, recent trends in this region show more evidence of rising urban poverty, in the midst of growing cities and looming food shortages. These challenges of food and nutrition insecurity in and around cities lead urban dwellers to engage in farming activities to help satisfy their food needs. The global share of African urban dwellers is projected to rise from 11.3 % in 2010 to a 20.2 % by 2050, further increasing urban food demand. Although many studies have reported on food and nutrition insecurity and its interaction with agriculture, little is known, however, about how this differs between multiple locations along the urban - rural continuum. The urban – rural continuum approach enhances formulation of efficient urban sustainability policies as it is inclusive and addresses sustainability in areas large enough to encompass urban, periurban and rural areas unlike other approaches which focus on the dichotomy between urban and rural areas. Information on spatial variation of household food and nutrition insecurity can be very useful in understanding its dynamics in various locations and help in resource allocation and proper intervention targeting.

The primary objective of the study was to understand and map the dynamics of household food and nutrition insecurity in urban, periurban and rural settings. The study was conducted along the urban - rural continuum of two sub-Saharan African cities; in Tamale (Ghana) and Ouagadougou (Burkina Faso). Furthermore, the role played by urban, periurban and rural agriculture was investigated.

The study used a mixed method approach, with a transect approach building the foundation for data collection. Transects, 2 km wide and 70 km from Ouagadougou and Tamale central markets, were laid radially. Based on the relevant literature, working definitions of urban, periurban and rural areas were established. Within 10 km of the city centre was considered as urban, between 10 km to 40 km as periurban, and between 40 to 70 km as rural. All households along the transects were digitised and randomly selected using Geographic Information Systems (GIS). A total of 240 households were selected (4 transects

x 3 zones x 20 households) in each location (Tamale and Ouagadougou). The waypoint data was transferred to a Global Positioning System (GPS) device, which helped in locating and identification of sampled households. A structured questionnaire was used to collect data on: household food insecurity using the Household Food Insecurity Access Scale (HFIAS); household nutrition insecurity using Women`s Dietary Diversity Score (WDDS) and anthropometric measurements; household agricultural activities (crop and livestock production) and household food coping strategies using the Coping Strategy Index (CSI). Focus group discussions and in-depth interviews were used to verify household coping strategies. In contrary to many other studies, the chosen approach allows much better to localize food related problems on different scales.

The results of this study revealed varying involvement in agriculture and consumption patterns in Ouagadougou and Tamale along the urban – rural continuum. Highest dietary diversity (WDDS ≥ 6) was recorded in the urban areas compared to periurban and rural areas in Tamale. This was due to the presence of many food dealers, shops and food markets in urban areas compared to periurban and rural areas. In Ouagadougou households in the rural areas had the highest dietary diversity (WDDS ≥ 6), compared to periurban and urban households. This was because of the subsistence nature of crop production in rural areas, coupled with presence of wild fruits and traditional vegetables that offered the opportunity to a wide diversity of food groups compared to urban and periurban areas. This shows that access (purchasing power, income and markets infrastructure) and availability (domestic production) are key factors of food and nutrition security in both locations. Households from the urban areas in Tamale (36%) were more food insecure (HFIAS > 11) compared to their counterparts in periurban areas (9%) and the rural zone (10%), while in Ouagadougou households in periurban areas had the highest relative proportion (54%) of food insecurity (HFIAS > 11), compared to urban areas (39%) and rural areas (45%). The subsistence nature of agriculture in rural areas in both locations helped rural households to provide food to their families compared to periurban and urban households. The periurban area in Ouagadougou is associated with seasonal flooding with most households practising minimum or no agriculture, thus perpetuating food shortages. In both locations, periurban households had the highest relative proportion of stunting prevalence compared to urban and rural households. Periurban were perceived as safety nets in both locations, thus high influx of people from both urban and rural areas.There was evidence of more inclination toward staple crops compared to vegetables along the urban – rural continuum for both production and

consumption, clearly shown in crops grown and food groups mostly consumed (cereals and tubers rather than dark green vegetables). In Ouagadougou households doing livestock keeping reduced significantly wasting (WHZ) and overweight (BAZ) compared to households not doing livestock keeping. Livestock keepers also sold their animals to generate income which was used to meet family food need and other requirements. Unexpectedly, households involved in crop production increased significantly food insecurity (HFIAS) compared to households without crop production. With the subsistence nature of agriculture in the study area we expected crop production to reduce household food insecurity. Low crop yields due to use of poor farmer saved seeds, prevalent erratic rains and poor soils contributed to this finding. Growing crops and keeping livestock was significantly associated with reduction in wasting among children under five years of age. On the other hand rural livestock production in Tamale, reduced the HFIAS significantly compared to periurban and urban livestock production. Most households in rural areas were keeping livestock to sell during times of hardship to meet households needs including buying food. The changes were insignificant among crop growers versus non-growers in urban, periurban and rural areas in Tamale.

Study results reveal that food coping strategies vary from one spatial entity to another in terms of frequency, severity and coping strategy indices along the urban – rural continuum. The study identified five coping strategies along the urban - rural continuum as the most severe in times of food insecurity, namely; skipping food for a whole day, borrowing, buying food on credit, consuming seed stock and restricting adult intake in favour of children. Hunting, consuming less preferred food, taking occasional jobs and engaging in small trading were considered as not severe. In both Tamale and Ouagadougou, women were forming critical coping strategies to provide food to the family by involved in trading and doing small jobs. In Tamale, due to the cultural orientation women were observed to play important role of providing nutritious diets and soup for the family.

Erratic rains, poor soils, use of poor quality farmer saved seeds and shortage of land were identified as some of the causes of food and nutrition insecurity in Tamale and Ouagadougou. A close look at land tenure systems shows that there are competing land uses between infrastructure development and agriculture in both locations. Strategies used by urban and periurban dwellers in Tamale to cope with these complex tenure systems for food

production are: urban–periurban-rural migrant farming and buffer zone farming. In Ouagadougou, rural – rural migration during the dry season was observed as a survival strategy in search of land and water to produce crops. This finding reveals the connectivity of urban, periurban and rural areas, in terms of resource sharing.

The study concludes that food and nutrition insecurity certainly has a socio-spatial dimension that is highly influenced by the degree of urbanity along the urban – rural continuum and is related to urban, periurban and rural agriculture. The interaction between urban, periurban and rural areas along the continuum enhanced access to food, resources, infrastructure and services. The complexity of periurban areas coupled with the scourge of food and nutrition insecurity will require more promotion of periurban agriculture and food policy consideration.

Zusammenfassung

Ernährungsunsicherheit bleibt eine globale Herausforderung, doch besonders schwer wiegt diese Last für Länder südlich der Sahara. Frauen, insbesondere diejenigen im gebärfähigen Alter (15 – 49 Jahre), und Kinder unter fünf Jahren gehören zu den am stärksten betroffenen Gruppen. Üblicherweise wurde Ernährungsunsicherheit vor allem als ein Problem der ländlichen Räume angesehen, da urbane Räume südlich der Sahara hinsichtlich Infrastruktur eine bessere Lage als ländliche Gebiete aufweisen. Gleichwohl zeigen jüngste Trends für die Region, dass ein Anstieg von Armut und Nahrungsmittelknappheit auch inmitten von urbanen Räumen evident sind. Die Herausforderung, die eigene Ernährung zu sichern, führt in Städten und deren Umgebung dazu, dass viele Bewohner, um ihren eigenen Bedarf abzusichern, selbst landwirtschaftlichen Aktivitäten nachgehen. Es wird geschätzt, dass der globale Anteil der afrikanischen Stadtbevölkerung von 11,3% im Jahre 2020 bis 2050 auf bis zu 20,3% ansteigt, somit steigt auch der Nahrungsmittelbedarf in dieser Zeit enorm an. Obwohl viele Studien den Zusammenhang von Ernährungsunsicherheit und landwirtschaftlicher Struktur herausstellen, ist wenig darüber bekannt, wie sich diese wechselseitige Beziehung abhängig von der Lage im Raum und entlang des Stadt-Land-Kontinuums verändert. Die Stadt-Land-Kontinuum-Ansätze tragen jedoch zu einem besseren Raumverständnis bei. Sie ermöglichen im Gegensatz zu Ansätzen, die auf einem dichotomen Stadt-Land-Verständnis gründen, die Einbeziehung von urbanen, periurbanen und ruralen Räumen und dadurch eine effizientere und nachhaltigere Stadt- und Interventionsplanung. Informationen über räumliche Variationen von Nahrungsmitteln und Ernährungsunsicherheit kann sehr nützlich für das Verständnis und deren Dynamik an verschiedenen Standorten sein und ist für eine angemessene und zielgruppenspezifische Ressourcenzuweisung hilfreich.

Das vorrangige Ziel dieser Studie war, das Verständnis und die Kartierung der Dynamiken von Nahrungsmittel- und Ernährungsunsicherheit innerhalb von Haushalten in urbaner, periurbaner und ruraler Umgebung. Die Untersuchung wurde entlang des Stadt-Land-Kontinuums in zwei Ländern südlich der Sahara durchgeführt; in Tamale (Ghana) und Ouagadougou (Burkina Faso). Außerdem wurde die Rolle von urbaner, periurbaner und ruraler Landwirtschaft untersucht.

Die Studie beruht auf einem breiten Methodenspektrum. Jeweils zwei Transekte von 2 km Breite und 70 km Länge, die radial von den zentralen Marktplätzen von Ouagadougou und Tamale ausgehen, bilden die Grundlage für die Datenerhebung. Basierend auf

entsprechender Fachliteratur wurden Definitionen zum urbanen, periurbanen und ruralen Raum erarbeitet. Demnach wurde der Raum, der sich innerhalb von 10 km vom Stadtzentrum entfernt befindet, als urban aufgefasst, derjenige der sich in einer Entfernung zwischen 10 und 40 km befindet, als periurban und derjenige mit einer Entfernung zwischen 40 und 70 km als rural. Alle Haushalte entlang dieser Transekte wurden digitalisiert und mit Hilfe eines Geographischen Informationssystems (GIS) wurden aus diesen wiederum 240 (4 Transekte x 3 Zonen x 20 Haushalte) Haushalte zufällig in beiden Städten (Tamale und Ouagadougou) ausgewählt. Die Geodaten der Haushalte wurden auf ein Global-Positioning-System-Gerät (GPS-Gerät) übertragen, welches dabei half, die Haushalte im Feld aufzusuchen und zu identifizieren. Ein strukturierter Fragebogen wurde genutzt, um die Datenerhebung standardisiert durchzuführen: Nahrungsmittelunsicherheit auf Haushaltsebene wurde mittels der Houshold Food Insecurity Access Scale (HFIAS) erhoben; die Ernährungsgewohnheiten wurden mittels des Women`s Dietary Diversity Score (WDDS) und anthropometrischen Messungen ermittelt; die landwirtschaftlichen Aktivitäten (Feldbau und Tierhaltung) der Haushalte sowie deren Anpassungsstrategien wurden mittels des Coping Strategy Index (CSI) erfasst. Fokusgruppendiskussionen und vertiefende Interviews wurden zudem zur Verifizierung der Anpassungsstrategien durchgeführt. Im Gegensatz zu vielen anderen Studien erlaubt dieser Methodenansatz eine bessere Verortung ernährungsbezogener Probleme auf verschiedenen Skalen.

Die Ergebnisse dieser Untersuchung zeigen mannigfaltige Muster hinsichtlich landwirtschaftlicher Aktivitäten und Ernährung in Ouagadougou und Tamale entlang des Stadt-Land-Kontinuums. Im Vergleich der drei Räume Tamales wurde die vielseitigste Ernährung bei Frauen (WDDS $\geq$ 6) in urbanen Gebieten im Gegensatz zu den periurbanen und ruralen Räumen gemessen. Dies ist auf mehr Nahrungsmittelhändler, Geschäfte und Märkte im urbanen Gebiet im Vergleich zum periurbanen und ruralen Gebiet zurückzuführen. In Ouagadougou weisen die Frauen der Haushalte der ruralen Gebiete die höchsten Werte (WDDS $\geq$ 6) im Vergleich zu denjenigen in periurbanen und urbanen Gebieten auf. Dies ist auf eine Subsistenzwirtschaft, die in Verbindung mit vielen Wildfrüchten und traditionellen Anbauprodukten eine breite Diversität in ruralen Gebieten bereitstellt, zurückzuführen. Es zeigt, dass Zugang (Kaufkraft, Einkommen und Marktinfrastruktur) und Verfügbarkeit (Eigenerzeugung) Schlüsselfaktoren für Ernährungssicherheit an beiden Untersuchungsorten sind. Haushalte in urbanen Gebieten in Tamale (36%) wiesen eine höhere Ernährungsunsicherheit auf (HFIAS > 11), als periurbane (9%) und rurale Gebiete (10%).

Während in Ouagadougou die Haushalte aus den periurbanen Gebieten den höchsten relativen Anteil (54%) an Ernährungsunsicherheit (HFIAS > 11) im Vergleich zu den urbanen (39%) und den ruralen Gebieten (45%) aufwiesen. An beiden Untersuchungsorten trägt Subsistenzwirtschaft in den ruralen Gebieten im Vergleich zu periurbanen und urbanen Gebieten wesentlich dazu bei, die Haushalte mit Nahrungsmitteln zu versorgen. Die periurbanen Gebiete in Ouagadougou sind durch saisonale Überflutungen gekennzeichnet, sodass die meisten Haushalte nur minimalen oder überhaupt keinen landwirtschaftlichen Aktivitäten nachgehen, was Nahrungsmittelknappheit verfestigt. Die periurbanen Gebiete beider Standorte hatten den höchsten relativen Anteil an Unterentwicklung im Vergleich zu urbanen und ruralen Haushalten. Zugleich wurden die periurbanen Gebiete beider Orte als Schutznetz wahrgenommen, dadurch findet ein hoher Zustrom von Menschen aus urbanen und ruralen Gebieten statt.

Entlang des Stadt-Land-Kontinuums gibt es Hinweise für eine Neigung hin zu mehr Grundnahrungsmitteln, sowohl im Hinblick auf die Herstellung als auch auf den Verbrauch, das wird anhand der angebauten und konsumierten Anbaukulturen deutlich (Getreide und Wurzelknollen eher als Blattgemüse mit hohem Anteil an Vitamin-A). In Ouagadougou weisen Haushalte, die Tiere halten, im Vergleich zu denjenigen, die keine Tiere halten, einen signifikant geringeren Wert hinsichtlich Übergewicht, sowohl in Bezug auf die Körpergröße als auch auf das Alter, auf. Außerdem können Tierhalter durch den Verkauf ihrer Tiere ein weiteres Einkommen erwirtschaften und dieses für andere Nahrungsmittel oder Bedarfsgüter des Haushalts nutzen. Überraschenderweise sind Haushalte, die in landwirtschaftliche Aktivitäten involviert sind, signifikant stärker von Ernährungsunsicherheit betroffen als Haushalte, die keine landwirtschaftlichen Aktivitäten betreiben. In den Untersuchungsgebieten wurde erwartet, dass Subsistenzlandwirtschaft Ernährungsunsicherheit reduziert. Geringe Ernten aufgrund schlechten Saatgutes, unregelmäßiger Niederschlag und nährstoffarme Böden tragen dazu bei. Feldbau und Tierhaltung zeigten einen signifikanten Zusammenhang mit reduziertem Untergewicht bei Kindern unter fünf Jahren. Andererseits war Tierhaltung im ruralen Tamale im Vergleich zu Tierhaltung in periurbanen und urbanen Gebieten signifikant mit einem reduzierten HFIAS verbunden. Die meisten Haushalte der ruralen Gebiete halten Tiere, um sie in Krisenzeiten zu verkaufen und sich vom Erlös andere Nahrungsmittel leisten zu können. In den urbanen, periurbanen und ruralen Gebieten Tamales waren die Unterschiede unbedeutend unter Haushalten, die Feldfrüchte anbauten und solchen, die keine anbauten.

Die Untersuchungsergebnisse zeigen, dass die Ernährungsanpassungsstrategien von einer räumlichen Einheit zu einer anderen entlang des Stadt-Land-Kontinuums hinsichtlich Häufigkeit, Intensität und Art der Anpassungsstrategie variieren. In der Untersuchung wurden entlang des Stadt-Land-Kontinuums die fünf schwerwiegendsten Anpassungsstrategien hinsichtlich Intensität identifiziert: die Ernährung den ganzen Tag aussetzen, leihen, Nahrungsmittel auf Kredit kaufen, den Saatgutvorrat aufbrauchen, den Konsum der Erwachsenen zum Vorteil der Kinder einschränken. Jagen, der Konsum von weniger bevorzugten Nahrungsmitteln, die Aufnahme von Gelegenheitsjobs und kleine Handelsgeschäfte wurden als nicht so schwerwiegend betrachtet. Sowohl in Tamale als auch in Ouagadougou bilden Frauen entscheidende Anpassungsstrategien, um Nahrungsmittel für ihre Familien bereitzustellen, indem sie Tauschgeschäften oder kleinen Tätigkeiten nachgehen. In Tamale wurde beobachtet, dass Frauen aufgrund des kulturellen Kontextes eine wichtige Rolle für eine nährstoffreiche Nahrung der Familie spielen.

Unregelmäßiger Niederschlag, nährstoffarme Böden, Einsatz von schlechtem Saatgut und Mangel an Land wurden als Gründe für Ernährungsunsicherheit in Tamale und Ougadougou identifiziert. Eine nähere Betrachtung des Grundbesitzsystems zeigt, dass in beiden Untersuchungsorten ein Wettbewerb zwischen für Infrastrukturentwicklungen genutztem und landwirtschaftlich genutztem Land besteht. Strategien der Bewohner der urbanen und periurbanen Räume in Tamale, sich an dieses schwierige Grundbesitzsystems für die Nahrungsmittelproduktion anzupassen, sind: Landwirtschaftliche Wanderarbeiten zwischen urbanen, periurbanen und ruralen Gebieten und Landwirtschaft an Randbereichen. In Ougadougou wurden in der Trockenzeit Migrationsvorgänge in Richtung ruraler Gebiete als Überlebensstrategie beobachtet, die daraug zielen, andernorts Land und Wasser für den Feldbau zu nutzen. Diese Erkenntnis zeigt die Verbindung von urbanen, periurbanen und ruralen Gebieten hinsichtlich Ressourcenteilung.

Aus dieser Studie wird geschlussfolgert, dass Nahrungsmittel und insbesondere Ernährungsunsicherheit eine sozialräumliche Dimension besitzen, die stark vom Urbanitätsgrad entlang des Stadt-Land-Kontinuums beeinflusst ist und mit der urbanen, periurbanen und ruralen Landwirtschaft verbunden ist. Die Interaktionen zwischen urbanen, periurbanen und ruralen Räumen auf dem Kontinuum verbessern den Zugang zu Nahrungsmitteln, Ressourcen und Infrastruktureinrichtungen. Die Komplexität von periurbanen Räumen ist gekoppelt an das Übel der Ernährungsunsicherheit und benötigt eine

stärkere Förderung von periurbaner Landwirtschaft sowie Berücksichtigung von Ernährungspolitiken.

CHAPTER 1

Introduction: Food and nutrition insecurity

1.1 Food and nutrition insecurity and its links to urban and periurban agriculture

Global food and nutrition insecurity continues to be a problem, threatening the livelihoods of millions of poor people, with sub-Saharan Africa worst affected (IFPRI 2014; FAO, IFAD, and WFP 2014). A total of 842 million people in 2011–13, or around one in eight people in the world, were estimated to be suffering from chronic hunger, regularly not getting enough food to conduct an active life (FAO, IFAD, and WFP 2013). It is estimated that following the food and financial crisis in 2008, the number of undernourished people in sub-Sahara Africa increased from 236 million in 2007 to 265 million in 2009 (FAO 2009).

Recently, the Food and Agriculture Organisation (FAO) and the World Health Organisation (WHO) organised the first globally intergovernmental conference that addressed food problems in the 21st century - The Second International Conference on Nutrition (ICN2). The meeting took place at the FAO Headquarters in Rome from 19 – 21 November 2014 and attracted senior political representatives. This conference clearly reaffirmed the relevance and importance of tackling food and nutrition insecurity in all its forms. The ICN2 came out with about 60 measures that address various issues and provided the framework for respective measures individual states shall take in view of their specific situations (FAO and WHO 2014). The ICN2 undertook the responsibility to implement the Framework for the "Action to fight against hunger and malnutrition" in the Post-2015-Agenda. The "post-2015" framework aims at defining the future global development framework that will succeed the Millennium Development Goals (MDGs).

FAO, IFAD, and WFP (2013:50) defined malnutrition as "an abnormal physiological condition caused by inadequate, unbalanced or excessive consumption of macronutrients and/or micronutrients, it includes undernutrition and overnutrition as well as micronutrient deficiencies".

At least 10% of children under five show signs of wasting globally, which indicates acute malnutrition, and 30% are chronically malnourished, which manifests in short stature for age (stunting), with the greatest proportion being in South Asia and sub-Saharan Africa (Ruel and Hoddinott 2008). Severe acute malnutrition affects nearly 20 million preschool-age children, mostly from Africa and South-East Asia (WHO 2013). Malnutrition is a significant factor in approximately one third of the nearly 8 million deaths of children who are under 5 years of age worldwide (WHO 2013). Darnton-Hill et al. (2005) highlighted that for Africa to move out of poverty there is need for advocacy on the role of nutrition. Chopra and Darnton-Hill (2006:545) argued that: "to achieve this requires an understanding not just of the critical role of nutrition for health and development (both individual and national), but also of how recent global changes are affecting the nutritional status of women and children". World Health Organization, Food and Agriculture Organization of the United Nations and HarvestPlus proposed dietary diversity as one of the strategies to tackle the scourge of micronutrient malnutrition (WHO and FAO 2006; Nestle et al. 2006). Other strategies to prevent micronutrient malnutrition include; food fortification, supplementation, biofortification of staple crops or agriculture based strategy (WHO and FAO 2006; Nestle et al. 2006). Nutrition sensitive agriculture approaches have been recently recommended during the recent ICN2 under recommendation number 8, to ensure food security and enable healthy diets (FAO and WHO 2014).

FAO, IFAD, and WFP (2013:50), defines food insecurity as: "a situation that exists when people lack secure access to sufficient amounts of safe and nutritious food for normal growth and development and an active and healthy life". Food and nutrition insecurity, accompanied by a rapid urban growth, poses a serious challenge to livelihoods of many poor people (UN 2007; UN 2008; Lee-Smith 2010). These challenges include food insecurity, malnutrition, growing poverty, unemployment, deterioration of the environment amongst others (Hardoy et al. 2001; UNFPA 2007). This often leads urban dwellers to engage in farming activities to help satisfy their food needs (Drescher and Iaquinta 2002). According to (Mougeot 2000) urban agriculture (UA) includes horticulture, floriculture, forestry, aquaculture and livestock production as well as related activities like delivery of inputs and the processing and marketing of products. UA has been argued to be part of sustainable future cities development (Drescher 2003; Magigi 2008).

Urban and periurban agriculture (UPA), especially in developing countries has been associated with risks ranging from use of waste water to unsafe use of pesticides (Kamga et al. 2013; Drechsel et al. 2006; Owusu-Boateng and Amuzu 2013). Climate change in the form of increased prevalence of extreme events and increased unpredictability of weather patterns also affect UPA, thus the need to adopt climate-smart agriculture (CSA) (FAO 2013). According to FAO (2013:ix), "Climate-smart agriculture integrates the three dimensions of sustainable development (economic, social and environmental) by jointly addressing food security and climate challenges". Climate-smart agriculture seeks to address the following three main areas: sustainable increase in agricultural productivity and incomes; adapting and building resilience to climate change; reducing and/or removing greenhouse gases emissions (FAO 2013). Although many dwellers in African cities are engaging in UPA, this activity is often forbidden or restricted by city authorities. For example, the legislation in Ouagadougou does not allow activities of urban agriculture (Maire de Ouagadougou 1997; Bagre et al. 2002). The confused statutes in Cameroon, Kenya and Uganda has been reported to marginalise urban agriculture (Prain et al. 2010). According to Mougeot (2000:2), "legitimizing urban agriculture can help its low-income practitioners gain access to land, needed services, and credit". This can be done through Governments by providing land for urban agriculture in city master plans, support greenbelt projects, and set up a network of input and service centers (Mougeot 2000).

Many households are involved in urban food production in sub-Saharan Africa, for example 50% practice subsistence urban agriculture in Accra, Ghana (Millstone and Lang 2008). According to the UN-HABITAT (2014), the global share of African urban dwellers is projected to rise from 11.3 % in 2010 to a 20.2 % by 2050, further increasing urban food demand. High urban population growth is often due to rural – urban migration and natural urban population growth (Drescher and Iaquinta 2002, Prain et al. 2010). Most people, especially young ones migrate from rural areas to urban areas in pursuit of modern urban lifestyle compared to rural life (Bakewell and Gunvor 2011). Nevertheless, rapid urbanization in sub-Saharan Africa has resulted in urban poverty severe enough to jeopardize livelihoods and households food and nutrition security (Maxwell et al. 2000). Analysis of 12 of the 14 countries showed that urban households are living on less than $1/d and spent more than one-half of their budgets on food (Ahmed et al. 2007). In another study, poor urban households were estimated to spend 60–80 % of incomes on food (Baiphethi and Jacobs 2009). This finding makes it likely that urban poverty will be manifested at least in part as a food

insecurity problem (Maxwell et al. 2000). In 2002, about one third of the world's urban poor were in sub-Saharan Africa (34 %) and almost half of the world's urban poor were in South Asia (46 %) for $1/day line (Baker 2008). About 40% of urban inhabitants were living on less than US$1 a day, while simultaneously 70% are living on US$2 a day (FAO 2012). The rapid urban growth which is outstripping job creation and the ability of governments to avail essential infrastructure and services, is one of the causes of urban income poverty, health risks and food insecurity (Prain et al. 2010).

Radimer et al. (1990), confirmed the observation, already common in developing country literature, that food insecurity is largely a ''managed process''. That is, "people are not passive victims of sudden events but are active participants in responding to the risks they face in their daily lives" (Radimer et al. 1990:1545; Radimer et al. 1992; Coates et al. 2007). This corresponds with the "resilience" concept. Maxwell et al. (2013:6), reiterated that; "The ability of an individual, a household, a community, or an institution to 'bounce back' in such a manner—to cope with adversity by adapting, learning, and innovating—has lately come to be termed 'resilience'." Resilience has become an important operational concept in chronically vulnerable or food-insecure areas of the world (Maxwell et al. 2013). The study uses an innovative approach of urban – rural continuum to understand the dynamics of household food and nutrition insecurity and the implications of urban, periurban and rural agriculture. There is growing evidence of interaction between urban, periurban and rural areas, accompanied by flow of people, resources, goods and services. Forster and Escudero (2014:1), reiterated that: "Rethinking the urban - rural continuum comprising urban, periurban and rural landscapes can help integrate food and nutrition security with climate action planning, disaster risk reduction, economic and community development, water, biodiversity and other aspects of natural resource management".

1.2 Problem statement, research gaps and justification of the research

Food and nutrition insecurity has traditionally been looked at as a problem of rural areas as portrayed in a number of concepts including the "urban bias" by (Lipton 1977). Urban bias has the notion that urban populations are structurally privileged over their rural counterparts, mostly in sub-Sahara Africa. It became the cornerstone of economic reforms in Africa in the 1980s (World Bank 1981). Accordingly much of the policy issues have been targeting rural populations. However, increasingly research findings are showing that urban populations can

also be highly affected by food and nutrition insecurity (Caesar et al. 2013; Mvula and Chiweza 2013; Tawodzera et al. 2007; Becquey et al. 2010; Maxwell et al. 2000). While such studies are few and isolated, there is need for more evidence-based studies to inform policy makers. Specific policy attention to issues of urban poverty such as food and nutrition insecurity has lagged behind the research, despite the demonstrated need (Maxwell et al. 2000). Urban poverty is different and the policy and programmatic lessons generated by decades of work in rural Africa may not be directly applicable to cities (Maxwell et al. 2000). Urban poverty is unique as it is associated with the following characteristics: "commoditization (reliance on the cash economy); overcrowded living conditions (slums); environmental hazard (stemming from density and hazardous location of settlements, and exposure to multiple pollutants); social fragmentation (lack of community and inter-household mechanisms for social security, relative to those in rural areas); crime and violence; traffic accidents; and natural disasters" (Baker and Schuler 2004; Baharaoglu and Kessides 2002).

UNICEF's (1990) conceptual framework for malnutrition guided the study to understand household food and nutrition insecurity, with more emphasis on the sections highlighted in blue in Figure 1. These sections of the UNICEF framework for malnutrition helped to understand the relation between resource availability and household behaviour to food security in situations of lack of resources. The UNICEF framework was modified as shown by sections in italics in Figure 1, so as to reflect the situation in the study area. For example, land tenure is a very intriguing issue in northern Ghana, especially in urban and periurban areas and this affects the production of food. On the other hand issues to do with climate smart agriculture and nutrition sensitive agriculture are important approaches, especially in the study area which is highly affected with series of droughts and high levels of food and nutrition insecurity. Nutrition-sensitive agriculture is an approach that seeks to maximize agriculture's contribution to nutrition by utilizing diverse agro-based food (FAO and WHO 2014). The approaches targets the poor households, promotes gender equity, and provides nutrition education so that household resources are used to improve household members' nutrition, especially that of women and young children (FAO and WHO 2014). Nutrition-sensitive agriculture helps to avoid dangers of the underlying and basic causes of malnutrition in the UNICEF conceptual framework and it explore to establish long-term solution to malnutrition (Balz et al. 2015; Levinson and Balarajan 2013; Ruel et al. 2013).

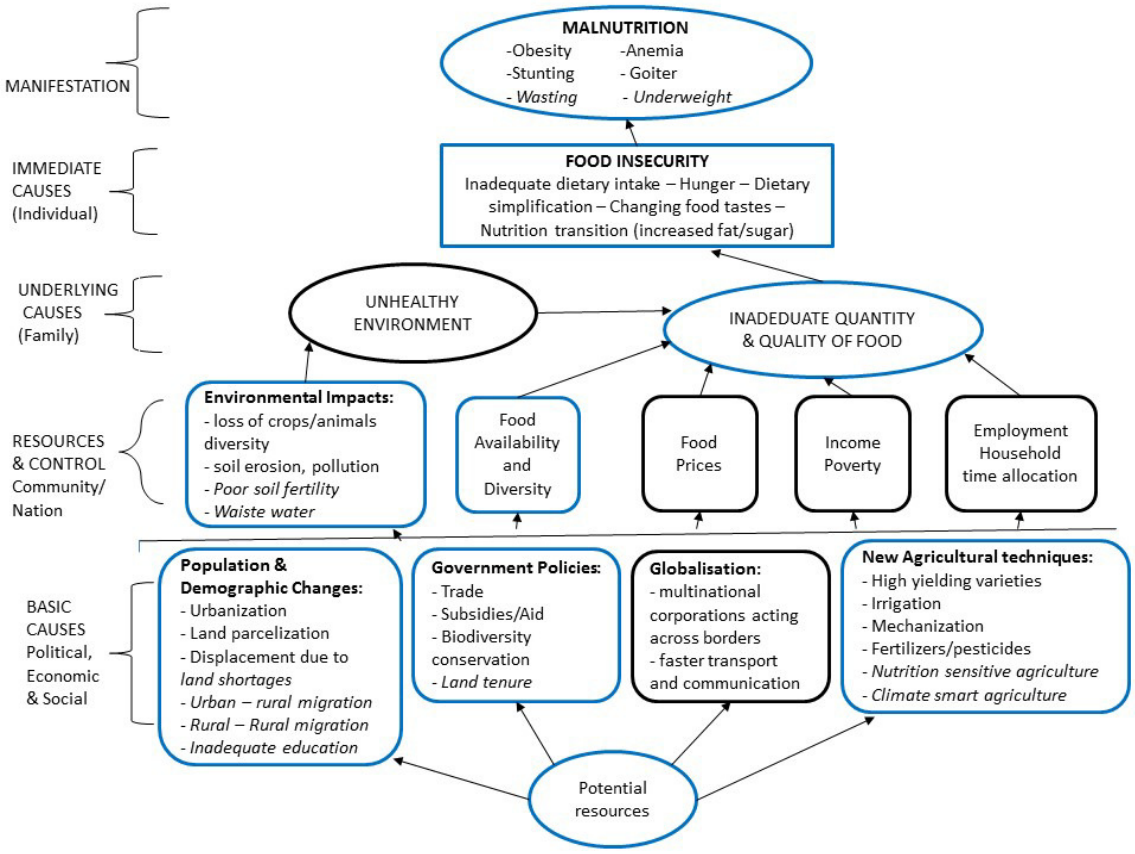

Figure 1: Conceptual framework - modified from UNICEF (1990:22)

Although many of the above mentioned studies have reported food and nutrition insecurity and its interaction with urban and periurban agriculture, little is known on how these factors change and interact along the urban – rural continuum. The importance of these factors were recently emphasized by Funch (2015:10) by saying: “How food and nutrition security (FNS) and agriculture will feature in the new post-2015 development agenda is now crucial”. The aim of this study is to retrieve information on how food and nutrition insecurity levels relate to urban and periurban agriculture (production and consumption of crops and livestock) and understand how the food coping strategies changes with space along the urban - rural continuum. This study seeks to explore, map, describe, and analyse the behaviour and attitude of urban, periurban and rural households that relate to food and nutrition insecurity and its relation to agriculture activities in and round the cities. Measures of household food and nutrition insecurity are needed mostly where households are chronically vulnerable due to

deepening poverty, environmental and climatic shocks, rapid economic change, and conflicts (Maxwell et al. 2008). Indicators may be used to predict crises (early warning), to understand shortfalls in access to adequate food (assessment), to allocate resources (targeting) or to track the impact of interventions (monitoring and evaluation) (Maxwell et al. 2008).

In contrary to many other studies, the chosen approach allows much better to localize food related problems on different scales.

1.3 Study objectives

The main objective of the study is to understand and map the dynamics of household food and nutrition insecurity along the urban -rural continuum of sub-Saharan Africa, specifically in Tamale (Ghana) and Ouagadougou (Burkina Faso), and to investigate the role played by urban, periurban and rural agriculture (production and consumption of crops and livestock) in mitigating household food and nutrition insecurity. The following measurable specific objectives were formulated to help in addressing the main objective:

Firstly, to determine the effectiveness and contribution of urban, periurban and rural agriculture along the urban – rural continuum in mitigating household food and nutrition insecurity, especially for the most vulnerable groups (e.g. women of reproductive age (15 – 49 years) and children under five years of age). This is addressed in Chapter 3, 4, 5 and 6.

Secondly, to identify the causes of food and nutrition insecurity along the urban – rural continuum. This is reported in Chapter 3, 4, 5 and 8.

Lastly, to determine how food insecurity coping strategies change or varies in space along the urban – rural continuum in terms of frequency, severity and coping strategy indices. This is the topic of Chapter 7.

1.4 Structure of the thesis

Chapter 2 presents the research methodologies used in this study. It starts by giving study area locations and then discusses the research design and sampling approaches. Special focus is on the transect approach, which brings out the notion of urban – rural continuum and spatial analysis of household data. Data collection tools and approaches used in this study are then discussed, that is: Geographical Information Systems (GIS)-based analyses, Household

Food Insecurity Access Scale (HFIAS), Anthropometric measurements, The Coping Strategies Index (CSI) and Women's Dietary Diversity Score (WDDS). Furthermore, data management and analysis is discussed.

The third chapter presents the implication of urban, periurban and rural agriculture on food and nutrition insecurity in Northern Ghana, with special emphasis on crop production and livestock keeping along the urban – rural continuum.

In the fourth chapter, an analysis of household food and nutrition insecurity and the contribution of urban, periurban and rural agriculture along the urban – rural continuum in Ouagadougou is discussed. Special focus is on use of causal and structural models to infer causality and structural relationships on livestock and crop production attributes to household food and nutrition insecurity.

The fifth chapter gives an analysis of changes in vegetable production, consumption and its contribution to diets along the urban – rural continuum in Northern Ghana. Particular attention is given to staple crop production versus vegetable production and eating habits associated with various locations.

In the sixth chapter, the women`s dietary diversity scores and anthropometric measurements as indices of nutrition insecurity along the urban – rural continuum in Ouagadougou are presented. Emphasis is given on how WDDS and anthropometric measurements can be useful proxy for household nutrition.

The seventh chapter presents food coping strategies in Northern Ghana. Special focus is on socio-spatial analysis along the urban – rural continuum.

In the eighth chapter, land tenure and its implications for food and nutritional insecurity in the Northern Region of Ghana is discussed. Emphasis is on the communal land tenure system in Northern Ghana and the role of women in providing nutritious diets and soup for the family.

The last chapter provides a summary of the main results as it addresses the research objectives of the study and draws some recommendation and finally gives an outlook for future research.

Each chapter has a different citation style followed by a complete reference list, tables and graphs, due to the varying requirements of different journals.

1.5 Work contribution to thesis articles

This thesis consist of six articles. All articles were drafted by T. Chagomoka with contribution from other authors. The following table gives a summary of work contribution to thesis articles in chapters 3 - 8:

Table 1: Work contribution to thesis articles

Chapter	Idea	Research design and data collection tools	Data collection	Data analysis	Manuscript
3	Chagomoka	Chagomoka	Chagomoka	Chagomoka Nyandoro	Chagomoka Drescher Glaser Marschner Schlesinger Abizari Karg Nyandoro
4	Chagomoka	Chagomoka	Chagomoka	Chagomoka Nyandoro	Chagomoka Drescher Glaser Marschner Schlesinger Nyandoro
5	Chagomoka	Chagomoka	Chagomoka	Chagomoka Nyandoro	Chagomoka Drescher Glaser Marschner Schlesinger Nyandoro
6	Chagomoka	Chagomoka	Chagomoka	Chagomoka Nyandoro	Chagomoka Drescher Glaser Marschner Schlesinger Nyandoro
7	Chagomoka	Chagomoka	Chagomoka Unger	Chagomoka Unger	Chagomoka Unger Drescher Glaser Marschner Schlesinger
8	Chagomoka	Chagomoka Nchanji	Chagomoka Nchanji	Chagomoka Nchanji	Chagomoka Nchanji Bellwood-Howard Glaser Schareika Drescher Schlesinger

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CHAPTER 2

Methodology

2.1 Study areas

The study was conducted in two West African cities of Tamale, Ghana and Ouagadougou, Burkina Faso (Figure 1).

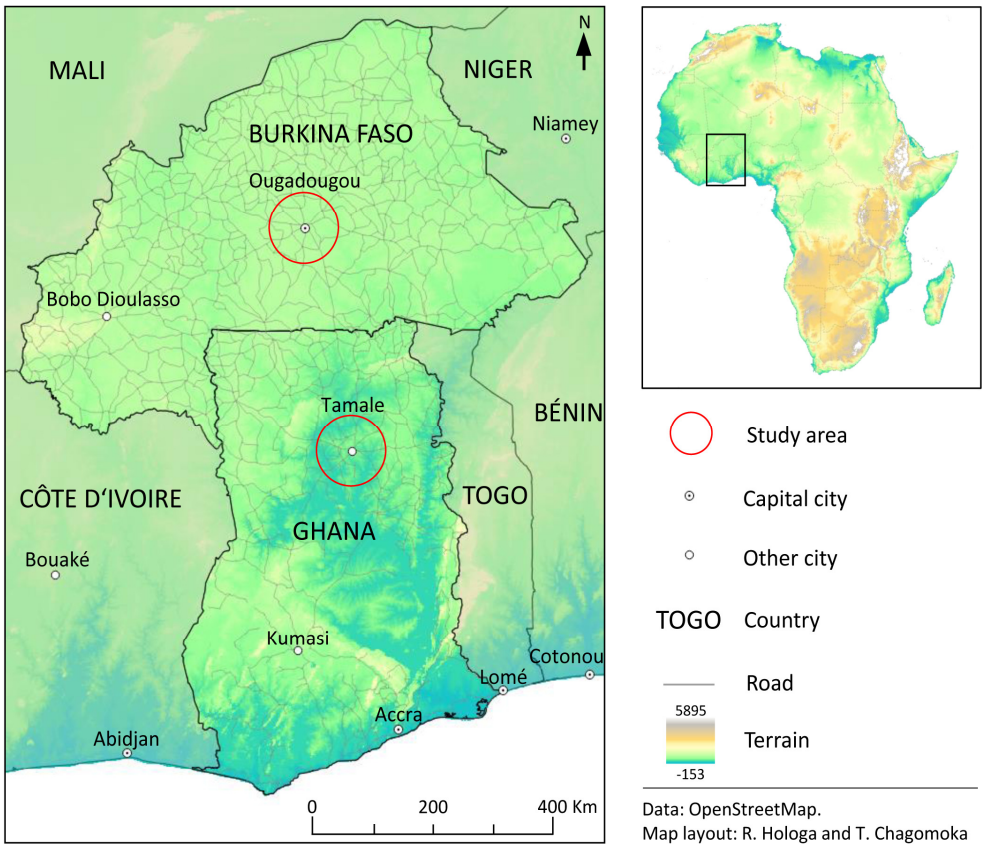

Figure 1: Study area location

2.2 Research design and sampling approach

The study took an innovative approach based on the concept of an urban – rural continuum to analyse the dynamics of household food and nutrition insecurity and the implications of urban, periurban and rural agriculture on household food and nutrition insecurity in two West African cities (Tamale and Ouagadougou). A mixed method approach, combining both quantitative and qualitative methods was used to conduct the research to enhance the study`s scientific rigor and details of which are described below.

Data collection was guided by the transect approach. Four transects were laid out radially, heading towards North, East, South, and West, respectively and four compass directions were chosen, with Tamale and Ouagadougou central markets as the center (Figure 2).The transects were 2 km wide and 70 km from the center. The working definitions of urban, periurban and rural in this study were established based on the relevant literature (Drechsel et al. 2006; Adam 2001; Erenstein et al. 2004; Simon et al. 2006; Moustier and Fall 2004; Moustier 2001). Within 10 km of the city centre was considered as urban, between 10 km to 40 km as periurban, and from 40 to 70 km as rural. The work of Iaquinta and Drescher (2000), strongly supported the identification of the periurban areas. All houses along the transects were digitised based on recent satellite imagery using Geographic Information Systems (GIS). The division into three zones (urban, periurban and rural) was repeated in all the four transects across the cities (Figure 2). Then, 20 households per zone were randomly selected using GIS in both locations (Tamale and Ouagadougou). Accordingly, a total of 240 households were selected (4 transects x 3 zones x 20 households) in each location. The 240 randomly selected households per study areas) along the urban – rural continuum were used to investigate activities of urban, periurban and rural agriculture (production and consumption of crops and livestock) in relationship with the food and nutrition insecurity status. Additional women of reproductive age (15 – 49 years) and children under five years of age staying with the sampled households contributed in computing Women`s Dietary diversity scores and anthropometric indices.

