FACULTY OF AGRICULTURAL SCIENCES

Institute of Crop Science
Section of Crop Physiology of Specialty Crops
University of Hohenheim

Supervisors: **Prof. Dr. Jens Norbert Wünsche** †
Prof. Dr. Regina Birner

The role of home gardens in mitigating food insecurity and dietary quality: The case of the Mbororo community in the Northwest Region of Cameroon

Dissertation

submitted in fulfillment of the regulations to acquire the degree "Doktor der Agrarwissenschaften"
(Dr.sc.agr. in Agricultural Sciences)

To the
Faculty of Agricultural Sciences
presented by

Pride Anya Ebile
Born in Victoria, Cameroon

University of Hohenheim

2021

This thesis was accepted as a doctoral thesis (Dissertation) in fulfilment of the regulations to acquire the doctoral degree "Doktor der Agrarwissenschaften by the Faculty of Agricultural Sciences at University of Hohenheim on 03.12.2021

Date of the oral examination: 26.1.2022

Examination Committee

Chairperson of the oral examination	Prof. Dr. Uwe Ludewig
Supervisor and Reviewer	Prof. Dr. Regina Birner
Co-Reviewer	Prof. i.R. Dr. Michael Krawinkel
Additional examiner	Prof. Dr. Christian Zörb.

Dedications

This doctoral thesis is dedicated to you, Diotima. Thank you for the sacrifices that you have made over the years. Believe me; I know what you are going through.
This thesis is also dedicated to my parents, Mr. Ebile Sylvester of blessed memory, and Mrs. Angwi Pauline for all the support and encouragement from childhood.

Acknowledgments

I thank Prof. Dr. Jens Norbert Wünsche for believing in me from our first meeting. You gave me a chance without even knowing me; for that, I am grateful. You were not only my supervisor; you were a mentor, teacher, and a father. You taught me how to trust myself and you were always frank. I am blessed to have come across you in my life. I highly appreciate your support through this journey and beyond. I know you are watching me from above, thank you.

I am also grateful to Prof. Dr. Regina Birner; you are always there by mail or in person to give your support over all these years. Once again you are here as always, it means a lot to me, and I appreciate all you have done for me. Special thanks also go to Prof. i.R. Dr. Michael B. Krawinkel to accept being one of the principal examiners.

Special appreciation goes to Dr. Andrea Fadani of the Fiat Panis foundation. You took time to shape the home garden project on which I based doctorate research.

Thank you, Dr. rer.agr. Hycenth Tim Ndah, you help shape me and my work in a short time.

I thank my siblings and family, for being patient with me over the years; I am grateful. I know we are scattered all over the place like Amino often puts it.

To my colleagues at the Institute of crop science section of crop physiology of specialty crops, one word: AWESOME. Best group of people to work with.

Many thanks to my family and friends for your financial, moral, technical, and academic support, I appreciate all your efforts and support.

To the Eco-garden team, I am here because of the hard work you guys did. Thank you; Ukeme Okon Archibong, Nadia Foy, Sigrun Wagner, Foncham Linda Konnant, Ramata Raman, and Kidio Eris Ndim.

Special appreciation goes to all the institutions that supported me financially and technically. The Food Security Center at the University of Hohenheim, Fiat Panis foundation, PROTUS, Stiftung Entwicklungs-Zusammenarbeit (SEZ), and MBOSCUDA.

Table of contents

List of Figures

List of Tables

List of abbreviations

DAAD	German Academic Exchange Service
DDS	Dietary Diversity Scores
FAO	Food and Agriculture Organization of the United Nations
FSC	Food Security Centre
HIV/AIDS	Human immunodeficiency virus infection and acquired immunodeficiency syndrome
MBOSCUDA	Mbororo Social and Cultural Development Association
MUAC	Mid-Upper Arm Circumference
NGO	Non-Government Organizations
NSA	Nutrition-sensitive agriculture
NWR	North West Region

Chapter 1

1 General Introduction

The Ph.D. work was two-fold. First, the introduction and implementation of a home garden project within the Mbororo minority community of the Northwest Region in Cameroon. Second, research on nutrition and micronutrient deficiency within the Mbororo minority community, and the potential of the home garden to mitigate food and nutrition insecurity challenge within the context of nutrition-sensitive agriculture.