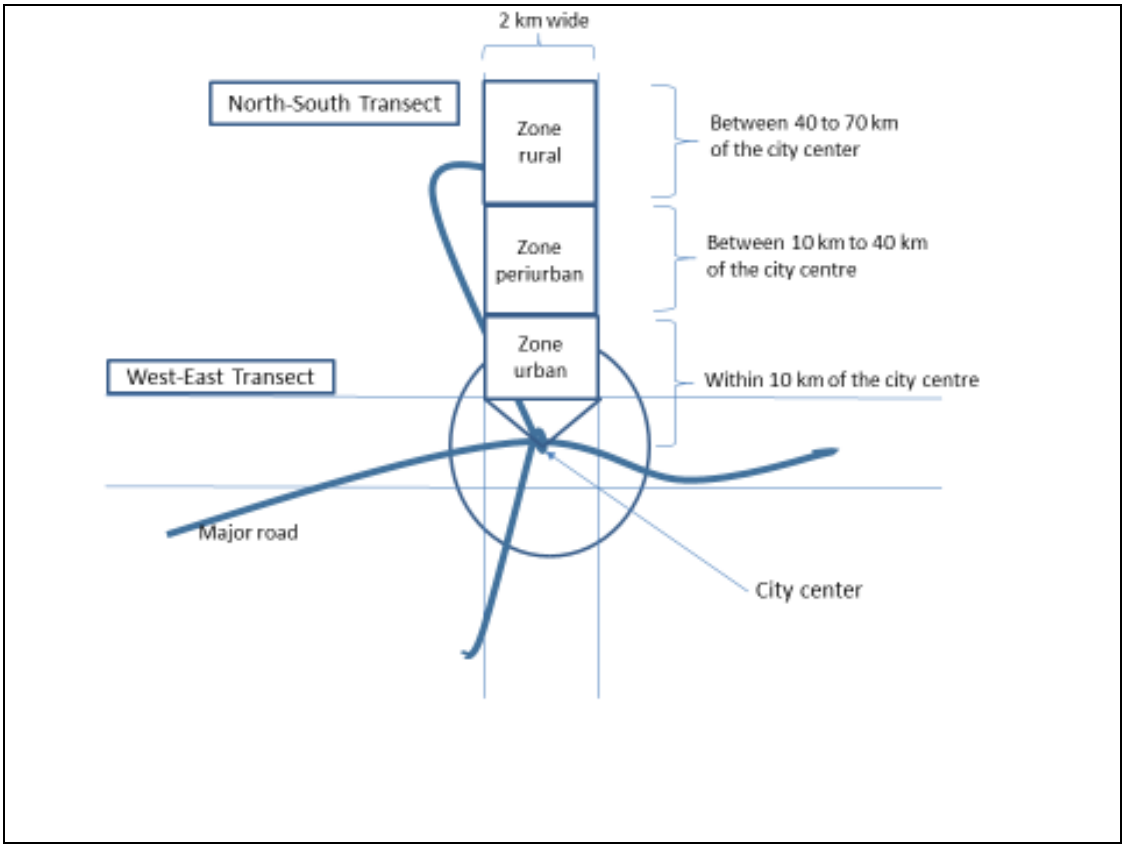

Figure 2: Transect sampling approach

2.3 Geographic information systems - based analyses

The term Geographic Information Systems (GIS) has been used to refer to different meanings such as an industry, a product, a technology, and a science (Reader 1995:3). In this study the following definitions of GIS were adopted:

Nuttall et al. (1995:59) defined GIS as "a computer based system for inputting, storing, accessing, analyzing, and presenting spatially referenced data from various sources in the form of maps". On the other hand Chrisman (1999:175) defined GIS as "organized activity by which people measure and represent geographic phenomena then transform these representations into other forms while interacting with social structures".

In this study GIS helped in random selection of households. All households along the transects were digitized in GIS using satellite images before random selection. The coordinates of the randomly selected households were transferred to a Global Positioning System (GPS) to help in locating and tracking the households along the transects. Geographical positions of the sampled households were recorded to allow spatial analysis of the household data using Geographic Information Systems (GIS). Use of GIS and GPS in this

study helped to produce georeferenced data, which allowed spatial analysis of agriculture and food and nutrition insecurity along the urban – rural continuum. This was the basis to generate maps from the survey data. The use of GPS and GIS has already been applied in many studies to identify available urban agriculture spaces or other natural resources that are available and suitable for urban and periurban agriculture (Dongus 2001; Hovorka et al. 2009; Dongus and Drescher 2006; Schlesinger 2013). In this study it helped to spatially analyse and visualize the distribution of food and nutrition insecure households along the urban – rural continuum.

2.4 Household Food Insecurity Access Scale (HFIAS)

In this study the Household Food Insecurity Access Scale (HFIAS), which is an adaptation of the approach used to annually estimate the prevalence of food insecurity in the United States (U.S.) (Coates et al. 2007) was used to measure food insecurity in urban, periurban and rural areas of Tamale and Ouagadougou. The HFIAS consists of eighteen generic questions about behaviours and attitudes that relate to various aspects of the food insecurity experience (FAO 2011). This generic questionnaire was adapted to the research site by involving key informants in focus group discussions or key informants interviews. During the adaptation process, context specific terms like “household” and “lack of resources” were defined based on the local context and added to the questionnaire. The respondents were the household head or person in the household who is most involved with the food and meals preparation and this person answered all the questions on behalf of the household and all its members.

The HFIAS method allows comparing of results from the two study cities and elsewhere, where a similar methodology was used. The field validation studies of this approach of measuring food insecurity (access) more directly, have demonstrated its feasibility and usefulness in very different developing countries (Webb et al. 2002; Webb et al. 2006; Coates et al. 2003; Perez-Escamilla et al. 2004; Frongillo and Nanama 2003; Coates et al 2007).

2.5 Anthropometric measurements

Anthropometric data (height/length and weight) of children under five years staying with the interviewed household member were taken. The data was entered and analysed in the WHO Anthro software (WHO 2010). This allowed correlation analysis of the cumulative food security index with dietary and nutritional indicators, including the commonly used

anthropometric indices like the height-for-age (HAZ), weight-for-age (WAZ), weight-for-height (WHZ), body mass index (BMI)-for-age and weight-for-height (WHZ). Each index was recorded as a z-score that describes how far and in what direction an individual's anthropometric measurement deviates from the median in the 2006 WHO Child Growth Standards for his or her sex (FANTA 2011; WHO 2006). For an example WHZ is a good index to assess the nutritional status of children from birth to 59 months of age. WHZ compares a child's weight to the weight of a child of the same length/height and sex in the World Health Organization (WHO) Child Growth Standards to classify the child's nutritional status (FANTA 2013). Early childhood nutrition plays a key role in cognitive achievement, learning capacity and ultimately household welfare.

2.6 The Coping Strategies Index (CSI)

The Coping Strategies Index (CSI) based on CARE (Cooperative for Assistance and Relief Everywhere) and World Food Programme (WFP) (CARE / WFP 2003) was used to complement the HFIAS and identify area-specific food coping strategies in Tamale and Ouagadougou. The CSI was developed as a context-specific indicator of food insecurity that counts up and weighs coping behaviours at the household level (Maxwell et al. 2008). CSI was originally developed as a rapid alternative to a 24-hour consumption recall (Maxwell et al. 2008). It is relatively simple and quick to use, straightforward to understand, and correlates well with more complex measures of food security (Maxwell et al. 2003; Maxwell et al. 2008) like dietary diversity scores used in other studies (Arimond et al. 2010; Hoddinott and Yohannes 2002; Hatløy et al. 1998; Hatløy et al. 2000). The CSI is an indicator of household food security behaviour that asks a single question: "What do you do when you do not have enough food, and do not have enough money to buy food?" (Maxwell 1996; Maxwell et al. 2008:534). A set of questions can be asked around this single question to capture people basic consumption related coping responses to inadequate access to food in a given culture or location (Maxwell et al. 2003). Additional questions were added during the Focus Group Discussions (FGD) to find out causes of food insecurity. The use of the CSI therefore enables the extraction of area-specific food coping strategies based on qualitative data.

2.7 Women's Dietary Diversity Score (WDDS)

Dietary diversity is a qualitative measure of food consumption that reflects household access to a variety of foods, and is also a proxy for nutrient adequacy of the diet of individuals (FAO 2011). Food biodiversity is defined as the diversity of plants, animals and other organisms used as food, covering the genetic resources within species, between species and provided by ecosystems (FAO 2010).

According to FAO (2011:5), "the dietary diversity questionnaire represents a rapid, user-friendly and easily administered low-cost assessment tool" and was administered based on a 24-hour recall period in this study. Using one 24-hour recall period does not provide an indication of an individual's habitual diet, but it does provide an assessment of the diet at the population level and can be useful to monitor progress or target interventions (Savy et al. 2005). The recall period of 24 hours was also chosen by FAO as it is less subject to recall error, less cumbersome for the respondent and also conforms to the recall time period used in many dietary diversity studies (Kennedy et al. 2007; Steyn et al. 2006; Savy et al. 2005; Arimond et al. 2010).

The Household Dietary Diversity Score (HDDS) is meant to reflect, in a snapshot form, the economic ability of a household to access a variety of foods (FAO 2011). Studies have shown that an increase in dietary diversity is associated with socio-economic status and household food security (household energy availability) (Hoddinott and Yohannes 2002; Hatløy et al. 2000). In this study Individual Dietary Diversity Score (IDDS) targeting women of reproductive age (15 – 49 years) referred to as Women's Dietary Diversity Score (WDDS) was used to complement other measures of food and nutrition insecurity and help to reflect nutrient adequacy of the diets. An increase in IDDS is related to increased nutrient adequacy of the diet (Hoddinott and Yohannes 2002; Hatløy et al. 2000). Positive correlation of scores with adequate micronutrient density of complementary foods for infants and young children have been noted (FANTA 2006), and macronutrient and micrantrient adequacy of the diet for non-breast-fed children (Hatløy et al. 1998; Steyn et al. 2006; Kennedy et al. 2007), adolescents (Mirmiran et al. 2004) and adults (Foote et al. 2004; Arimond et al. 2010).

2.8 Data management and analysis

Data was entered in Epidata version 9 and exported to Statistical Package for the Social Science (SPSS) 16 and STATA 12 for further cleaning and analysis. Anthropometric data of

children under 5 years were entered and analysed in WHO Anthro (WHO 2010). Household georeferenced data was used to produce maps in both ArcGIS and QGIS (Quantum GIS).

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CHAPTER 3

Urban and periurban agriculture and its implication on food and nutrition insecurity in Northern Ghana. A socio-spatial analysis along the urban-rural continuum.

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This paper has been submitted to MDPI - Agriculture. The version included in the thesis has been slightly modified to ensure consistency of style and usage with other chapters.

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3.1 Abstract

Food and nutrition insecurity has traditionally been looked at as a problem of rural areas in sub-Saharan Africa. Several studies have been done looking either at urban or rural areas, not capturing the whole continuum. Two hundred and forty households were surveyed along the urban-rural continuum in Northern Ghana, between November and December 2013. The study objective was to understand the socio-spatial dynamics of household food and nutrition insecurity and to investigate the role played by urban, periurban and rural agriculture. There was more involvement in agriculture in rural areas (crops 64%; livestock 95%) compared to periurban areas (crops 58%; livestock 92%) and urban areas (crops 15%; livestock 79%). Households from urban areas (36%) were more food insecurity (HFIAS > 11) compared to their counterparts in periurban (9%) and the rural (10%) areas. Highest dietary diversity (WDDS ≥ 6) was recorded in urban areas (22%) compared to periurban and rural (21% and 18% respectively). High incidence of stunting (38%) and wasting (11%) were reported in periurban areas while more cases of underweight were in urban areas (26%) amongst children under 5 years. The results reveal that food and nutrition insecurity has a socio-spatial dimension and is related to agricultural activities.

Keywords: Urban and periurban agriculture, food and nutrition insecurity, urban – rural continuum, transect approach.

3.2 Introduction

The scourge of global food insecurity continues to be a serious problem, threatening the livelihoods of millions of poor people, with sub-Saharan Africa bearing an inordinate share of this burden (FAO 2010). A total of 842 million people in 2011– 2013, or around one in eight people in the world, were estimated to be suffering from chronic hunger (FAO, IFAD, and WFP 2013). At least 10% of children under 5 years of age show signs of wasting, which indicates acute malnutrition, and 30% are chronically malnourished, which manifests in short stature for age (stunting), with the greatest proportion being in South Asia and sub-Saharan Africa (Ruel and Hoddinott 2008). Severe acute malnutrition affects nearly 20 million preschool-age children, mostly from Africa and South-East Asia. Malnutrition is a significant factor in approximately one third of the nearly 8 million deaths of children who are under 5 years of age worldwide (WHO 2013). Darnton-Hill et al. (2005) highlighted that for Africa

to move out of poverty there is need for advocacy on the role of nutrition. Chopra and Darnton-Hill (2006: 545) argued that: "to achieve this requires an understanding not just of the critical role of nutrition for health and development (both individual and national), but also of how recent global changes are affecting the nutritional status of women and children."

Food insecurity is defined as: "limited or uncertain availability of nutritionally adequate and safe foods or limited or uncertain ability to acquire acceptable foods in socially acceptable ways" (Bickel et al. 2000:6). Food and nutrition insecurity has traditionally been looked at as a problem of rural areas as portrayed in a number of concepts including the "urban bias" by Lipton (1977) and Bates (1981). Urban bias has the notion that urban populations are structurally privileged over their rural counterparts. Urban bias became the cornerstone of economic reforms in Africa in the 1980s (World Bank 1981). Accordingly, much of the policy issues have been targeting rural populations. The work of Kessides (2006), reviewing data of rural and urban poverty from African countries, revealed that not only rural poverty rates were higher, but how close urban poverty was to rural poverty. Analysis on extreme poverty and hunger of 12 of the 14 countries showed that urban households are living on less than $1/day and spent more than half of their budgets on food (Ahmed et al. 2007). This finding makes it likely that urban poverty will be manifested at least in part as a food insecurity problem (Maxwell et al. 2000). Increasingly research findings are also showing that urban populations can also be highly affected by food and nutrition insecurity (Caesar et al. 2013; Mvula and Chiweza 2013; Tawodzera et al. 2012; Becquey et al. 2010; Maxwell et al. 2000; Drescher and Iaquinta 2002). While such studies are few and isolated, there is need for more evidence-based studies to inform policy makers. Maxwell et al. (2000:1), pointed out that: "urban poverty is unique. The valuable policy and programmatic lessons generated by decades of work in rural Africa may not be directly applicable to cities."

Food insecurity, accompanied by a rapid urban growth, poses a serious challenge to livelihoods of many poor urban people (UN 2007; UN 2008; Lee-Smith 2010). These challenges include food insecurity, malnutrition, growing poverty, unemployment and deterioration of the environment amongst others (Hardoy et al. 2001; UNFPA 2007). This often leads urban dwellers to engage in farming activities to help satisfy their food needs (Drescher and Iaquinta 2002). According to Mougeot (2000) urban agriculture (UA) includes horticulture, floriculture, forestry, aquaculture and livestock production as well as related

activities like delivery of inputs and the processing and marketing of products. UA has been argued to be part of sustainable future cities development (Drescher 2003; Magigi 2008). Many households are involved in urban food production in sub-Saharan Africa, for example 50% practice subsistence urban agriculture in Accra, Ghana (Millstone and Lang 2008). However, there have been reports on confusion regarding the legal status or regulations of UA in many cities in Africa, associated with insecurity and uncertainty by producers who face harassment and intimidation by city authorities (Prain et al. 2010). According to the UN-HABITAT (2014), the global share of African urban dwellers is projected to rise from 11.3 % in 2010 to a 20.2 % by 2050, further increasing urban food demand. To the best of our knowledge, very little research has been done to understand the socio-spatial dynamics of household food and nutrition insecurity and the role of urban, periurban and rural agriculture along the urban – rural continuum.

The main purpose of the study was to understand the socio-spatial dynamics of household food and nutrition insecurity in urban, periurban and rural settings (along the urban-rural continuum) of Tamale (Ghana) and to investigate the role played by urban, periurban and rural agriculture in household food and nutrition insecurity.

3.3 Materials and methods

A mixed method approach was used to conduct the research, including both quantitative and qualitative methods. Mixed methods research provides strengths by neutralizing or offsetting some of the disadvantages of both quantitative and qualitative research methods (Creswell et al. 2003). Nevertheless, mixed methods can be a challenge if assumptions for both methodologies are violated (Morse 2005). In this research, the mixed methods were useful, especially in implementing the Household Food Insecurity Access Scale - HFIAS and the Women's Dietary Diversity Score - WDDS tools. These tools provide the possibility of subsequent qualitative and quantitative types of questions and responses as highlighted by Tashakkori and Creswell (2007). Thus, the mixed methods allowed for the integration of findings, and draws inferences by using both qualitative and quantitative approaches. A structured questionnaire was used to collect crop and livestock production and consumption data between November and December 2013. Three inter-dependent measures of food and nutrition security (HFIAS, WDDS and Anthropometric measures) were used to assess the magnitude of household food and nutrition insecurity and its consequences on the nutritional

status of children under 5 years and women of reproductive age (15 - 49 years) along the urban – rural continuum of Tamale in Northern Ghana.

Description of study area

The study was conducted in seven districts in Northern Region of Ghana[1]. The Tamale Metropolitan Assembly (TMA) is located at the centre of Ghana´s Northern Region and is the capital town and administrative headquarters of this region (Figure 1). It lies in the savannah climate region of West Africa, with an altitude of 180 meters above sea level. The climate is characterised by two main seasons, one rainy season from April to October with rainfall of more than 1000 mm and a dry season from November to March (Obuobie et al. 2006). As a result, the city is poorly endowed with surface water, with only few seasonal streams that dry up during the dry season (Obuobie et al. 2006). The soils are Savanna Ochrosols that are poor in organic matter, but loamy, well drained and porous. They develop over Birrimian rocks that consist of phyllites, schists and metamorphosed lavas (Robert 2010, 141). Farming is the main occupation in rural areas, thus increasing pressure on the natural savannah vegetation and on existing farmland where reduced fallow periods lead to declining soil fertility (Kranjac-Berisavljevic et al. 1999). The Northern Region is among the three poorest regions in Ghana (poverty rate of 52% in 2005/2006) and has been underserved in terms of infrastructure and investments, in particular in the rural areas (UNDP 2007). Consequently, Tamale has been target of an influx of rural population in search of employment opportunities and has therefore experienced annual urban growth rates of more than 3.5%. The population of the Tamale Metropolitan Area was estimated to be 370,000 as of the year 2010 (Ghana Statistical Service 2012)

[1] Central Gonja, East Gonja, Mion, Sagnarigu, Savelugu-Nanton, Tamale Metropolitan and Tolon

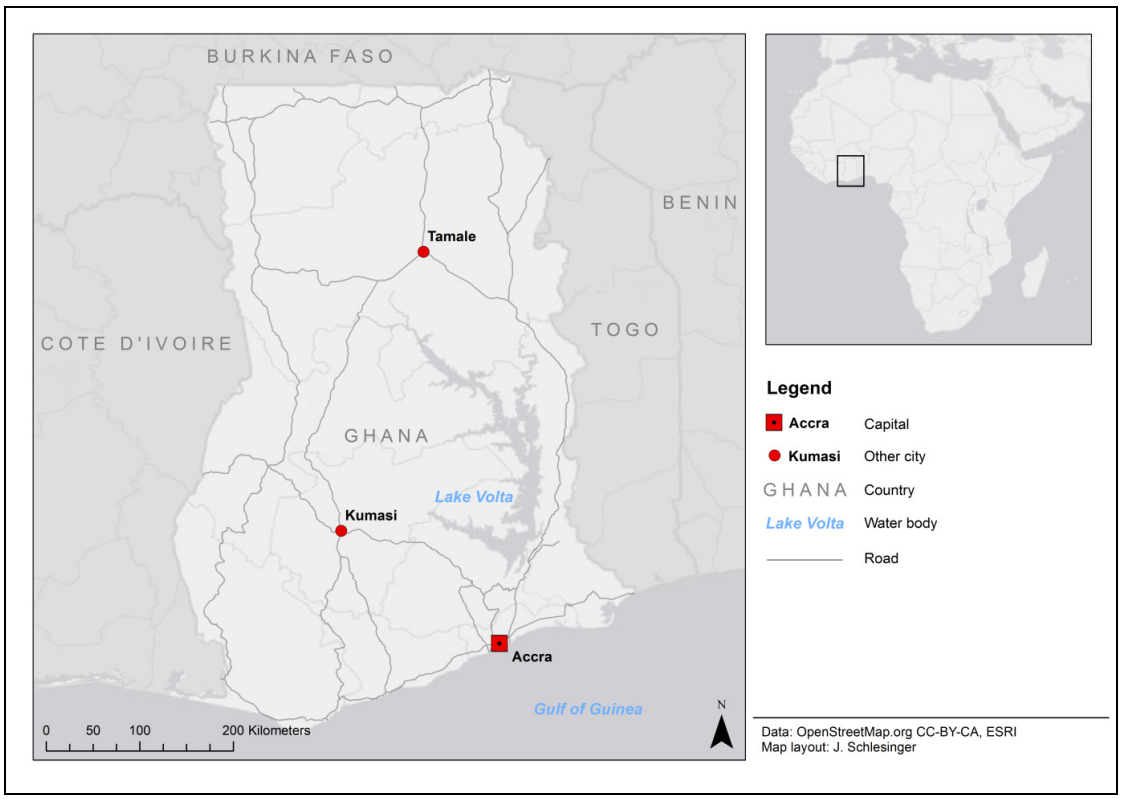

Figure 1: Location map of Tamale in Northern Region of Ghana

Study design and sampling approach

A transect approach was used to guide data collection. This approach has been used in many studies, some of them analysing vegetation, vegetable production and use of natural resources (Kamga et al. 2013; Schlesinger 2013; Luck and Wu 2002; McKinney 2008; Alberti 2008; Porter et al. 2001; Loewenstein and Loewenstein 2005). However, the transect approach has not yet been used in studies measuring levels of food and nutrition insecurity in urban, periurban and rural areas in developing countries. The advantage of this approach is the probability of including households which can be excluded in most sampling approaches which follow the linear settling pattern of households along major development lines like main roads. Its disadvantage include concentration along the transects only and not elsewhere.

Four transects, 2 km wide and 70 km long were laid out radially, heading towards North, East, South, and West, respectively with Tamale central market being the centre (Figure 2). Each transect was divided into three zones (urban, periurban and rural), based on the reviewed literature on the extent of urban, periurban and rural areas in West Africa. The identification of the periurban areas was strongly supported by the work of Iaquinta and Drescher (2000).

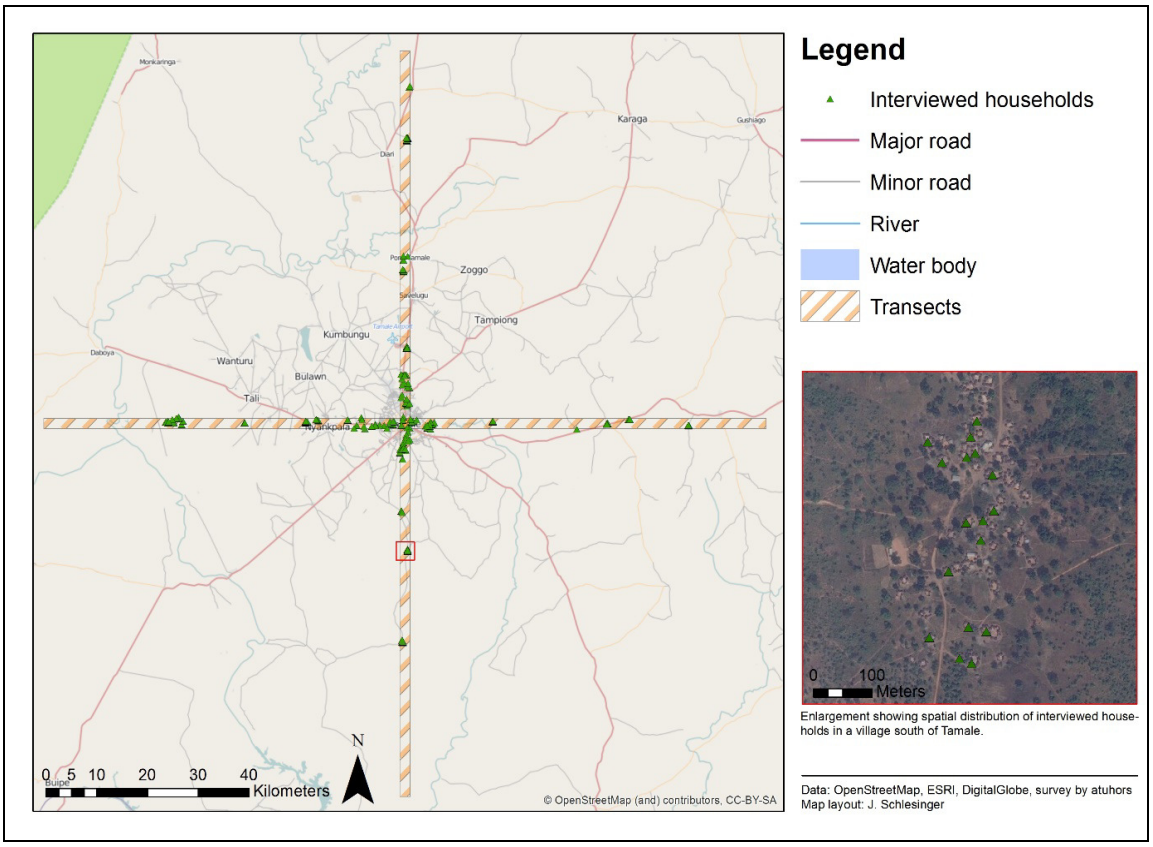

Figure 2: Transect sampling

The terms urban and periurban have faced various definitions and interpretations from one city to another, as there is no universally accepted definition (Simon et al. 2006; Iaquinta and Drescher 2000). Moustier and Fall (2004) tried to show how this may differ with places by saying, “even what authorities in Sierra Leone call “urban” might qualify only as a small town in Nigeria”. Studies done by Natural Resources Institute (NRI), International Water Management Institute (IWMI), and the African Rice Center (WARDA) in Ghana,

Côte d'Ivoire and Mali estimated a rural-urban interface (periurban area) to be about 30-40 km from urban centres with larger distances along major roads and much shorter where the road network is limited (Drechsel et al. 2006; Adam 2001; Erenstein et al. 2004). Moustier (2001) observed that in West and Central Africa agriculture stops beyond about 50 km from city centres, showing the typical features of periurban farming, which often takes place surrounding the boundaries of cities. Urban Tamale extends up to 10 km from the city centre, while periurban Tamale extends to about 40 km along its major East-West and North-South roads but only about 15 km in between (IWMI 2003, unpublished). In this study, the first zone (urban) was within 10 km, the second zone (periurban) between 10 km to 40 km, and the third zone (rural) between 40 to 70 km distance from the city centre. All houses along the transects were digitised based on recent satellite imagery using Geographic Information Systems (GIS). The division into three zones (urban, periurban and rural) was repeated in all the four transects across the city (Figure 2). Then, 20 households per zone were randomly selected. Accordingly, a total of 240 households was selected (4 transects x 3 zones x 20 households). The 240 randomly selected households along the urban – rural continuum were used to investigate activities of urban, periurban and rural agriculture (production and consumption of crops and livestock) in relationship with the food and nutrition insecurity status. The coordinates of the randomly selected households were transferred to a Global Positioning System (GPS) device to help in locating and tracking the households along the transects.

Data collection

Data was collected by the first author with the assistance of a translator in November and December 2013. The same translator was used for the whole study to minimize inter- and intra-observer error. To avoid recall bias, the objectives of the study were clearly explained to the respondents and they were told that their responses were purely for research and not for them to get help or aid in future. To ensure correctness and consistence in translation, the translator was trained and pretested with the assistance of experts from University of Development Studies in Tamale, Ghana. Household face-to-face interviews targeting the household head or the person in the household most involved in food preparation, women of reproductive age and children under 5 years were conducted. Structured questionnaires were used to collect data on crop and livestock production and consumption, prevalence of food

and nutrition insecurity and anthropometric measurements of height and weight for children under 5 years as discussed below:

Assessment of household food insecurity

Food insecurity was measured through the standardised Household Food Insecurity Access Scale (HFIAS). HFIAS consists of 18 generic questions about behaviours and attitudes that relate to various aspects of the food insecurity experience (Coates, et al. 2007). These generic questions were adapted to the research site by involving key informants. The responses of 18 questions (consisting of 9 occurrence questions and 9 frequency-of-occurrence questions) over the past four weeks resulted in households being assigned scores that ranged from 0 to 27. A higher HFIAS score reflects greater household food insecurity and poor access to food. Households were divided into two classes of HFIAS based on the distribution in the sample as recommended by FAO (2011), with a score of ≤ 11 as food secure and a score of >11 as food insecure.

Assessment of household nutrition insecurity

Nutrition insecurity was measured through Individual Dietary Diversity Score (IDDS) which reflects nutrient adequacy (FAO 2011). In this study IDDS targeting women of reproductive age (15 – 49 years) referred to as Women's Dietary Diversity Score (WDDS), which is a proxy of household nutrition was used (FAO 2011). Based on food items consumed in the past 24 hours, respondents were assigned number of food groups they consumed ranging from 0 to 9. An increase in the number of food groups or WDDS is related to increased nutrient adequacy of the diet, and vice versa. Households were classified into three groups based on the distribution in the sample: ≤ 3 food groups as lowest dietary diversity, 4 – 5 food groups as medium dietary diversity and ≥ 6 highest dietary diversity.

Anthropometric measurements for children under 5 years

Anthropometric data (height/length and weight) of children under 5 years in the sampled households were taken. The data was entered and analysed in the WHO Anthro software (WHO 2010a). Nutrition indices like height-for-age (HAZ), weight-for-age (WAZ) and weight-for-height (WHZ) were computed and used to interpret stunting, wasting and underweight respectively among children based on WHO Child Growth Standards (WHO 2006). Each index was computed as a z-score that describes how far and in what direction an

individual's anthropometric measurement deviates from the median in the WHO Child Growth Standards for his or her sex (FANTA 2011; WHO 2006, WHO 2010b). The height and length of children were taken by an infantometer (light portable wooden board with a graduated tape measure). The length of children (recumbent) between 0 and 23 months were taken while children were lying on their back while the height of children between 24 and 59 months were taken while standing (Cogill 2003). Weight of children between 0 and 59 months were taken using a SECA floor electronic scale (model 881 U). Children who could not stand on the scale on their own, the mother/baby weight recording approach was used as discussed in Cogill (2003).

Data management and analysis

Data was captured in Epidata version 9 data entry platform and exported to SPSS 16 and STATA 12 for further cleaning and analysis. Stratified analysis by position along the urban - rural continuum, discriminant analysis and Multivariate Analysis of Variance (MANOVA) methods were used to detect HFIAS and WDDS mean difference due to effects of crop and livestock production responses. The means were separated by adjusted Bonferroni methods. Simple logistic regression was used to assess the independent contribution of livestock production and crop production to food and nutrition security. The Chi-square test technique was used to test for significance between categorical relationships of food groups, agricultural production, food access and nutrition status along the urban - rural continuum. Anthropometric data of children of 0–59 months were entered and analysed in WHO Anthro (WHO 2010a).

Ethical considerations

In each community, study objectives and purpose were clearly conveyed to community leaders and respondents. Permission was sought before data collection from local leaders and respondents. Respondents had the opportunity to stop participating in the research at any time of their choice during interviews. However, none of the participants opted to stop.

3.4 Results

The results represent the findings of a survey conducted between November and December 2013 in and around Tamale, Northern Region of Ghana. Results present crop production,

livestock keeping, consumption patterns and feeding habits and various food and nutrition indicators along the urban – rural continuum as guided by the transect approach.

Socio-demographic profile of study sample

A total of 240 respondents participated in the study, with 61% being males and 39% females. About 68% of respondents never attended school. The Dagomba ethnic group (70%) constituted the majority of the sample. Other details of the sample characteristics including respondent's age and religion are in Table 1.

Table 1: Demographic Characteristics of respondents

Characteristics		Urban % (*n*)	Periurban % (*n*)	Rural % (*n*)	Total % (*n*)
N		*(80)*	*(80)*	*(80)*	*(240)*
Gender	Men	53	65	66	61
	Women	48	35	34	39
Age class of respondents	≤ 20 years	3	1	0	1
	21 – 59 years	90	96	100	96
	≥ 60 years	8	3	0	3
Level of education	None	50	75	79	68
	Primary	4	0	6	3
	Secondary	25	10	5	13
	Tertiary	15	5	0	7
	Koranic	6	9	10	8
Household Religion	Muslim	88	88	99	91
	Christian	11	8	0	6
	Mix m + c	1	5	1	3
Ethnic group	Dagomba	80	64	66	70
	Gonja	3	24	25	17
	Fulani	1	4	9	5
	Dagati	4	0	0	1
	Others	13	9	0	7

Urban, periurban and rural agriculture along the continuum

Maize *(Zea mays)* is the mostly grown crop along the urban – rural continuum, with 99% of respondents in rural areas producing it (Figure 3). Amaranths *(Amaranthus spp.),* jute mallow *(Corchorus olitorius)* and sweet potato *(Ipomoea batatas)* were grown more by households in urban areas compared to periurban and rural areas. On the other hand, maize, yam *(Dioscorea alata),* okra *(Abelmoschus esculentus)*, roselle *(Hibiscus sabdariffa)*, cassava *(Manihot esculenta),* sorghum *(Sorghum bicolor)*, pepper *(Capsicum)* and groundnuts *(Arachis hypogaea)* were amongst the mostly grown crops in rural areas compared to periurban and

rural areas. Rice *(Oryza sativa)* and soya bean *(Glycine max)* were grown more in periurban areas compared to urban and rural areas (Figure 3).

Chicken were the most reared livestock along the urban – rural continuum, with more households keeping them in rural areas compared to periurban and rural areas (Figure 4). On the other hand more households in periurban areas were keeping sheep, goats and cattle compared to rural and periurban areas. Pigs were the least owned livestock and were only present in urban and periurban areas.

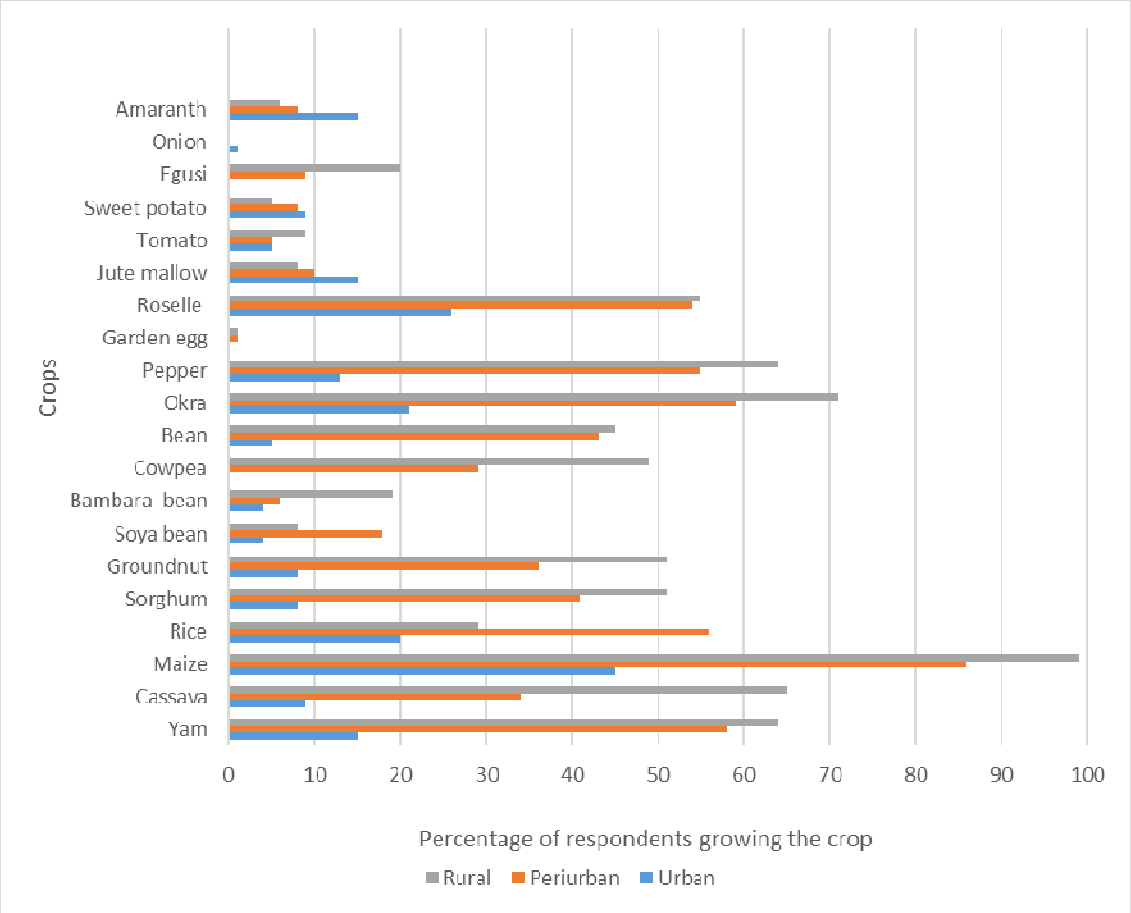

Figure 3: Crop production along the urban – rural continuum (n = 80 households per area - urban, periurban and rural).

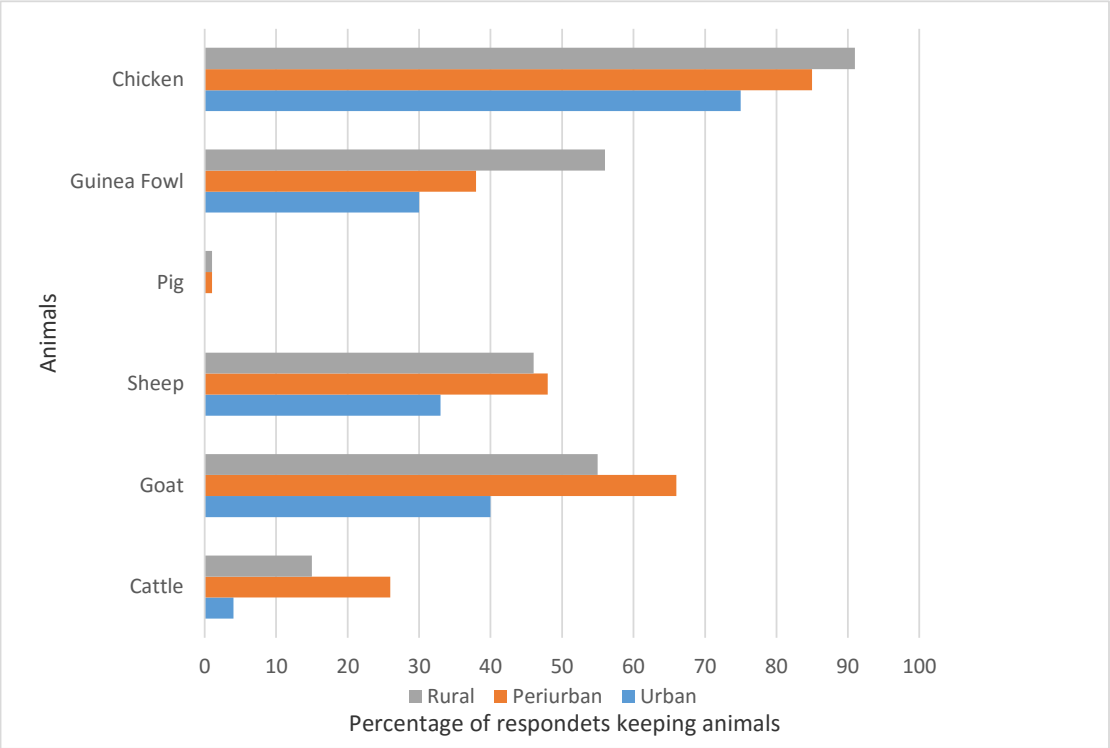

Figure 4: Livestock keeping along the urban – rural continuum (n = 80 households per area - urban, periurban and rural)

Urban, periurban and rural interactions

The results of the study reveal some level of interactions between urban, periurban and rural areas. One example is Suga-naa, a typical periurban village with close ties with the city located in the East transect about 18 km from Tamale. Accessibility to this village is very difficult, more so during the rainy season. Yet, over 50% of the residents of this village commute to Tamale on motorbikes or bicycles 2-3 times a week. In most cases husbands stay in the village to farm so as to provide food and generate income for their families that are based in urban Tamale. A similar case was noticed in Yobsheri-Kuraa village along the West transect, about 8 km from the White Volta river and about 49 km from Tamale. Most farmers only come to this village during the rainy season to grow crops and go back to Tolon, Tali and Tamale after harvesting.

There was strong connectivity of periurban and rural areas to the urban areas in terms of sharing resources such as land for agricultural purposes and market infrastructure. Farmers from as far as Jimle (about 40 km East of Tamale), Pong Tamale (about 33 km North of Tamale), Tolon (about 25 km West of Tamale), Digma (about 41 km South of Tamale) and

Zosali (about 54 km North of Tamale) sell most of their crops to Aboubu market in central Tamale.

Consumption patterns and food habits along the urban – rural continuum

There was a significant association between food groups and the urban - rural continuum (p=0.004) (Table 2). Cereals were the most consumed food group along the urban – rural continuum, with 98% of respondents indicating its uptake during the reported period (Table 2). Mostly consumed cereals included maize, rice and sorghum. Dark green leafy vegetables like amaranth, jute mallow and roselle were mostly consumed in urban areas, with a relative proportion of 29% compared to 25% in the periurban areas and 23% in the rural areas. Urban households were consuming more of oil and fats, with a relative proportion of 27% compared to 18% in the periurban areas and 21% in the rural areas. Consumption of flesh meat was also more in urban areas (21%) compared to periurban areas (14%) and rural areas (8%).

Table 2: Association between households' food groups and the urban – rural continuum

		Urban % (*n*)	Periurban % (*n*)	Rural % (*n*)	Total % (*n*)
N		*(68)*	*(56)*	*(62)*	*(186)*
Food groups	Cereals	99	100	97	98
	White roots and tubers	31	29	50	37
	Vitamin A rich vegetables and tubers	87	86	91	88
	Dark green leafy vegetables	29	25	23	26
	Other vegetables	93	97	84	91
	Vitamin A rich fruits	56	86	70	73
	Other fruits	12	4	0	16
	Organ meat	0	0	0	0
	Flesh meat	21	14	8	15
	Eggs	3	4	0	2
	Fish and sea food	84	89	90	88
	Legumes, nuts and seeds	50	61	58	56
	Milk and milk products	3	0	3	2
	Oil and fats	27	18	21	22
	Sweets	62	64	68	65
	Spices, condiments, beverages	99	100	100	99
	Red Palm products	7	4	3	5

Chi-square value = 54.3, Pr = 0.004 (there is a significant association at 95% CI)

Various food and nutrition indicators along the urban – rural continuum

There was a statistically significant association between the position along the urban - rural continuum and production indicators (Pearson chi-square value of 17.9, P<0.001) (Table 3). There was also a statistically significant association between the position along the urban - rural continuum and access indicators (Pearson chi-square value of 79.7, P<0.001) (Table 3). Nevertheless, there was no statistically significant association between the position along the urban - rural continuum and nutrition status indictors.

Households in urban areas (36%) had the highest relative proportion of food insecurity compared to periurban areas (9%) and rural areas (10%) (Table 3). The worst case of spending the whole day and night without eating anything because there was not enough food was only recorded in urban areas (8%). Nevertheless, more households in urban areas had the highest relative proportion of food diversity (22%) WDDS ≥ 6 compared to periurban (21%) and rural areas (18%).

There were more cases of stunting in periurban areas, with relative proportion of (38%) compared to urban areas (36%) and rural areas (22%) (Table 3). Wasting was also more prevalent in periurban areas, with relative proportion of (11%) compared to urban areas (8%) and rural areas (7%). Nevertheless, there was a high relative proportion of cases of underweight (26%) in urban areas, compared to periurban areas (25%) and rural areas (19%).

Table 3: Various food and nutrition indicators associated with the urban – rural continuum

	Indicators	Urban % (*n*)	Periurban % (*n*)	Rural % (*n*)	Association
Production	*N*	*(80)*	*(80)*	*(80)*	
	Producing staple crops & vegetables	15	58	64	*Chi=17.99*
	Keeping livestock	79	91	95	*Pr = 0.0001*
Access	HFIAS > 11 (Food Insecure)	36	9	10	
	Worry that household would not have enough food	74	49	54	
	Not eating kinds of foods you preferred because of a lack of resources	83	88	88	
	Eat limited variety of foods due to lack of resources	65	36	51	
	Eat foods that you really did not want to eat because of a lack of resources	40	9	8	*Chi=79.69*
	Eat a smaller meal than they felt they needed	55	44	46	*Pr = 0.0001*
	Eat fewer meals in a day because there was not enough food	50	38	40	
	No food to eat of any kind in your household because of lack of resources to get food	33	8	8	
	Sleep at night hungry because there was not enough food	33	10	9	
	Spend whole day and night without eating anything because there was not enough food	8	0	0	
Nutrition status	*N*	*(68)*	*(56)*	*(62)*	
	WDDS ≥ 6 (Highest food diversity)	22	21	18	
	N	*(53)*	*(56)*	*(58)*	*Chi=1.44*
	Wasted (WHZ < -2 SD)	8	11	7	*Pr = 0.964*
	Stunted (HAZ < -2 SD)	36	38	22	
	Underweight (WAZ < -2 SD)	26	25	19	

There is a significant association at 95% CI.

Implications of urban and periurban agriculture on household food and nutrition insecurity

Rural livestock production reduced the HFIAS significantly ($p<0.05$) compared to periurban and urban livestock production (Table 4). The less the HFIAS the more the food secure the household is. On the other hand the changes were insignificant among crop growers versus non-growers in urban, periurban and rural area ($p<0.005$).

Table 4: Pairwise Comparisons - the effect of livestock production on WDDS and HFIAS along the urban - rural continuum

Position on urban-rural continuum	Dependent Variable	(I) Do you own livestock ?	(J) Do you own livestock ?	Mean Difference (I-J)	Std. Error	p[a]	95% Confidence Interval for Difference[a]	
							Lower Bound	Upper Bound
Urban	WDDS	no	yes	-.057	.354	.872	-.765	.650
	HFIAS	no	yes	-1.890	1.782	.293	-5.451	1.671
Periurban	WDDS	no	yes	-.545	.633	.393	-1.815	.725
	HFIAS	no	yes	1.430	3.064	.643	-4.716	7.576
Rural	WDDS	no	yes	.141	.599	.814	-1.056	1.339
	HFIAS	no	yes	5.181*	2.390	.034	.400	9.961

Based on estimated marginal means
a. Adjustment for multiple comparisons: Bonferroni.
*. The mean difference is significant at the .05 level.

3.5 Discussion

The results reveal some important aspect for understanding the socio-spatial dimension of food and nutrition insecurity along the urban – rural continuum in Northern Ghana. The use of transect approach enabled the inclusion of unique areas in this study with interesting features of urban, periurban and rural agriculture. Two examples are the Suga-naa village (periurban) located in the East transect about 18 km from Tamale and Yobsheri-Kuraa village (rural) along the West transect, about 8 km from the White Volta river and about 49 km from Tamale. Households were relocating to these villages to practice agriculture during the rainy season and later go back to their urban homes during the dry season. Such scenarios were referred by Kuuire et al. (2013:125) as "migrant farming and remit agricultural produce back home". The transect approach can be a useful tool in understanding the socio-spatial dynamics of urban and periurban agriculture and its impact to food and nutrition security, especially the urban-rural linkages.

The interaction between urban, periurban and rural areas was mostly evident in sharing resources such as land for agriculture purposes and markets infrastructure. This shows connectivity based on economic activities and geography, as such economic organs act as magnet to both poor and rich (Iaquinta and Drescher 2000; Drescher and Iaquinta 2002).

The results reveal crop and livestock production at different magnitudes across the urban – rural continuum with more households in rural areas involved in crop and livestock production than periurban and urban households. Livestock production significantly contributed to household food security in rural areas by reducing the HFIAS ($p<0.05$) compared to urban and periurban areas. Most households in rural areas were keeping livestock to sell during times of hardship to meet households needs including buying food. Verpoorten (2009) also reported that in Rwanda animals (cattle) were kept and sold to buy food during the year of genocide (1994), although this may not be a similar scenario to the study area.

More urban households (36%) were food insecure (HFIAS > 11) compared to periurban households (9%) and rural households (10%), at the same time the involvement of urban households in crop production and livestock keeping was also the lowest compared to periurban and rural households (Table 3). These results support the growing evidence reported elsewhere, of increasing urban poverty and hunger in African cities (Maxwell et al. 2000; Tawodzera et al. 2012; Mvula and Chiweza 2013; Kessides 2006; Ahmed et al. 2007). Above all, the three domains of HFIAS which are; anxiety and uncertainty about the household food supply, insufficient quality (includes variety and preferences of the type of food) and insufficient food intake and its physical consequences (Coates et al. 2007), show that urban households were experiencing the worst scenario of food insecurity. On the other hand, urban households (22%) were having the highest dietary diversity (WDDS ≥ 6) compared to periurban households (21%) and rural households (18%). The explanation is the presence of many food dealers, shops and food markets in urban areas compared to periurban and rural areas, where subsistence farming was a major source of food. However, although urban households were having the highest dietary diversity, they were reported to eat fewer and smaller meals per day due to food shortages (Table 3).

There were more problems of wasting (< -2 z-score) and stunting (< -2 z-score) in periurban areas compared to urban and rural areas (Table 3). The explanation could be that periurban areas are transition zones, perceived by most households as a safety net as they migrate from either rural or urban areas, often times due to hardships. Nevertheless, there were more problems of underweight (< -2 z-score) in urban areas compared to periurban and rural areas (Table 3). This is also a sign of growing urban poverty. Underweight may reflect both stunting and wasting (WHO 2010b; FANTA 2011). In neighbouring Burkina Faso,

nutrition related problems, in the form of anaemia (based on haemoglobin) were also reported in school children in urban and periurban areas, with 40.4% prevalence of anaemia (Daboné et al. 2011). Iaquinta and Drescher (2000) describe periurban as a complex zone as it combines both urban and rural elements and often experience in and out migration, including "step migration". According to Iaquinta and Drescher (2000:7) step migration is, "wherein rural migrants move first to villages or small towns and successively to more urban environments".

As expected, the results reveal that diets of most households along the continuum heavily depend on cereals like maize, sorghum and pearl millet, often consumed as porridge or local dishes namely: Tuo Zaafi or TZ (thick porridge), banku and kenkey (fermented corn dough). More households in urban areas were consuming oil and fats, which can be referred to as *oily diets feeding habit*. This could be attributed to changing lifestyles due to modernisation, where urban dwellers are following diverse lifestyles including unfortunate eating habits. Lokuruka (2013) pointed out that obesity is prevalent in African cities especially among the low-income groups who often improve their income to buy predominately high fat and energy-dense foods.

3.6 Summary and conclusions

The results from this study reveal that food and nutrition insecurity along the urban – rural continuum in Northern Region of Ghana has a socio-spatial dimension and is related with agriculture.

The results show a strong connectivity between the urban, periurban and rural areas in terms of sharing resources like land for agriculture purposes and market infrastructure, for example shared markets like Aboubu market and Tamale central market. In some cases scenarios referred by Kuuire et al. (2013:125) as "migrant farming and remit agricultural produce back home" was noted in periurban villages, where over 50% of residents commute to Tamale on motor bikes or bicycles 2-3 times a week. In most cases only husbands spend more time in this village to produce food for the family while the rest of the family are based in Tamale urban.

The study further reveals that more urban households (36%) were food insecure (HFIAS > 11) compared to periurban households (9%) and rural households (10%), at the

same time the involvement of urban households in crop production and livestock keeping was also the lowest compared to periurban and rural households.

There was high relative proportion of households with highest dietary diversity (WDDS ≥ 6) in the urban areas (22%) compared to periurban and rural areas (21% and 18% respectively). This was attributed to the availability of many food dealers, shops and food markets in urban areas compared to periurban and rural areas were subsistence farming was a major source of food. Yet, the same urban households were reported eating fewer meals and smaller meals per day due to food shortages.

The results show a relative high proportion of stunting in periurban areas (38%) compared to urban areas (36%) and rural areas (22%) – which reflects chronic malnutrition, and wasting (11%) in periurban areas compared to urban areas (8%) and rural areas (7%) – which reflects acute malnutrition. On the other hand, more cases of underweight were reported in the urban areas (26%) compared to periurban areas (25%) and rural areas (19%) – which reflects both chronic malnutrition and acute malnutrition of children under 5 years.

3.7 Acknowledgements

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CHAPTER 4

Contribution of urban and periurban agriculture to household food and nutrition security along the urban – rural continuum in Ouagadougou, Burkina Faso.

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The version included in the thesis has been slightly modified to ensure consistency of style and usage with other chapters.

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4.1 Abstract

There is growing evidence of urban poverty in and around cities in sub-Saharan Africa in the form of food and nutrition insecurity. Although many studies have been done across sub-Saharan Africa on urban agriculture, food and nutrition insecurity, little is known about the association of urban agriculture to household food and nutrition insecurity along the urban – rural continuum, especially in West African cities. Therefore, a survey was carried out between August and September 2014 in and around Ouagadougou (Burkina Faso), using a transect approach to guide the data collection. The purpose of this study was to understand the dynamics of urban, periurban and rural agriculture and its association with household food and nutrition insecurity. A total of 240 households participated in the survey. From these households, data was collected on 179 women of reproductive age (15 – 49 years) and 133 children under the age of 5 years to compute Women's Dietary Diversity Scores and other anthropometric indices. The results of this study provide a general picture of crop production which is inclined to subsistence and income generation. Households in rural and periurban areas were more engaged in crop and livestock production compared to their urban area counterparts. Households in periurban areas had the highest relative proportion (54%) of food insecurity (HFIAS > 11), compared to urban areas (39%) and rural areas (45%). At the same time the periurban households had the highest relative proportion of stunting and wasting prevalence compared to urban and rural households. Households in the rural areas had the highest dietary diversity (WDDS $\geq$ 6), compared to periurban and urban households. Households keeping livestock significantly experienced less wasting (WHZ) (coef = -0.15; p = 0.008) by a factor of 0.15, and overweight (BAZ) (coef = -0.12; p = 0.015) by a factor of 0.12 compared to households not doing livestock keeping. Households involved in crop production significantly experienced more food insecurity, HFIAS (coef = 2.55; p = 0.042) by a factor of 2.55 compared to households without crop production. The complexity of periurban areas coupled with the scourge of food and nutrition insecurity will require more periurban agriculture and food policy consideration.

Keywords: Urban and periurban agriculture, food and nutrition insecurity, urban – rural continuum, Ouagadougou.

4.2 Introduction

The scourge of food and nutrition insecurity remain a challenge worldwide, despite overall progress, with sub-Saharan Africa with the highest prevalence in the world[1]. Sub-Saharan Africa has made insufficient progress towards international hunger targets, with more than one in four people remaining undernourished[1]. Accordingly, the IFPRI (2015:74)[2] states: "The pace of poverty and hunger reduction has been too slow to prevent the absolute number of poor and hungry from rising, and, on average, Africa as a whole will not meet the first Millennium Development Goal of halving 1990 poverty and hunger rates by 2015".

About 805 million people face challenges of not having enough calories, but about 2 billion face micronutrient deficiencies--referred to as hidden hunger[2]. The Food and Agriculture Organization of the United Nations (FAO), International Fund for Agricultural Development (IFAD), and World Food Programme (WFP) (2013:50)[3], defined food insecurity as, "a situation that exists when people lack secure access to sufficient amounts of safe and nutritious food for normal growth and development and an active and healthy life". Malnutrition is defined as, "an abnormal physiological condition caused by inadequate, unbalanced or excessive consumption of macronutrients and/or micronutrients and includes undernutrition and overnutrition as well as micronutrient deficiencies"[3]. Women and children are at the helm of these challenges of food and nutrition insecurity. Approximately 23 million primary-school aged children in Africa attend classes hungry[4]. Each year more than 3 million children under the age of five pass away, 45% of them due to poor nutrition[5].

There has been an influx of people in many cities in sub-Saharan Africa, with the urban population rising by 11.3 % in 2010 and expected to rise by 20.2 % in 2050[6]. Several studies have reported challenges related to the combination of fast growing cities and food and nutrition insecurity[7–10]. Many studies have recently reported evidence of growing urban poverty in African cities, with food and nutrition insecurity as indicators of urban poverty amongst other indicators[11–16]. These studies also pointed out the engagement of African urban dwellers in agricultural activities ranging from crop production to livestock keeping in an endeavour to address these challenges. Prain et al. (2010:vii)[17], stated that; "urban agriculture is uniquely well positioned to respond to these challenges". Nevertheless, the work of Badami and Ramankutty (2015:8)[18] concluded that: "urban agriculture can only make a limited contribution in achieving urban food security in low-income countries".

Urban and periurban agriculture (UPA) is generally defined as the growing of plants and keeping of animals within and around cities. It includes horticulture, floriculture, forestry, aquaculture and livestock production as well as related activities like delivery of inputs and the processing and marketing of products[19–21]. Although many dwellers in African cities are engaging in urban agriculture, this activity is often illegalised by city authorities. Prain et al.[17] highlighted that the confused statutes in Cameroon, Kenya and Uganda have marginalised urban agriculture. Bopda et al. (2010:6),[22] emphasised the ambiguity of these regulations confusion by saying, "urban agriculture has been playing hide-and-seek with urban management for a century". As of 2002, urban agriculture employed nearly 45,000 people in Ouagadougou[23]. Nevertheless, the legislation in Ouagadougou does not allow urban agricultural activities[24,23]. About 36% of households in Ouagadougou are involved in urban farming, and urban agriculture sometimes provides nearly 50% of the food consumed by the urban poor in Ouagadougou[25].

Many studies have been done in African cities on urban agriculture[26–28,17,29,30] and prevalence of food and nutrition insecurity[11,12,14,31,32]. Nevertheless, little is known about the spatial variation of agriculture, food and nutrition insecurity and their relationship along the urban – rural continuum. We found that periurban areas had the highest relative proportion of food insecurity (HFIAS > 11), stunting and wasting prevalence compared to urban and rural areas of Ouagadougou. Our results show that livestock and crop production contribute to household food and nutrition security at different levels; for example livestock keeping reduced wasting (WHZ) and overweight (BAZ) individuals amongst the livestock keeping households compared to non-livestock keeping households. Funch (2015:10)[33], emphasized the importance of these factors by saying: "How food and nutrition security (FNS) and agriculture will feature in the new post-2015 development agenda is now crucial". The urban – rural continuum approach enhances formulation of efficient urban sustainability policies as it is inclusive and addresses sustainability in areas large enough to encompass urban, periurban and rural areas unlike other approaches which focus on the dichotomy between urban and rural areas[34]. Information on spatial variation of household food and nutrition insecurity can be very useful in understanding its dynamics in various locations and help in resource allocation and proper intervention targeting[35]. The objective of this study was to determine the contribution of urban, periurban and rural agriculture along the urban – rural continuum in mitigating household food and nutrition insecurity. We tested the hypothesised relationship/association between growing crops, keeping livestock and food nutrition and

insecurity using structural modelling. This paper takes a close look at agriculture activities (crop and livestock keeping) and how the related dynamics of food and nutrition insecurity vary along the urban – rural continuum in Ouagadougou, Burkina Faso. The study further uses causal and structural models to infer causality and structural relationships between livestock and crop production and attributes of food and nutrition insecurity.

4.3 Materials and methods

Description of study area

Agriculture is the major contributor to the economy of Burkina Faso and it employs more than 80% of the workforce[36]. In 2005, Burkina Faso was ranked number 176 out of 177 countries on the UNDP Human Development Index, with an average annual per capita income between 230 and 250 dollars compared to 500 dollars in sub-Saharan Africa[37]. Ouagadougou, the capital of Burkina Faso, is situated on the central plateau with an altitude of around 300 meters above sea level (Figure 1). It is also the country's largest city, with a population of approximately 1,400,000 according to the 2006 census[38]. Ouagadougou falls under the Sudano-Sahelian climatic zone. Annual rainfall is around 800 mm, with the rainy season running from May to October. Heavy rains are usually experienced during the months of July and August[39].

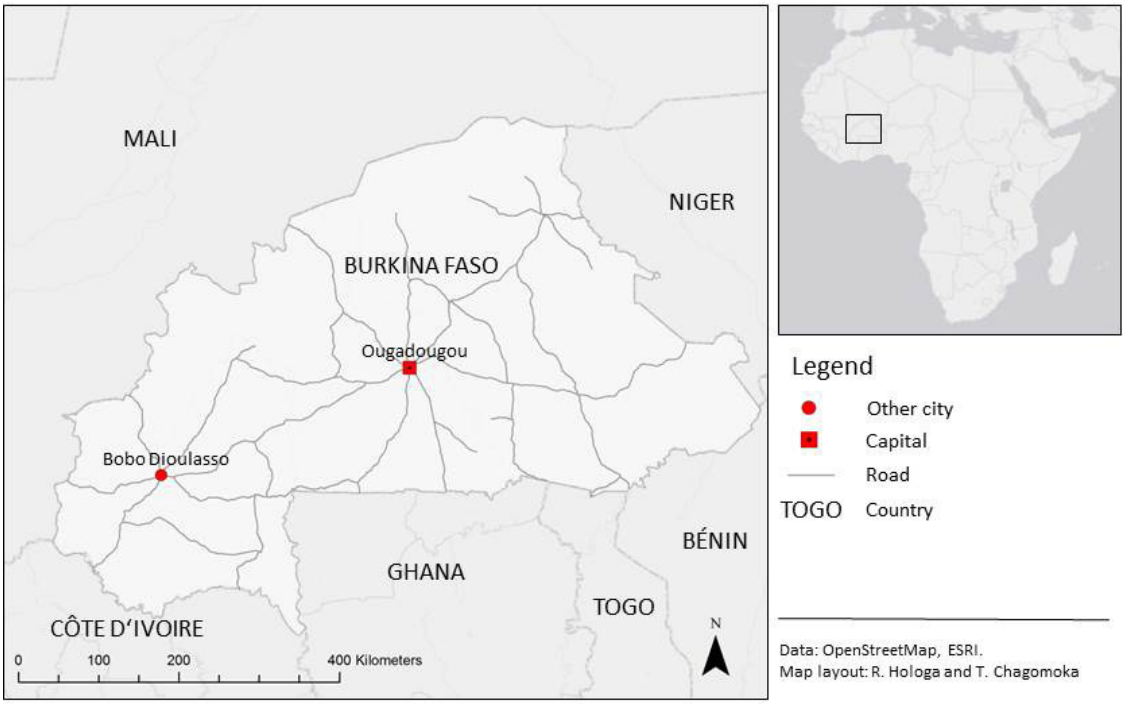

Figure 1: Study area location map

Study Design and Sampling Approach

A transect approach was used to guide data collection. Transects, 2 km wide and 70 km from Ouagadougou central market, were laid radially as shown in Figure 2. A number of studies have used this approach to analyse vegetation, vegetable production and use of natural resources[40,41,42]. However, the transect approach has not yet been used in studies measuring levels of food and nutrition insecurity in urban, periurban and rural areas in developing countries. The advantage of this approach is the probability of including households which can be excluded in most sampling approaches which follow the linear settling pattern of households along major development lines like main roads. Its disadvantage include concentration along the transects only and not elsewhere.

The terms urban and periurban have faced various definitions and interpretations from one city to another, as there is no universally accepted definition[43,44]. Moustier and Fall[45] tried to show how this may differ with places by saying, "even what authorities in Sierra Leone call "urban" might qualify only as a small town in Nigeria". Based on the relevant literature, working definitions of urban, periurban and rural areas were established[46–48,43,45,49]. Within 10 km of the city centre was considered as urban areas, between 10 km to 40 km as periurban areas, and between 40 to 70 km as rural areas. The work of Iaquinta and Drescher[44] strongly supported the identification of the periurban areas. All houses along the transects were digitised based on recent satellite imagery and randomly selected using Geographic Information Systems (GIS) (see Figure 2). The waypoints data were transferred to Global Positioning System (GPS), which helped in locating and identification of randomly selected households. Base maps of digitised and randomly selected houses were printed to help in locating and identification of survey households. Households which could not be located, either due to errors in the satellite images used or refusing to take part in the survey were systematically replaced by taking the next house to the east. The survey covered thirty two districts (Districts 1, 2,3,4,5, 8, 9, 10, 11, 12, Baskuy, Dapelgo, Dawelge, Doulougou, Ipelce, Kindi, Kombissiri, Komsilga, Mogtedo, Nagreongo, Nandiala, Nongremassom, Ourgou-Manega, Paabre, Roulougou, Saaba, Sapone, Sourgoubila, Tanghindassouri, Zam, Ziniare and Zorgho) in and around Ouagadougou. Data collection was done between August and September 2014 by the first author with the assistance of translator. Household face-to-face interviews were conducted targeting the household head or the person in the household most involved in food preparation, women of reproductive age (15 – 49 years) and the youngest

child of those under 5 years. Household in this study refers to those that sleep under the same roof and take meals together at least four days a week. This is the period immediately following the rain season and most farmers were weeding their crops. During this time food supplies are low in most households (lean season). The advantage of collecting data during this time of the season is ability to have a clear picture of household food security situation during the lean season especially when using the HFIAS[50]. Its disadvantage is that the results may not reflect the food security situation during the peak season when households are harvesting their crops and have access to diverse food.

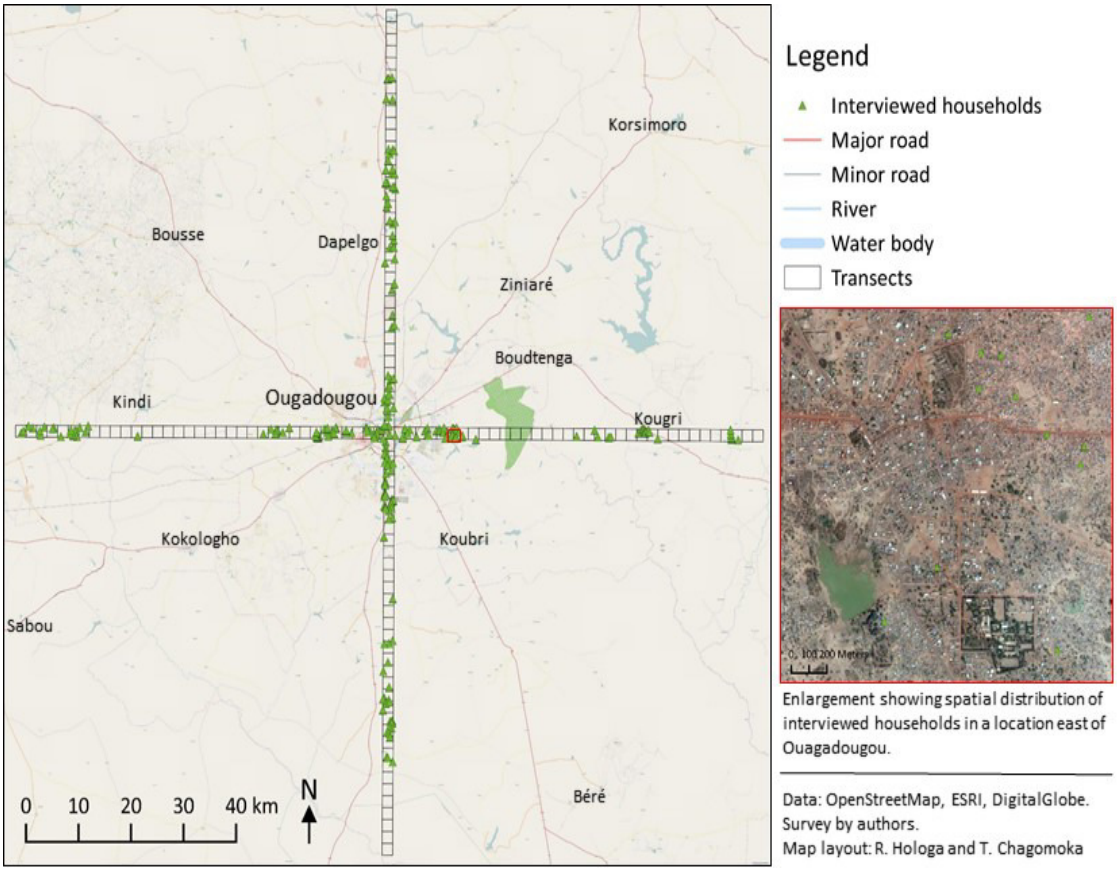

Figure 2: Transect sampling

Crop production and livestock keeping

Activities related to crop production and livestock keeping were collected using a pre-tested semi-structured questionnaire. Data on both dry and wet season crop production were collected using the recall method, for data on the previous season.

Household food insecurity

A standardised Household Food Insecurity Access Scale (HFIAS), based on the responses of 18 questions over the past four weeks about behaviours and attitudes that relate to various aspects of the food insecurity experience was used to assess household food insecurity[50]. HFIAS ranges from 0 – 27 and the lower the HFIAS the better the household food security and access situation. Based on the distribution in the sample, households were divided into two groups: with a HFIAS of ≤ 11 as food secure and a HFIAS of >11 as food insecure[51].

Household nutrition insecurity

Women's Dietary Diversity Score (WDDS) developed by FAO (2011) and anthropometric indices for children under 5 years were used to assess household nutrition insecurity. WDDS and anthropometric indices for children under 5 years such as weight-for-height (WHZ) are a good proxy of household nutrient adequacy and nutrition security[51,52]. WDDS is based on 9 food groups consumed in the past 24 hours and an increase in the number of food groups or WDDS is related to increase in nutritional adequacy of the diet. Based on the distribution of WDDS in the sample, households were classified into three groups; ≤ 3 food groups as lowest dietary diversity, 4 – 5 food groups as medium dietary diversity and ≥ 6 highest dietary diversity.

Anthropometric measurements were collected, guided by the work of Cogill[53]. Weight was measured using a SECA floor electronic scale (model 881 U) and height and length were measured using an infantometer (light portable wooden board with a graduated tape measure). Nutrition indices like height-for-age (HAZ), weight-for-age (WAZ), weight-for-height (WHZ) and body mass index (BMI)-for-age (BAZ) were computed in WHO Anthro v.3.2.2 and used to interpret stunting, wasting and underweight respectively among children based on WHO Child Growth Standards[54,55].

Stunting (HAZ < -2 z-score) - Inadequate length or height relative to age (reflects chronic malnutrition) and usually due to long term nutritional deprivation[56,57]. Wasting (WHZ < -2 z-score) - Inadequate weight relative to length or height (reflects acute malnutrition) usually due to insufficient food intake or a high incidence of infectious diseases like diarrhoea[56,57]. Underweight (WAZ < -2 z-score) - Inadequate weight relative to age (reflects both chronic malnutrition and acute malnutrition)[56,57]. Overweight (BAZ > +2 z –

score) - Excessive fat accumulation that presents a risk to health, childhood obesity is associated with a higher probability of obesity in adulthood[56,57].

Data management and analysis

Data entry was done in Epidata 9 and exported to Stata 12 software for cleaning and analysis. The analysis focused on testing associations between categorical variables and confirming hypothesized networks of relationships based on theory through confirmatory analysis and fitting a final structural model. The two chi-square tests were used; the Pearson chi-square,where expected frequency were more than a value of 5 in each cell and the Fisher's exact test, where at least one expected cell frequency had less than a value of 5. Categorical variables associations such as nutritional status versus geographical location along the urban - rural continuum were determined. Confirmatory analysis was done separately for each construct before fitting the final structural model to show the possible effects of livestock keeping and crop production to food and nutrition insecurity. The relationships tested are shown in figures 3 and 4. The z-scores for anthropometric data of children of 0–59 months were calculated in WHO Anthro v.3.2.2 and then merged with other variables before analysis in Stata software. GIS was used for random selection of households and compilation of maps.

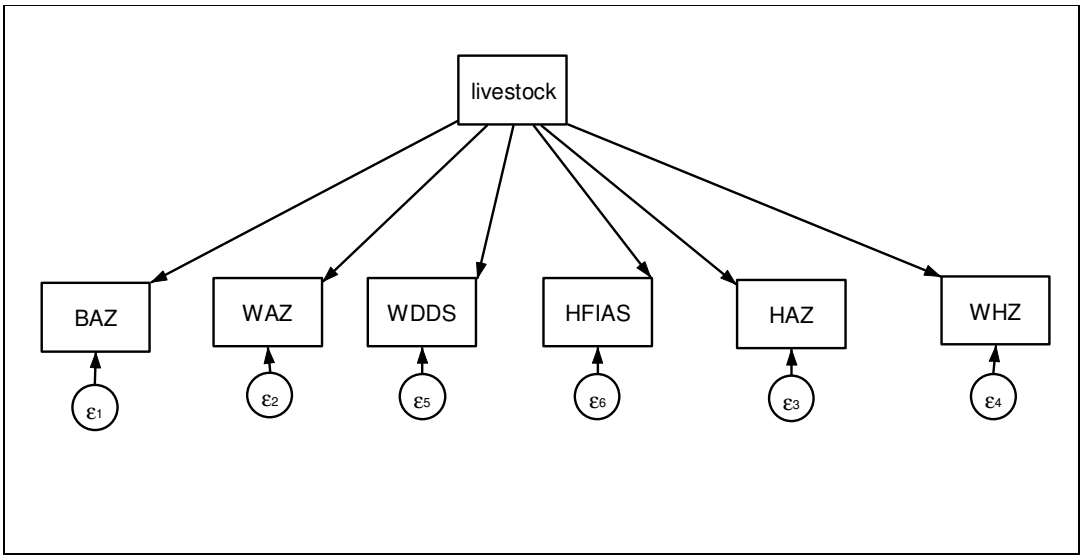

Figure 3: Structural model showing the contribution of livestock keeping to food insecurity (HFIAS) and nutrition status (WDDS, WHZ, HAZ, WAZ and BAZ) across the urban – rural continuum.

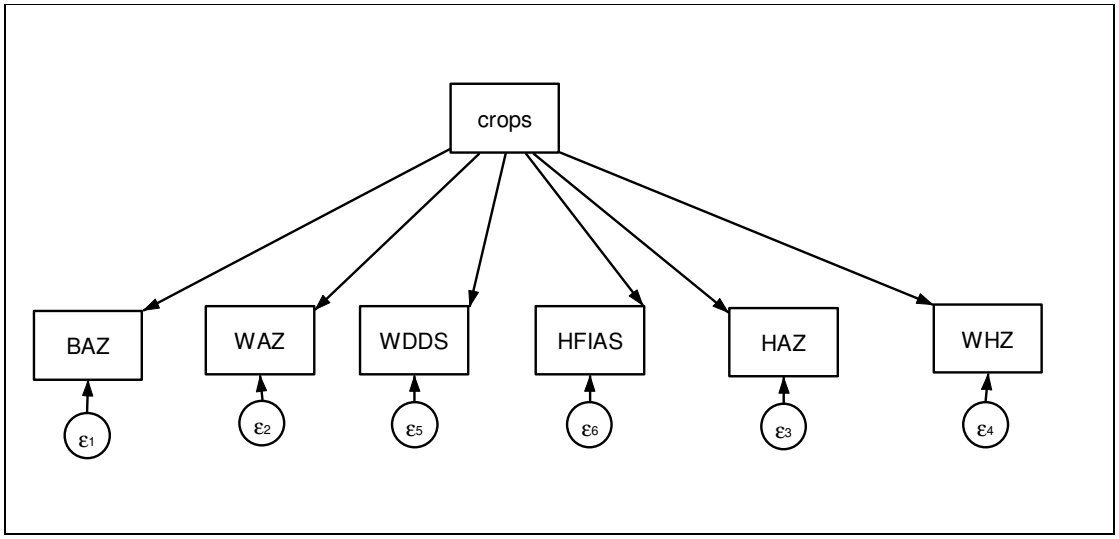

Figure 4: Structural model showing the contribution of crop production to food insecurity (HFIAS) and nutrition insecurity (WDDS, WHZ, HAZ, WAZ and BAZ) across the urban - rural continuum.

Ethical considerations

Study objectives and purpose were communicated to the community leaders and household heads. Permission was sought before data collection from local leaders and respondents. Respondents had the opportunity to stop participating in the research at any time of their choice during interviews. None of the participants opted to stop.

4.4 Results

The first section of the results gives a brief background of the demographic profile of the respondents in this study. In the second section urban, periurban and rural agricultural activities in the study area (livestock keeping, wet and dry season crop production) along the continuum are highlighted. The subsistence nature of crop production, looking at the proportion of the produce consumed versus marketed at household level, is presented in the third section. The forth section presents various food and nutrition indicators along the urban - rural continuum. The last section of the results highlights the relationship of crop production and livestock keeping on household food and nutrition insecurity.

Socio-demographic profile of study sample

Study respondents consisted of 52% men and 48% women (Table 1). The majority of the respondents were aged between 21 – 59 years (84%) and had not attended school (55%).

Muslim (46%) and Christians (45%) constituted the majority of the survey sample. The Mossi ethnic group (88%) was the majority.

Table 1: Demographic Characteristics of respondents

Characteristics		Urban % (n=80)	Periurban % (n=80)	Rural % (n=80)	Total % (n=240)
Gender	Men	37	63	56	52
	Women	63	37	44	48
Age class of respondents	≤ 20 years	4	0	1	2
	21 – 59 years	87	86	79	84
	≥ 60 years	9	14	20	14
Level of education	None	38	55	71	55
	Primary	22	28	15	22
	Secondary	29	6	6	14
	Tertiary	10	4	3	5
	Koranic	1	7	5	4
Household Religion	Muslim (m)	58	50	30	46
	Christian (c)	39	46	50	45
	Tradition (t)	1	3	13	5
	Mix m+ c	1	0	4	2
	Mix m + t	0	0	1	.4
	Mix c + t	0	1	1	.8
	Mix all	1	0	1	.8
Ethnic group	Mossi	75	93	96	88
	Samo	6	3	0	3
	Gourounsi	4	1	1	2
	Bissa	4	2	0	2
	Fulani	1	1	3	2
	Others	10	0	0	3

Urban, periurban and rural agriculture along the continuum

The most commonly grown crops during the wet season along the urban – rural continuum were: sorghum *(Sorghum bicolor)*, maize *(Zea mays)*, pearl millet *(Pennisetum glaucum)*, Okra *(Abelmoschus esculentus)*, roselle *(Hibiscus sabdariffa)*, groundnuts *(Arachis hypogaea)*, roundnuts *(Vigna subterranea)*, cowpea *(Vigna unguiculata)* and sesame *(Sesamum indicum)* (Figure 5). There was no statistically significant association between crops grown during the wet season and the geographical location (Chi-square value (d.f= 38) = 37.94, P = 0.472) (Figure 5). The majority of crop production took place in periurban and rural areas during the wet and dry season compared to urban areas (Figure 5 and 6). About 54% of farmers in the study area used farmer saved seeds (Table 2).

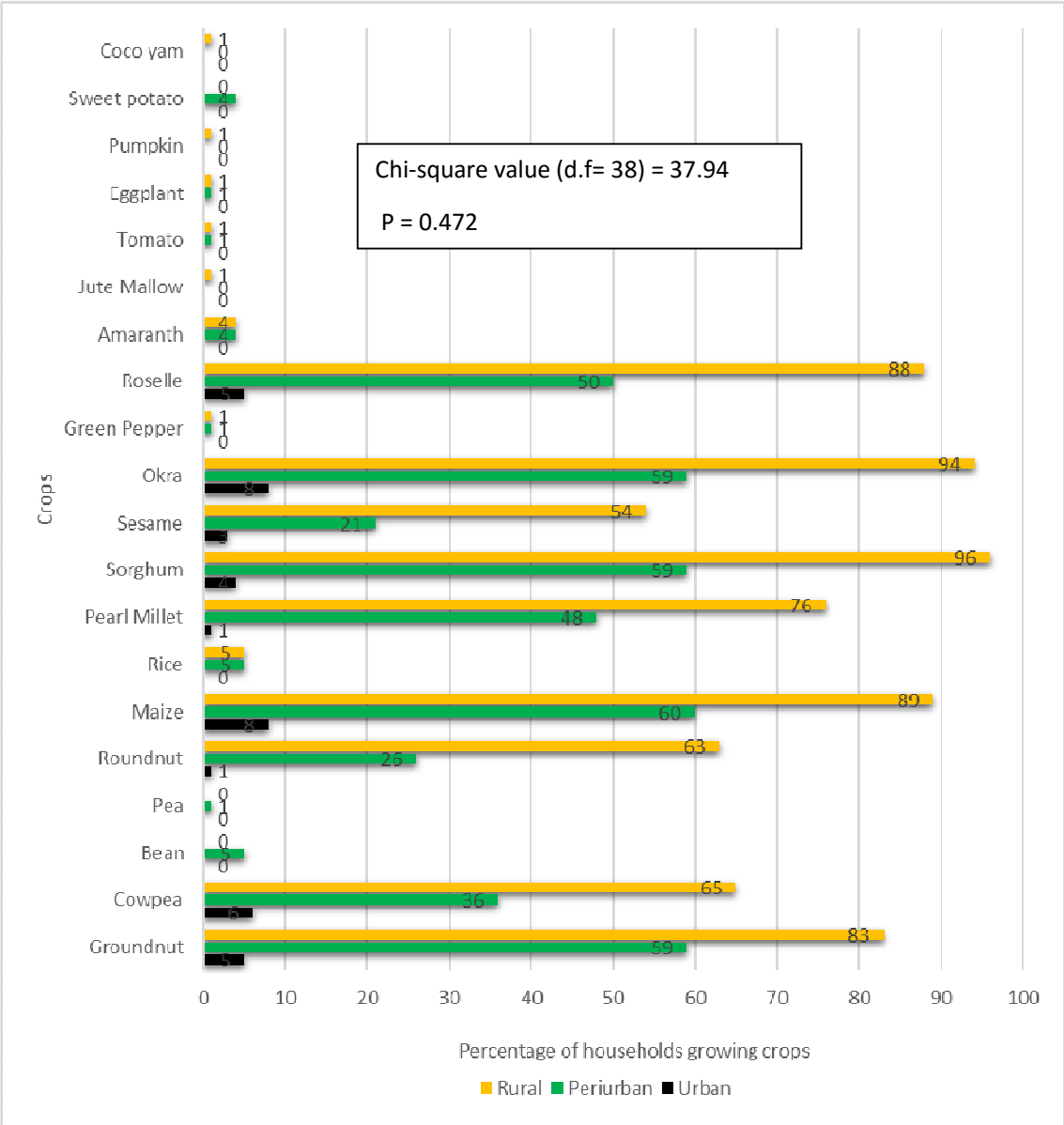

Figure 5: Wet season crop production along the urban – rural continuum (n = 80 households per area - urban, periurban and rural)

Table 2: Sources of seeds for crop production

Position		Urban % (n=80)	Periurban % (n=80)	Rural % (n=80)	Total % (n=240)
Seed sources and Not growing crops	Save own seeds	4	64	92	54
	Buy from seed dealers	9	11	5	8
	Not growing crops	87	25	3	38
		Chi-square value = 366.17, p-value <0.001			

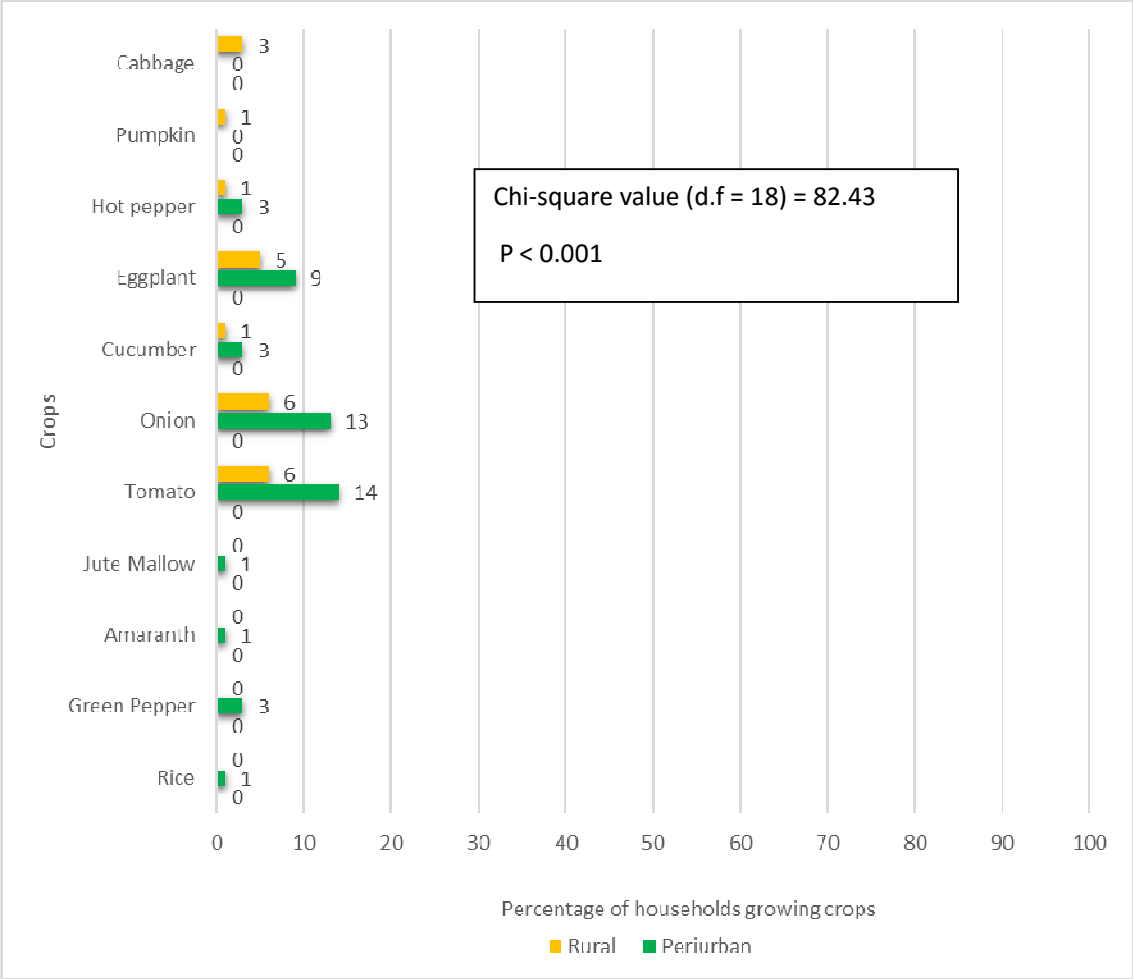

Figure 6: Dry season crop production along the urban – rural continuum (n = 80 households per area – urban, periurban and rural)

Tomato *(Solanum lycopersicum)*, onion *(Allium cepa)*, cucumber *(Cucumis sativus)*, eggplant *(Solanum macrocarpon)*, hot pepper *(Capsicum spp)*, green pepper *(Capsicum spp)* and cabbage *(Brassica oleracea)* were the most grown crops during the dry season along the urban – rural continuum (Figure 6). Most of the dry season production of crops like tomato, onion and eggplant took place in the periurban and rural areas. There was statistically significant association between crops grown during the dry season and the geographical location (Chi-square value (d.f = 18) = 82.43, P < 0.001) (Figure 6).

Livestock keeping activities were more present in periurban and rural areas, compared to urban areas, with more households in rural areas keeping livestock compared to other locations (Figure 7). Goat, donkeys, chicken, sheep and cattle where the most kept livestock.

Pigs were the least kept livestock along the continuum, mostly in urban areas compared to periurban and rural areas. Nevertheless, there was no statistically significant association between livestock kept and the geographical location (Pearson chi-square (d.f=12) =19.99, P = 0.067) (Figure 7).