1.1 Problem statement, justification, and objectives

Micronutrient deficiencies, also known as hidden hunger, are an acute problem in developing countries, and this adds to the burden of food insecurity with long-term developmental consequences (Haselow et al., 2016). Recent reports from the International Food Policy Research Institute have stressed that micronutrient deficiency-related ailments are a challenge to mitigate as many people are not aware that they are deficient in these nutrients (Grebmer et al., 2014). The same report by Grebmer et al. (2014) stated that an estimated 2 billion people suffer from micronutrient deficiencies, and most of these people are found in rural communities. The impact of hidden hunger is high in many minority communities, such as the Mbororo minority community of Cameroon, as most minority communities are marginalized (Jessica et al., 2013; Pelican, 2008). People in minority communities do not have equal access to basic infrastructures such as clean water, clinics, and even markets to buy food as their counterparts in the same locality (Freedman & Bell, 2009). In the Mbororo minority community, their nomadic and semi-nomadic lifestyle increases their vulnerability to food and nutrition insecurity (Amadou, 2017). According to Amadou (2017), the Mbororos are in daily conflict with neighbouring farmers as cattle are

their primary source of their livelihood and the availability of grazing land has been reduced over time due to increased farming activities and longer dry seasons. A lack of access to clinics and health-centers puts the Mbororo women and children who are deficient in micronutrients, such as iron, vitamin A, iodine, and zinc, at high risk of malnutrition (Haselow et al., 2016). It is estimated that 190 million children and 19 million pregnant women suffer from vitamin A deficiency, and over 1.62 billion people are anemic due to iron deficiency (Alzaheb & Al-Amer, 2017; Low et al., 2017).

Despite data indicating the negative impact of micronutrient deficiencies on women and children, many governments in developing countries rank other ailments such as malaria and HIV/AIDS at the top of their policy agenda, with micronutrient deficiencies given less attention (Tulchinsky H Theodore, 2010). Though much has been done to combat other forms of malnutrition like under-nutrition with programs to increase caloric intake in rural communities in Africa; little has been done in the case of micronutrient-related ailments (Frison et al., 2011). Little data is available to aid nutrition stakeholders with implementation interventions in rural communities. The negative impact of micronutrient deficiency does not only limit maternal and infant morbidity and mortality but, as Ruel & Alderman (2013) have demonstrated, malnutrition is strongly inversely correlated to the gross national product. Thus, it is imperative to seek community-based solutions to micronutrient deficiencies in rural minority communities. However, as Ramakrishnan et al., (2001) puts it, “the challenge facing nutritionist and other professionals in the field of health is to identify strategies to prevent malnutrition that is economically feasible in rural communities.”

One of the community-based solutions proposed to combat food and nutrition insecurity is the food-based approach. Under the food-based approach is the concept of nutrition-sensitive agriculture (NSA) intervention, with examples such as bio-fortification of cultivated crops, agricultural training, inputs, irrigation, poultry production, and home gardening. Home gardens as an NSA intervention have demonstrated to increase income, food availability, and vitamin A levels

in the population of benefiting communities (Berti et al., 2016; Faber & Jaarsveld, 2007; Hannah Jaenickea, 2013). However, a recent study by Osei et al. (2017) to appraise the nutrition effects of garden interventions has found little or no impact.

The current Ph.D. work introduced, implemented, and coordinated a home garden project as a food-based nutrition-sensitive intervention within the Mbororo minority community of the Northwest Region of Cameroon. Furthermore, the Ph.D. work assessed if the project impacted the food and nutrition situation of the beneficiaries and came up with a possible explanation that might help similar interventions in developing countries.