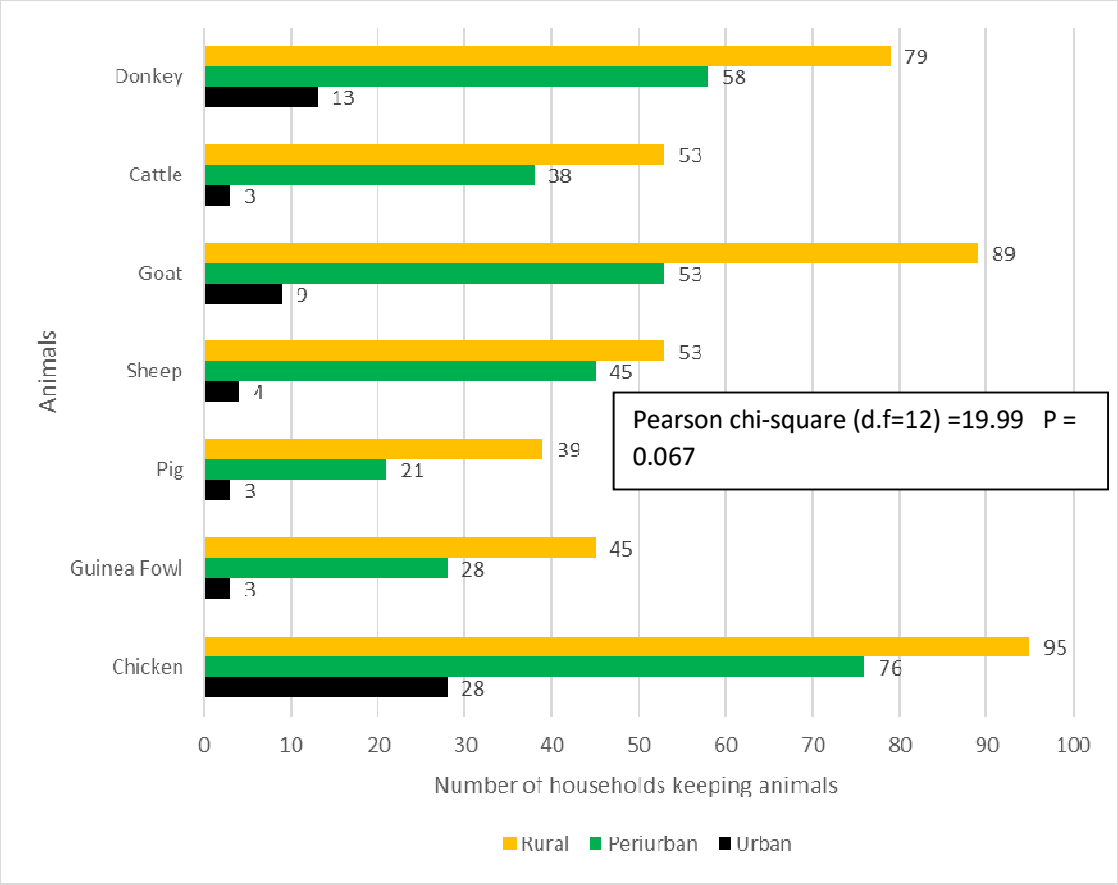

Figure 7: Livestock keeping along the urban – rural continuum (n = 80 households per area - urban, peri-urban and rural)

Production and marketing of crops along the urban - periurban continuum

The results in table 3 and 4, demonstrate the subsistence nature and income generation of agriculture along the urban – rural continuum during the wet and dry season. The results of this study show a general picture of crop production which is more inclined to subsistence during the wet season (Table 3) and income generation during the dry season (Table 4). Most crops grown by urban households during the wet season were mainly for subsistence purposes. Maize, Pearl millet, and sorghum were mainly grown to feed the households with few households selling them during the wet season production. Crops which are not sold at household level are used to feed the family and the income generated from the crops sold is

used to buy non agriculture food like salt, cooking oil, sugar and meet other household financial needs.

Table 3: Wet season crop production and marketing along the urban – rural continuum

Location	Urban %	Periurban %	Rural %	Urban %	Periurban %	Rural %
	Respondents growing the crop (n=80)	Respondents growing the crop (n=80)	Respondents growing the crop (n=80)	Sold >50%	Sold >50%	Sold >50%
Groundnut	9	59	83	86	34	36
Cowpea	6	36	65	0	21	19
Bean	0	5	0	0	25	0
Pea	0	1	0	0	100	0
Roundnut	1	26	63	0	14	22
Maize	8	60	89	0	2	6
Rice	0	5	5	0	50	50
Pearl Millet	1	48	76	0	5	2
Sorghum	4	59	96	0	2	5
Sesame	3	21	54	0	24	49
Okra	8	61	94	0	10	12
Green Pepper	0	1	1	0	100	0
Roselle	5	50	88	0	8	3
Amaranth	0	4	4	0	33	0
Jute Mallow	0	0	1	0	0	100
Tomato	0	1	1	0	100	100
Eggplant	0	1	1	0	0	100
Pumpkin	0	0	1	0	0	100
Sweet potato	0	4	0	0	67	0
Coco yam	0	0	1	0	0	100
	Chi-square =110, p-value <0.001			Chi-square Fisher's exact p value = 0.264		

Notes to table 3: Sold >50% represents the percentage of respondents growing the crop and selling >50%

Table 4: Dry season crop production and marketing along the urban – rural continuum

Location	Urban % Respondents growing the crop (n=80)	Periurban % Respondents growing the crop (n=80)	Rural % Respondents growing the crop (n=80)	Urban % Sold >50%	Periurban % Sold >50%	Rural % Sold >50%
Cabbage	0	0	1	0	0	100
Hot Pepper	0	3	1	0	100	100
Cucumber	0	3	1	0	100	100
Onion	0	13	6	0	80	80
Rice	0	1	0	0	100	0
Green Pepper	0	3	0	0	100	0
Amaranth	0	1	0	0	100	0
Jute Mallow	0	1	0	0	100	0
Tomato	0	14	6	0	91	100
Eggplant	0	9	5	0	100	100
Pumpkin	0	0	1	0	0	100
	Chi-square Fisher's exact p-value = 0.006			Chi-square Fisher's exact p-value = 0.928		

Notes to table 4: Sold >50% represents the percentage of respondents growing the crop and selling >50%

Various food and nutrition indicators along the urban – rural continuum

The results of this study show that households in periurban areas had the highest relative proportion of food insecurity (54%) (HFIAS > 11), compared to urban areas (39%) and rural areas (45%) (Table 5). Stunting (31%) and underweight (19%) individuals were also common in periurban areas than in urban (11% and 5% respectively) and rural areas (29% and 15% respectively). Households in rural areas (15%) had the highest relative proportion of dietary diversity (WDDS ≥ 6), compared to urban areas (11%) and periurban areas (8%). There was statistically significant association between access indicators and geographical location (Chi-square value 33.12, p=<0.001) (Table 5). There was also statistically significant association between nutrition status indicators and geographical location (Chi-square value 32.95, p=<0.001) (Table 5).

Periurban households also had the highest prevalence of following food access indicators: worry that household would not have enough food, eat fewer meals in a day because there was not enough food and sleep at night hungry because there was not enough food (Table 5).

Table 5: Various food and nutrition indicators along urban – rural continuum areas.

	Indicators	Urban % *(n=80)*	Periurban % *(n=80)*	Rural % *(n=80)*	Chi-square	P-value
Production	Producing staple crops and vegetables	13	76	99	9.06	0.011
	Keeping livestock	36	81	99		
Access	HFIAS > 11 (Food Insecure)	39	54	45	33.12	<0.001
	Worry that household would not have enough food	64	81	64		
	Not eating kinds of foods you preferred because of a lack of resources	85	95	88		
	Eat limited variety of foods due to lack of resources	60	40	48		
	Eat foods that you really did not want to eat because of a lack of resources	44	50	44		
	Eat a smaller meal than they felt they needed	48	64	65		
	Eat fewer meals in a day because there was not enough food	54	75	66		
	No food to eat of any kind in your household because of lack of resources to get food	29	31	23		
	Sleep at night hungry because there was not enough food	33	46	39		
	Spend whole day and night without eating anything because there was not enough food	13	23	23		
Nutrition Status	*Sample size*	*(n=66)*	*(n=59)*	*(n=54)*	32.95	<0.001
	WDDS ≥ 6 (Highest food diversity)	11	8	15		
	Sample size	*(n=37)*	*(n=48)*	*(n=48)*		
	Wasted (WHZ < -2 SD)	16	6	2		
	Stunted (HAZ < -2 SD)	11	31	29		
	Underweight (WAZ < -2 SD)	5	19	15		

Attributes of livestock production to indicators of nutrition and food insecurity

Households doing livestock keeping significantly experienced less wasting (WHZ) (coef = -0.15; p = 0.008) by a factor of 0.15, and (BMI)-for-age BAZ (coef = -0.12; p = 0.015) by a factor of 0.12 compared to households not doing livestock keeping (Table 6). However there were weak correlations between WHZ and keeping livestock (corr = 0.24) and between BAZ and keeping livestock (corr = 0.22). The linear model explains a very low percentage of the variation WHZ (R^2=5.5%), BAZ (R^2=4.6%) in the data, so there is a need to further explore nonlinear models. There was no statistical significance (p value > 0.05) for other indicators (HAZ, WAZ, WDDS, HFIAS).

Table 6: Univariate analysis of livestock keeping attributes to indicators of food and nutrition insecurity.

Model type-Structural	Coefficient	[95% Confidence Interval]	P value	Correlation	R^2
*WHZ <-livestock	-.15	-.26 -.04	0.008	.24	.055
constant	.19	.09 .29	0.000		
HAZ <-livestock	.12	-.07 .31	0.207	.11	.013
constant	.15	-.01 .32	0.067		
WAZ <-livestock	.07	-.08 .23	0.346	.09	.007
constant	.08	-.05 .21	0.245		
*BAZ <-livestock	-.12	-.22 -.02	0.015	.22	.046
constant	.15	.07 .24	0.001		
WDDS <-livestock	.04	-.49 .57	0.887	.01	.0002
constant	3.96	3.49 4.43	0.000		
HFIAS <-livestock	1.46	-1.35 4.28	0.309	.09	.008
constant	9.65	7.16 12.15	0.000		

*statistically significant at 95% level of confidence

Attributes of crop production to indicators of nutrition and food insecurity

Table 7: Univariate analysis of crop production attributes to indicators of food and nutrition insecurity.

Model type-Structural	Coefficient	[95% Confidence Interval]	P value	Correlation	R^2
WHZ <-crops	.30	-.15 .76	0.190	.12	.014
constant	-.49	-.86 -.11	0.011		
HAZ <-crops	-.47	-.99 .05	0.078	.16	.025
Constant	-.83	-1.26 -.39	0.000		
WAZ <-crops	-.14	-.55 .27	0.507	.06	.004
constant	-.73	-1.07 -.39	0.000		
BAZ <-crops	.28	-.17 .72	0.219	.11	.012
constant	-.34	-.71 .03	0.069		
WDDS <-crops	-.15	-.62 .31	0.521	.06	.003
constant	4.11	3.72 4.49	0.000		
*HFIAS <- crops	2.55	.09 4.99	0.042	.18	.033
constant	9.03	6.99 11.06	0.000		

*statistically significant at 95% confidence level

Households involved in crop production significantly experienced more food insecurity HFIAS (coef = 2.55; p = 0.042) by a factor of 2.55 compared to households without crop production (Table 7). However there were weak correlations between HFIAS and crop production (corr = 0. 18). The linear model explains very low percentage of the variation HFIAS (R^2=3.3%) in the data, so there is a need to further explore nonlinear models. There was no statistical significance (p value > 0.05) for other indicators (WHZ, HAZ, WAZ, BAZ, WDDS).

4.5 Discussion

This study reveals some relationships and association between crop production and livestock keeping with various food and nutrition indicators. The significance of these various associations varies from one indicator to another.

Urban, periurban and rural agriculture along the urban – rural continuum

Study results show that most agricultural activities, both crop production and livestock keeping took place in periurban and rural areas (Figure 5, 6 and 7). More urban households engaged in livestock keeping compared to crop production, with chickens, donkeys, goat and sheep being the most commonly kept livestock. One of the reasons urban

households opt for livestock keeping versus crop production is large space requirement for most crop production activities compared to livestock pens or corrals. Limited engagement of urban households in agriculture was expected and can be explained by the prevailing statutes by the city of Ouagadougou, which does not allow agricultural activities[24,23].

Wet season production was mainly for subsistence while the majority of dry season production was for income generation (Table 3 and 4). It was observed that during the dry season household heads or young to middle aged boys move from their villages to distant villages where there was water to do dry season farming (rural – rural migration). Interviews revealed that often times these household heads and boys stay in the dry season production sites until they harvest and market the crop. Crops produced during the dry season included tomatoes which were marketed as far as Ghana through farm gate sales (buyers coming from Ghana to purchase the produce at production sites). Income generated from dry season production was used to buy food not produced by farmers (like sugar, cooking and salt) and to meet other household financial needs like paying school fees. Konseiga[58] discussed another similar form of household regional migration in Burkina Faso and attributed it to a survival strategy in a region confronted with severe scarcity of natural resources. Ndao[59], attributed the cause of rural – rural migration amongst young people in West Africa to a lack of access to land, to poor soil fertility which limits their income from farming, and to the unavailability of non-farming employment.

Food and nutrition security along the urban – rural continuum

More households in periurban areas were food insecure (HFIAS > 11), compared to urban areas and rural areas (Table 5). More problems of stunting and underweight individuals were also observed in periurban areas than in urban and rural areas. Daboné et al. (2011:1)[32], also reported that, “thinness and stunting were significantly higher in periurban compared to urban schools”. We also observed a number of mud houses constructed around the urban Ouagadougou (periurban), mostly occupied by households either from the urban Ouagadougou or rural areas. Households were building low cost mud houses as they could not afford modern brick and mortar houses. The results show the complex nature of periurban areas which is associated with an influx of people from urban and rural areas. Periurban areas tend to be seen as safety nets by poor households, often in search of food and other resources like land to improve livelihoods. This, however, is putting pressure on natural resources, which can explain the reasons of high levels of food and nutrition insecurity in this

area. The periurban in the study area was characterised by poor infrastructure such as poor access to clean drinking water and lack of toilet facilities, these factors must have contributed to children malnutrition. In Northeast India drinking water and toilet facilities were also cited as household risk factors affecting child malnutrition[64]. The uniqueness of characteristics of periurban households has been discussed in a number of studies[41,60,61]. Schlesinger et al. (2015:110)[62] pointed out that these characteristics differ: "in terms of social configurations, political-administrative frameworks, and natural resource endowment, and that may significantly differ from their urban or rural counterparts".

Association of urban, periurban and rural agriculture and household food and nutrition security

Households in rural areas had the highest relative proportion dietary diversity (WDDS ≥ 6), compared to urban areas and periurban areas (Table 6). The subsistence nature of crop production in rural areas, coupled with presence of wild fruits and traditional vegetables offers the opportunity to a wide diversity of food groups compared to urban and periurban areas where there is competition to use land for construction and agro-biodiversity[63]. Studies have reported an increase in biodiversity with reduced urbanisation[41,65,66]. Urban areas are also associated with loss of indigenous knowledge on production and utilisation of indigenous species, therefore contributing to limited dietary diversity. The work of Sogbohossou et al. (2015:9)[67], along the urban-rural continuum of Southern Benin, reported that: "urbanization was found to negatively affect the knowledge and uses of wild species". Although, urban areas had lower WDDS compared to rural areas, they were still better than periurban areas. The difference between urban and periurban areas in terms of dietary diversity can be explained by presence of diverse sources of food outlets in urban areas compared to periurban areas, ranging from food shops, vegetable and fruits markets.

Households doing livestock keeping significantly experienced less wasting and overweight compared to households not doing livestock keeping (Table 6). The work of Zezza A and Tasciotti (2010:265)[68] based on the household survey data for 15 developing or transition countries also found "fairly consistent evidence of a positive statistical association between engagement in urban agriculture and dietary adequacy indicators". Animal based food have been argued to provide much needed micronutrients which are bioavailable to the human body, such as haem iron in organ meat (liver, heart and blood based foods)[51]. The work of Schönfeldt et al. (2013:394)[69], highlighted that: "In addition to quantity, the high

quality of the nutrients in animal source foods is important as high-quality nutrients are more readily absorbed into the human body than lower-quality nutrients from other food and non-food sources". Livestock keeping was common in rural areas compared to periurban and urban areas, and often times households slaughtered livestock like goats, sheep, chicken and guinea fowl for household consumption.

Households involved in crop production had higher household food insecurity scores (HFIAS) compared to households without crop production (Table 7). This result suggests that engagement in crop production was worsening the household food security situation. Ownership of livestock is a sign of wealth in the study area and often poor households will solely engage in crop production. Most households who were not engaging in crop production were keeping livestock and engaging in non – farm activities like trading and non-farm employment, these helped in generating income to source food for the households. Another explanation for crop producers experiencing food insecurity is high use of poor quality farmer saved seeds by crop producers, 92% of rural households were saving their own seeds (Table 2). If farmers use farmer saved seeds consecutively for many years without proper selection and going back to the clean parent material, the quality of the seed goes down. Poor quality seed will lead to poor yields and eventually to household food shortages. Setimela et al.[70], emphasized the importance of quality seeds as the basis for a meaningful agricultural based food production system. Poor crop yields will worsen the food security situation, mostly of the subsistence households. Other environmental factors like erratic rains and poor soil fertility can also explain why crop production worsens food security instead of improving it. Rockström et al. (2015:284)[71], pointed out that in Africa: "when crops fail, the reason is usually an extended dry spell, or one at a crucial point in the growing season, such as the flowering period, rather than low rainfall. Several weeks without rain are common and may occur each season, sometimes with a devastating effect". Erratic rains and poor soils are prevalent in the study area and can cause poor yields and perpetrate food insecurity. The work of Ouedraogo et al.[74] based on the analysis of remotely-sensed and rainfall data from 1975–2011 in Burkina Faso reported experiences of erratic rains. The majority of households rely on rain-fed agriculture in the study area. Hummel (2015:41)[72], highlighted that in the Sahel: "households which are highly dependent on rain-fed agriculture are particularly vulnerable to rainfall variability and ecosystem degradation because these environmental factors have negative effects on crop yields and harvests". Due to recurrent droughts and frequent harvest failures, farmers in Burkina Faso started improving traditional planting pits

(zaï)[73]. It was also observed that most of the households not involved in crop production were involved in livestock keeping and non-farming income generating activities like trading of various goods including food stuffs.

4.6 Summary and conclusions

The results of this study show that livestock and crop production contribute to household food and nutrition security at different levels; for example livestock keeping reduced wasting (WHZ) and overweight (BAZ) individuals amongst the livestock keeping households compared to non-livestock keeping households. On the other hand, households engaged in crop production were more food insecure than those not producing crops. This situation could be due to use of poor quality seeds, erratic poor rains and poor soils. Households not producing crops were often involved in livestock keeping and other non-farming income generating activities, like trading small goods and food staffs.

The periurban areas were worst affected by food and nutrition insecurity in Ouagadougou. Based on our results, we recommend the policy formulation and implementation to support agricultural activities mostly in urban and periurban areas. The following specific recommendation are given to address some of the observed challenges in the study area: Firstly, the provision of quality seed possibly through community based seed groups. This can target common initiative farmer groups and the capacity of these farmers can be built by national organisations like Institut de l'Environnement et Recherches Agricoles (INERA) and other non-governmental organisations. Secondly, investing in water harvesting techniques as stressed in the work of Rockström and Falkenmark[71] will help crop production which sorely relies on rain fed production system in a region of erratic rains. These techniques can take the form of traditional planting pits (zaï) as discussed by Kabore and Reij[73] amongst others. Thirdly, use of organic manure and compost to improve soil fertility to improve the contribution of crop production to food security. These can take the form of compost pits which we observed in some surveyed villages promoted by the Adventist Development and Relief Agency (ADRA). The complexity of periurban areas coupled with the scourge of food and nutrition insecurity will require more periurban agriculture and food policy consideration.

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CHAPTER 5

Vegetable production, consumption and its contribution to diets along the urban – rural continuum in Northern Ghana

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The version included in the thesis has been slightly modified to ensure consistency of style and usage with other chapters.

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5.1 Abstract

Malnutrition continues to be a problem, with sub-Saharan Africa affected the worst. Women and children are at the pinnacle of this problem. The perpetual scourge of malnutrition in urban and periurban settings, coupled with levels of vegetable consumption below the recommended amounts, are a major problem in most African countries including West African cities. A household survey was conducted between November and December 2013 (dry season) in and around Tamale, Ghana as part of an urban food system analysis, to understand vegetable production and consumption and its contribution to household diets and income along the urban – rural continuum. Data collection was guided by a transect approach. A total of 240 households participated in the survey, with 62% males and 38% females. Additionally, 186 women of reproductive age (15 – 49 years) staying in the sampled households contributed to the computing of household dietary diversity through Women's Dietary Diversity Scores (WDDS). Most vegetables produced were for subsistence use, considering that most households sold less than 50% of the crops and consumed the rest. Vegetable production varied significantly along the urban - rural continuum, with more households in rural areas producing all the requirements of their vegetables compared to urban and periurban areas. Nevertheless, the households in the rural areas (16%) had the lowest dietary diversity (≤ 3 WDDS) compared to urban areas (13%) and periurban areas (5%). The study showed low consumption of vegetables (especially the dark green vegetables) mostly in the rural area and limited diversity of vegetables, especially vitamin A rich vegetables and tubers, with only three vegetables (carrots, red pepper and sweet potato) consumed. There was evidence of more inclination toward staple crops compared to vegetables along the urban – rural continuum for both production and consumption, clearly shown in crops grown and food groups mostly consumed (cereals and tubers rather than dark green vegetables). There was overall low consumption of dark green leafy vegetables, such as amaranth, with only 26% reported to have consumed them during the reported period compared to food groups like cereals (98%). This study confirms the dual purpose of vegetables in complementing dishes (balanced diets) with much needed micronutrients and helping households along the urban – rural continuum to generate income.

Key words: Vegetables, dietary diversity, food groups, urban – rural continuum, Northern Ghana

5.2 Introduction

Malnutrition is rampant and continues to be a global challenge, contributing to approximately one third of the nearly eight million deaths of children under five years of age worldwide [1]. At the same time, about 500 million people still suffer from protein-energy malnutrition, over 1.6 billion suffer from iron deficiency and over 200 million from vitamin A insufficiency [2,3]. These problems are more likely to manifest in cities, mostly in the developing world [4]. There is growing evidence that cities in the developing world will face a rapid influx of people due to rural-urban migration and the natural population increase [5]. The number of African urban dwellers has been projected to rise from 11.3 % in 2010 to a 20.2 % by 2050 [6], further perpetuating urban food and nutrition demands.

Rapid growth of cities has posed a lot of challenges to urban dwellers including unemployment, food insecurity and malnutrition [7]. Although it has been believed over the years that urban households are better placed than their rural mates in terms of infrastructure (urban bias) [8], recent trends show more evidence of rising urban poverty [9]. In the midst of growing cities, looming food shortages and sometimes unfortunate eating habits, urban populations are likely to face a double burden of malnutrition amongst the urban poor and obesity amongst the so called middle class [4].

Vegetable production and consumption have the potential to create employment and generate income in the developing world [10], while at the same time providing much needed micronutrients for the body and antioxidants and phytochemicals that may protect people against non-communicable diseases [11]. Some protective properties against ulcers induced experimentally, have been found in African eggplant, making it a cheap and natural anti-ulcer remedy [12]. Nevertheless, the consumption of vegetables globally remains below the expected minimum of 400g of fruit and vegetables per day (excluding potatoes and other starchy tubers), with sub-Saharan Africa lagging behind [13]. The consumption of vegetables can be improved by incorporating vegetables in tasty and attractive meals as demonstrated in the work of Chagomoka *et al.* [14], but developing recipes including nutritious vegetables has been a neglected research area [15]. The production of vegetables in and around cities, especially in developing countries has been associated with risks ranging from use of waste water to unsafe use of pesticides [16–19]. Nevertheless, urban agriculture, which often takes the form of vegetable production, has been argued to be part of sustainable urban development [20]. Vegetable production has been associated with diverse gender issues, for

example, often times the marketing of vegetables and production of less profitable crops is dominated by women while laborious tasks and production of high cash crops are taken over by men [21].

Studies on production and consumption of vegetables have been done in sub-Saharan Africa; nevertheless, there is lack of knowledge of the changes in the contribution of vegetables to diets along the urban – rural continuum. Using data of a larger study conducted between November and December 2013 that had the objective to understand the socio-spatial dynamics of household food and nutrition insecurity in sub-Saharan Africa, this paper addresses vegetable production, consumption and contribution to diets in Tamale (Ghana). The overall aim was to investigate the role played by urban and periurban agriculture.

5.3 Materials and methods

Mixed methods from natural and social science were used in this study to strengthen the scientific rigor. A structured questionnaire was used to collect crop production, consumption and marketing data between November and December 2013. Individual dietary diversity scores (IDDS), targeting women of reproductive age (15 – 49 years), referred to here as the Women's Dietary Diversity Score (WDDS) was used to assess the dietary diversity at the household level and reflect the presence of vegetables in household diets across the urban – rural continuum .

Description of study area

The study covered seven districts[2] in Ghana´s Northern Region, located in and around Tamale. The Tamale Metropolitan Assembly (TMA) is the capital town and administrative headquarters of the Northern Region (Figure 1). It is within the savannah climate region of West Africa, with an altitude of 180 meters above sea level. The soils are mostly Savanna Ochrosols that are poor in organic matter, but loamy, well-drained and porous. The climate is characterised by two main seasons, one rainy season from April to October with rainfalls of more than 1000 mm and a dry season from November to March. As a result, the city is poorly endowed with surface water, with only a few seasonal streams that dry up during the dry season. Tamale Metropolitan Area population was estimated to be 370,000 as of the year 2010 [22]. West Africa has been experiencing intensive urbanization for many years. The

[2] Central Gonja, East Gonja, Mion, Sagnarigu, Savelugu-Nanton, Tamale Metropolitan and Tolon

urbanization process in Africa is taking place in the absence of significant industrial expansion and mostly driven by rural-urban migration.

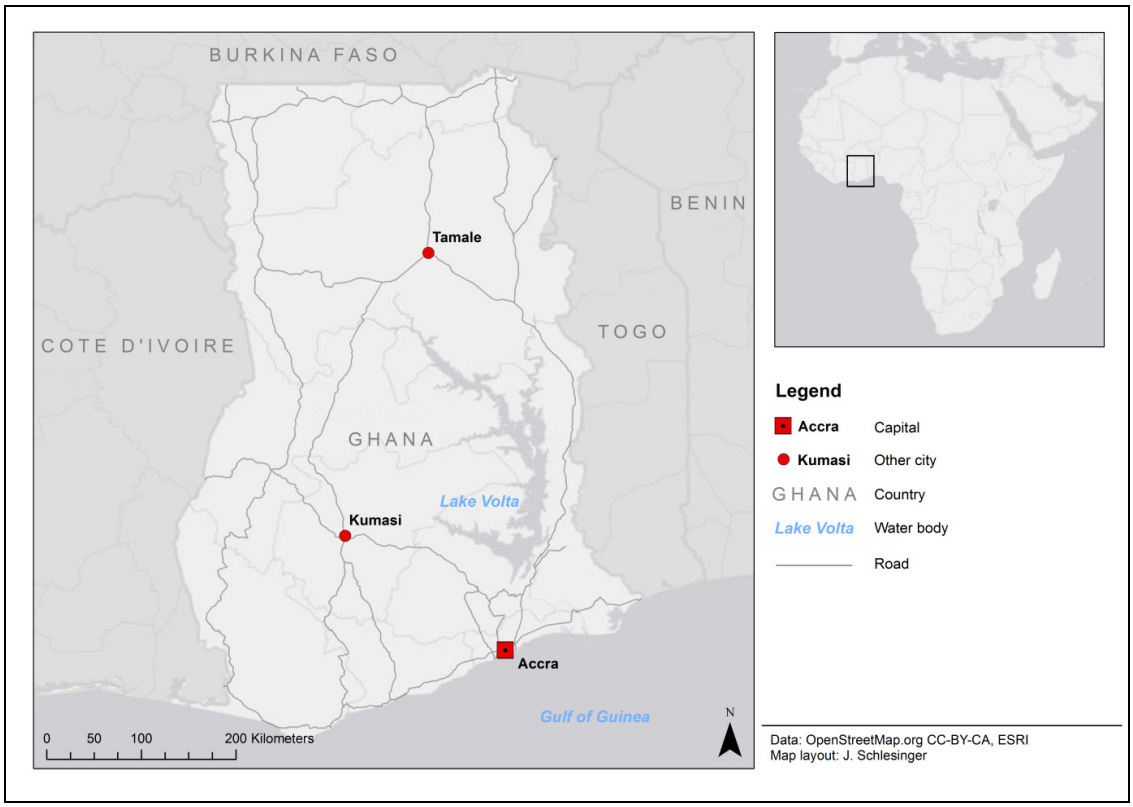

Figure 1: Location map of Tamale in Northern Region of Ghana

Study design and sampling approach

A transect approach was used to guide data collection. This approach has been used in many studies, some of them analysing vegetation, vegetable production and use of natural resources [16,23]. Four transects, 2 km wide and 70 km long were laid out radially, heading towards North, East, South, and West, respectively and four compass directions were chosen (quasi random sampling) with Tamale central market being the centre (Figure 2). Each transect was divided into three zones (urban, periurban and rural), based on the reviewed literature on the extent of urban, periurban and rural areas in West Africa. [17,24,25]. The identification of the periurban areas was strongly supported by the work of Iaqiunta and Drescher [26]. The advantage of this approach is the probability of including households that may be excluded in most sampling approaches, which usually follow the linear settlement pattern of households

along developments like major roads. The weakness of this approach is the concentration along the transects and not elsewhere.

In this study, the first zone (urban) was within 10 km and the second zone (periurban) between 10 km to 40 km and the third zone (rural) between 40 to 70 km distance from the city centre. All households along the transects were digitised and randomly selected using Geographic Information Systems (GIS). All three zones were repeated on all four transects across the city (Figure 2). Twenty households per zone were randomly selected meaning 3 zones by distance x 4 sections of town x 20 households = 240. This translated to 80 households in each zone (urban, periurban and rural). The coordinates of the randomly selected households were transferred to a Global Positioning System (GPS) to help in locating and tracking the randomly selected households along the transects. Additionally, 186 women of reproductive age (15 – 49 years) staying in the sampled households contributed to the computing of Women's Dietary Diversity Scores (WDDS).

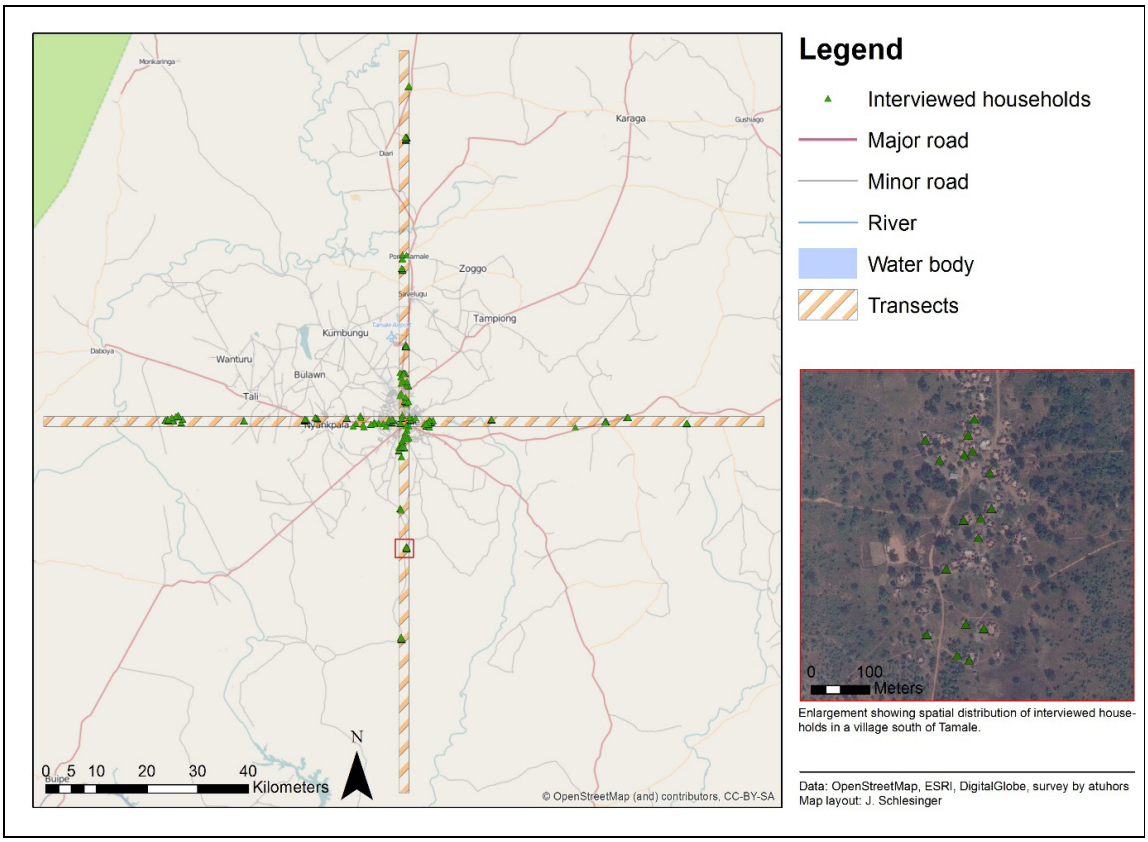

Figure 2: Transect sampling

Data collection

Household face-to-face interviews targeting household heads and women of reproductive age using structured questionnaires were used to collect data on crop production, consumption, marketing, income and household dietary diversity. The details of these are below:

Assessment of household dietary diversity

Dietary diversity was assessed through Women's Dietary Diversity Score (WDDS) which reflect nutrient adequacy and is a proxy of household nutrition [27]. The study targeted women of reproductive age to assess dietary diversity. All ingredients used in preparing different dishes consumed by women were noted to assist in identifying and tracking where vegetables were consumed. Based on the food items consumed in the past 24 hours, respondents were assigned the number of food groups they consumed ranging from 0 to 9. An increase in number of food groups or WDDS is related to increased dietary diversity. Women were classified into three groups based on the distribution in the sample; ≤ 3 food groups as lowest dietary diversity, 4 – 5 food groups as medium dietary diversity and ≥ 6 highest dietary diversity.

Data Management and Analysis

Epidata 9 was used for data entry before data were exported to SPSS 16 and STATA 12 for further cleaning and analysis. For continuous outcomes, statistical significance was assessed using Multivariate Analysis and posthoc to control for confounding factors. For categorical and dichotomous outcomes, chi-square tests were used to assess statistical significance. Continuous data were checked for normality and the analysis of variance was used to assess the independent contribution of vegetables to dietary diversity.

Ethical issues

In each community, study objectives and purpose were clearly conveyed to community leaders and respondents. Permission was sought before data collection from local leaders and respondents. Respondents had the opportunity to stop participating in the research at any time of their choice during interviews and none opted out of the interviews.

5.4 Results

The results represent vegetable production, consumption, and marketing and their contribution to diets along the urban – rural continuum as guided by the transect approach. The authors are aware of other main vegetable production sites in and around Tamale including Gumbihini new dam area, Gumbihini old dam area, former Gumbihini Volta River Authority (VRA) area, Sangani area, Zagyuri, Golinga irrigation, Savelugu irrigation sites and Botanga irrigation among others, which are not part of the transects and thus not reflected in this paper.

Vegetable production along the urban – rural continuum

The following vegetables were the most grown along the urban – rural continuum in and around Tamale; okra *(Abelmoschus esculentus)*, pepper *(Capsicum spp)*, roselle *(Hibiscus sabdariffa)*, jute mallow *(Corchorus olitorius)*, tomato *(Solanum lycopersicum)*, egusi *(Citrullus colocynthis)*, amaranth *(Amaranthus spp.)*, onion *(Allium cepa)* and garden egg *(Solanum melongena)* (Table 1). Most vegetables were grown in rain-fed cultivation systems in the months of May to October. During the dry season (November to April), however, smaller areas were cultivated with dug outs, shallow wells and waste water being the main sources of water. Okra, pepper and roselle were the most commonly produced vegetables. They were mainly cultivated for subsistence, as most households sold less than 50% of the crops and consumed the rest (Table 1).

There was great variability in types of vegetables produced from one ethnic group to another. For example egusi was a common crop amongst the Gunja ethnic group in the East and Central Gunja districts while roselle and okra were more common with the Dagomba ethinic group. One of the possible explanations could be the difference in cultural dishes and tastes amongst the ethnic groups influencing the choice of vegetable crops produced. For example, okra and Tuo Zaafi or thick porridge is a staple dish amongst the Dagomba ethnic group. Tomatoes, in contrast, were scarcely produced along the urban – rural continuum (only 6% of the interviewed households were producing tomatoes), with most tomatoes on the markets reported to be coming from elsewhere as far as Ouagadougou, Burkina Faso. Nevertheless, tomatoes and okra were the most consumed vegetables, clearly portraying Tamale as a tomato consuming area rather than a major production area.

More households in the rural areas produced vegetables to meet all the requirements of their households compared to urban and periurban areas (Figure 3). Nevertheless, the households in the rural areas (16%) had the lowest dietary diversity (≤ 3 WDDS) compared to urban areas (13%) and periurban areas (5%) (Table 2). One of the reasons could be limited diversity in vegetables consumed (Table 3). On the other hand, there was a greater proportion of households producing staple crops to meet all the requirements of their households compared to those producing vegetables (Figure 3 and 4). Amaranth, Jute mallow, tomato and egusi were on the top of being grown as cash crops compared to other crops, with more of households growing them selling more than 50% of the crop (Table 1).

There was a statistically significant association between the position along the urban - rural continuum and the level of vegetable production (Pearson chi-square value of 39.4, $P<0.001$). There was also a statistically significant association between the position along the urban – rural continuum and the level of staple crop production (Pearson chi-square value of 113.4, $P<0.001$). Nevertheless, the results reveal that vegetable production in and around Tamale has no statistically significant contribution to the changes in WDDS, because at all vegetable production levels, the mean WDDS is not significantly different compared to the non-vegetable producing level ($p=1.000$).

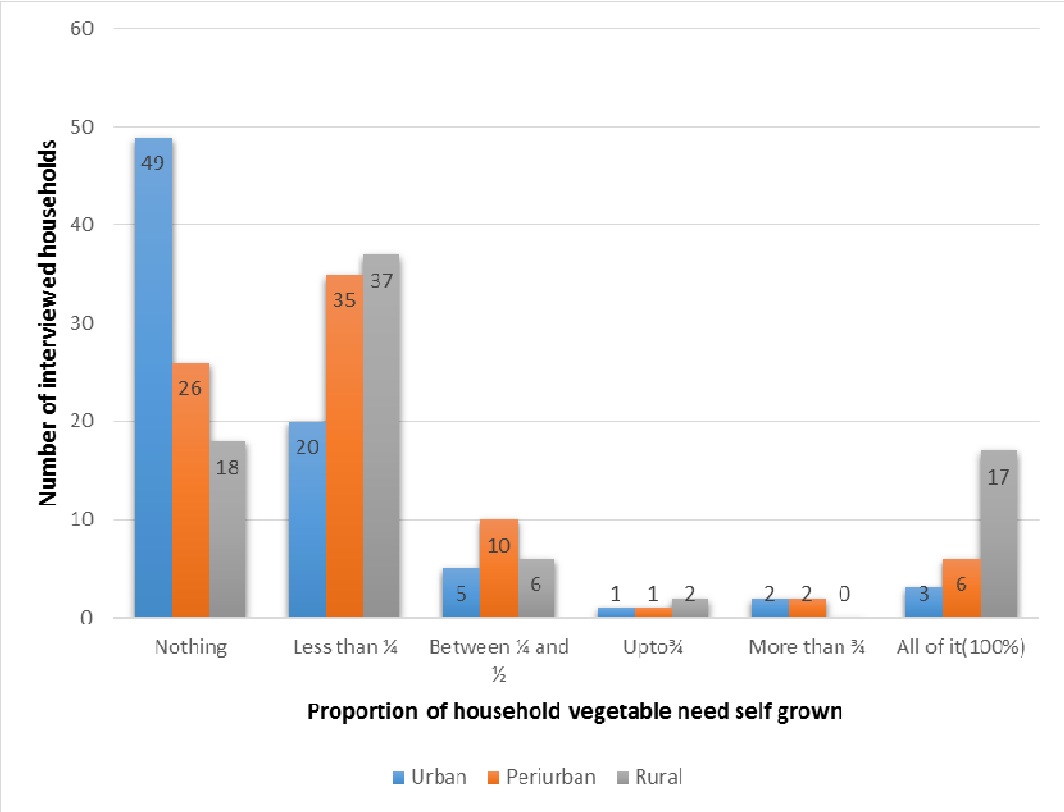

Figure 3: Vegetable production along the urban - rural continuum

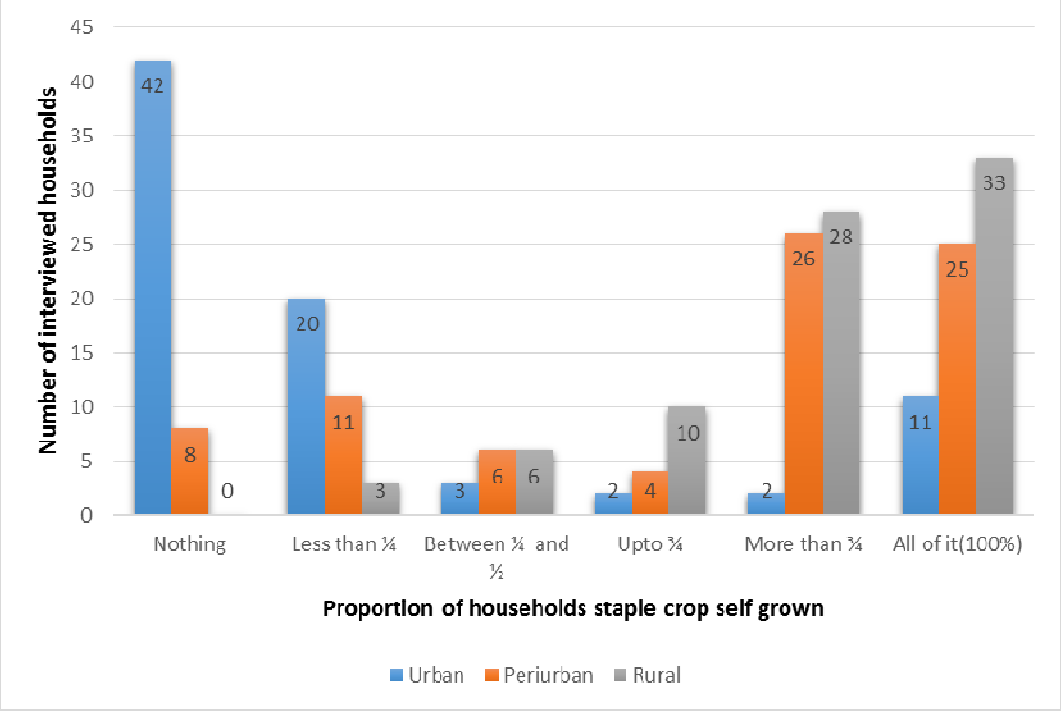

Figure 4: Staple crop production along the urban - rural continuum.

Vegetable consumption along the urban – rural continuum

The results reflected the presence of vegetables consumed by surveyed households along the urban – rural continuum between November and December 2013 (dry season), as part of their dishes. (Table 2). Nevertheless, at a closer look there was a mixed picture along the urban – rural continuum of consumption of dishes including vegetables; with rural households consuming more vitamin A-rich vegetables and tubers (90%); urban households consuming more dark green leafy vegetables (29%) and periurban households consuming more of other vegetables (96%). There was overall low consumption of dark green leafy vegetables, such as amaranth, with only 26% reported to have consumed them during the reported period compared to food groups like fish and seafood (88%) and cereals (98%). More households in the urban setting were consuming more oil and fats (27%), which can be described as an "oily diet" in the cities compared to periurban and rural. Besides evidence of low consumption of vegetables, especially the dark green vegetables that are rich in vitamin A, the results also show limited diversity in the consumed vegetables (Table 3). In some households the diversity was limited to dry okra. Mostly consumed vegetable based on different food groups are shown in Table 3, with only three vegetables (carrots, red pepper and sweet potato) under vitamin A rich vegetables and tubers.

5.5 Discussion

This study revealed that okra, pepper and roselle were the most produced vegetables along the urban - rural continuum in and around Tamale. These crops were mainly cultivated for subsistence. The reason could be that crops like okra form a critical part of traditional dishes in and around Tamale with over 45% of women of reproductive age eating it during the reported period. Okra and other crops like jute mallow are produced mainly for subsistence because they are perceived as less profitable crops as also reported by Kessler *et al.* [21]. Production of vegetables and fruits has been seen as a critical strategy to improve consumption as recently revealed in the work of Kabunga *et al.* in Uganda [28].

There was a greater proportion of households producing staple crops to meet all the requirements of their households compared to those producing vegetables (Figure 3 and 4). This could be due to the subsistence nature of staple crops and food consumption habits in these regions, where there was more presence of staple crops like maize, cassava, rice and yams in most consumed dishes usually accompanied by small quantities of vegetables

(Table 2). This was also reflected in consumed dishes, with a limited variety of vegetables. Nevertheless, vegetable production has been reported to have great potential to generate extra income, which can also be used to buy household food demands while at the same time providing much needed micronutrients [10,11,29].

There was low consumption of dark green leafy vegetables, such as amaranth, compared to food groups like fish and seafood (Table 2). Dark green vegetables have higher levels of vitamin A than other vegetables [27], as also reflected in the recent work of Kamga et al. [29] in Cameroon. Vitamin A insufficiency is a worrying global problem [3]; however, production and consumption of nutrient dense vegetables can be a cheap and easy way for the urban and rural poor to increase micronutrients in their diets [30].

The study showed low consumption of vegetables (especially the dark green vegetables) and limited diversity of vegetables, especially vitamin A rich vegetables and tubers with only three vegetables (carrots, red pepper and sweet potato) consumed (Table 2 and 3). In some households the diversity was limited to dry okra often accompanied by Tuo Zaafi (thick porridge usually made from maize or sorghum). Based on previous studies, it is more beneficial for households to diversify their vegetable crops as a strategy to enhance income and nutrient adequacy. The work of Kamga *et al.* [29] reveals that nutrient content of various vegetables can vary between accessions, thus critical to diversity within accessions of the same crop (for examples AB2 and DB3 accessions of eggplant - *Solanum aethiopicum*) and not only between various crops (for example, jute mallow and African eggplant). On the other hand, studies have classified some vegetables as more profitable than others including the work of Kessler *et al.* [21].

The results reveal varying food habits along the urban – rural continuum, for example, urban households (27%) were consuming more food under the oil and fats group *(which can be referred to as oily diets)* compared to periurban (18%) and rural (21%) households (Table 2). The same trend was also under the red palm products with 7% of urban households consuming them compared to 4% of households in the periurban area and 3% in the rural area (Table 2). On the other hand, more households in rural areas (50%) were consuming food under white roots and tubers *(which can be referred to as starch-based diets)* compared to urban households (31%) and periurban households (29%).

5.6 Conclusions

Vegetable production varied significantly along the urban - rural continuum (Pearson chi-square value of 39.4, $P<0.001$), with more households in rural areas producing all the requirements of their vegetables compared to urban and periurban areas. Nevertheless, households in urban areas had the highest dietary diversity, including the highest dark green leafy vegetable consumption, which may be due to accessibility to various sources of food suppliers ranging from shops, and fruit and vegetable markets.

There was evidence of more inclination towards staple crops compared to vegetables along the urban – rural continuum for both production and consumption, clearly shown in crops grown (more households producing all the requirements of their staple crops than vegetables) and food groups mostly consumed (more cereals and tubers than vegetables).

The study also showed a limited diversity in both vegetables produced and consumed (especially the dark green vegetables) mostly in the rural area, strongly supporting the notion confirmed in Uganda that increased production of vegetables may eventually lead to improved consumption [28]. The production and consumption of nutrient dense vegetables can be a cheap and easy way for urban and rural poor to increase micronutrients in their diets.

This study confirms the potential dual purpose of vegetables of complementing dishes (balanced diets) with much needed micronutrients and also helping to generate income to households along the urban – rural continuum.

5.7 Acknowledgements

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Table 1: Vegetable production and marketing along the urban – rural continuum

Location	Urban		Periurban		Rural	
	Respondents growing the crop (%)	Sold >50% (%)	Respondents growing the crop (%)	Sold >50% (%)	Respondents growing the crop (%)	Sold >50% (%)
Okra	21	29	59	17	71	18
Pepper	13	70	55	39	64	24
Roselle	26	29	54	12	55	9
Jute Mallow	15	33	10	0	8	0
Tomato	5	25	5	50	9	43
Egusi	0	0	9	43	20	38
Amaranth	15	33	8	17	6	0
Onion	1	100	0	0	0	0
Garden egg	0	0	1	100	1	100

Table 2: Percentage of households consuming various food groups and Women's Dietary Diversity Score along the continuum

Location		Urban % (n)	Periurban % (n)	Rural % (n)	Overall % (n)
N		100 (68)	100 (56)	100 (62)	100 (186)
Food groups	Cereals	99 (67)	100 (56)	97 (60)	98 (183)
	White roots and tubers	31 (21)	29 (16)	50 (31)	37 (68)
	Vitamin A rich vegetables and tubers	87 (59)	86 (48)	90 (56)	88 (163)
	Dark green leafy vegetables	29 (20)	25 (14)	23 (14)	26 (48)
	Other vegetables	93 (63)	96 (54)	84 (52)	91 (169)
	Vitamin A rich fruits	56 (38)	86 (48)	70 (49)	73 (135)
	Other fruits	12 (8)	4 (2)	0 (0)	16 (10)
	Organ meat	0 (0)	0 (0)	0 (0)	0 (0)
	Flesh meat	21 (14)	14 (8)	8 (5)	15 (27)
	Eggs	3 (2)	4 (2)	0 (0)	2 (4)
	Fish and sea food	84 (57)	89 (50)	90 (56)	88 (163)
	Legumes, nuts and seeds	50 (34)	61 (34)	58 (36)	56 (104)
	Milk and milk products	3 (2)	0 (0)	3 (2)	2 (4)
	Oil and fats	27 (18)	18 (10)	21 (13)	22 (41)
	Sweets	62 (42)	64 (36)	68 (42)	65 (120)
	Spices, condiments, beverages	99 (67)	100 (56)	100 (62)	100 (185)
	Red Palm products	7 (5)	4 (2)	3 (2)	5 (9)
WDDS ≤ 3		13 (9)	5 (3)	16 (10)	12 (22)

Table 3: Specific vegetables consumed from different food groups in Tamale

Food Group	Specific vegetables
Vitamin A rich vegetables and tubers	Carrots, pepper, sweet potato
Dark green leafy vegetables	Amaranth, roselle, jute mallow, okra leaves, onion leaves,
Other vegetables	Cabbage, garlic, okra, onion, tomato, eggplant, lettuce

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CHAPTER 6

Women's dietary diversity scores and childhood anthropometric measurements as indices of nutrition insecurity along the urban – rural continuum in Ouagadougou, Burkina Faso.

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The version included in the thesis has been slightly modified to ensure consistency of style and usage with other chapters.

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6.1 Abstract

Background: Malnutrition is still prevalent worldwide, and its severity, which differs between regions and countries, has led to international organisations proposing its inclusion in the post-2015 framework. In sub-Saharan Africa, malnutrition is particularly severe, among women and children under five years of age. The prevalence of malnutrition has been reported worldwide, differing from region to region and country to country. Nevertheless, little is known about how malnutrition differs between multiple locations along an urban-rural continuum.

Objective: Therefore, a survey was carried out in and around Ouagadougou, Burkina Faso between August and September 2014 to map household nutrition insecurity along the urban – rural continuum, in a transect approach.

Design: Transects of 70 km long and 2 km wide directed radially from the city centre outwards were laid and data were collected from randomly selected households along these transects. Women's dietary diversity scores (WDDS) were calculated from a sample of 179 women of reproductive age (15-49 years) from randomly selected households. Additionally, anthropometric data (height/length and weight) of 133 children under five years of age were collected along the same transects for the computation of anthropometric indices.

Results: We found that relative proportions of the nutrition indices WDDS, stunting, wasting and underweight varied across the urban – rural continuum. There was a significant difference in the prevalence of wasting across the continuum ($p = 0.046$). More children under five years were wasted in urban areas (16%), compared to periurban areas (6%) and rural areas (2%). Growing crops ($p = 0.005$) and keeping livestock ($p = 0.021$) were significantly associated with reduction in wasting among children under five years of age.

Conclusion: Childhood undernutrition certainly has a spatial dimension that is highly influenced by the degree of urbanity, which should be taken into consideration in policy formulation and implementation.

Keywords: Women dietary diversity score, anthropometric measurements, nutrition security, urban – rural continuum, Ouagadougou.

6.2 Introduction

Malnutrition is severe, affecting lives of millions of people worldwide, mostly children and women (1). "Malnutrition is an abnormal physiological condition caused by inadequate, unbalanced or excessive consumption of macronutrients and/or micronutrients, it includes undernutrition and overnutrition as well as micronutrient deficiencies" (2). More people are affected by micronutrient deficiency, also referred to as hidden hunger, than to not having enough calories (over 2 billion versus 805 million respectively) (3). According to the 2014 Global Nutrition report (1), two to three billion people are malnourished, diagnosed as undernourished, overweight or obese, or deficient in micronutrients. Furthermore, malnutrition is the major cause of mortality in children under 5 years old worldwide (approximately one third of the nearly 8 million deaths) (4).

Muthayya et al.'s (5) analysis of national data from 149 countries on stunting, anaemia and low serum retinol levels among infants and estimates of disability-adjusted life years (DALYs) attributed to micronutrient deficiencies in 136 countries, reveals alarming high levels of hidden hunger, stunting, iron deficiency anaemia and vitamin A deficiency in sub-Sahara Africa. Studies from Burkina Faso confirm the prevalence of malnutrition in various age groups, mostly in children and women (6–8)

Women's dietary diversity scores (WDDS) have been proven to be an accurate measure of household macronutrient adequacy and household nutrition insecurity (9, 10). The WDDS are based on number of food groups consumed and reflects the probability of micronutrient adequacy of the diet (10). Anthropometric indices like weight-for-height (WHZ) especially of children under five years, are suitable to assess the nutritional status of children from birth to 59 months of age (11). Pinstrup-Andersen (12), pointed out that policies and programs aimed at improving child nutrition can be better informed by anthrometric measures than food security estimates. The 10-year USAID multiple-sectorial nutrition strategy also identified both women's dietary diversity scores and anthropometric measurements as part of the six outcome level indicators (13). FAO et al. (14) proposed the use of the following indicators in the post–2015 framework; prevalence of stunting, prevalence of wasting, prevalence of overweight/obesity, prevalence of anaemia among women and children and dietary diversity of women and infants. These indicators were proposed with the goal of ending all forms of malnutrition (undernutrition, micronutrient

deficiencies and overnutrition), with special attention to ending stunting (14). The FAO post-2015 framework aims at defining the future global development framework that will succeed the Millennium Development Goals (MDGs).

Although many studies have reported different measurements and prevalence of malnutrition in Burkina Faso (7, 8, 15–17), little is known about differences in malnutrition along the urban - rural continuum. Information on spatial variation on household nutrition insecurity is very useful in understanding the dynamics of household nutrition insecurity in various location and help in resource allocation (targeting) (18). Therefore this study analyses whether women's dietary diversity scores and anthropometric measurements of children under five years, as proven indices of nutrition security, vary along the urban – rural continuum in Ouagadougou. Many studies have also reported the involvement of urban households in agriculture in and around cities as a source of food and nutritious diets to cope with food and nutrition problems (19–22). This study also investigates the general association between households growing crops and keeping livestock and the selected anthropometric measurements and WDDS.

6.3 Materials and methods

A structured questionnaire was used to collect information on both WDDS and anthropometric measurements. In total, 179 women of reproductive age (15 – 49 years) were interviewed to obtain data on the WDDS. Additionally, anthropometric measurements (height/length, weight, sex and date of birth) of 133 children under the age of five years were collected. A SECA floor electronic scale (model 881 U) was used to record the weight of the children, while height and length of children were measured by an infantometer (light portable wooden board with a graduated tape measure). The collection of anthropometric measurements was guided by the work of (23). In order to determine the relation between the nutritional status and agricultural activities of the households, information on the households' crop production (crops gown, quantities sold and quantities consumed) and livestock keeping (animals kept, quantities sold and quantities slaughtered for household consumption) was collected. All data was collected between August and September 2014.

Description of study area

Agriculture contributes significantly to the economy of Burkina Faso and more than 80% of the workforce is employed in the agriculture sector (24). Burkina Faso is amongst the least developed countries in the world. In 2005, Burkina Faso was placed on number 176 out of 177 countries under the UNDP Human Development Index; with average annual per capita income between 230 and 250 dollars against 500 dollars in sub-Saharan Africa (25). Ouagadougou (Figure 1), the capital of Burkina Faso, is situated on the central plateau with an altitude of around 300 meters above sea level. It is also the country's largest city, with a population of approximately 1,400,000 according to the 2006 census (26). Ouagadougou is situated in the Sudano-Sahelian climatic zone. Annual rainfall is around 800 mm, with rainfall season running from May to October. Heavy rains are usually experienced during the months of July and August (27).

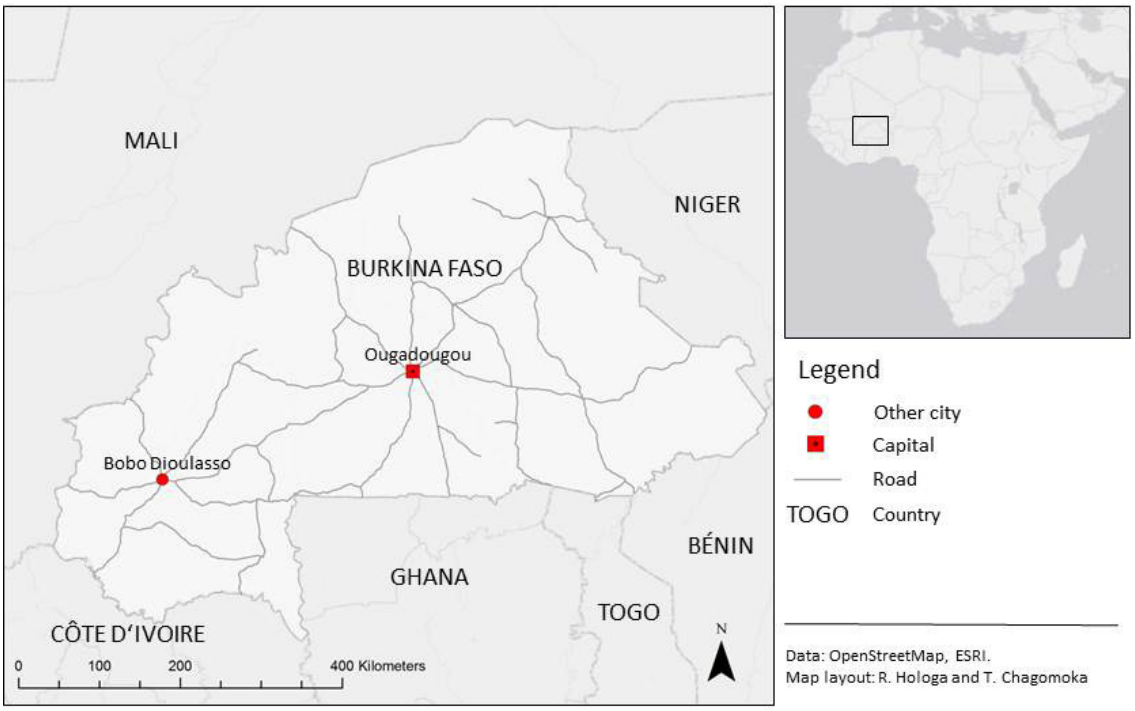

Figure 1: Study area location map

Study Design and Sampling Approach

A transect approach was used to guide data collection. Transects, 2 km wide and 70 km from Ouagadougou central market, were laid radially as shown in Figure 2. Based on the relevant literature, working definitions of urban, periuban and rural areas were established (28–33). Within 10 km of the city centre was considered as urban area, between 10 km to 40 km as periurban area, and between 40 to 70 km as rural area. The work of Iaquinta and Drescher (34) strongly supported the identification of the periurban areas. Periurban areas have been reported to be complex zones, with dwellers moving from rural areas in transit to urban areas looking for ´greener pastures` and on the other hand dweller moving from urban areas running away from scourging urban poverty to periurban and rural areas. All households along the transects were digitised and randomly selected using Geographic Information Systems (GIS) (see Figure 2). The waypoints data was transferred to Global Positioning System (GPS), which helped in locating and identification of selected households. The survey covered thirty two districts[3] in and around Ouagadougou.

[3] Districts 1, 2,3,4,5, 8, 9, 10, 11, 12, Baskuy, Dapelgo, Dawelge, Doulougou, Ipelce, Kindi, Kombissiri, Komsilga, Mogtedo, Nagreongo, Nandiala, Nongremassom, Ourgou-Manega, Paabre, Roulougou, Saaba, Sapone, Sourgoubila, Tanghindassouri, Zam, Ziniare, Zorgho

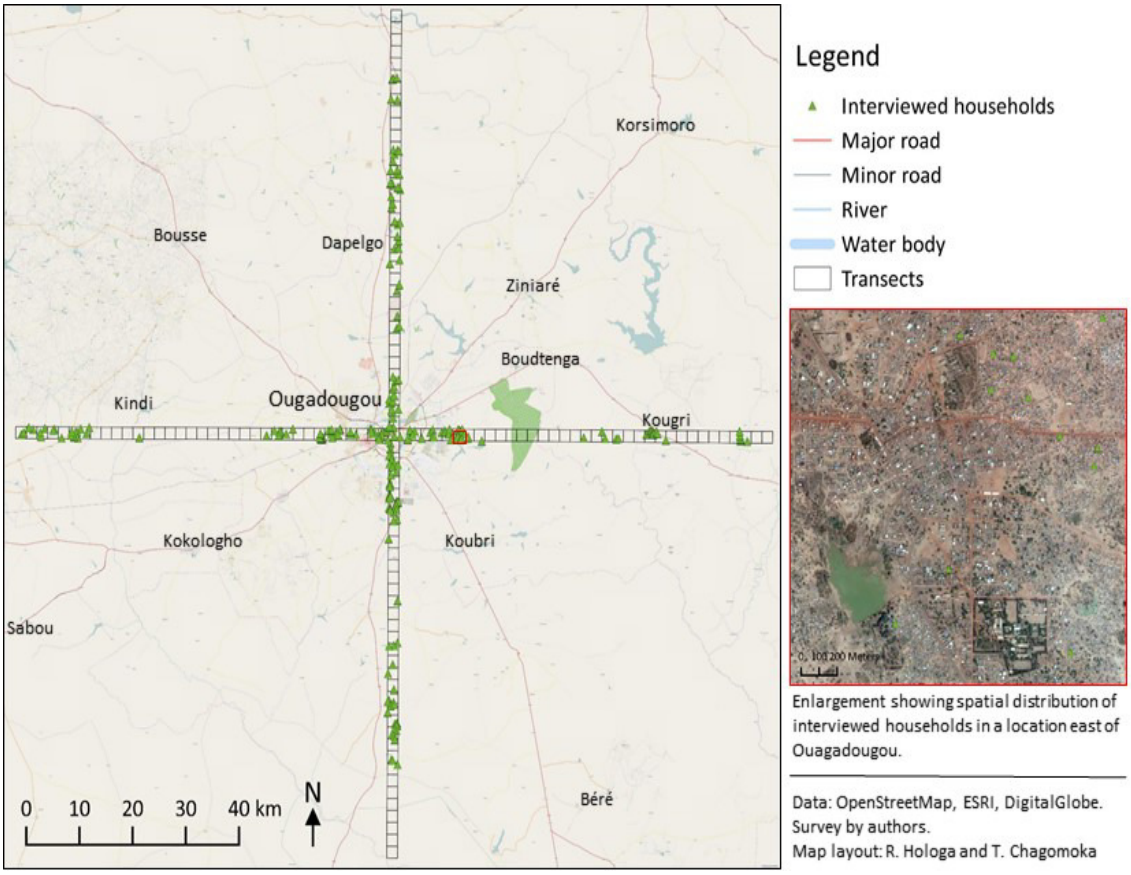

Figure 2: Transect approach

Study nutrition indicators

The study used four indicators of nutrition (WDDS, stunting, wasting and underweight) described below:

Women Dietary Diversity Score (WDDS) – proxy of household dietary diversity, the higher the WDDS the higher the dietary diversity (ranging from 0 to 9) (10). Based on the distribution of the data, the respondents were grouped into three groups as follows; ≤ 3 food groups as lowest dietary diversity, 4 – 5 food groups as medium dietary diversity and ≥ 6 high dietary diversity.

Stunting (< -2 z-score) - Inadequate length or height relative to age (reflects chronic malnutrition) and usually due to long term nutritional deprivation (35, 36).

Wasting (< -2 z-score) - Inadequate weight relative to length or height (reflects acute malnutrition) usually due to insufficient food intake or a high incidence of infectious diseases like diarrhoea (Ibid).

Underweight (< -2 z-score) - Inadequate weight relative to age (reflects both chronic malnutrition and acute malnutrition) (35, 36).

Data management and analysis

Data was entered in Epidata 9 software and then exported to Stata 12 for cleaning and analysis. Chi-square tests were run to determine the presence and significance of association after categorizing nutrition status indicators. We tested for association between either crop production or livestock production versus nutrition status. Anthropometric data of children of 0–59 months were entered and analysed in WHO Anthro v.3.2.2 (37).

Ethical considerations

The study objectives and purpose were made clear to community leaders, households heads and respondents. Permission was sought before data collection from local leaders and respondents. Respondents had the opportunity to stop participating in the research at any time of their choice during interviews. None of the participants opted to stop.

6.4 Results

The results represent the findings of a household survey carried out between August and September 2014 in and around Ouagadougou. The first section of the results looks at the consumption distribution based on the nine food groups. The second section of results highlights the distribution of WDDS along the continuum. The third section of the result presents WDDS and anthropometric measurements as indices of household nutrition along continuum. The last section of the results highlights the association between households growing crops and keeping livestock and the various anthropometric measurements and WDDS.

Consumption distribution based on nine food groups

Out of the nine identified food groups (see Table 1), 98% of respondents were found to consume food items from the starchy samples group along the urban – rural continuum. More households in rural areas (80%) consumed more of the green leafy vegetables, compared to households in periurban areas (56%) and urban areas (45%). Of this group, most consumed dark leaf vegetables included baobab leaves *(Adansonia digitata)*, cowpea leaves *(Vigna unguiculata)*, jute mallow *(Corchurus olitorious)*, bean leaves *(Phaseolus vulgaris)*, onion leaves *(Allium cepa)* and roselle leaves *(Hibiscus sabdariffa).* Rural households also consumed more (78%) of the food items from the group, other vitamin A fruits/vegetables, compared to periurban households (59%) and urban households (56%). Sumbala *(Parkia biglobosa)* and sheanut tree fruits *(Vitellaria paradoxa),* were the most consumed food items under the other Vitamin A fruits and vegetables. On the other hand, urban household consumed more (85%) of food groups from other fruits/vegetables compared to periurban households (69%) and rural households (67%). Urban households also consumed more legumes (52%) compared to periurban households (32%) and rural households (30%).

Table 1: Consumption distribution based on nine food groups

Location		Urban % (n=66)	Periurban % (n=59)	Rural % (n=54)	Totals % (n=179)
Food groups	Starchy samples	98	98	98	98
	Dark green leafy vegetables	45	56	80	59
	Other Vitamin A fruits/vegetables	56	59	78	64
	Other fruits/vegetables	85	69	67	74
	Organ meat	0	0	2	1
	Flesh meat	73	73	63	70)
	Eggs	2	3	4	3
	Legumes	52	32	30	39
	Milk	3	2	0	2
WDDS ≤ 3		30	32	25	30

Distribution of WDDS along the urban – rural continuum

Along the urban-rural continuum, none of the households consumed as much as 7-9 food groups (Figure 3), revealing a general limited diversity of diets. The WDDS was low mostly in urban areas compared to periurban and rural areas. Less than 10% of the households

consumed more than 5 food groups and only 20% of the households consumed up to 5 food groups. On the other hand only few households in urban and periurban areas consumed only one food group during the reported period.

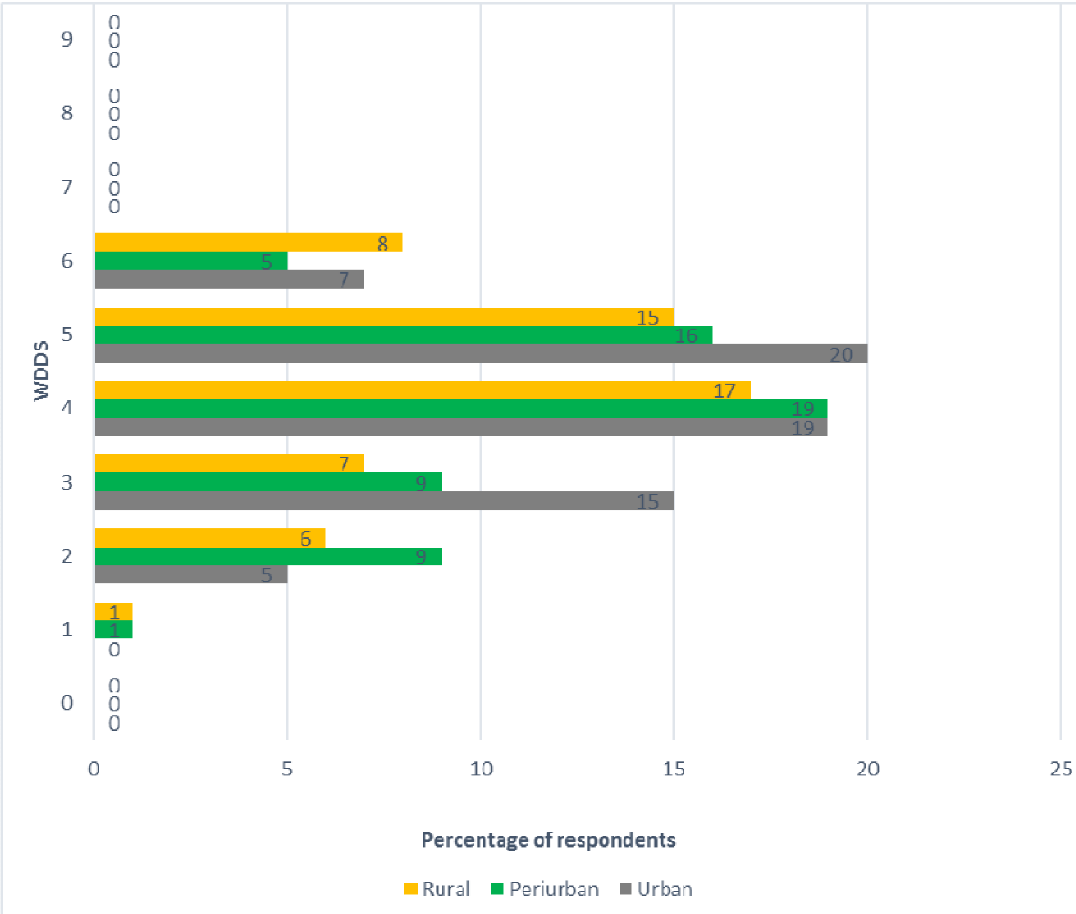

Figure 3: Distribution of WDDS along the urban – rural continuum

WDDS and anthropometric measurements as indices of household nutrition along the urban – rural continuum

There were variations in the prevalence of different nutrition indices along the urban – rural continuum (Table 2). Nevertheless, only wasting was statistically significant (p – value = 0.046) along this continuum, with more children under five years in urban areas (16%) wasted compared to periurban areas (6%) and rural areas (2%). Rural households (15%) had the highest relative proportion of WDDS compared to urban households (11%) and periurban households (8%). There was high relative proportion of stunting in periurban areas (31%) compared to rural areas (29%) and periurban areas (11%). Periurban areas also had the

highest relative proportion of underweight (19%) compared to rural areas (15%) and urban areas (5%). Nevertheless, the differences in WDDS, stunting and underweight along the continuum were not statistically significant (Table 2).

Table 2: Women and children nutrition status across the rural - urban continuum

	Indicators	Urban %	Periurban %	Rural %	p-value
Women	Sample size (n)	*(n=66)*	*(n=59)*	*(n=54)*	
	WDDS ≥ 6 (Highest food diversity)	11	8	15	0.555
Children	*Sample size (n)*	*(n=37)*	*(n=48)*	*(n=48)*	
	Wasted (WHZ < -2 SD)*	16	6	2	0.046
	Stunted (HAZ < -2 SD)	11	31	29	0.066
	Underweight (WAZ < -2 SD)	5	19	15	0.197

*there was a statistically significant association at 95% confidence level between child wasting and their location (rural, periurban, and urban).

Association between livestock production, crop production and nutrition indicators

In this study, growing crops (p value = 0.005) and keeping livestock (p value = 0.021) was significantly associated with a reduction in wasting (WHZ-indicator) among the children under five years of age (Table 3). Urban households had the highest relative proportion of wasting (16%) compared to periubran households (6%) and rural households (2%).

Table 3: Association between livestock, crop production and nutrition indicators

Agriculture production	Nutrition status indicators							
	Women		Children					
	WDDS ≥ 6		HAZ< -2SD		WHZ< -2SD		WAZ < -2SD	
	Yes	No	Yes	No	Yes	No	Yes	No
Livestock								
Yes	15	109	75	29	5	99	16	88
No	5	48	24	4	5	23	2	26
p-value	0.582		0.140		0.021*		0.259	
Crops								
Yes	12	95	27	65	3	89	14	78
No	8	64	6	35	7	34	4	37
p-value	0.983		0.070		0.005*		0.395	

*statistically significant at 95% level of confidence

6.5 Discussion

Dietary diversity is one of the strategies proposed to tackle the scourge of micronutrient malnutrition by many organisations including World Health Organization and the Food and Agriculture

Organization of the United Nations and HarvestPlus (38, 39). Other strategies to prevent micronutrient malnutrition include; food fortification, supplementation, biofortification of staple crops or agriculture based strategy (38, 39). The pros and cons of the different strategies have been discussed, for example, the use of encapsulation options in iron fortification was reported to increase the price of the fortified product, by as much as 30% (38).

However, our study results show that most households in and around Ouagadougou relied mostly on starchy based diets, with 98% of households consuming this food group (Table 1). This is different from what was observed in Ethiopia, where rural households in Ethiopia were consuming more of starchy based food compared to urban households (40). Nevertheless, this result confirms more or less of what was observed before in Ouagadougou (15). High consumption of starchy diets could be explained by high production of starchy based cereal crops like pearl millet *(Pennisetum glaucum)*, sorghum *(Sorghum bicolor)* and maize *(Zea mays)* which are often used to prepare staple traditional dishes like *Tô* (cooked millet, sorghum or corn meal), *Zoomkoom* (a soft drink made from millet flour) and *Degue* (a drink made from pearl millet and yogurt).

Households in rural areas were consuming more of dark green leafy vegetables (80%) compared to households in periurban areas (56%) and households in urban areas (45%) (Table 1). These dark green leafy vegetables include the following: baobab leaves, cowpea leaves, jute mallow, bean leaves, onion leaves and roselle leaves. The reason for rural households consuming more dark green leafy vegetable than urban households and periurban households, is the availability of these vegetables naturally (for example, baobab) and through subsistence cultivation (for example, cowpea leaves and roselle leaves amongst others). Mertz et al.'s (41), work also noted the high usage of baobab leaves, onion leaves and jute mallow in Burkina Faso. Dark green vegetables are recommended as a good source of vitamin A (10). Vitamin A deficiency is one of the most challenging form of micronutrient deficiency with serious effect like night blindness and cognitive impairment mostly on children under five years and pregnant women (1, 35). Jute mallow, one of the most

consumed leafy vegetables, was reported to have high levels of iron (42, 43). Iron deficiency is the cause of about 50% cases of anaemia (44). This makes jute mallow a potential source of iron for vulnerable groups such as children under five years and pregnant women.

The results show a general limited dietary diversity, with less than 10% of the households consuming more than 5 food groups out of the nine food groups (Figure 2). None of the households consumed between 7- 9 food groups. Becquey et al. (15), reported that the diets in Ouagadougou were mainly made of cereals, vegetables and fats from vegetable sources. FAO (10), highlighted that, WDDS food groups give a good reflection of micronutrient intake than economic access to food. The regular consumption of dishes covering only a limited food groups may translate to stunting, wasting and underweight. Rural households had the highest dietary diversity compared to urban and periurban households and this is due to subsistence farming and availability of natural resources like baobab trees. Interestingly, rural households who had the highest proportion of WDDS had also the lowest prevalence of wasting (WHZ < -2 SD) (Table 2).

There was limited consumption of organ meat in the study sample, with only 2% of the households in rural areas reported to have consumed this food group and none in both urban areas and periurban areas. Organ meat falls in the food groups that are sources of haem iron, which is more bioavailable than non-haem iron and also enhances the absorption of non-haem iron present in the same meal (10). Organ meats (liver, kidney, heart or blood-based foods) are the richest source of haem iron. Iron deficiency anaemia is considered a public health problem and can affect the immune status and morbidity from infections of all age groups and increases perinatal risks for mothers and neonates (45). The work of Daboné et al. (7) in Ouagadougou, based on haemoglobin (Hb) concentration to assess anaemia in school children in urban and periurban areas, reported a 40.4% prevalence of anaemia.

Study results show a variability in different nutrition indices along the urban – rural continuum. There was a significant difference regarding children under five years wasted, with more children in urban areas (16%), compared to children in periurban areas (6%) and children in rural areas (2%), p – value = 0.046 (Table 2). These results support the growing evidence of urban poverty and its associated challenges of food and nutrition insecurity in most cities in sub-Sahara Africa (46–48). Wasting reflects acute malnutrition and is usually due to insufficient food intake or a high incidence of infectious diseases like diarrhoea (35). There was also high relative proportion of stunted children in periurban areas (31%),

compared to urban areas (11%) and rural areas (29%). Daboné et al. (7), also reported higher levels of thinness and stunting in periurban compared to urban schools in Ouagadougou (Burkina Faso).

Growing crops (p value = 0.005) and keeping livestock (p value = 0.021) was significantly associated with reduction in wasting among children under five years of age in the study area. On the other hand, urban households had the highest significant prevalence of wasting (p – value = 0.046) in urban areas (16%), compared to periurban areas (6%) and rural areas (2%). Zezza and Tasciotti (49) reported consistent evidence of positive statistical association between engagement in urban agriculture and dietary adequacy indicators. Drescher and Iaquinta (50), highlighted that challenges of rapid growing cities and food shortages often leads urban dwellers into farming so to feed their families. The results of this study, suggest that engagement of urban households in crop production and livestock keeping helps to reduce wasting significantly.

6.6 Summary and conclusions

Study results reveal that malnutrition certainly has a spatial dimension that is highly influenced by the degree of urbanity. Furthermore it could be shown that WDDS and anthropometric measurements are useful indices of household nutrition along the urban - rural continuum. There was a significant prevalence of wasting in urban areas, compared to periurban areas and rural areas. This result confirms the growing evidence of urban poverty related challenges like food and nutrition insecurity in and around cities in sub-Sahara Africa. There was also high relative proportion of stunting in periurban areas, compared to urban areas and rural areas. This reveals the complexity of periurban areas which is often associated with an influx of people from rural areas and urban areas, perceived as safety net.

The study shows a general low diversity of household diets along the urban – rural continuum, with less than 10% of households consuming five food groups. Nevertheless, the availability of some traditional vegetables like jute mallow and trees like baobab played a critical role in the study area as sources of micronutrients, as they formed an important part of the surveyed households' diets. Rural households had the highest dietary diversity compared to urban and periurban households.

Most households relied on starchy based food staff across the urban - rural continuum. Sorghum, pearl millet and maize formed important parts of the starchy based cereals often used in the study area and consumed as traditional processed dishes.

Households who were producing crops and keeping livestock in the study area were in a slightly better position to reduce wasting amongst children under five years of age compared to those not producing crops or not keeping livestock. Urban households had the highest significant prevalence of wasting. Therefore, the involvement of urban households in crop production and livestock keeping will reduce wasting significantly.

6.7 Acknowledgements

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CHAPTER 7

Food coping strategies in Northern Ghana. A socio-spatial analysis along the urban-rural continuum.

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The version included in the thesis has been slightly modified to ensure consistency of style and usage with other chapters.

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7.1 Abstract

Food insecurity is a worrying challenge worldwide, with sub-Sahara Africa most affected. Literature reveals that in developing countries, food insecurity is a largely ‘‘managed process’’, meaning people are active participants in responding to the risks they face in life. This paper focuses on how households cope with food shortages and how these food coping strategies vary along the urban-rural continuum. A transect approach was used to guide data collection in and around the city of Tamale in northern Ghana. A total of 19 focus group discussions, having eight participants each (four women, four men), was conducted between March and May 2014. Additionally, three qualitative in-depth interviews were also conducted, one each in the urban, periurban and rural area. In periurban and rural areas, gathering of wild food and selling of charcoal was widely practised, while in urban areas, most households tended to reduce the number of meals as a more frequent coping strategy. The study identified five coping strategies along the urban -rural continuum as the most severe in times of food insecurity, namely; skipping food for a whole day, borrowing, buying food on credit, consuming seed stock and restricting adult intake in favour of children. Hunting, consuming less preferred food, taking occasional jobs and engaging in small trading were considered as not severe. Study results reveal that food coping strategies vary from one spatial entity to another in terms of frequency, severity and coping strategy indices along the urban – rural continuum.

Keywords: Food coping strategies, food insecurity, transect approach, urban – rural continuum.

7.2 Introduction

Food insecurity and undernourishment have persisted in the developing world despite overall progress made globally, with sub-Saharan Africa showing limited progress in recent years, remaining the region with the highest prevalence of undernourishment [1]. Around one in eight people in the world in 2011 – 13, was estimated to regularly not getting enough food to conduct an active life (chronic hunger) [2].

Food insecurity is defined as “limited or uncertain availability of nutritionally adequate and safe foods or limited or uncertain ability to acquire acceptable foods in socially

acceptable ways" [3]. According to FAO, IFAD and WFP (2013:50) [4], "Food security is a situation that exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life". The main pillars of this definition are: stability (adequate resources to get food and sufficient quantity), stable access (to have food at all times), and utilization (adequate diet, sanitation and health care for nutritional well-being).

Problems of food insecurity and poverty have been mostly reported in rural areas and most of the international development focus was directed on rural farming in the past. Nevertheless, research results from studies in Africa show its occurrence in and around cities [5,6]. The growing evidence of food insecurity in and around cities and an estimated exponential growth of population in African cities, projected to rise from 11.3% in 2010 to a 20.2% by 2050 [7], calls for a critical analysis of potential challenges concerning urban dwellers and how this population would cope with these challenges.

Literature reveals that in developing countries, food insecurity and hunger is largely a ''managed process'', meaning "people are not passive victims of sudden events but are active participants in responding to the risks they face in their daily lives" [8–10]. Sen [11] looks at starvation in relation to food availability and food entitlement. "A person´s ability to command food – indeed, to command any commodity he wishes to acquire or retain – depends on the entitlement relations that govern possession and use in that society" (Sen 1981:154) [11]. "Individuals face starvation if their full entitlement set does not provide them with adequate food for subsistence" (Devereux 2001:246) [12]. The notion of active responding to food shortages at household levels referred as 'coping' in the paper has; "proven useful to operational humanitarian agencies and researchers in measuring localized food insecurity" (Maxwell et al. 2008:533) [13].

Urban agriculture has been pointed out as one of the strategies adopted by most urban dwellers to manage the scourge of food shortages, with most produced food used for personal consumption providing a degree of food security and dietary diversity for many of the urban poor [14,15].

Various food coping strategies have been reported in Africa varying from one region to another. In Rwanda, for example, the sale of cattle during peacetime was due to shift in assets of households. Nevertheless, during the time of genocide (1994), about half of cattle sales were driven by the need to buy food [16]. In Nairobi, Kenya, the slum dwellers were

reported to use frequently strategies related to reduction of food consumed (69%) and credit (52%) [17]. In Nigeria, about 95.8% of the entire population rely on less preferred food while 83.5% rely on limiting food portion at meal times [18]. In Ghana, poor rural families rely on food remittances to cope with chronic hunger, from household members who migrate to distance agriculture-rich hinterland [19].

In predominantly slum communities of Bolivia, Ecuador, Philippines, and Thailand, women have been reported to take lead in adopting various coping strategies in times of food shortages. Women in vulnerable households, for example, were found to likely engage in food enterprises, where choice of business is associated with household vulnerability to food insecurity [20]. Urban low-income households were reported to select enterprises that earn them money to get food for consumption as a strategy to mitigate the risk of food shortages [20].

Although diverse food coping strategies have been adopted by different communities, cultural food beliefs and taboos sometimes detect or determine food coping strategies. These sometimes "have a significant influence on family nutritional well-being…, often related to foods of animal origin and mainly affect women and children" [21].

In Ghana, poverty and hunger is more prevalent in the three northern regions. About 28% of households in Upper East region suffer severe or moderate food insecurity while 10% in Northern region and 16% in Upper East region suffer the same [22]. The poorest households in Northern Ghana resort to severe coping strategies like spending the whole day without eating more than wealthier households [22]. Quaye (2008:334) [23] noted that during the months of insufficient food, households use coping mechanism like; "migration to southern Ghana for wage labour, support from relatives and friends outside the regions, sales from livestock and household valuables as well as reduction of food intake and consumption of less preferred food".

Although many studies have been conducted across sub-Saharan Africa on food coping strategies [23,25–30], little has been reported on how these strategies can vary across the urban – rural continuum, in the advert of increasing reported cases of the scourge of urban poverty and food insecurity. Variation in food coping strategies from one spatial entity to another in terms of frequency, severity and coping strategy indices can be useful indicators to predict crisis (early warning), to understand shortfalls in access to adequate food (assessment), to allocate resources (targeting) or to track the impact of interventions

(monitoring and evaluation) [13]. According to Maxwell et al. (2008:533) [13] "these kinds of analyses are needed to strengthen geographic targeting and the impartial allocation of assistance". This study seeks to explore and describe the behaviour and attitude of urban, periurban and rural households that relate to food and nutrition insecurity. This paper thereby particularly focuses on food coping strategies and how these coping strategies vary along the urban – rural continuum.

7.3 Methods

This study uses a descriptive qualitative approach to provide information about the behaviour, attitudes and other characteristics of households related to food insecurity along the urban – rural continuum. As Yin [39] points out that qualitative research persuade through rich description and strategic comparison across cases. It also helps the researcher to generate an in-depth account that will present a lively picture of the research respondents' reality [40]. Some of the limitations of qualitative approach are that data collection and data analysis of the material can be time consuming, thus expensive [41].

The survey was carried out between March and May 2014 in Ghana´s Northern Region, covering seven districts[4] in and around Tamale (Fig 1). According to the census of 2010, Tamale Metropolitan Area was estimated to have a population of ca. 370,000 [24]. Tamale has an altitude of 180 meters above sea level and lies within the savannah climate of West Africa.