1.2 Theoretical concepts and background

The following section outlines theoretical concepts and provides a background to this study to help readers understand and interpret the empirical research documented in the subsequent chapters.

1.2.1 Food and nutrition insecurity

Food security is a situation 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 (FAO, 2010). There are four main pillars to food security (availability, access, use and utilization, and stability). If any of these pillars is not satisfied, a person is said to be food insecure. Nutrition security, however, is achieved when secure access to an appropriately nutritious diet is coupled with a sanitary environment, adequate health services, and care to ensure a healthy and active life for all household members (FAO et al., 2018). Food security is a subset of nutrition security, as shown in Figure 1.1. The framework in Figure 1.1 shows the differences (with a small dotted triangle) between food security and nutrition security.

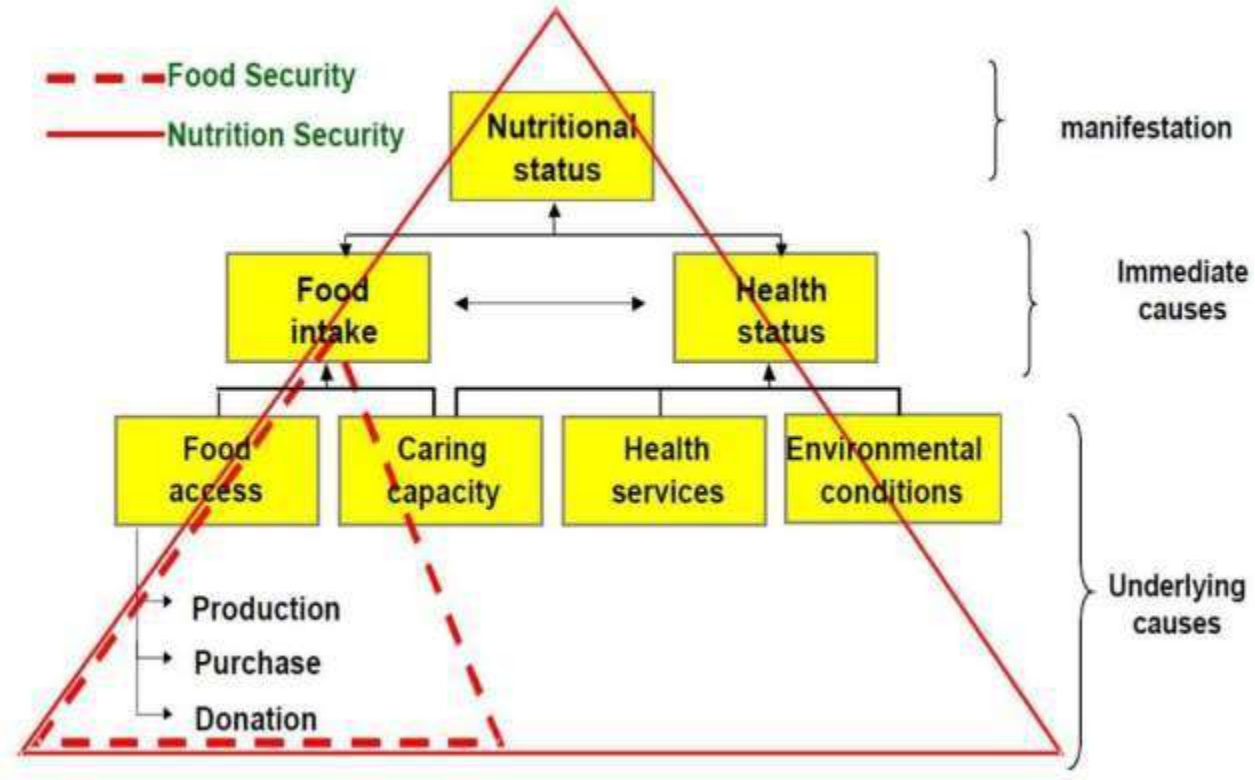

Figure 1.1: *Framework presenting food security as part of nutrition security, and the type of causes of nutritional insecurity. (Source: Gross et al. (2000)*