[4] Central Gonja, East Gonja, Mion, Sagnarigu, Savelugu-Nanton, Tamale Metropolitan and Tolon

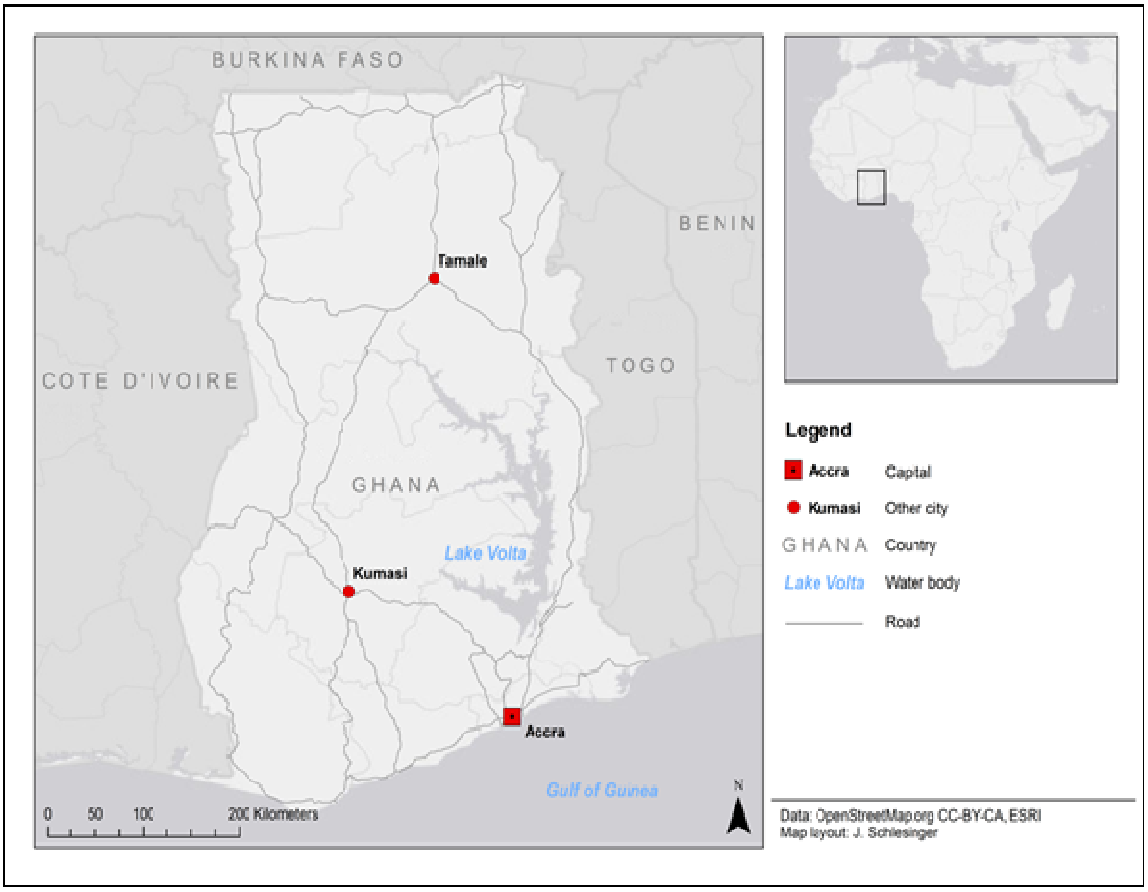

Fig 1: Location map of Tamale in Northern Region of Ghana

Study design and sampling procedures

Transects laid out radially, heading towards North, East, South and West with Tamale central market being the centre guided the data collection. The transects were 2 km wide and 70 km long. Three areas by distance were identified based on reviewed literature on the extend of urban, periurban and rural areas in West Africa and author perception [31–36]. The work of Iaquinta and Drescher [37] strongly helped in the identification of the urban, periurban and rural areas. Therefore the first 10 km from Tamale central market was considered to be urban, distance between 10 km to 40 km periurban zone and distance between 40 km to 70 km rural area. We are thereby aware of the shortcomings raised by [38] of a strictly distance-based definition of these spatial entities. For the purpose of comparability and simplicity of the sampling procedure, however, we applied the thresholds as outlined above. Participants of the focus group discussions (FGD) were selected randomly from a list of 240 households who participated in a purely quantitative study which was conducted along the same transects to

understand the socio-spatial dynamics of household food and nutrition insecurity and the role of agricultural activities in urban and periurban settings of sub-Saharan Africa.

Focus group discussion

A total of 19 focus group discussions, with eight participants (four women, four men), each were conducted along the transects (Fig 2). The FGD took place in randomly selected places along the north-south and east-west transect, considering the three spatial dimensions of the urban, periurban and rural areas in and around Tamale. All participants were familiar with the research subject as they had previously participated in the first study. Transferring the concept of FGD to the local Dagbani culture implied some methodological constraints. Indeed, Dagbani people's oral tradition of detailed story telling favours a FGD whereas the concept does not quite match their conversational habits. When asking an open question to the whole group, generally the oldest man answered first. His ideas were then commented by the other men and afterwards by the women. Women only answered first when asked directly. Nevertheless, participants mostly agreed on one opinion and rarely contradicted each other. Interview languages were Dagbani and English with a translator facilitating communication. Inevitably, the language barrier implies information loss and misunderstandings which were tried to be limited as much as possible by detailed enquiry and use of illustrations (Fig 3). Written notes could not be used in the FGD due to the majority's illiteracy. Average duration of each FGD was about 90 minutes with some discussions being extended by participants' detailed answers and others being finished after 60 minutes if the interviewees had to leave because of other commitments.

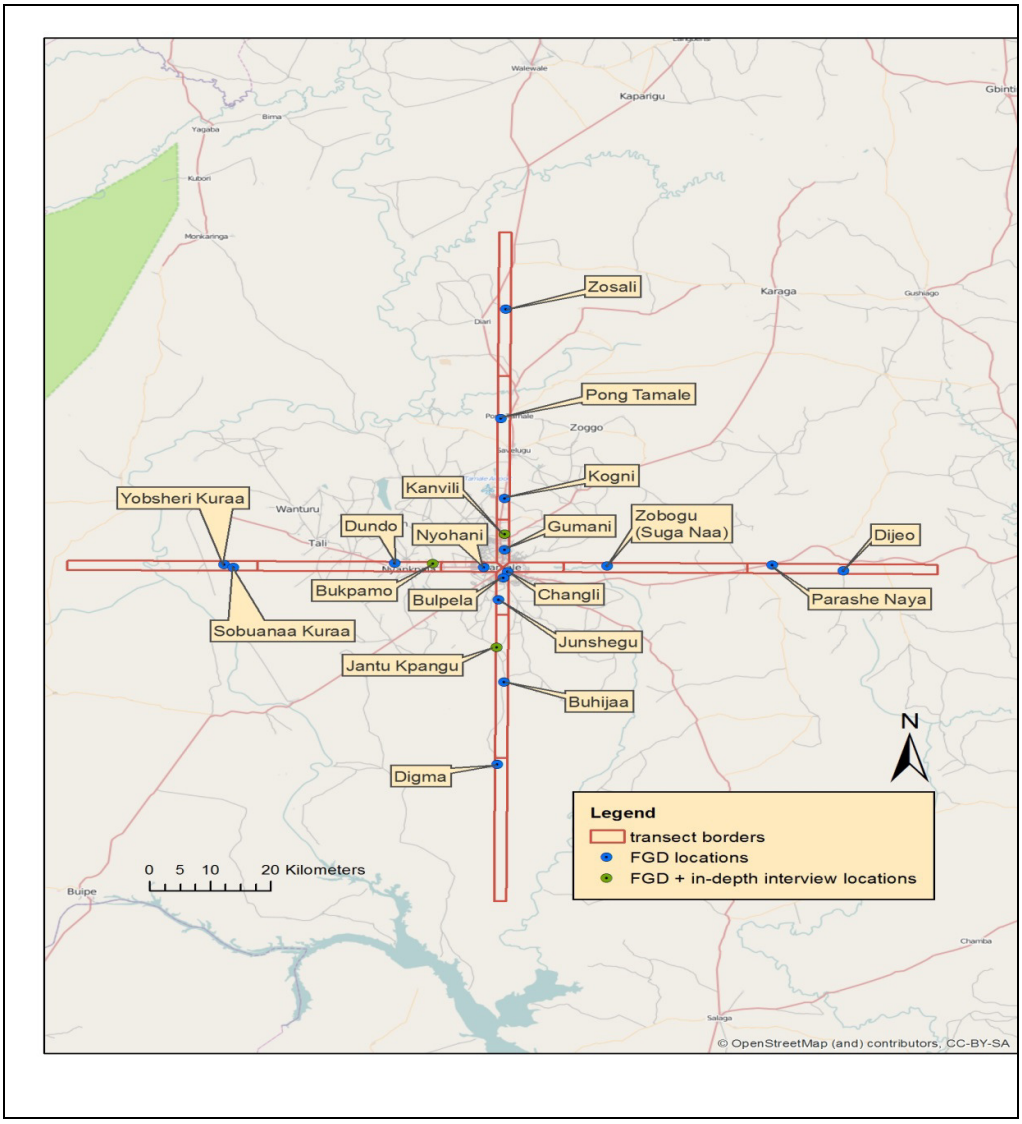

Fig 2: Sampling of focus group discussions and in—depth interviews along the urban - rural continuum

Fig 3: Focus group discussion and illustrations to facilitate discussion

In-depth interviews

To triangulate the information from the FGD and deepen some aspects, three qualitative interviews were conducted, one in each spatial dimension (urban, periurban and rural). The idea was to focus on women's perspectives and create a women-only interview situation without men setting the general opinion. Therefore, three or four women who had already participated in a FGD were asked to participate. The interviews followed a loose guideline with open questions, allowing enough space for the participants to add further information. The in-depth interviews were generally characterized by a familiar atmosphere as all involved persons already knew each other.

Data Management and Analysis

Data from focus group discussion were entered and processed to produce frequencies, severity levels, coping strategy indices, tables and graphs.

Frequency and severity of each coping strategy were derived from quantitative data collected during the FGD as suggested in Maxwell et al. [42,43]. Numeric values were assigned to each category to process the information in excel. When asked for the frequency ("How many days in a week do you practice ...?") participants' answers were categorized as following: "All the time"/every day = 7; "pretty often"/three to six days per week = 4.5; "once in a while"/one or two days a week = 1.5; "hardly at all"/ less than once a week = 0.5; "never" = 0. The numeric value is either the exact number of days per week on which the correspondent coping strategy was practiced or the average value (e.g. 4.5 for "three to six days per week").

To quantify the severity, numbers from 1 to 4 were assigned to each of the four categories starting with 1 = "not severe", 2 = "moderate", 3 = "severe" and ending with 4 = "very severe". After quantifying frequency and severity the Coping Strategy Index (CSI) was calculated by combining both values for each location. First, a score for each single strategy in each location was produced by multiplying the frequency and severity values. All the scores were then summed up to form the CSI for that specific location. Comparison of relative severity of different location can be useful for geographic targeting or resource allocation [43].

The Coping Strategies Index (CSI) counts and weights coping behaviour at the household level and has been developed as a context-specific indicator of food insecurity

[13]. As increasing frequency and severity are both represented by increasing values, a high CSI consequently portrays a serious situation of food insecurity. This situation is marked by the frequent application of coping strategies that are perceived as severe or very severe. In contrast, a low CSI stands for little dependence on severe coping strategies and thus more food secure. However, it needs to be pointed out that the index rather provides a relative measurement than an absolute assessment of the food security situation of the communities.

Ethical Considerations

Permission was sought from participants of focus group discussion and in-depth interviews as well as community leaders where focus group discussions took place along the transects. Both participants of focus group discussion and in-depth interviews had option to stop participating in the discussion or interviews at any time of their choice. None of the participants opted out of the interviews and discussions during this study.

7.4 Results

The results represent the findings of focus group discussions and in-depth interviews conducted between March and May 2014 in and around Tamale, Northern Region of Ghana. The majority of households experienced a poor harvest in the previous growing season and they were consequently expecting to experience food insecurity in the current season. All interviewees explained that the most difficult time in terms of food insecurity were the months of June and July. This is the period when the rainy season has already started and people are engaged in farming, but crops not yet mature.

Food coping strategies along the urban-rural continuum

The results of the study reveal that the frequency of some coping strategies was varying from one place to another (Figure 3).

Urban

Borrowing, purchasing food on credit, consumption of seed stock, sending children to eat with neighbours, trading and skipping food for a whole day are most frequent in the urban area (Figure 3). Purchasing food on credit was more common for urban areas than for the periurban or rural area. One explanation is that many people in urban areas have some

source of financial income through trading or jobs so traders are more likely to allow a credit. Borrowing and sending children to eat with neighbours was practised in urban areas but is often tabooed in rural areas where traditional rules still play an important role. People in urban areas tend to consume seed stock more frequently in times of need than rural households. This is explained by the fact that rural households worry about how they could afford to buy new seeds if they consumed them all, since they have few income related strategies like occasional jobs. Interestingly, skipping food for a whole day (most severe coping strategy) is more common in urban areas and does rarely happen in periurban and rural areas. This phenomenon is explained by the fact that households in rural and periurban areas have many and sufficient coping strategies to respond to food shortages. In contrast, urban areas sometimes lack certain strategies like relying on wild plants or the sale of animals or charcoal.

Periurban

Hunting, reliance on prepared food, sale of animals, charcoal, firewood or handcraft and occasional employment are most frequent in the periurban area (Fig 4). The periurban area offers enough space to raise animals and more natural growing trees for fire wood and charcoal. The periurban places are also close enough to the urban centre, where their produce can be sold and it is easy to find occasional jobs. Occasional jobs for men like masoning, block moulding, carpentry, metal worker or bicycle fitter as well as the sale of traditional handcraft like woven mats were more common in periurban areas than in urban locations. Lack of job opportunity and remote location are the main reasons for occasional jobs being uncommon in rural areas. The sale of animals, charcoal and fire wood were typical source of income for periurban households as periurban places are still well connected to paved roads which facilitate trading and transportation of goods.

Rural

Consumption of less preferred food, wild plants and immature crops as well as limiting portion size, adult intake and the daily number of meals are most frequent in the rural area (Fig 4). Reliance on wild plants was more common in rural areas than in urban or periurban areas due to simple availability of edible plants. Consumption of less preferred or less expensive food was more or less equally applied in urban, periurban and rural places, although frequency in rural areas is slightly higher.

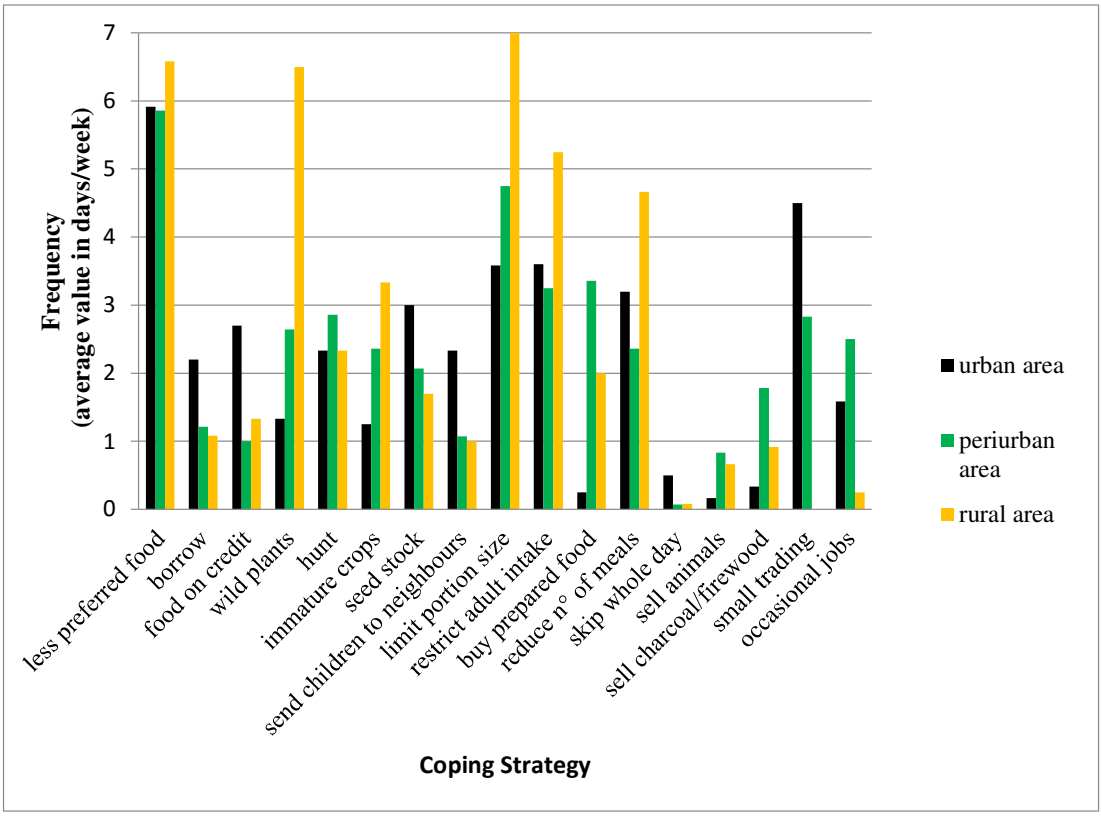

Fig 4: Frequency usage of various coping strategies along the urban – rural continuum

Urban, periurban and rural interactions

There was strong connectivity of periurban and rural zones to the urban zone as reflected, in households as far as Jimle (about 40 km East of Tamale), Pong Tamale (about 33 km North of Tamale), Tolon (about 25 km West of Tamale), Digma (about 41 km South of Tamale) and Zosali (about 54 km North of Tamale) selling most of their crops to Aboubu market in central Tamale. Women in both urban and periurban often come to provide labour in these markets in order to get money to purchase food for their families. On the other hand, some urban households were temporally migrating to periurban during the rainy season to grow crops to feed the family and return after the harvest. For example, Suga-naa village located in the East transect about 18 km from Tamale, over 50% residents of this village commute to Tamale on motor bikes or bicycles 2-3 times a week and in most cases only husbands spend more time in this village growing crops while the rest of the family is based in Tamale. Urban household

also moved temporally to practice hunting and picking of fruits in both periurban and rural areas as a food coping strategy.

Gender and coping strategies

The results from the in-depth interviews reveal that women often engage in income generating activities to buy food for the household in times of food shortages. Some of the activities mentioned include trading with those food items that cannot be produced on the fields like salt, sugar, bread, milk powder or imported rice as well as selling of fire wood and charcoal along roadsides and day labour at the markets. For rural women and young girls it is also typical to leave their village for a longer period to work on the big markets in Accra or Kumasi. This activity is referred to as kayayei and is generally practiced for several months up to one year. Hence, weekly or monthly frequency could not be assessed, this is why kayayei is not listed as a coping strategy in this study.

Women in the northern region of Ghana, are expected to provide soup (relish, in the form of vegetables) which accompany or goes with the main starchy based meal (often from maize, sorghum or millet) usually provided by the man, referred to as landlord. Women usually do not own land to produce these vegetables, often times they are allocated land at the edges of the main crop field to produce these vegetables. Sometimes women are involved in harvesting crops in order to provide the soup for the household. Women also make use of dawadawa tree *(Parkia biglobosa)* and sheanut tree *(Vitellaria paradoxa)* to help to generate income and provide nutritious soup to their families. Nevertheless, the land on which these trees grow belongs to the man and chiefs, thus women always have to seek permission to access them.

On the other hand, occasional jobs like masoning, block moulding, carpentry, metal worker or bicycle fitter as well as the sale of traditional handcraft like woven mats were more often practiced by men mostly in periurban locations.

In times of limited food, children and elders are always provided first. Women stated that no difference is being made between boys and girls concerning the quality and quantity of the food. When it comes for the adults to restrict themselves or forgo entire meals, pregnant and breast feeding women are favoured. Men's nutrition needs are put behind those of all women.

Coping strategies severity along the urban – rural continuum

The results revel that the severity of coping strategies varies along the urban – rural continuum (Fig 5). The coping strategy of skipping food for a whole day where considered as very severe in urban, periurban and rural areas with a severity value of 4 (Fig 5). Sending children to eat elsewhere also had the same severity value of 3 across the urban – rural continuum. On the other hand the coping strategy of hunting varied in severity from urban to rural, with more than 1.5 in urban areas and only one in rural areas (meaning being considered as more severe in urban areas compared to rural areas).

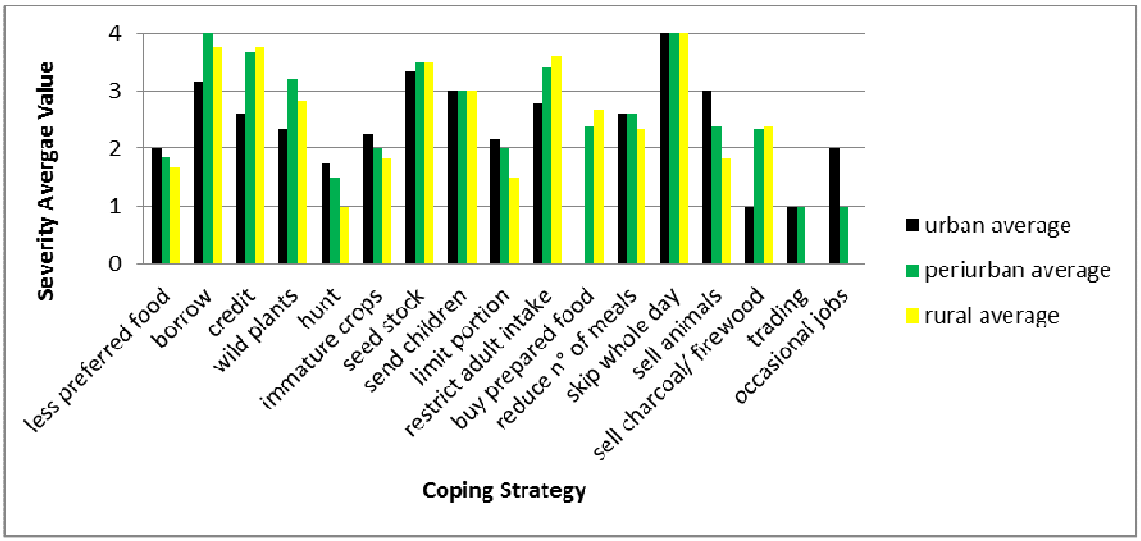

Fig 5: Severity of coping strategies along the urban – rural continuum (1 = not severe, 2 = moderate, 3 = severe and 4 = very severe).

Least severe coping strategies

The study identified the following four strategies as least or not severe: hunting, less preferred food, small trading and occasional jobs (Fig 6). Fig 6 also shows how the severity differed between urban, periurban and rural. For example, hunting was noted as the least severe coping strategy, more in rural areas, where it was considered to be normal and an acceptable way of reacting to food shortages, compared to urban locations. Although less preferred food was identified as not severe, it is disliked mostly by children who usually prefer tasty dishes including meat or eggs. Most preferred food included fufu (dough of yam) which is mainly consumed in the main wet season when farming households harvest their

own yams. The main staple food is Tuo Zaafi (TZ) that is preferably made from maize flour but can be prepared partly or totally from cassava flour, which is less preferred.

Hunting was perceived as a hobby for men although it sometimes supplies food or money from meat sales to the household. Commonly hunted animals include: rabbits, grass cutters, rats, wild guinea fowl and other wild birds and sometimes big animals like antelope. All strategies ranked as least severe produce additional financial income, both directly and indirectly and help to avoid selling of animals to get food and harvesting of immature crops for consumption.

Moderate severe coping strategies

Gathering wild fruits and limiting portion size per meal, rationing the available money to buy prepared food, consuming immature crops and selling of animals were identified as moderate food coping strategies (Fig 7). The most commonly picked wild plants are the leaves and seeds of dawadawa *(Parkia biglobosa)*, leaves of wild roselle *(Hibiscus sabdariffa)* and nuts of the shea tree *(Vitellaria paradoxa)*. Some households were reported to collect wild honey, for own consumption as well as for sale. Shea nuts are usually mature at the beginning of the rainy season when most field crops are not yet ready to harvest. The gathering and selling of shea nuts is another income generating activity mostly done by women apart from selling wood and charcoal while men start preparing the fields. Selling of animals was mostly as a safety net in times of food shortages or other pressing household needs like school fees.

Severe coping strategies

The following three coping strategies were ranked as severe by most FG are: send children to eat with neighbours, reduce the number of daily meals and the sale fire wood and charcoal (Fig 8). Most severe coping strategies were perceived as strategies which could allow households to keep it secret that they lack food which is considered shameful and not preferred to make it public.

Most severe coping strategies

The study identified five coping strategies as the most severe namely: skipping food for a whole day, borrowing food or money to buy food, purchasing food on credit, consuming seed stock and restricting adult intake in favour of children (Fig 9). Some strategies were associated with extreme hardship as expressed with certain phrases like “the house has

collapsed", for example when a household consumed seed stock. Some most severe strategies were applied selectively across household members, for example, skipping food for a whole day and restricting adult intake were mainly targeting adults (first men, then women) and not children.

Borrowing and buying food on credit were considered to be similar as both strategies leave the household with an obligation to pay back. This situation of living on credit has been identified as a stressful scenario by households practising it. Borrowing food was also associated with shame as most households felt that asking for food from a neighbour - especially if they are not related - is a matter of exposing one's level of poverty to other villagers. Both borrowing and buying food on credit were associated with similar risks of possibility of paying back with interest especially when you borrow or buy on credit from traders. These two coping strategies were also associated with default payments, so if borrowers die without paying back the credit, it is passed on to the living family member. Such speculation forced many households to perceive these strategies as most severe and more shameful.

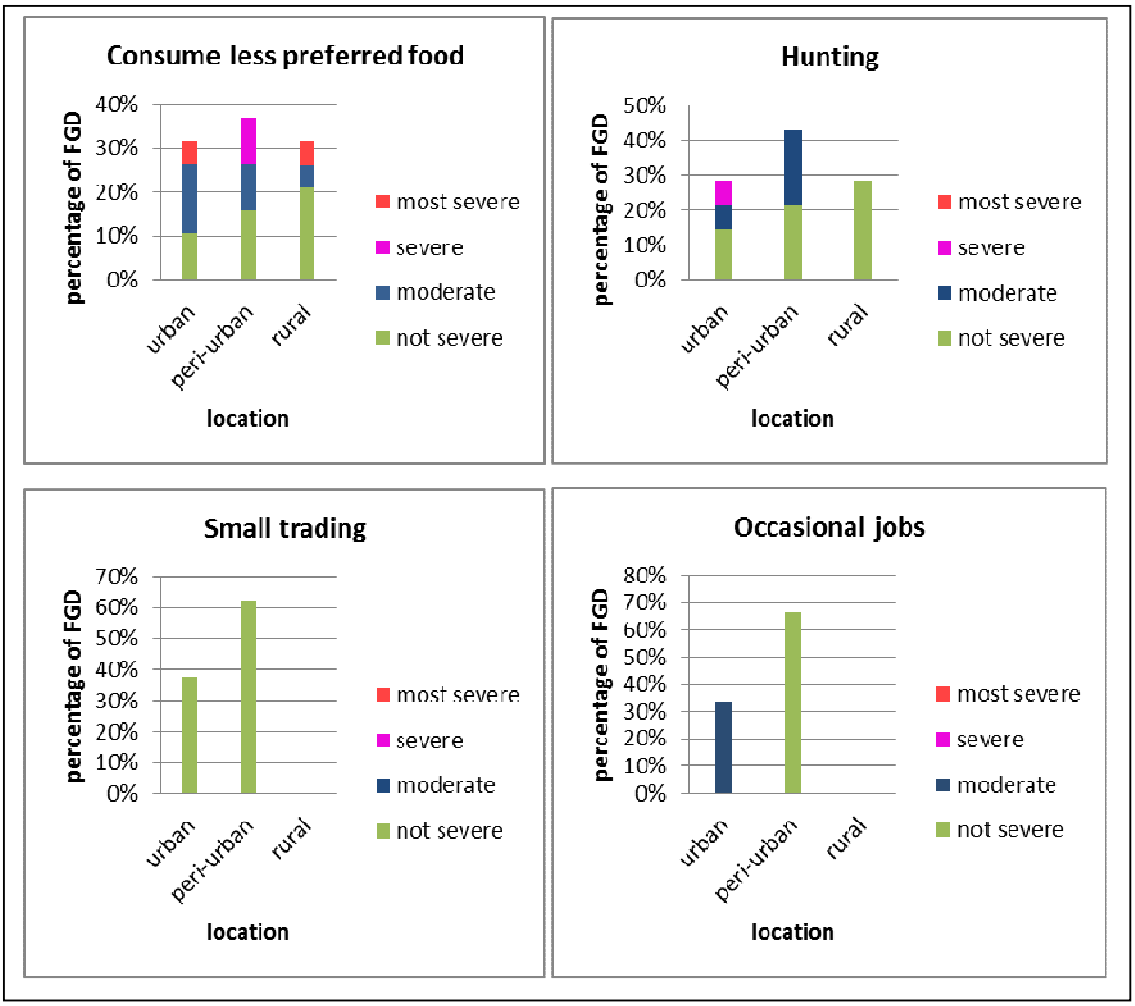

Fig 6: Least severe coping strategies

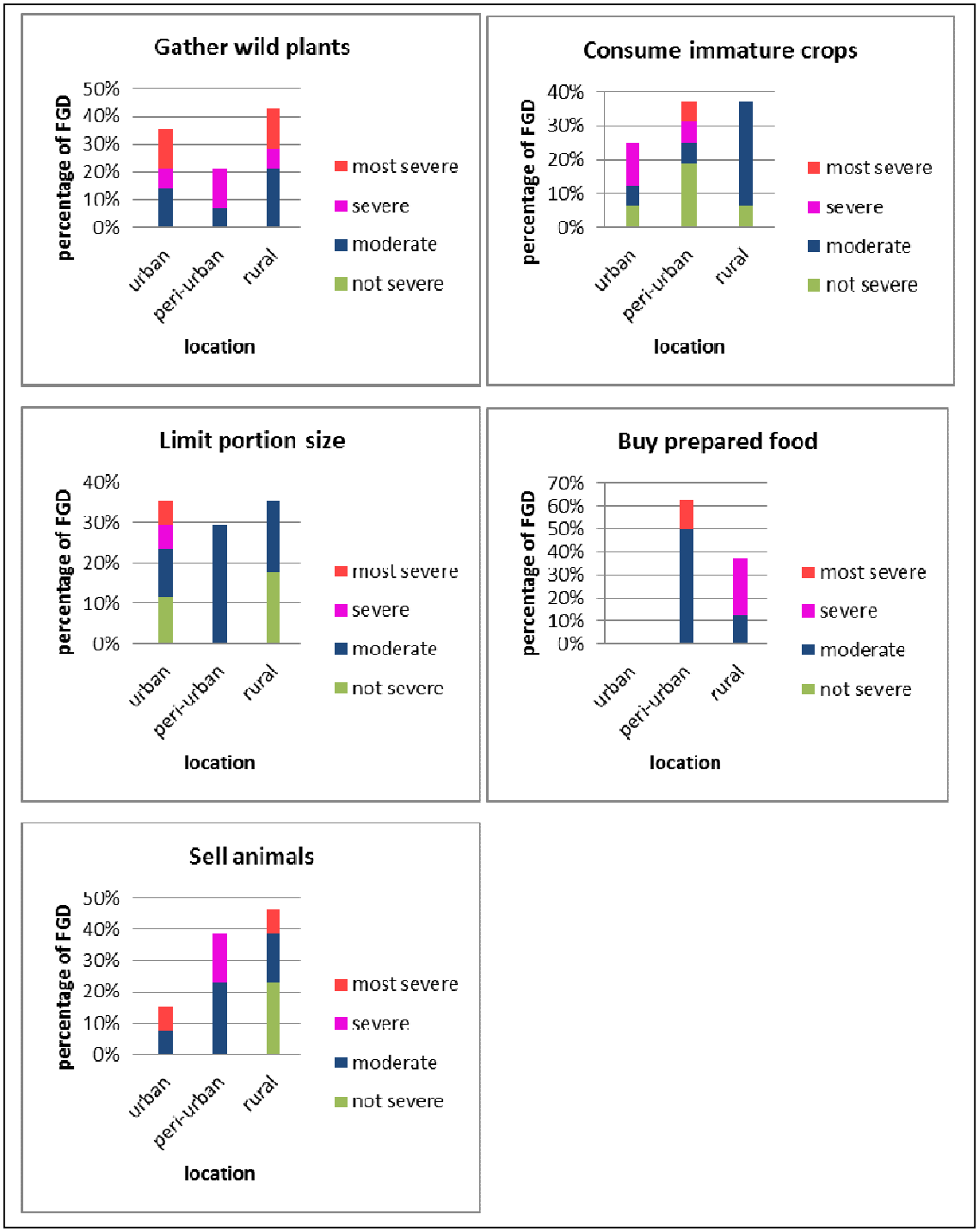

Fig 7: Moderate severe coping strategies

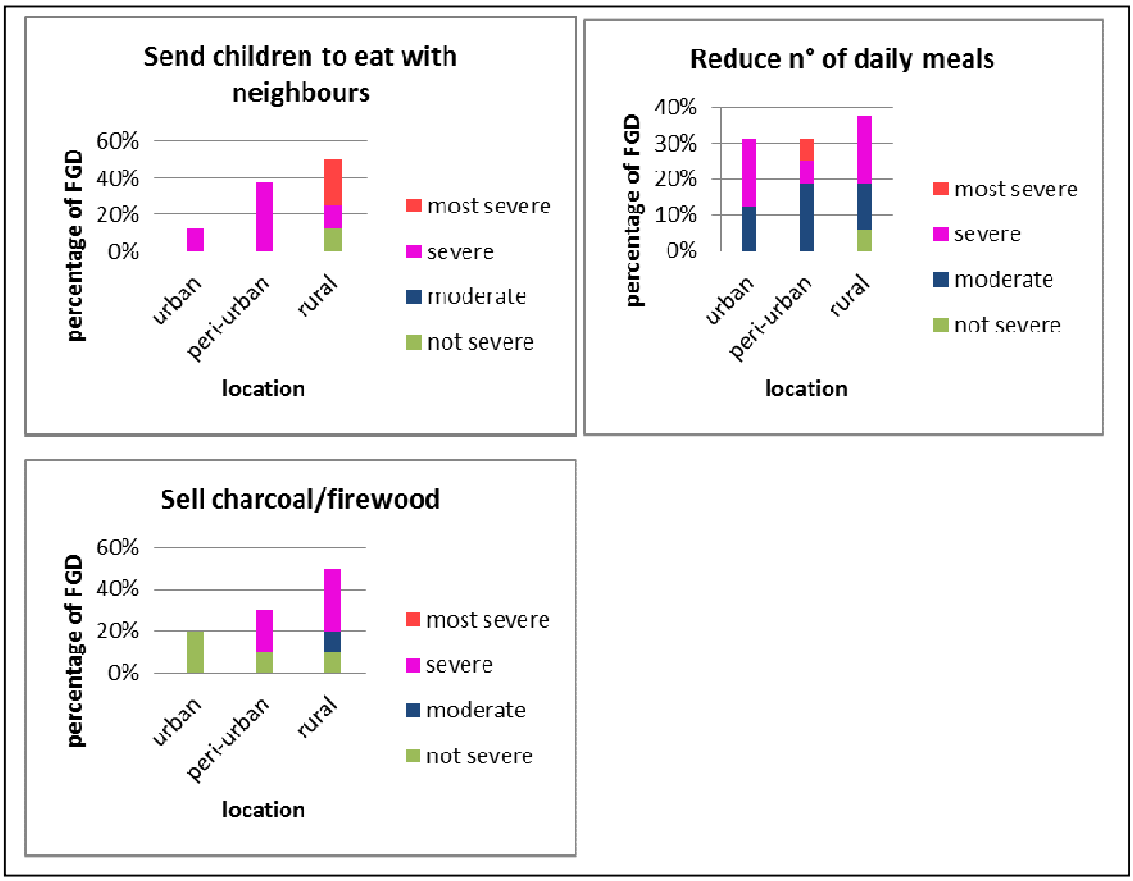

Fig 8: Severe coping strategies

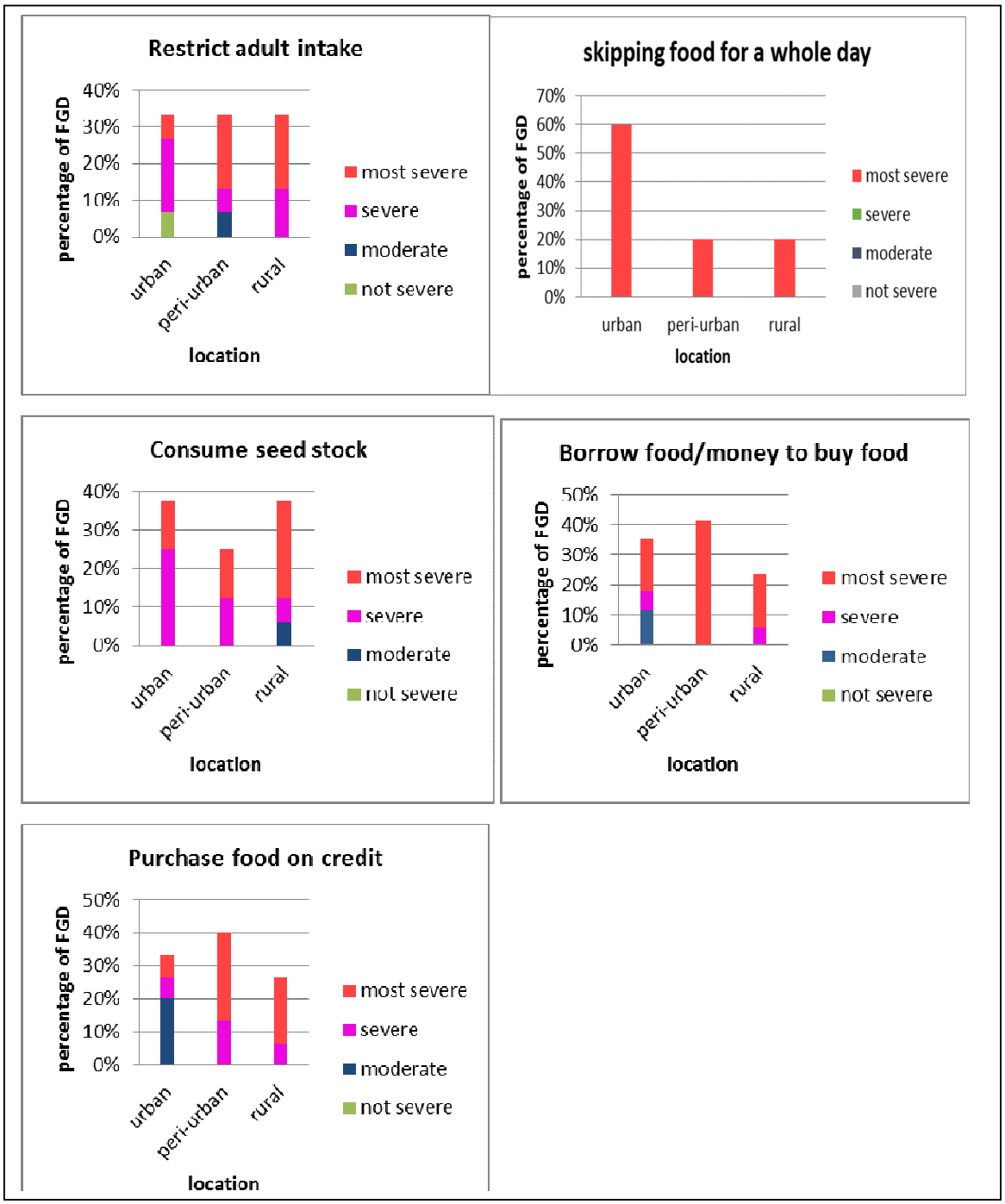

Fig 9: Most Severe coping strategies

Coping strategy indices along the urban –rural continuum

The coping strategy index for each location results from the combination of severity and frequency value (Fig 10). The dark red bar represents the total average index which is set to a value of 100 points for better understanding. All the other values are respectively adjusted by the rule of proportion. Listed below are the values for all urban (orange), periurban (blue) and rural locations (green). The average values for each spatial area can be compared to the total average value.

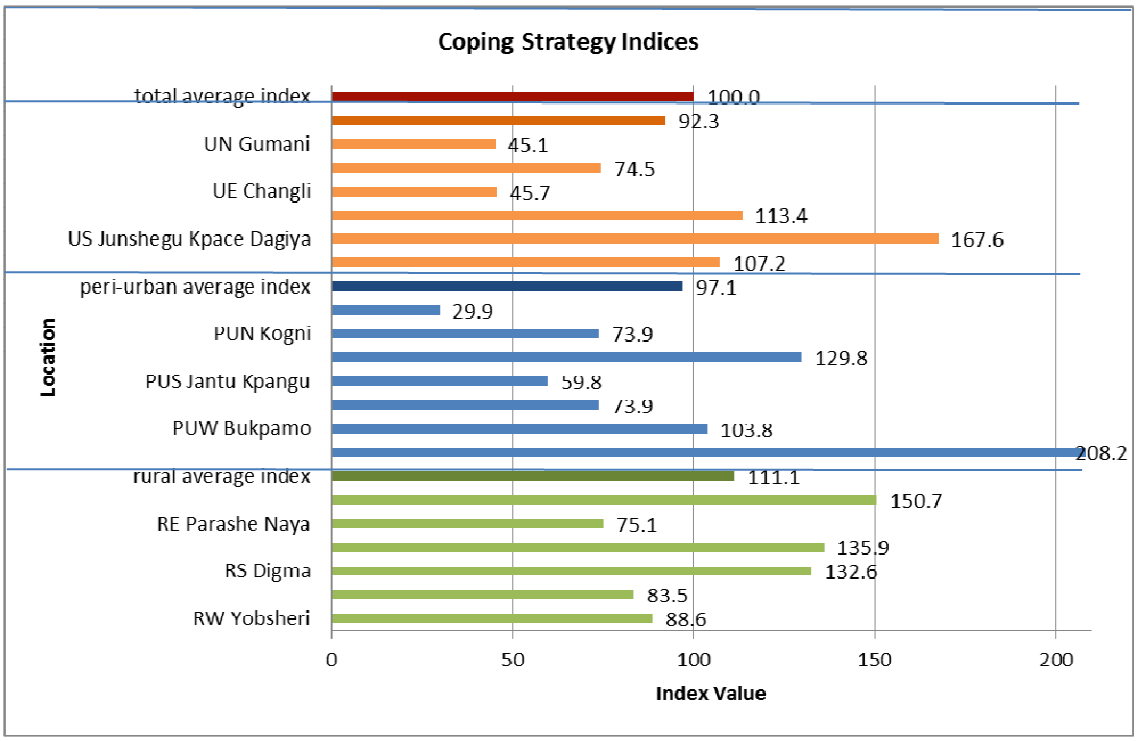

Fig 10: Coping Strategy Indices along the urban – rural continuum. (Abbreviations: urban=U, periurban=PU, rural=R; N=north, S=south, W=west, E=east; meaning RN=”rural north”, PUW=periurban west …)

The results reveal that the urban CSI average was 92.3, which lies slightly below the total average. The rural CSI average was 111.1, which is significantly higher than the total average. The periurban CSI average was 97.1, which is in between urban and rural CSI averages.

The CSI values in Fig 9 show us that rural households generally were using many coping strategies compared to periurban and urban. This may be ambiguously interpreted as that the rural households were more food insecure than other location. Nevertheless, the urban

households have been noted to use more of most severe coping strategy more than other location, which is another reflection of worst food insecurity situation.

A closer observation of the single location CSI values reveals a more complex picture along the continuum. The rural CSI values range from 75.1 (RE Parashe Naya) to 150.7 (RN Zosali). Periurban CSI values vary from 29.9 (PUN Pong Tamale) to 208.2 (PUW Dundo). In the periurban space we find the biggest range between maximum and minimum. The urban CSI values had a minimum of 45.1 (UN Gumani) and a maximum of 167.9 (US Junshegu). The great variability in CSI in urban and periurban was due to difference in the extend at which various areas were participating in income generating activities (socio-spatial heterogeneity). For example in PUN Pong Tamale and UE Changli most participants had some jobs. There was relative similarity of CSI values in the rural, which shows that people in the rural area are in a more homogenous situation as compared to the population of the periurban and urban area.

7.5 Discussion

Study results reveal that food coping strategies vary from one spatial entity to another in terms of frequency, severity and coping strategy indices along the urban – rural continuum. According to Maxwell et al. (2008:534) [13], “more extreme behaviours, such as sales of productive assets to purchase food, hold more long-term consequences for the household”. Households tend to use severe coping strategies which represent greater food insecurity and sometimes less reversible in worsening food security situations [50,51]. Most households would first employ coping strategies with the lowest severity and highest frequency such as eating less preferred food [13]. The changes in the CSI shows fluctuations in household food security status, with lower CSI representing low coping and better food security situation [13].

Although many studies have revealed the use of various food coping strategies by urban, periurban and rural populations, including the recent work of Agada and Igbokwe; Knight et al. [18,44], less has been reported on how these strategies can vary along the urban-rural continuum. In this study, households in urban areas used more frequently severe and most severe coping strategies compared to their periurban and rural counterparts, such as skip whole day without eating food, borrow food or money to buy food, consume seed stock

and purchase food on credit (Fig 4 and 9). Consumption of seed stock has been cited as one of the extreme cases and referred to as “the household has collapsed”. Most rural households avoided eating seed stocks as they were afraid to face the risk of not affording to buy the replacement seeds. The work of Waal [52] pointed out that during the famine in Sudan in the mid-1980s seed stocks were mixed with sand by adults to prevent children from eating the seed stock. This reveals the importance of seed stock in meaningful crop production systems. Setimela et al. [53] also confirmed the importance of seed by highlighting that, “seed is an important catalyst for development of agriculture”. Frequent usage of most severe coping strategies like skipping food for the whole day, is associated with daring food insecurity situations [13]. Several studies have also reported the growing scourge of food insecurity in urban areas in African cities [54–58].

Least and moderate severe strategies were frequently used in both periurban and rural areas. Gathering of wild food and selling of charcoal were common strategies in periurban and rural areas. Cruz-Garcia and Price [59] also pointed out that wild food is “an essential part of the diet, constituting a ‘rural safety net’ particularly for vulnerable households” Amongst the *Tonga* tribe in the Southern province of Zambia, gathering and hurting were supporting traditional food security [60]. The consumption of immature crops was also more present in periurban and rural areas than in urban (Fig 4). The reason could be the pronounced presence of agricultural activities in periurban and rural more than urban areas due to high urbanisation and conversion of agricultural land to residential areas. Thus, households in periurban and rural areas had the chance to target immature crops as a source of food. Sale of animals, was also more implemented in periurban and rural areas, where more livestock keeping is practiced (as animal keeping is officially forbidden in the urban centre by law, so cattle owners give their cattle to Fulani herders for keeping in periurban and rural areas) and production of charcoal take place. Sales of livestock was also cited as one of the coping strategies used in Northern Ghana and Gambia by households to buy food [45,46]. Elsewhere, the work of Verpoorten [16], in Rwanda also shows the use of livestock as a coping strategy, although it does not emphasise how the frequency of this strategy vary between urban, periurban and rural.

This study confirms commonly used coping strategies, widely reported elsewhere as not severe like the consumption of less preferred food. Maxwell et al. [43], also reported that

less preferred food as a coping strategy was perceived as a low severity coping strategy in Ghana, Eritrea, Kenya, Malawi, Zambia, Zimbabwe and Ethiopia.

The results show that women were engaging in income generating activities like selling food and getting short term employment as market women in order to get money and buy food in times of household food shortages. In Hovorka et al. [61], the role of women in feeding the urban population was emphasised, with women contributing to food security through activities like urban farming amongst others. Floro and Swain [47], reported that women from urban low income households were engaging in food enterprises and earn money income to be used as a direct source of food for consumption. The work of Schindler [48], discussed the use of credits by market women and reveals that often times they invest more time to nature the relationship in order to secure access to credit once shocks occur. Hope et al. [62], highlighted that formal credit schemes are a challenge in Accra, nevertheless vegetable sellers who are mostly women pre-finance farming activities by giving agricultural inputs like seeds. In Ghana, Awumbila and Ardayfio-Schandorf [49] point out that , "young girls from rural areas, particularly the northern regions move to markets in urban centres to serve as *kayayei*, female porters, who carry goods on their heads for a negotiated fee". This was also found to be practiced in Tamale, even if *kayayej* was not listed as coping strategy in this study.

7.6 Conclusions

The study concludes that food coping strategies vary from one spatial entity to another in terms of frequency, severity and coping strategy indices along the urban – rural continuum rather than only varying from one town or country to another as reported in previous studies [18,43,44]. This knowledge on how households at different locations along the urban – rural continuum cope with food shortages will be useful for geographic targeting or resource allocation along the urban – urban continuum [43].

Various coping strategies were identified and rated differently as least severe, moderate severe, severe and most severe along the urban – rural continuum. The urban households have been noted to use more of most severe coping strategies compared to periurban and rural households like borrowing food, buying food on credit and skipping food for the whole day more than periurban and rural, which is another reflection of worst food insecurity situation.

Coping Strategy Index values varied along the urban – rural continuum, with rural areas having the highest average CSI compared to periurban and rural. Nevertheless, a closer observation of the single location CSI values reveals a more complex picture along the continuum, with varying CSI within the same location. There was relative similarity of CSI values in the rural, which shows that people in the rural area are in a more homogenous situation as compared to the population of the periurban and urban area.

Women in the study area participated in coping strategies which helped in providing food in many households, like trading items, shea butter processing and other handcraft. We recommend further support by respective institutions such as microfinance in providing financial means to start small business and establish trading cooperatives as a contribution to food security in northern Ghana. Success was reported in Ghana and South Africa following microfinance interventions in terms of increased business incomes, improved access to life-enhancing facilities, and empowerment of people, particularly women [63]. The microfinance innovations may take the form of loans and savings as discussed by Dary and Haruna [64].

We acknowledge that this study only focuses in one of the three regions of northern Ghana mostly affected by hunger and poverty. We recommend future studies to look at all the three northern regions of Ghana (Upper West, Upper East and Northern) using the urban - rural approach and summarize the coping strategies employed by the households across these regions.

7.7 Acknowledgements

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CHAPTER 8

Land tenure and its implications for food and nutritional insecurity in the Northern Region of Ghana

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This paper is bieng prepared for submission to Land — MDPI. The version included in the thesis has been slightly modified to ensure consistency of style and usage with other chapters.

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8.1 Abstract

Links between land tenure and food and nutritional insecurity are receiving increased attention. Nevertheless, urban and periurban dwellers face challenges in accessing land to produce food for subsistence and sale. An ethnographic study and food and nutrition insecurity survey was conducted between October 2013 and November 2014 in Tamale, Northern Region of Ghana, to explore the dynamic and recursive links between land access, food access and the ability to maintain resources to meet long-term needs. Results showed that infrastructural development and agriculture compete for land. The shortage of land for agricultural purposes was pronounced in urban areas (20%) and periurban areas (1.3%) compared to rural areas (0 %). There was a statistically significant association between household who were not producing crops due to land shortages and food insecurity (Fisher's exact probability = 0.040). Urban and periurban dwellers cope with the communal tenure systems by using strategies including urban–periurban-rural migrant farming and buffer zone cultivation. The role of women in providing nutritious soups is especially important. Political, economic and cultural elements thus interact to constitute the link between land and food.

***Keywords*:** Land tenure, urban and periurban agriculture, food and nutritional insecurity, gender.

8.2 Introduction

Land tenure systems as well as food and nutritional insecurity have been the subjects of wide-ranging research over the years, though separately [1–4]. Food and nutritional insecurity has remained a worldwide problem which is yet to be solved [5]. Despite decades of international and national attention, food security still remains an issue of significant global attention [6]. Land tenure systems and how they are administered is part of this discourse [7]. Links between these two issues are now receiving increasing attention.

Maxwell and Wiebe (1999:825) [1] defined land tenure as "the system of rights and institutions that governs access to and use of land and other resources", while [8] focused more on the terms and conditions on which land is held, used and transacted. Generally these systems are not static and their changes can potentially affect food and nutritional insecurity. The processes through which land reforms have taken place around the world have varied widely. In some cases in Latin America large estates were broken up and redistributed to tenants, while in East Asia the tenant/landlord contract was broken and land given to tenants

[9]. All of these actions were to serve the notion of equity and efficiency [9]. In Africa the land tenure system is shifting towards private property ownership, not land redistribution, serving the notion of tenure security [10]. The key question, especially in the context of rapid urbanisation remains; is the communal land tenure system secured or not? A lot of research has been done on communal tenure system in Africa and its effect on agriculture [3,11,12]. Tenure security has been reported in many studies to have a positive and significant impact on investment and productivity of land use [13–15], but this is not always the case as other studies have showed that the reverse is true [16,17]. In Ghana the insecure land tenure system is associated with greatly reduced investment in land fertility [18]. On the other hand, the work of Migot-Adholla et al. [19] shows no relationship between investment and land rights.

FAO, IFAD, and WFP (2013:50) [20], defined food insecurity as: "a situation that exists when people lack secure access to sufficient amounts of safe and nutritious food for normal growth and development and an active and healthy life". The main pillars of this definition are: stability (adequate resources to get food and sufficient quantity), stable access (to have food at all times), and utilization (adequate diet, sanitation and health care for nutritional well-being).

The challenges of rising global food prices, rapid population growth, urbanization pressures and increasing demands on the agricultural land base have increased global food security awareness [21]. Food security has been pushed up to the top priority of 2012's G8 and G20 Summits [22]. Food and nutrition security has also been placed at the top of governments' policy agenda, for example, in South Africa where the right of access to sufficient food is found in Sections 26 and 27 of the South African Constitutional Law of 1996 [23]. Yet food insecurity and malnutrition continue to be worldwide problems, despite efforts by governments and the international community to reduce them [20]. In Ghana, the three northern regions (Upper West, Upper East and Northern) continue to record higher incidences of poverty, food insecurity and malnutrition, despite an overall improvement in recent years of wealth and development in Ghana [24].

According to Abdulai et al. (2011:67)[25], in Ghana: "there is a complex system of communally owned land in the rural Northern regions of the country, with many local variations. Land tenure is generally based on the community's social organization, and the basic unit of ownership is the family or clan." Unlike in the Northern region of Ghana, the Brong Ahafo region in the South has four tenure systems: owner-operated with full property

rights, owner-operated with restricted property rights, fixed-rent and sharecropping contracts [25]. Urbanisation, population pressure and land markets has led to changes in land use patterns and unavailability of prime agricultural land contributing to low agricultural productivity, a low standard of living and food insecurity [27].

Much research has been done on the conventional link between access to land and access to food in the short run [10,12,26], but less on a recursive link between access to land and access to food and the ability to maintain sufficient resources to meet long term needs. This paper will explore on how urban and periurban households are affected by the legal status of tenure system and how they adapt to feed their families in urban and periurban settings. It will demonstrate the importance of change, as farmers employ adaptive land access strategies in a situation of increasing tenure insecurity. At the same time, the continuity observed in enduring gender roles is a complementary food security strategy.

8.3 Methods

A mixed method approach was used in this study. Mixed methods research provides strengths by offsetting some of the disadvantages of both quantitative and qualitative research methods [28]. Nevertheless, mixed methods can be a challenge if assumptions for both methodologies are violated [29]. A survey was carried out from November to December 2013 in and around Tamale (Figure 1). The aim of the survey was to understand the dynamics of food and nutrition insecurity and the role played by urban, periurban and rural agriculture along the urban – rural continuum. This survey involved 240 households randomly selected over seven districts (Figure 1). Structured questionnaires were used to collect data on crop and livestock production and consumption, prevalence of household food and nutrition insecurity. In that survey one of the reasons raised by 7.1% of respondents for not growing crops along the urban-rural continuum was not having land to farm.

Simultaneously, an ethnographic study was carried out from October 2013 to November 2014 in and around Tamale to understand the resource use politics of urban and periurban vegetable farming. Informal conversations, focus group discussions and interview guides were used to collect data, through purposive sampling. Lack of access to land was a central theme raised by respondents in that study.

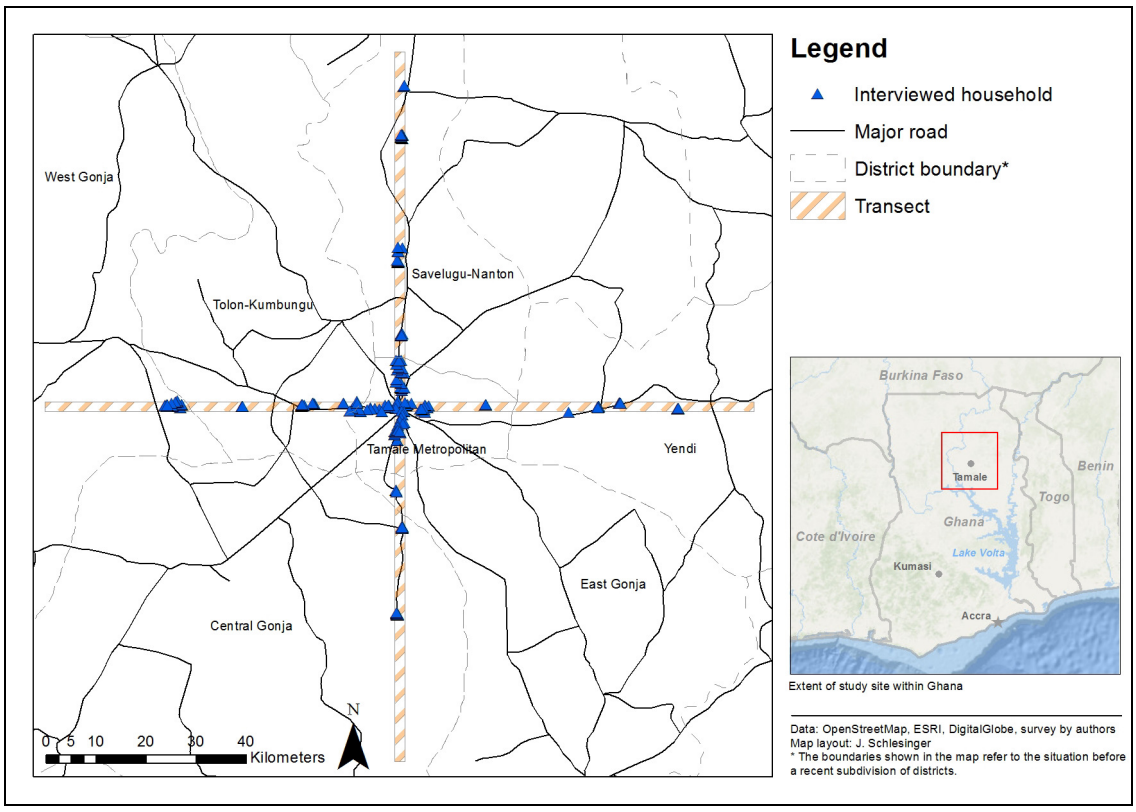

Figure 1: Location map of study area

2.1 Sampling

This study is built on the food and nutrition insecurity survey which was based on a transect approach. The transect approach has been used in a number of studies in accessing vegetable production, use of natural resources and analysis of vegetation [30–32]. Transect were laid radially, 70 km long and 2 km wide from the Tamale central market (Figure 1). Working definitions of urban, periurban and rural areas were based on reviewed literature on the extend of urban, periurban and rural areas in West Africa [33–36]. The work of Drescher and Iaquinta (2002), helped to identify the periurban areas. In this study upto 10 km is urban areas, 10 – 40 km is periurban and 40 - 70 km is rural areas from the city center. All the houses along the transects were digitised in Geographical Information Systems (GIS) using recent imagery. Twenty households were randomly selected per transect using GIS, giving a total of 240 households being selected (20 households x 3 areas/zones x 4 transects). Twelve households were randomly selected from the 240 households who participated in the food and nutrition survey covering urban and periurban Tamale, six from urban and six from periurban areas, to find out how land tenure systems influence their food and nutritional

insecurity. One representative from each household was chosen as a key informant, resulting in a sample of 5 men and 7 women.

A series of targeted in-depth interviews, informal conversations with key informants and participant observations were carried out from December 2013 to November 2014, specifically to delve deeper into the link between access to land and food security in urban and periurban Tamale. The current paper uses data from both studies

2.2 Study food and nutrition indicators

The food and nutrition insecurity study used the following households' food and nutrition Indicators:

Household Food Insecurity Access Scale (HFIAS) – It is based on the responses of 18 questions about behaviours and attitudes related to food insecurity experience over the past four weeks (consisting of 9 occurrence questions and 9 frequency-of-occurrence questions), resulting in households being assigned scores that ranged from 0 to 27 [37]. Households were divided into two classes of HFIAS based on the distribution in the sample as recommended by [38], with a score of ≤ 11 as food secure and a score of >11 as food insecure. A higher HFIAS score reflects greater household food insecurity and poor access to food.

Women's Dietary Diversity Score (WDDS) - is a proxy of household nutrition [38]. Based on food items consumed in the past 24 hours, respondents were assigned number of food groups they consumed ranging from 0 to 9. An increase in the number of food groups or WDDS is related to increased nutrient adequacy of the diet, and vice versa. Households were classified into three groups based on the distribution in the sample: ≤ 3 food groups as lowest dietary diversity, 4 – 5 food groups as medium dietary diversity and ≥ 6 highest dietary diversity.

2.3 Data management and Analysis

Data entry was done in Epidata version 9, and exported to Stata 11 software for analysis. The Pearson chi-square test was used to test for association between reasons for not growing crops and geographical location. Fisher's exact chi-square test was used were expected cell frequencies were less than 5 and N< 50. We did the Fisher's chi-square exact test for household nutrition and food insecurity indicators associated with reasons for not growing crops. Interview guides were used in directing discussion with informants. All in-depth-

interviews and focus group discussions were recorded and transcribed using the F4 transcription tool.

2.4 Ethical Considerations

In each community, study objectives and purpose were clearly conveyed to community leaders and respondents. Permission was sought before data collection from local leaders and respondents. Respondents had the opportunity to stop participating in the research at any time of their choice during interviews and none opted out during this study.

8.4 Results

The results represents findings from the following two studies: the food and nutrition insecurity survey that aimed to understand the dynamics of food and nutrition insecurity and the role played by urban, periurban and rural agriculture along the urban – rural continuum. And also the ethnographic study on the resource use politics of urban and periurban vegetable farming.

3.1 Socio-demographic profile of study sample

The Dagomba (70%) and Gonja (17%) ethnic groups formed the majority of respondents who took part in the food and nutrition survey which informed the sampling population for further in-depth interviews. Women (39%) and men (61%) participated in the food and nutrition survey (Table 1).

Table 1: Demographic characteristics of respondents

Characteristics		Urban % (n=80)	Periurban % (n=80)	Rural % (n=80)	Total % (n=240)
Gender	Men	53	65	66	61
	Women	48	35	34	39
Age class of respondents	≤ 20 years	3	1	0	1
	21 – 59 years	90	96	100	96
	≥ 60 years	8	3	0	3
Level of education	None	50	75	79	68
	Primary	4	0	6	3
	Secondary	25	10	5	13
	Tertiary	15	5	0	7
	Koranic	6	9	10	8
Household Religion	Muslim	88	88	99	91
	Christian	11	8	0	6
	Mix m + c	1	5	1	3
Ethnic group	Dagomba	80	64	66	70
	Gonja	3	24	25	17
	Fulani	1	4	9	5
	Dagati	4	0	0	1
	Others	13	9	0	7

3.2 Association between Reason for not growing crops and geographical location

The results of the food and nutrition survey reveal that 7.1% of respondents where not producing crops because of not having land. More households in urban areas (20 %) and periurban areas (1.3 %) were not producing crops because of not having land compared to rural areas (Table 2).

Table 2: Association between Reason for not growing crops and geographical location

		Urban % *(n=80)*	Periurban % *(n=80)*	Rural % *(n=80)*	Total % *(n=240)*
Growing crops	Growing crops	55	93.8	100	82.9
Reasons for not growing crops	No Capital	2.5	1.3	0	1.3
	No Land	20	1.3	0	7.1
	Not interested in farming	1.3	0	0)	0.4
	Sickness	2.5	1.3	0	1.3
	Trading	3.8	0	0	1.3
	Working	15	2.5	0	5.8

Pearson chi-square = 69.53, (d.f) =18, P < 0.001

3.3 Association between Reasons for not growing crops and household nutrition security

There were statistically significant difference between reasons for not growing crops and household food security, with more households not having land experiencing food insecurity compared to other reasons (Table 4). Nevertheless, there was no statistically significant difference between various reasons for not growing crops and household nutrition security (WDDS) (Table 3).

Table 3: Association between Reasons for not growing crops and household nutrition security

		Lowest dietary diversity ≤ 3WDDS	Medium dietary diversity 4 – 5 WDDS	Highest dietary diversity ≥ 6 WDDS	Total
Reasons for not growing crops	No Capital	1	0	1	2
	No Land	1	12	3	16
	Not interested in farming	0	1	0	1
	Sickness	0	1	1	12
	Trading	1	1	1	3
	Working	3	3	6	12

Fisher's exact probability= 0.102 (insignificant)

Table 4: Association between Reasons for not growing crops and household food insecurity

		Food insecure HFIAS>11	Food Secure HFIAS≤ 11	Total
Reasons for not growing crops	No Capital	1	1	2
	No Land	5	11	16
	Not interested in farming	1	0	1
	Sickness	2	0	2
	Trading	1	2	3
	Working	1	11	12

Fisher's exact probability = 0.040 (significant)

3.4 Land tenure systems in Northern Region of Ghana

In this study the land tenure system was communal with some pockets of public land. These public lands host government buildings and state provided socio-cultural and economic needs of the people. In this communal system, land belonged to communities and families. The chiefs are custodians of community lands in trust for the people while the lineage heads are in

charge of their family land. Chiefs have allodial rights[5] over the community land and the farmers have usufructs rights over these same lands, which they can pass on from generation to generation legally. In this system the chief who is the custodian of land for the people is expected to use it on behalf of and in trust for the subjects in accordance with customary law and usage. In this case the chief could sell a community land that was being farmed if it was for the development of the community. Land used for agricultural purposes in urban and periurban areas can be acquired with a gift token of "kola" (kola here varies in form as it can be kola nuts, bread etc.). When this is done, the "new owner" automatically has "users" rights on the land. If the indigene needs land for a residential building, the same rule follows but with an allocation note from the chief stating that the land now belongs to person "A" who has allodial rights over the land. Prices for 100m x 100m of land in periurban areas range from 2500 to 5000 new Ghana Cedi (1 Ghana Cedi is approximately 0.25 Euro as by October 2014) while in the urban areas land prices range from 8000 to 15000 new Ghana Cedi. When "kola" and cash are given to a chief he issues an allocation note. The buyer then goes to the land commission, where he presents the allocation note and he is explained the necessary procedures of acquiring a land title. Land given out just for "kola" can also be sold to prospective buyers prepared to give cash and "kola", to use the land for development. Land bought or leased is generally used for construction of houses and not for any farming activity, as observed by the authors. As noted, 7.1% of respondents in the above mentioned food and nutrition insecurity survey indicated that the reason they were not growing crops was due to shortage of land (Table 2). Most land owners highlighted in interviews that land and physical properties like houses were secured for posterity and not to be sold, even in a case of extreme food crisis. They argued that land is a symbol of identity and pride to be inherited and never sold.

3.5 Strategies for securing land

This study revealed that most periurban farmers tended to find ways to secure their agricultural land due to uncertainties that plague the communal land system. After the harvesting of cereals and tubers the farmer gives about 100kg bag of the crop (usually referred to as kola) to the chief to maintain ties of trust and loyalty and in so doing secure the use of the land for the next season, similar to land buyers who provide "kola" with additional

[5] Free, not subject to the rights of any lord or superior, owned without obligation of vassalage or fealty

cash when they want to acquire land for residential and commercial purposes. If the farmer fails to do this because he did not have enough produce to feed his household, the land might be taken from him and given to someone else. The chief usually appoints elders whose role is to check that farmers give him a share of the harvest, which he will uses for his family's needs and not community development. Unfortunately this mechanism stands as a deterrent to food security in these communities.

In urban Tamale, there are buffer zones labelled as disaster zones, not to be converted to residential housing, following a flood that happened in 1989. These lands are contested between different chieftaincy gates, the Ghana Water Company (GWC), Volta River Authority of the Northern Electricity Distribution Company (VRA/NEDco). The government institutions have won ownership of these lands in the court of law but are not using the lands because the Town and Country Planning Department has marked these lands as disaster zones. The chiefs still maintain that these lands were not sold to the government and are trying to sell plots of lands from these zones to any interested buyer. These lands are the Gumbihini old dam, Gumbihini new dam and the former Gumbihini Volta River Authority site (also known as "Waterworks") (Figure 2).

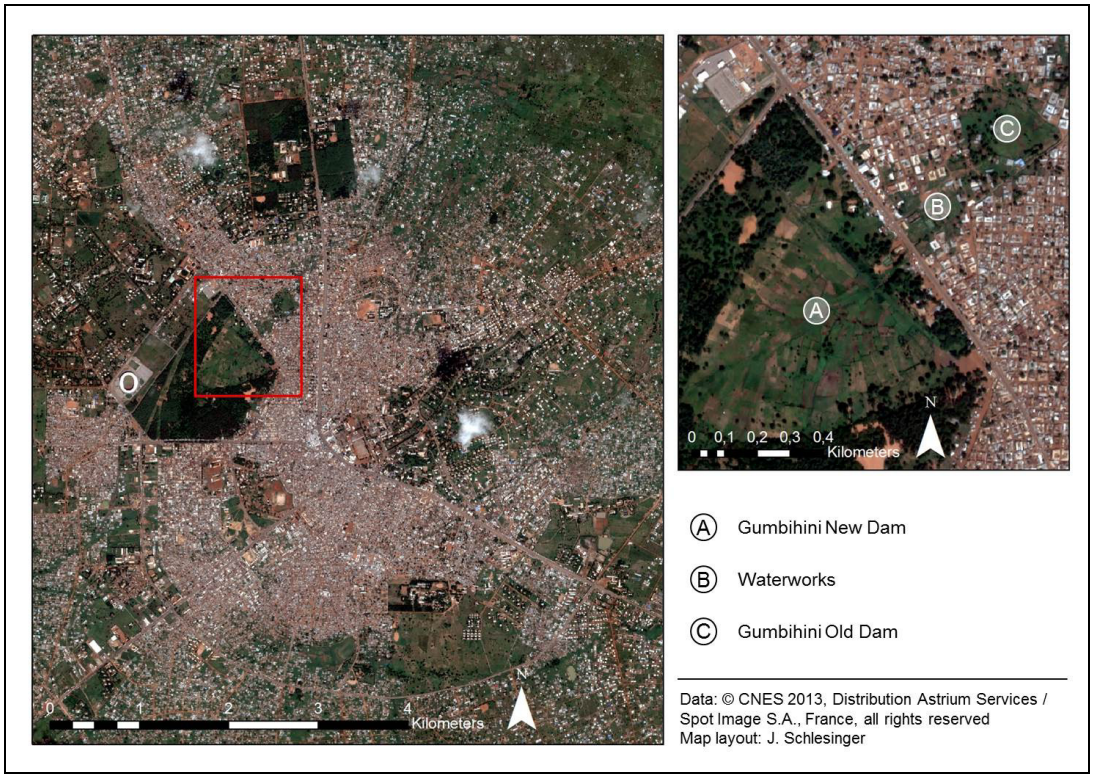

Figure 2: Location map of buffer zone areas in Tamale

Farmers who are using these lands for agricultural purposes had increased after the disaster. These farmers are creating and building networks that can help them stake a claim to these zones. Farmers are collaborating with various institutions including the Urban Agriculture Network (Urbanet) to facilitate infrastructural development in some of the sites; specifically, the installation of piped water for vegetable irrigation at the Gumbihini old and new dam sites and securing the land for future use. The main users of these lands are dry season farmers who produce vegetables including cabbage (*Brassica oleracea)*, lettuce *(Lactuca sativa)*, amaranth *(Amaranthus spp),* roselle *(Hibiscus sabdariffa)*, jute mallow *(Corchurus olitorious)* and okra *(Abelmoschus esculentus)*. The buffer zone covers approximately 125 000 m^2. Besides easing the pressure of land shortages, the use of buffer zones provides a wide range of vegetables to the urban and periurban population.

Farmers have also taken up cultivation on other vacant areas of land outside the buffer zone, for example at Choggu Cheferuguni, Ganasco dam, Sangani, and Zagyuri amongst others, where vegetables like cabbage, cowpea *(Vigna unguiculata)* lettuce, amaranth, roselle,

jute mallow, pepper *(Capsicum annuum)* and tomatoes *(Solanum lycopersicum L)* are grown. These open spaces are public, private and community lands to which the farmers do not have allodial but usufruct rights. Some of the farmers are squatting on private and public land; others have borrowed land from its legal owners and are acting as caretakers to secure it from encroachment.

3.6 Land, agriculture and soil fertility

Shortage of land in the urban and periurban areas was mostly due to community land being sold for development which implies that farmer produce crops on less than half a hectare of land annually. Also this has pushed some farmers to crop in and around buildings. This practice has led to depleted and poor soils on farmers' fields, lowered yields and contributed to shortages of household food. Farmers, in a bid to overcome this problem, are using several options. They practice mixed cropping to improve the soil's fertility (for example, intercropping with nitrogen fixing legumes like cowpea), and the use of inorganic fertilisers such as sulphate of ammonia, and different blends of compound NPK fertiliser, which, even though relatively expensive, are readily available in the markets. There is also a sizable proportion of farmers using organic manures such as cow dung, human excreta, and chicken manure as well as compost to improve soil fertility which is a problem in the urban areas. Poor yields also propel some farmers to use pesticides to boost production. Due to high levels of illiteracy in the study areas (Table 1), the recommended rates of pesticides are not always applied and some farmers use non-recommended combinations. Interviews with farmers in Tamale revealed that investments in soil fertility is linked to farmers socio-political space as explained above and has no direct implication with the "security" of the land.

3.7 Gender and land ownership

From interviews we were informed that the men 'land lords' were the household heads and owners of land. During the main farming season the woman was usually given a small portion of land on the farm around the edges of her male relatives' field to produce or cultivate vegetables. This plot of land was usually unfertile and considered not 'good enough' for cereals or legumes production, which are the main crops. The vegetables cultivated are usually jute mallow, roselle, pepper and okra. This way of growing vegetables by women and sometimes preserving them for use in the dry season is a strategy for improving household food and nutritional insecurity.

Text box 1: Women negotiating land tenure security

Nina (name has been changed), is a widow in a periurban village known as Jimle. She lives with her aged mother and children and borrowed land from her brother. Nina complains that this land is infertile and would like to borrow more productive land from elderly men who have larger surface area of lands and cannot afford to cultivate them, but she has not been lucky. She exercises her resource gathering rights by picking sheanut and dawa dawa fruits from communal holdings. She processes these into oil and spice; used for domestic consumption and also as source of income. Nina also gets permission from her brother to cut down neem trees found on his land, which she sells as firewood to sustain her family. She is of the opinion that non-family members are kinder to women with no land than family members are. Nina argues that borrowed land is secured if you maintain a good relationship with the owner. This involves giving some crops, gifts or other basic commodities like salt to the owner after every harvest. Maintaining a good personal relationship is a starting point for negotiating security of tenure for women.

Interview results showed that, in order to provide soup for the household while sometimes not having access to enough land, women often work on the farms of their husband or other male kin during harvesting. After harvesting, a certain portion of the crop is given to the female harvesters. In the case of okra, a bowl of okra or more is given to each woman depending on the number of harvesters. In the case of pepper a basin is given to each woman. These vegetables are usually used in the household by the women to prepare soup. In the case of abundant vegetables given after harvesting, women also sell some to get income to buy spices and salt to prepare the soup. In the case of widows, harvesting of cereals and legumes are a must if they are to feed their household as well as sell to supplement household needs. Although women do not own land and sometimes find it difficult to provide the soup, men usually leave some crops during harvesting which women glean and use to provide the soup. After the farm owner harvests, widows and old women can enter any field with their bowls to harvest the “left over cereals”.

Another interesting element related to women’s responsibility to provide soup lies in the presence of two economic trees. These trees are the dawadawa tree *(Parkia biglobosa)* and sheanut tree *(Vitellaria paradoxa)*. For women to access these trees they have to go through men, as these trees are on land owned by men. The fruit of the dawadawa and sheanut trees are consumed by the community as spice for soup, porridge and as oil respectively. The dawadawa tree is owned by the chief/sub chief in that community, so in most cases permission needs to be sought for its harvesting. Women also collect sheanut

fruits to eat and sell the seeds to individuals or shea butter extraction production centres. They also use the shea butter for cooking and pepper preservation. These trees therefore give income generating opportunities to the women who sell the fruits and their by-products.

Text box 2: Improving value chains

In urban Tamale, around Gumani, securing land for agricultural activities is difficult, as Ashaitu (name has been changed for ethical reasons) notes. Her husband has no piece of land and former land holdings have been sold by the chief to estate developers as residential areas. She is the sole provider of food for the household. She has multiple activities she engages in to feed her family. Ashaitu does harvesting for her friends and kin, and she is paid with the crop she harvests. She does not have the luxury of choosing the type of crops she can harvest, so she harvests any crop she is called upon to assist. Ashaitu prefers to harvest rice, cereals, groundnuts and vegetables. She consumes all the vegetables either fresh or in dried form and she processes the rice she harvests and sells it to generate more income. Ashaitu says land ownership is important but not sufficient, as you need other technical farm inputs to be able to get a good yield from the farm to feed the family.

3.8 Land and migrant farmers

In this study site, we observed a new phenomenon of urban to rural migration, from discussions with farmers who indicated their search for agricultural land in rural areas. Farmers move to rural areas where urbanisation, population pressure and shortage of arable land are not yet perceived to be a problem. They give "kola" in exchange for agricultural land where they farm. After harvesting they bring their harvest back to the periurban and urban areas for consumption and sale.

Urban farmers, due to land shortage, are also moving to irrigation sites where they rent plots of land and pay for water charges to grow their vegetables and staple crops for home consumption and income generation. There is an influx of urban farmers from Kumbungu, Tamale and Bawku to the irrigation sites such as Botanga and Golinga, This usually occurs during the dry season, when okra, onion *(Allium cepa)*, green pepper and rice *(Oryza sativa)* are grown, to target the early market (the festive periods like Christmas and new year holidays). Onions are produced in large quantities which are sold in Tamale, Kumasi and Accra amongst others destinations.

8.5 Discussion

This study reveals that chiefs' manipulation of the customary land tenure system in Northern Region of Ghana is one mechanism whereby agricultural land is lost to residential construction. This pattern results from the changes from the customary system to a profit-making system of land governance. As Yaro (2010:200) [10] comments, such changes results in the "conversion of token customary gifts for land acquisition into monetary payments or higher exactions in the form of livestock and cash". The significance of this trend with respect to food security is that the eventual land area available to agriculture diminishes. In this study, the shortage of land for agricultural purposes was more pronounced in urban areas (20%) and periurban areas (1.3%) compared to rural areas (0 %) (Table 2). There was statistically significant association between household who were not producing crops due to land shortages and food insecurity (Fisher's exact probability = 0.040) (Table 4). According to Valente [39], access to land have positive effect on the poor, particularly in terms of food security. Land scarcity has been also argued as a cause of malnutrition and poverty [40]. The World Food Programme reports that "food security and wealth increase with farm size" [21,24], tying with data that reduction of agricultural land area subsequently increases food insecurity [21].

In Tamale, community members lose out during economic transactions on their lands since they do not conduct the affairs in the land markets [41]. This non fungibility of land and cash from the users' point of view contributed towards the study respondents' noncommercial conceptualization of land, and results in the 'kola' giving they engage in to secure their access to it. Similar strategies were observed by Townsend [42] in India, where households preferred to deplete their cash reserves and adjust their eating habits rather than sell their capital assets. The work of Corbett [43], revealed that households refused to sell any capital assets but instead decided to reduce their food consumption or take up any food coping strategy which would not hinder their household income generation in the long term.

However, despite the threat to their ability to access land, farmers in Tamale were using ingenious methods to access interstitial urban and periurban spaces and thus continue cultivation. In addition to counteracting land sales by chiefs with 'kola', they cultivate on the buffer zones and other unoccupied urban land. The movement of urban farmers to periurban spaces, including irrigation sites, can also be seen as part of this trend. All these farmers are

exploiting loopholes and gaps in existing tenure arrangements to gain access to the crucial resource, land in order to feed their families.

The urban to rural migration we encountered contrasts with the longstanding phenomenon of rural-urban migration by farmers offering labour for wages [44]. This changing strategy has also been noted by Yaro [10], who describes a case where farmers migrated to Gbanyamni, a periurban town 10 km from Malshegu, Tamale, and had to further move due to land commodification some years later to a rural area in search of land to farm. In Burkina Faso the Groupe de Recherche et d'Action sur le Foncier [45], discovered that migration patterns towards the rural areas for land were due to poor soils in the urban area, pastoralists' new livelihood strategy of practicing agriculture for fodder and the rise of a new class of rich land owners. The changing land access strategies of Northern Region of Ghanaian urban and periurban farmers thus reflect those of other West African colleagues.

Many economic studies have indicated that secure tenure increases incentives to undertake a highly intensive agricultural investment [46–49]. Farmers will be more willing to invest for essentially three reasons: to enjoy the returns of long term improvement and conservation measures of which [11,50] call the 'assurance effect'. Returns on investment made can easily be recuperated, which is the 'realisation effect' and lastly increase farming productivity through increases in allocative efficiency. Bruce [51] questioned the direction of causality between tenure and investment, arguing that tenure security may not cause investment to increase but rather investment may stimulate land security. A study by the World Bank on Ghana concluded that tenure security had a very positive impact on investment in the Anloga area but a less noticeable impact in Wassa and no influence in Ejura [17,52]. Besley [16] used the same data to assess the sensitivity of the results to the estimation methodology used, and reached the conclusions that better land rights facilitated investment in Wassa but not in Anloga. In Tamale interviews with the farmers revealed that investments in soil fertility of land is tied to their socio-political space and has no direct implication with the "security" of the land. Organic manures such as faecal sludge are also being used by farmers in Tamale to improve their soil fertility and increase yields to be able to feed their families [53,54]. In Burkina Faso, when women plant legumes to fix nitrogen in the soil, the men take the improved soil the next year to plant their cereals [55]. Like the majority of West African farmers in the increasingly common situation of land scarcity, those

in Tamale implement diverse soil fertility management strategies to maintain high yields using urban waste as well [53].

The majority of crops grown on these urban farmlands are vegetables, which are good sources of micronutrients [56,57] and help households to generate income [58], urban agricultural activity does contribute to improved household food and nutritional security. However, the use of these interstitial spaces for agriculture does have its drawbacks for the consuming urban populace. Pesticide misuse and the occasional use of waste water for irrigation [32,33,59,60] mean that intensive urban and periurban farming has possible health and food safety risks, which occur partly as a result of farmers' intensive use of chemical inputs on their small spaces of land in the urban zone.

The role of women in maintaining household food security is crucial. The recent report of Bread for the World Institute [61] highlighted that tackling discrimination against women will help to end persistent hunger. Our data revealed that, historically, women have used food security strategies that reconciled their lack of access to land with their "traditional provisioning responsibilities" also pointed out by Apusigah [26]. Thus, in a situation where land is becoming scarcer in general, these strategies, involving gleaning and cultivating on field edges and small plots, come to the fore. Women's cultivation of soup vegetables is not exclusive to Northern Region of Ghana: in Kenya and Burkina Faso women also cultivate crops perceived as less valuable [55,62]. Mechanisms have also developed that allow women access to use of natural resources on land owned by men, concomitant with their role as gatherers [63]. Their use of fruits and seed for food and as a source of income mirrors their use of other natural resources such as firewood and water. Yet they do not gain ownership over any of these resources. Inter-gender, class and status power relations are especially evident in the case of dawadawa tree, which is considered to belong to the traditional authorities [64].

The activities employed by women to guarantee food security like harvesting from male kin, relying on economic trees and cultivating borrowed land set to continue and gain importance in the future, as more of the urban population loses access to agricultural land.

8.6 Conclusion

The study concludes that the communal nature of the land system in Northern Region of Ghana has an impact on agricultural activities and consequently affects household food and

nutritional security. Due to the complexity of land access mechanisms in urban and periurban areas and the commodification of urban land, farmers are adapting various strategies to provide food for their households. These strategies include use of buffer zones; migration to irrigation sites to rent land and water, and movement from urban to periurban and rural areas in search of land.

In the midst of this complex interaction between land tenure and food and nutritional security are women. They do not usually own land, but are expected to provide soup for the household. To cope with this dilemma, they are found working as harvesters so as to have crops like okra and pepper to provide soup for their household. Simultaneously, they seek permission from men to harvest from trees of economic importance such as the dawadawa and sheanut. These food provisioning strategies of the landless may continue in a situation of increasingly difficult access to land and have implications for the conservation of these trees including neem.

Land tenure and food and nutritional insecurity are thus embedded in the socio-economic and political environment of urban and periurban farming households. Therefore, understanding the urban and periurban farmers' context can help to grasp the recursive links between access to land, access to food and the ability to maintain sufficient resources to meet long term needs. Thus, from a policy perspective, understanding and ability to manipulate the flexibility of the communal land system through encouragement of integration of vegetable cultivation and other urban and periurban agricultural activities into the socio-political milieu will go a long way in improving household food and nutrition security. We recommend the creation and unveiling of more opportunities for women to have plots of land in government irrigation sites to enhance access to resources needed of soup preparation, thus, boosting household income and food security.

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CHAPTER 9

Conclusions and outlook

9.1 Conclusions

The main objective of the study is to understand and map the dynamics of household food and nutrition insecurity in urban, periurban and rural settings along the urban-rural continuum of two sub-Saharan Africa cities: in Tamale (Ghana) and Ouagadougou (Burkina Faso). Furthermore, the role played by urban, periurban and rural agriculture in mitigating household food and nutrition insecurity was investigated. The study is based on the concept of an urban - rural continuum using a transect approach to assess household food and nutrition insecurity in the study areas.

As a detailed discussion of the research results is given in each article presented in previous chapters, this chapter provides a summary of the main results, draws recommendations, and finally gives an outlook.

There was varying involvement of households in agriculture activities (crop production and livestock keeping) along the urban – rural continuum in both cities. In both locations, there was evidence of more inclination toward staple crops compared to vegetables along the urban – rural continuum for both production and consumption, clearly shown in crops grown and food groups mostly consumed (cereals and tubers rather than dark green vegetables). As expected, more households in the rural areas were involved in crop production and livestock keeping compared to periurban and urban households in both cities. The explanation of this variation is the by law illegalized nature of agricultural activities and a lack of arable land in the urban centres of Tamale and Ouagadougou (Maire de Ouagadougou 1997; Bagre et al. 2002; Giweta 2011; Ayamga 2006). Highest dietary diversity (WDDS ≥ 6) was recorded in the urban areas compared to periurban and rural in Tamale. This was due to accessibility to various sources of food suppliers ranging from shops, and fruit and vegetable markets. In Ouagadougou households in rural areas had the highest dietary diversity (WDDS ≥ 6), compared to periurban and urban households. This

was due to the subsistence nature of crop production in rural areas, coupled with presence of wild fruits and traditional vegetables. This offers the opportunity to a wider diversity of food groups in these areas compared to the urban and periurban where there is competition on land between construction and agro-biodiversity. The loss of traditional knowledge on how to grow and prepare diverse animal and plant based food sources as people move from rural areas to urban areas could be one causes of this difference in dietary diversity. Similar results were found by Sogbohossou et al. (2015:9) along the urban-rural continuum of Southern Benin, who reported that: "urbanization was found to negatively affect the knowledge and uses of wild species".