The framework in Figure 1.1 suggests that nutrition status can be divided into food intake status and health status. The food intake component is further subdivided into food access and caring capacity, while health status can be subdivided into health services and environmental conditions. Underlying causes of nutritional insecurity include determinants such as household food security, care for mothers and children, while immediate causes include determinants such as micronutrient deficiencies (FAO, 2020b). The underlying and immediate causes can be used to assess nutritional status. Nutrition insecurity can be measured using indicators such as mid-upper arm circumference for hunger (MUAC), while iron deficiency can be indicated by anemia, and night blindness by vitamin A deficiency (Gross et al., 2000).

Chapter 1

A global report on food crises in 2020 by the Food and Agriculture Organization of the United Nations (FAO) has shown that weather extremes such as droughts and floods, economic shocks such as high rates of unemployment, and conflicts such as internal violence, are the principal drivers of acute food insecurity (FAO, 2020a). According to this FAO report, the number of people battling acute hunger and suffering from malnutrition is on the rise yet again, reaching 123 million, with more than half of the affected in Africa.

Figure 1.2: *The distribution of the number of acutely food-insecure people in around the world. The size of the cycle reflects the proportion affected people. (Source: GRFC 2020)*

Many countries lack reliable and timely data to accurately estimate the magnitude and severity of food crises gripping vulnerable populations (FAO, 2020a). Cameroon, for example, has enjoyed several years of stability as it is rich in natural resources. However, recently, the country has been grappling with conflicts in the Far North, Northwest, and Southwest regions that has increased the food and nutrition insecurity of the country (FAO, 2020a). It is thus urgent to assess the food and nutrition situation of the country, especially in rural minority communities such as the Mbororo, to guide nutrition interventions.