Households located in the urban areas of Tamale (36%) were more food insecure (HFIAS > 11) than their counterparts in periurban areas (9%) and the rural areas (10%), while in Ouagadougou households in periurban areas had the highest relative proportion (54%) of food insecurity (HFIAS > 11), compared to urban areas (39%) and rural areas (45%). These findings confirm the growing evidence reported elsewhere of increasing urban poverty and hunger in African cities (Maxwell et al. 2000; Tawodzera et al. 2007; Mvula and Chiweza 2013; Kessides 2006; Ahmed et al. 2007). In both locations, periurban households had the highest relative proportion of stunting prevalence compared to urban and rural households. These results show the complex nature of periurban areas which is associated with an influx of people from urban and rural areas. Periurban areas tend to be seen as safety nets, often in search of food and other resources like land to improve livelihoods. This, however, is putting pressure on natural resources, which can explain the reasons of high levels of food and nutrition insecurity in this area. Marshall et al. (2009:28), pointed out that "For poor periurban communities, agriculture forms a key part of often diverse livelihood strategies – meeting basic food requirements for some or all family members through home production, or as a source of income through sale of produce or employment opportunities as farm labourers". In Dar es Salaam, Tanzania, periurban agriculture has been conceptualised as a survival strategy born of urban economic crisis, especially around 1980s during the austere conditions of structural adjustment (Sawio 1993; Mwamfupe 1994; Briggs and Mwamfupe 2000; Drescher et al. 2000; Nelson 2007). During this time people from a number of socio-economic backgrounds used the periurban zones to produce their own food for survival (Nelson 2007). Gyasi et al. (2014:89), highlighted that, "the growth of urban agriculture reflects a migration of poverty, food insecurity, and malnutrition from rural to urban areas". The unique characteristics in terms of social configurations, political-

administrative frameworks, and natural resource endowment of periurban areas has been also discussed in other studies (Schlesinger 2013; McGregor et al. 2006; Rakodi 1999).

The findings of this study reveal some relationships and association between crop production and livestock keeping with various food and nutrition indicators. The significance of these various associations varies from one indicator to another. In Ouagadougou households doing livestock keeping significantly reduced wasting (WHZ) (coef = -0.15; p = 0.008) by a factor of 0.15, and overweight (BAZ) (coef = -0.12; p = 0.015) by a factor of 0.12 compared to households not doing livestock keeping. Animal based food has been argued to provide much needed micronutrients which are bioavailable to the human body like haem iron in organ meat (liver, heart and blood based foods) (FAO 2011; Schönfeldt et al. 2013). Livestock keepers also sold their animals to generate income which was used to meet family food need and other requirements. Unexpectedly, households involved in crop production were significantly more food insecure, HFIAS (coef = 2.55; p = 0.042) by a factor of 2.55 than households without crop production. With the subsistence nature of agriculture in the study area we expected crop production to reduce household food insecurity. This result suggests that engagement in crop production was worsening the household food security situation. The explanation for this situation is high use of poor quality farmer saved seeds by crop producers (92% of rural households were saving their own seeds), prevalent erratic rains and poor soils in the study area contributing to poor yields and perpetrating food insecurity. If farmers use farmer saved seeds consecutively for many years without proper selection and going back to the clean parent material, the quality of the seed goes down. Poor quality seed will lead to poor yields and eventually to household food shortages. Setimela et al (2004) emphasized the importance of quality seeds as the basis for a meaningful agricultural based food production systems. Challenges associated with rain fed agriculture in this region have been reported in other studies (Rockström et al. 2015; Hummel 2015; Kabore and Reij 2004). Growing crops (p = 0.005) and keeping livestock (p = 0.021) was significantly associated with reduction in wasting among children under five years of age. The work of Zezza and Tasciotti (2010:265) based on household survey data for 15 developing or transition countries also found: “fairly consistent evidence of a positive statistical association between engagement in urban agriculture and dietary adequacy indicators”. On the other hand rural livestock production in Tamale reduced the HFIAS significantly ($p<0.05$). This was due to high ownership of livestock in rural areas compared to urban and periurban areas and also households were selling animals to source household food in times of food shortages. In

Rwanda, it is also reported that during the time of genocide in 1994, about half of cattle sales were driven by the need to buy food (Verpoorten 2009). The mean difference of HFIAS were insignificant among crop growers versus non-growers in urban, periurban and rural area ($p<0.005$) in Tamale.

Shortage of land was also identified as a cause of food and nutrition insecurity in Tamale and Ouagadougou besides erratic rains, poor soils and use of poor quality farmer saved seeds. A close look at land tenure systems shows that there are competing land uses between infrastructure development and agriculture in both locations. Strategies used by urban and periurban dwellers in Tamale to cope with these complex tenure systems for food production are: urban–periurban-rural migrant farming and buffer zone farming. Farmers usually move from urban areas to periurban and rural areas in search of land to produce crops to feed their families. There are buffer zones in urban Tamale labelled as disaster zones, not to be converted to residential housing, following a flood that happened in 1989. These lands are government lands belonging to the Ghana Water Company Limited and the Volta River Authority/Northern Electricity Development Corporation. These include Gumbihini old dam, Gumbihini new dam and the former Gumbihini Volta River Authority site (also known as ―"Waterworks"). In Ouagadougou, rural – rural migration during the dry season was observed as a survival strategy in search of land and water to produce crops. Such scenarios were referred by Kuuire et al. (2013:125) as "migrant farming and remit agricultural produce back home".

Food coping strategies vary from one spatial entity to another in terms of frequency, severity and coping strategy indices along the urban – rural continuum. The study identifies five coping strategies as the most severe in times of food insecurity, namely; skipping food for a whole day, borrowing, buying food on credit, consuming seed stock and restricting adult intake in favour of children. Hunting, consuming less preferred food, taking occasional jobs and engaging in small trading were considered as not severe. In both Tamale and Ouagadougou, women were forming critical coping strategies to provide food to the family by involving in trading and doing small jobs. Similar strategies were reported by Floro and Swain (2013) in Bolivia, Ecuador, Philippines and Thailand. In Tamale, due to the cultural social obligation women were observed to play an important role of providing nutritious diets and soup for the family. Variation in food coping strategies from one spatial entity to another in terms of frequency, severity and coping strategy indices can be useful indicators to predict

crisis (early warning), to understand shortfalls in access to adequate food (assessment), to allocate resources (targeting) or to track the impact of interventions (monitoring and evaluation) (Maxwell et al. 2008).

The study shows that food and nutrition insecurity certainly has a socio-spatial dimension that is highly influenced by the degree of urbanity along the urban – rural continuum and is related to urban, periurban and rural agriculture. Understanding how agriculture, food and nutrition insecurity interact and vary along the continuum will play a critical role in addressing urban poverty which often manifests in form of food and nutrition insecurity. The interaction between urban, periurban and rural areas along the continuum, in terms of land use, social and ecological interactions and interactions between the built and unbuilt environment, enhanced access to: food, resources, infrastructure and services. Therefore, the acknowledgement of the concept of an urban – rural continuum in urban planning is critical in addressing the challenges faced by urban dwellers, especially food and nutrition insecurity. The complexity of periurban areas coupled with the scourge of food and nutrition insecurity will require more promotion of periurban agriculture and food policy consideration. Integration of urban and periurban agriculture in city planning and implementation of these plans will eventually improve food and nutrition security of urban dwellers in Africa, especially the urban poor.

9.2 Outlook

The results of this study form the basis of a deeper understanding of the interaction between urban, periurban and rural agriculture and household food and nutrition insecurity in African cities. The approach used in this study helps to better understand the dynamics of household food and nutrition insecurity in different spatial contexts. Both the transect approach and the urban – rural continuum approach help to comprehend the complexity of periurban areas. The transect approach gives the opportunity of including areas and households often excluded in scientific studies, as more accessible areas along major roads tend to be oversampled.

Tamale is located in the Northern region of Ghana, one of the three regions most affected by food and nutrition related challenges. Future research, possibly using the same approaches, could also focus on other regions of Ghana affected by food and nutrition security in northern Ghana, such as the Upper West region and the Upper East region. In both

locations but mostly in Ouagadougou, there was high consumption of starchy staple crops like sorghum, pearl millets, cassava, yams and maize, while at the same time there was souring levels of wasting and stunting of children under the age of five years mostly in periurban areas. Therefore, the introduction of vegetables, especially traditional (indigenous) vegetables which are known to be rich in micronutrients including vitamin A and Iron (Yang and Keding 2009; Kamga et al. 2013) will help to diversify diets in the region. Further research regarding appropriate mechanisms to achieve this is needed.

The study area is part of the Sahel region often affected by droughts, erratic rains and sometimes flooding. Future research should therefore concentrate on climate smart agriculture approaches and its implication to household food and nutrition security.

According to UN-HABITAT (2014), the global share of African urban dwellers is projected to rise from 11.3 % in 2010 to a 20.2 % by 2050, further increasing urban food demand. Cities and surrounding areas are likely to face more challenges related to food and nutrition insecurity and other public health problems. Future research in urban and periurban agriculture should include facets of nutrition sensitive agriculture to help nourish urban dwellers who often engage in agriculture in an endeavour to provide food for their families in the midst of rising urban poverty.

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Appendix 1. Household questionnaire

African-German partnership to enhance resource use efficiency and improve food security in urban and peri-urban agriculture of West African cities

Household questionnaire

Introduction (interviewer/translator):

"Good morning/afternoon. Our names are _____ and _____. We are part of an African-German research team, conducting a survey on food and nutrition insecurity to learn how new agricultural technologies could assist urban and periurban farmers in (Tamale/Ouagadougou). We are not working for government/municipal institutions. We would like to ask you some questions that should take no more than one hour of your time. We would like to understand how food and livestock are grown and used in this region and the issues that you face regarding food production, livestock production and food shortages. Your name will not appear in any data that is made publicly available. The information you provide will be used purely for research purposes; your answers will not affect any benefits or subsidies you may receive now or in the future. Do you consent to be part of this study?

Has consent been given? Yes *(tick)* [ ]

A: Questionnaire information

A1 Questionnaire Nr.: _____

A2 City: Ouagadougou [ ] Tamale [ ]

A3 District_____ A4 Village name _____

A5 Name of household _____

A6 Position on rural-urban gradient: Urban [ ] Periurban [ ] Rural [ ]

A7 Interviewer: _____ A8 Interview date: _____

A9 Sampling unit (grid cell ID): _____ Code: [_ _ _]

A10 GPS coordinates of sampled household: Latitude: _____° N
Longitude: _____° W
Altitude: _____m

A11 Data entered by: _____ A12 Date data entered _ _/_ _/_ _ _

Notes on household and location:

_____

_____

B. Respondent

B1 What is your name?_____

B2 Sex: [ ] male [ ] female

B3 Are you the head of this household? [ ] No [ ] Yes

B 3a If no: how are you related to the head of your household?? _____

B4 How long have you and your household been a resident in this town/location?

._____years and _____months

B5 If moved, where did you live before you moved to this town/location:

_____

C. Household composition

C1a Household head and interviewee

No.	Relationship to interviewee (e.g wife, daughter, father...)	Age **for every person** 1= below schooling age(Less than 3 years) 2 = at school (4 – 20 years) 3 = adult (21 - 59 years) 4 = elderly (Over 60 years)	Sex **of each household member** 1 – M 2 – F	Highest education**(only for household head and interviewee)** 0 – never attended school 1 – primary 2 – secondary 3 – tertiary 4 – attended a Koranic school	Main economic occupation for **adults only** 0 – none (e.g child) 1 – owner farmer 2 – farm wage labourer 3 – non – farm wage labourer (specify) 4 – salaried job (specify) 5 – own business (specify) 6 – other (specify)
1	*Interviewee*				
2	(household head, if different from interviewee)				

C1b Household size: How many people live together with you in this household? (Define household as people who stay under the same roof for at least 3 months of the year and/or usually eat at least one meal daily/regularly together 'from the same pot'.)_____

	Adults(18 years or older)	Children (6 - 17 years)	Children 5 years and below
Females			
Males			

C2 What is your household religion?

Muslim [ ] Christian [ ] mix m+c [ ] mix m/t [ ] mix c/t [ ] mix (all) [ ]

C3 What is your nationality? (ask are you Ghanaian/Burkinabe)

(Nationality is the same as the country of residence) [ ]

[ ] It is another country:_____

C4 To which tribe (ethnical group) does the family belong? _____

D. Housing Situation

D1 Type of housing:

C1a Wall [ ] cement bricks [ ] mud bricks [ ] wooden poles & mud

C1b Roof [ ] Thatched grass [ ] Galvanized iron sheets [ ] cement tiles [ ] Some thatched and some with galvanized sheets [ ] others_____

D2 Does the house have electricity: [ ] No [ ] Yes

D3 Does the house have piped water: [ ] No [ ] Yes

D4 Type of toilet: [ ] bush (free range) [ ] pit latrine [ ] running water flashing [ ] other (specify)

D 5 Do you own this house or rent it: [ ] Own (without title deeds) [ ] Own (with title deeds)

[ ] Rent [ ] Other: _____

D 6 How many rooms are used by the household in total (excluding bathroom): _____

E. Agriculture – Food crops and vegetables

E1 Do you grow any staple foods or vegetables: [ ] No [ ] Yes

E1a If "No", why not: 1. _____

2. _____

3. _____

(proceed to "Section F")

E2 What is the source of your seeds: [ ] save my own seeds [ ] buy from seed dealers

[ ] get from a friend [ ] other (specify)

E3a Please estimate the amount produced in the last wet season (July - November 2013) and the unit price in the nearest shop or market:

Staple food or vegetable crop	Number of units produced	Units (e.g sack, bucket, basin, bowl)	> 50% sold? Yes=1 No=0	Sold where? 1 – farm gate 2 – market (give name) 3 - other (specify)	Sold to whom? 1 – Directly to consumer 2 – to middlemen 3 – others (specify)	Local price per unit	Source of water 1 – rainwater 2 – river 3 – piped water 3 – waste water 4 – dugouts 5 – shallow well 6 – others (specify)

E3b Please estimate the amount produced in the last dry season (December 2013 – June 2014) and the unit price in the nearest shop or market:

Staple food or vegetable crop	Number of units produced	Units (e.g sack, bucket, basin, bowl)	> 50% sold? Yes=1 No=0	Sold where? 1 – farm gate 2 – market (give name) 3 - other (specify)	Sold to whom? 1 – Directly to consumer 2 – to middlemen 3 - other(specify)	Local price per unit	Source of water 1 – rainwater 2 – river 3 – piped water 3 – waste water 4 – dugouts 5 – shallow well 6 – others (specify)

E4 Estimate, what proportion of your household staple foods and vegetables needs are self-grown:

	Nothing	Upto and ¼	Between ¼ upto and ½	Between ½ Upto and ¾	More than ¾	All
Staple foods						
Vegetables						

F. Agriculture – Livestock

F1 Do you own livestock? [ ] Yes [ ] No

(If no go to section G)

Livestock	Count	# Animal sold in the last 12 months	Selling price per animal	# Animal slaughtered for household consumption in the last 12 months
Cattle				
Goat				
Sheep				
Pigs				
Guinea Fowl				
Poultry				
Others				

G. Household Assets, Amenities and Income

G1 Which of the following items is owned by anyone in your household (please mention quantity, where applicable)? Tick as many as are applicable

[ ] Bicycle____[ ] Rubber boots____[ ] Water pump____ [ ] Radio_____

[ ] Motorbike____ [ ] Wheelbarrow____ [ ] Plough_____[ ] TV_____

[ ] Tractor____ [ ] Knapsack (sprayer?)_____ [ ] Mobile phone_____

H. Household Food Insecurity Access Scale – HFIAS

NO	QUESTION	RESPONSE OPTIONS	CODE
H1	In the past four weeks, did you worry that your household would not have enough food? By "household" we mean those of you that sleep under the same roof and take meals together at least four days a week.	0 = No (skip to QH2) 1=Yes	|___|
H1a	How often did this happen?	1 = Rarely (once or twice in the past four weeks) 2 = Sometimes (three to ten times in the past four weeks) 3 = Often (more than ten times in the past four weeks)	|___|
H2	In the past four weeks, were you or any household member not able to eat the kinds of foods you preferred because of a lack of resources? Whenever we say "lack of resources", we mean not having the means to get food, either through growing it, purchasing it, or trading for it. Preferred foods" might include big fish, fruits bought from the market, eggs, meat etc.	0 = No (skip to QH3) 1=Yes	|___|
H2a	How often did this happen?	1 = Rarely (once or twice in the past four weeks) 2 = Sometimes (three to ten times in the past four weeks) 3 = Often (more than ten times in the past four weeks)	|___|
H3	In the past four weeks, did you or any household member have to eat a limited variety of foods due to a lack of resources? A limited variety of foods" might be maize cake (Toa) with dry okra or baobab leaves only	0 = No (skip to QH4) 1 = Yes	|___|
H3a	How often did this happen?	1 = Rarely (once or twice in the past four weeks) 2 = Sometimes (three to ten times in the past four weeks) 3 = Often (more than ten	|___|

		times in the past four weeks)	
H4	In the past four weeks, did you or any household member have to eat some foods that you really did not want to eat because of a lack of resources to obtain other types of food? "A food you really did not want to eat" might include baobab leaves, bulvaka, wild grasses, discarded food, etc. *Food only consumed under hardship*	0 = No (skip to QH5) 1 = Yes	|___|
H4a	How often did this happen?	1 = Rarely (once or twice in the past four weeks) 2 = Sometimes (three to ten times in the past four weeks) 3 = Often (more than ten times in the past four weeks)	|___|
H5	In the past four weeks, did you or any household member have to eat a smaller meal than you felt you needed because there was not enough food?	0 = No (skip to QH6) 1 = Yes	|___|
H5a	How often did this happen?	1 = Rarely (once or twice in the past four weeks) 2 = Sometimes (three to ten times in the past four weeks) 3 = Often (more than ten times in the past four weeks)	|___|
H6	In the past four weeks, did you or any other household member have to eat fewer meals in a day because there was not enough food?	0 = No (skip to QH7) 1 = Yes	|___|
H6a	How often did this happen?	1 = Rarely (once or twice in the past four weeks) 2 = Sometimes (three to ten times in the past four weeks) 3 = Often (more than ten times in the past four weeks)	|___|
H7	In the past four weeks, was there ever no food to eat of any kind in your household because of lack of resources to get food? Did your household ever have no food on hand and there was no way of getting more?	0 = No (skip to QH8) 1 = Yes	|___|

H7a	How often did this happen?	1 = Rarely (once or twice in the past four weeks) 2 = Sometimes (three to ten times in the past four weeks) 3 = Often (more than ten times in the past four weeks)	|___|
H8	In the past four weeks, did you or any household member go to sleep at night hungry because there was not enough food? *By hungry we mean without having had adequate food*	0 = No (skip to QH9) 1 = Yes	|___|
H8a	How often did this happen?	1 = Rarely (once or twice in the past four weeks) 2 = Sometimes (three to ten times in the past four weeks) 3 = Often (more than ten times in the past four weeks)	|___|
H9	In the past four weeks, did you or any household member go a whole day and night without eating anything because there was not enough food?	0 = No (questionnaire is finished) 1 = Yes	|___|
H9a	How often did this happen?	1 = Rarely (once or twice in the past four weeks) 2 = Sometimes (three to ten times in the past four weeks) 3 = Often (more than ten times in the past four weeks)	|___|

H10 Typically, how many meals do members of the household eat per day _____

H11 Are there recurrent periods in a year when your households' income is insufficient to feed the family?

Yes [ ] Specify the Months: _____ No [ ]

H12 What do you think are the causes of food shortages in your household [ ] Shortage of land to produce food [ ] limited support on agricultural inputs from government to produce food [ ] big household size [ ] other (specify)

I. Consumption coping strategy index (CSI)

In the past 30 days, if there have been times when you did not have enough food or money to buy food, how often has your household had to:	Relative Frequency				
	All the time? Everyday	Pretty often? 3-6*/week	Once in a while? 1-2*/week	Hardly at all? <1 */ week	Never? 0*/week
I 1 Rely on less preferred and less expensive foods?					
I 2 Borrow food, or rely on help from a friend or relative?					
I 3 Purchase food on credit?					
I 4 Gather wild food, hunt, or harvest immature crops?					
I 5 Consume seed stock held for next season?					
I 6 Send household members to eat elsewhere?					
I 7 Send household members to beg?					
I 8 Limit portion size at mealtimes?					
I 9 Restrict consumption of adults in order for small children to eat?					
I 10 Feed working members of HH at the expense of non-working members					
I 11 Ration the money you had and buy prepared food?					
I 12 Reduce number of meals eaten in a day?					
I 13 Skip entire days without eating?					
Total					

J. Individual Dietary Diversity ONLY FOR WOMEN AGED 15-49 YEARS
Please describe the foods (meals and snacks) that you ate yesterday during the day and night, whether at home or outside the home. Start with the first food eaten in the morning,

J1. Did you eat anything (meal or snack) outside of the home yesterday?
1. Yes [ ] 2. No [ ]
J2. Was yesterday a special day for you e.g naming ceremony, wedding?
1. Yes [ ] 2. No [ ]
J3. Were you sick yesterday? 1. Yes [ ] 2. No [ ]
J4. Age_____

	Name of dish	Ingredients and Description	Remarks
Example:	**Benga**	Beans, rice, potasse/ash, oil, salt, tomato, onion, fish or meat	
Before breakfast			
Breakfast			
Snack before lunch			
Lunch			
Snack before dinner			
Dinner			
Snack after dinner			
Drinks			

When the respondent recall is complete, fill in the food groups based on the information recorded above. For any food groups not mentioned, ask the respondent if a food item from this group was consumed.

Question Number	Food group	Examples	YES=1 NO=0
J5	CEREALS	corn/maize, rice, wheat, sorghum, millet or any other grains or foods made from these (e.g. bread, noodles, porridge or other grain products) + local foods e.g. sakabo, porridge or paste	
J6	WHITE ROOTS AND TUBERS	white potatoes, white yam, white cassava, or other foods made from roots	
J 7	VITAMIN A RICH VEGETABLES AND TUBERS	pumpkin, carrot, squash, or sweet potato that are orange inside + other locally available vitamin A rich vegetables (e.g. red sweet pepper)	
J8	DARK GREEN LEAFY VEGETABLES	dark green leafy vegetables, including wild forms ones + locally available vitamin-A rich leaves such as bra, amaranth(alefu), cassava leaves, cowpea leaves, onion leaf, etc.	
J9	OTHER VEGETABLES	other vegetables (e.g. tomato, onion, eggplant, Okra) + other locally available vegetables	
J10	VITAMIN A RICH FRUITS	ripe mango, , sheanut fruits, watermelon, sumbala, cantaloupe, apricot (fresh or dried), ripe papaya, dried peach, and 100% fruit juice made from these + other locally available vitamin A rich fruits	
J11	OTHER FRUITS	other fruits, including wild fruits and 100% fruit juice made from these pineapple, apple, ebony fruits, blackberry, cashew fruits,	
J12	ORGAN MEAT	liver, kidney, heart or other organ meats or blood-based foods	
J13	FLESH MEATS	beef, pork, lamb, goat, rabbit, game, chicken, duck, other birds, insects	
J14	EGGS	eggs from chicken, duck, guinea fowl or any other egg	
J15	FISH AND SEAFOOD	fresh or dried fish or shellfish, yurayura (keta school boys)	
J16	LEGUMES, NUTS AND SEEDS	beans, peas, lentils, nuts, seeds, groundnuts, cowpea, soybean, bambara beans, pigeon peas, cashew nut, Bungu (sesami), neri (melon seeds) or foods made from these	
J17	MILK AND MILK PRODUCTS	milk, cheese, yogurt or other milk products	

J18	OILS AND FATS	oil, fats or butter added to food or used for cooking	
J19	SWEETS	sugar, honey, sweetened soda or sweetened juice drinks, sugary foods such as chocolates, candies, cookies and cakes	
J20	SPICES, CONDIMENTS, BEVERAGES	spices (black pepper, salt), condiments (soy sauce, hot sauce), coffee, tea, alcoholic beverages	
J21	RED PALM PRODUCTS	Red palm oil, palm nut or palm nut pulp sauce	
Individual level	Did you eat anything (meal or snack) OUTSIDE the home yesterday?		

K. Anthropometric measures ONLY FOR CHILDREN UNDER 5 YEARS

	K1 Height-cm (for children 24 months and above)	K2 Length-cm (for children 0 – 23months)	K3 Weight (kg)	K4 Age Years and Months	K5 Sex 1 – Male 2 - Female
Youngest child among the under 5 years					

(Examine documentary evidence of the birth date (such as birth, baptismal certificate, clinic care or maternity book)

L. Do you have any other comments to make about your life as a farmer and food security of your household?

This is the end of the survey. Thank you very much for your participation!

Would you be willing to participate in further focus group discussions?

Yes [ ] No [ ]

If yes, please provide us with your contact details (mobile no.):_____

Thank you very much for your patience!

Appendix 1. Focus group discussion (FGD) guide

Internal Information

A: Information about the FGD

A1 FGD Id:_____ A2 No. of participants:_____ A3 Date:_____
A4 Time:_____
A4: Assistant/Translator:_____

B: Information about the location

B1 Name:_____ B2 Zone (e.g. urban_north)_____
B3 GPS Point: Latitude_____ Longitude_____

Introduction (5 minutes)

- My name is…
- I am a student, I am not working for the government, so I cannot offer you any help
- Research Project GlobE/Urban Food Plus
    - African-German Cooperation; partners in Tamale: University for Development Studies
    - Food Security, urban and rural area
- No right or wrong answers (no test), all opinions are important, active participation
- Important rule: everyone can speak, please do not interrupt, respect all opinions
- Translator -> important to translate everything in detail
- During the discussion I will take notes and audio-record, because I can't write down everything. Is that ok for you?
- Any questions? Willing to go on? -> You can ask questions at any time!

Definition household: *"People eating out of one pot"*
Synonym of severe: grave, fatal, bad, hard, tough, arduous, heavy

Introduction (5 minutes)

A1: To start, I would like to get to know everyone in the group. So if you could tell me your names and I will put them on the list of participants. *[Ps know each other (same village)]*

A. Coping strategies and frequency (30 minutes)

B1: In the last 30 days, what did you do when you did not have enough to eat or money to buy food?

B2: How is that strategy applied? (Give details)

B3: Why is that strategy chosen?

B4: In times of food insecurity, how often is this strategy applied in one week?

[repeat these questions for all strategies they mention]

B5: You have mentioned many different strategies now. Have you ever done … in case of not enough food or money to buy food?

[Comparison with generic list of CS]

Be aware of differences (age, gender and ethnicity)
Do different people apply different CS with different frequency?

C. Severity (15 Minutes)

<table>
<tr><td rowspan="2">C1: Which of the CS are very bad (value 4), which are least (value 1)? Which are in between?</td><td>C1a: First select the most grave and the least grave individual strategies.
[refer to sheet with CS, add numbers: 1=not severe, 4=very severe]</td></tr>
<tr><td>C1b: Are the other strategies of more or less the equivalent in terms of how hard they are?

Aim: Group CS into categories of roughly the same severity
[very severe, severe, moderate, not severe]</td></tr>
<tr><td rowspan="2">C2: What does it mean if a strategy is very bad?</td><td>C2a: Consequences of CS</td></tr>
<tr><td>C2b: Perceptions of CS
What does it mean to you/your household?
What does it mean to others/ neighbours/ friends?
What disturbs you?
What worries you?</td></tr>
</table>

Appendix 2. Photos - Tamale

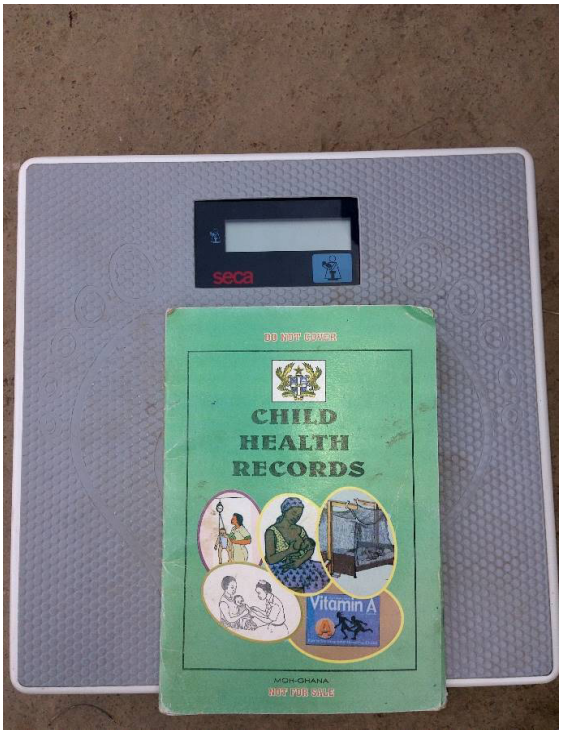

Photo 1: Child health record and Seca scale Tamale

Photo 2: Mother – baby weighing approach (SPT – *South Periurban Transect*)

Photo 3: Child birth certificate and Seca scale

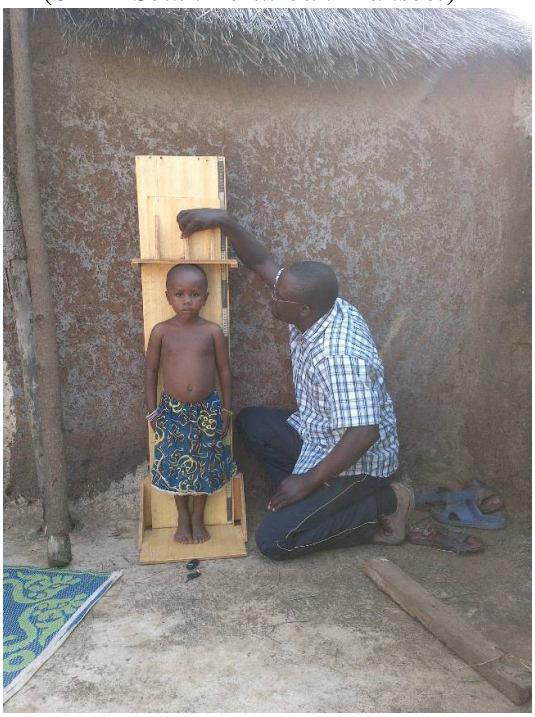

Photo 4: Measuring height of children over 2 years. (EPT – *East Periurban Transect*)

Appendix 2. Photos - Tamale

Photo 5: Measuring weight (WPT – *West Periurban Transect*)

Photo 6: Measuring length of children under 2 years (NUT – *North Urban Transect*)

Photo 7: Woman sorting dry okra (NRT – *North Rural Transect*)

Photo 8: Girls helping in shear butter processing (NPT – *North Periurban Transect*)

Appendix 2. Photos - Tamale

Photo 9: Cassava harvesting in rural areas (WRT – *West Rural Transect*)

Photo 10: Mixed local sorghum variety harvested (WRT – *West Rural Transect*)

Photo 11: Boiled roselle *(Hibiscus sabdariffa)* (NRT – *North Rural Transect*)

Photo 12: Processed dawa dawa *(Parkia biglobosa)* (SPT – *South Periurban Transect*)

Appendix 3. Photos - Ouagadougou

Photo 1: Fresh cut okra
*(*NRT – *North Rural Transect)*

Photo 2: Woman sorting jute mallow
(WRT – *West Rural Transect*)

Photo 3: Land degradation in periurban area (NPT – *North Periurban Transect*)

Photo 4: Donkey carts taking firewood from rural areas to urban areas (NRT – *North Rural Transect*)

Appendix 3. Photos - Ouagadougou

Photo 5: Periurban okra production (SPT – *South Periurban Transect*)

Photo 6: Rosell and roundnuts intercropping (WRT – *West Rural Transect*)

Photo 7: Urban livestock keeping (NUT – *North Urban Transect*)

Photo 8: Use of drought animal power in rural Areas (SRT – *South Rural Transect*)

Appendix 3. Photos - Ouagadougou

Photo 9: Shea nut fruits *(Vitellaria paradoxa)* Photo 10: *Nyoo* – cowpea leaves and maize

Photo 11: Sesami field (NRT – *North Rural Transect*)

Photo 12: Pearl millet field with a heavily harvested baobab tree (SRT – *South Rural Transect*)

Appendix 4: Curriculum vitae

Name: Takemore Chagomoka
Address: 3969 Tywald North
Harare
Zimbabwe
Email: tchagomoka@yahoo.co.uk
Date of birth: 7 April 1976
Place of birth: Marondera, Zimbabwe
Languages: Shona (proficient user/mother tongue), English (proficient user), French (independent user), Kiswahili (proficient user), Portuguese (basic user), German (basic user)
(*) Languages levels are based on Common European Framework of Reference for Languages

Education:

2013 - 2016	**Phd Student** Thesis title: Food and nutrition insecurity risk mapping (FNIRM) in urban and periurban areas in West African cities (Tamale and Ouagadougou).	University of Freiburg, Germany
2007 - 2009	**M. Sc in Strategic Management (Merit)** Thesis title: The use of communities by seed companies in seed production in developing countries. A case of Zimbabwe.	Chinhoyi University of Technology, Zimbabwe
2002 - 2006	**B. Sc Agriculture Management (Upper Second)** Thesis title: Effects of intercropping sorghum *(Sorghum bicola)* and cowpeas *(Vigna unguiculata)* on grain yield in Zhombe communal area of Zimbabwe.	Zimbabwe Open University, Zimbabwe
1999 - 2001	**Diploma in Agriculture (First Class)**	Gwebi College of Agriculture, Zimbabwe

International Graduate Academy, University of Freiburg courses attended

2014	Hands-on course on data analysis and statistics	Facilitated by Dr. Björn Schelter
2015	Advanced statistics and time series analysis	Facilitated by Dr. Björn Schelter
2015	Scientific writing	Facilitated by Dr. Helen Desmond
2015	Good scientific practice	Facilitated by Dr. Michael Gommel
2015	How to give successful scientific talks	Facilitated by Dr. Matthias Mayer
2015	The power of the voice - public speaking	Facilitated by Ulrike Semmelrock
2015	Slidewriting and storylining: optimize your own academic presentation	Facilitated by Dr. Markus Burger

Other training:

2014	Web course: Learning ArcGIS Desktop (for ArcGIS 10)	ESRI Training
2010	A1 & A2 French DELF Diploma	Alliance Franco Tanzanienne d'arusha, Tanzania
2012	Certificate of Participation Planning, Monitoring, Evaluation and Impact assessment of R & D interventions training workshop.	Conducted by Impact Training and Development Institute South Africa in **Tainan, Taiwan**
2011	Certificate of Completion Project Management	Conducted by MDF South Asia, Hosted by IRRI In **Dar es Salaam, Tanzania**
2009	Certificate of Attendance Result Based Management (RBM)	Conducted by Baastel in **Arusha, Tanzania**
2007	Certificate of Completion Vegetable Seed Production and Marketing	Conducted by AVRDC - The World Vegetable Center in **Arusha, Tanzania**
2006	Certificate of participation Agribusiness marketing and management Cape Town, South Africa	Conducted by Stellenbosch University (S.A) and Cornell University (U.S.A) in **Cape Town, South Africa**
2005	Certificate in maize breeding for stress and Quality Protein Maize	Conducted by CIMMTY in **Nairobi, Kenya**
2005	Certificate in maize seed and soil technology	Conducted by CIMMYT in Harare, Zimbabwe
2004	Certificate of participation Agribusiness marketing and management	Conducted by Stellenbosch University (S.A) and Cornell University (USA) in **Cape Town, South Africa**
2003	Certificate of Competence Training Manager	Conducted by Q-Partnership in **Harare, Zimbabwe**
2003	Certificate of Competence Training of Trainers in Responsible Use of Pesticides	Conducted by Croplife, Africa Middle East in **Harare, Zimbabwe**

Employment:

June 2013 to 2016	PhD student at University of Freiburg, **Germany**
February 2011 to May 2013	Liaison Officer for Cameroon & Seed Business Specialist, AVRDC Yaoundé, **Cameroon**
December 2008 to January 2011	Seed Marketing Specialist, Vegetable Breeding and Seed Systems (vBSS), AVRDC Arusha, **Tanzania**
November 2007 to November 2008	Managing Director, Semente Perfieta, Chimoio, **Mozambique**
January 2006 to October 2007	General Manager, Pristine Seeds P/L, Harare, **Zimbabwe**
July 2004 to December 2005	Operations Manager, Pristine Seeds P/L and Pymarc Manufacturing, Harare, **Zimbabwe**
April 2003 to April 2004	Field Officer, Agricultural Ethics Assurance Association of Zimbabwe, Harare, **Zimbabwe**
September 2001 to March 2003	Technical Sales Representative, Agricura Private Limited Harare, **Zimbabwe**
September 1999 to September 2000	Trainee Farm Manager, Hopedale Farm, Bindura, **Zimbabwe**
July 1997 to August 1997	Temporary Geography and Agriculture Teacher, Theydon Secondary School Marondera, **Zimbabwe**

Honours and awards:

2013	Awarded a PhD scholarship under the GlobE – Urban Food^{Plus} Project	From Federal Ministry of Education and Research (BMBF)
2012	Recognition for increasing funding base and operations of the Center in Cameroon	From AVRDC – The World Vegetable Center
2010	Recognition for performance and excellence as a Vice-Chairman of Research Operations Committee during the Agricultural Show in Tanzania	From AVRDC – The World Vegetable Center
2001	Agricultural and Rural Development Authority (ARDA) Shield and Prize (Best student in Crop Husbandry Project)	From Gwebi College of Agriculture
2001	Lilford Shield and Edward Hwara Prize (Best all round student at Practical)	From Gwebi College of Agriculture
2001	Pfizer Animal Health Trophy and Prize (Best student in Animal Health)	From Gwebi College of Agriculture

Project management experience:

I was involved in coordinating the following projects at AVRDC – The World Vegetable Center:

Understanding How to Achieve Impact-at-Scale through Nutrition-focused Marketing of Traditional African Vegetable (TAVs) and Orange-Fleshed Sweet potatoes (OFSP).	AVRDC - The World Vegetable Center, Coordinator.
Improving human nutrition and income through integrated agricultural research on production and marketing of vegetables in Malawi and Mozambique – SSA Challenge Project.	AVRDC - The World Vegetable Center, Coordinator.
Scaling up farmer-led seed enterprises for sustained productivity and livelihoods in Eastern and Central Africa.	AVRDC - The World Vegetable Center, Coordinator.
Livelihoods, Urbanisation and Natural Resources in Africa (LUNA Project).	AVRDC - The World Vegetable Center, Coordinator.
Enhancing horticultural productivity, incomes and livelihoods through integrated management of aphid pests on vegetables in sub-Saharan Africa – IITA/GTZ Aphid Project.	AVRDC - The World Vegetable Center, Coordinator.

Proposal development experience – Funded projects:

I participated in proposal development of the following funded projects:

Enhancing productivity, competitiveness and marketing of onion in the Sudano-Sahelian region of Cameroon	Funded by IFAD and Cameroon Government (2012 – 2014)
African-German partnership to enhance resource use efficiency in urban and peri-urban agriculture for improved food security in West African cities	Funded by BMBF and BMZ (2013 – 2016).
Livelihoods, Urbanisation and Natural Resources in Africa (LUNA Project II)	Funded by Volkswagen Foundation (2014 – 2016)

Publications:

Peer reviewed journal articles

Chagomoka T, Afari-Sefa V and Pitoro R. (2014). Value Chain analysis of Traditional vegetables in Malawi and Mozambique. *International Food and Agribusiness Management Review*; 17 (4): 57-83: http://www.ifama.org/files/IFAMR/Vol%2017/Issue%204/201400443.pdf

Abang A F, Srinivasan R, Kekeunou R, Hanna R, **Chagomoka T**, Chang J C and Bilong Bilong C F. (2014). Identification of okra (Abelmoschus spp.) accessions resistant to aphid (Aphis gossypii Glover) in Cameroon. *African Entomology*; 22 (2): 273-284: http://dx.doi.org/10.4001/003.022.0201

Afari-Sefa, V., **Chagomoka, T**., Karanja, D.K., Njeru, E., Samali, S., Katunzi, A., Mtwaenzi, H. and Kimenye, L. (2013). Private contracting versus community seed production systems: experiences from farmer-led seed enterprise development of indigenous vegetables in Tanzania. *Acta Hort.* (ISHS) 1007:671-680. Available http://www.actahort.org/books/1007/1007_78.htm

Kamga, R. Tchientche; Kouamé, C.; Atangana, A. R.; **Chagomoka, T** and Ndango, R. (2013). Nutritional Evaluation of Five African Indigenous Vegetables. *Journal of Horticultural Research*. Volume 21, Issue 1, Pages 99–106, ISSN (Online) 2300-5009, DOI: 10.2478/johr-2013-0014, July 2013. Available http://dx.doi.org/10.2478/johr-2013-0014

Kamga A, Kouamé C, Tchindjang M, **Chagomoka T** and Drescher A W. (2013). Environmental impacts from overuse of chemical fertilizers and pesticides amongst market gardening in Bamenda, Cameroon. *Revue Scientifique et Technique Forêt et Environnement du Bassin du Congo*; 1: 6-19.

Books

Chagomoka T, Kamga R, Tenkouano A and Mecozzi M. (2014). Traditional Vegetables: Recipes from Cameroon. AVRDC – The World Vegetable Center. Shanhua, Taiwan. (download: http://avrdc.org/download/publications/recipes/Cameroon%20cookbk_Eng_web1.pdf

Book of abstracts

Chagomoka T, Kamga R, Drescher A and Schlesinger J. (2013). Indigenous vegetable recipes in Cameroon. **In**: Hall, R. A., P. Rudebjer, and S. Padulosi. (eds.) 2013. 3rd International Conference on: Neglected and Underutilized Species (NUS): for a Food-Secure Africa. Accra, Ghana, 25-27 September 2013. Book of Abstracts. Bioversity International, Rome, Italy. P 122.

Conference presentations

Chagomoka T, Nchanji EB, Bellwood-Howard I, Glaser R, Schareika N, Drescher AW and Schlesinger J. (2015). Gender, Land Tenure, Food and Nutrition Insecurity in Northern Ghana. Tropentag conference, 16 – 18 September 2015, **Berlin, Germany.**

Nchanji EB, Bellwood-Howard I, Schareika N, Glaser R, Drescher AW, **Chagomoka T** and Schlesinger J. (2015). Land Use Changes and its Implication for Food Security and Sustainability in Northern Ghana. Tropentag conference, 16 – 18 September 2015, **Berlin, Germany**

Nchanji EB, Bellwood-Howard I, **Chagomoka T** and Schareika N. (2015). Excessiveness? Cabbage farmer's reality in Urban Tamale, Northern Ghana. 2e Congrès de l'A fea (Association française d'ethnologie et d'anthropologie), University of Toulouse-Jean Jaurès, France, 29 June - 2 July 2015, **Toulouse, France.**

Chagomoka T, Drescher A W, Glaser R and Schlesinger J (2015). Women dietary diversity scores and anthropometric measurements as indices of nutrition security along the urban – rural continuum in Northern Ghana. 2nd International Congress Hidden Hunger. 3 – 6 March 2015, **Stuttgart, Germany.**

Chagomoka T, Schlesinger J and Drescher1 A, (2014) Urban and periurban agriculture and its implications on agroecosystem resilience, food and nutrition security. Submitted for First International Conference on Enhancing Resilience to Climate and Ecosystem Changes in Semi-arid Africa. 6 -8 August 2014, **Tamale, Ghana.**

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Membership

African Association of agricultural economists - September 2013 – August 2016

Scholarly/Professional Service:

External Reviewer for Scholarly Journal (Requested Volunteer Task)

Reviewer for *PLOS ONE:* April 2015

Reviewer for Food & Nutrition Research: August and September 2015

Reviewer for Land - MDPI AG: August 2015

Reviewer for Population and Environment: February 2016