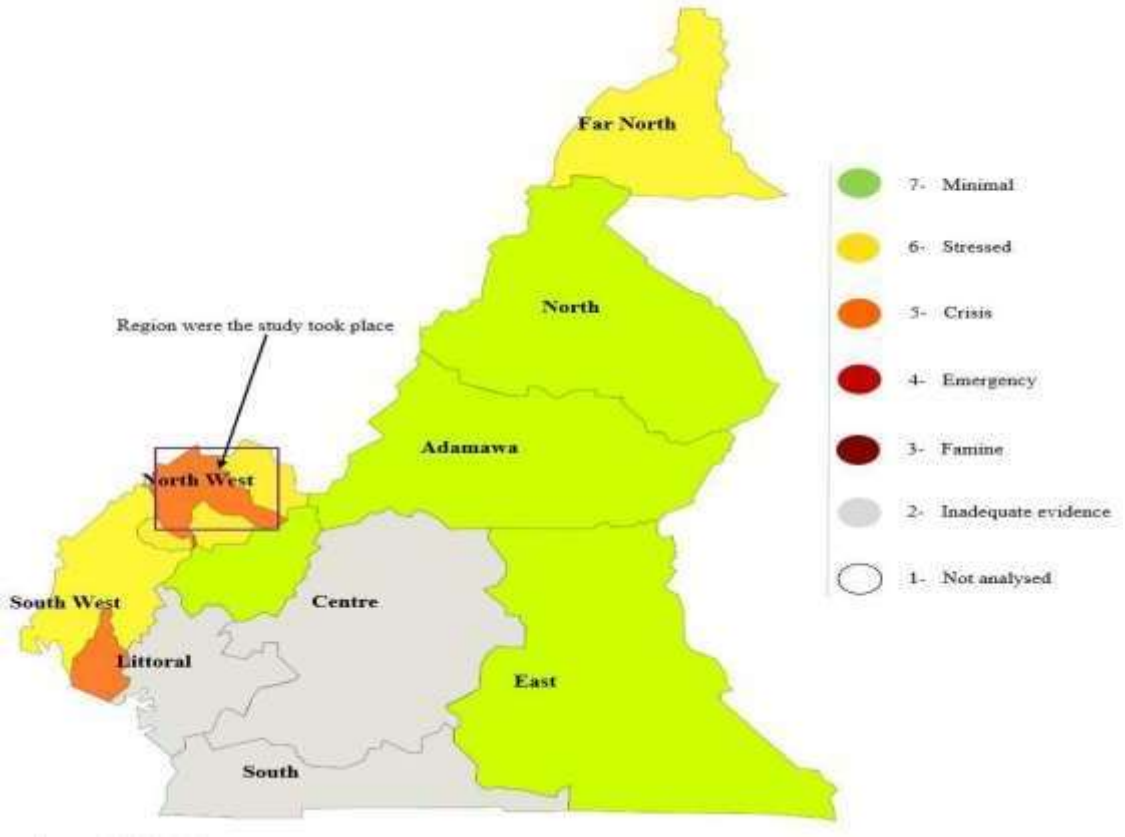

Figure 1.3: *Acute food insecurity situation in the different regions in Cameroon. The different colors indicate the severity of the condition in the regions. NWR is both a stressed and crisis region. June-August 2019. (Source: GRFC 2020)*

Both the home garden project documented by the Ph.D. study and the research work were implemented in the NWR (6°20′N 10°30′E) of Cameroon, with the project headquarters situated in Bamenda - one of the regions under stress and in crisis

(Fig. 1.3). The annual rainfall in the project area ranged from 1500 to 2000 mm, according to Neba (2009), while yearly temperatures range from 13 to 25°C (Nformi et al., 2014). The food and nutrition insecurity of the region has only deteriorated as the aforementioned conflicts have continued.

1.2.2 Malnutrition and micronutrient deficiencies

According to the World Health Organization (WHO), malnutrition refers to "deficiencies, excesses, or imbalances in a person's intake of energy and/or nutrients" (Tang et al., 2017). The term malnutrition covers conditions such as 'undernutrition' (low height for age), wasting (low weight for height), underweight (low weight for age) and micronutrient deficiencies or hidden hunger (Anna et al., 2015; Black et al., 2013; Osei et al., 2017). Overweight is a diet-related non-communicable disease, which is yet another form of malnutrition that can result in heart disease, stroke, diabetes, and cancer (Befort et al., 2012). The multiple forms of malnutrition, often referred to as the "triple burden" of malnutrition, have added to the challenge of food insecurity and hunger in developing countries (Gómez et al., 2013). However, the main focus of this Ph.D. thesis is micronutrient deficiencies or hidden hunger.

Micronutrients such as vitamins and minerals are not produced in the body but must be derived from the diet and are essential for well-being and disease prevention in humans (Anna et al., 2015; Booth & Smith, 2001; Kennedy et al., 2010). Micronutrient deficiencies have devastating consequences, especially on pregnant women and children, resulting in ailments such as blindness, measles, anemia, and babies with low birth weight (Black et al., 2013; Habib et al., 2016). Iron, vitamin A, zinc, and iodine are essential micronutrients required to maintain a healthy body. However, over 2 billion people suffer from micronutrient deficiencies such as vitamin A and iron (Alzaheb & Al-Amer, 2017; Islam et al., 2016; von Grebmer et al., 2014). As micronutrients are mostly obtained from the diet, and most rural communities do not have health clinics to help with

supplementation in the case of deficiencies, this study explore a food-based approach to fight micronutrient deficiencies in the Mbororo minority community in Cameroon.

1.2.3 Food-based interventions, nutrition-sensitive agriculture

Agriculture is the primary driver of food, employment, and the main source of income in many poor rural communities (Muhanji et al., 2011). Therefore, agriculture and food systems should be at the center of addressing food and nutritional insecurity. According to the FAO, "food-based interventions focus on food - natural processed, fortified, or in combination - as the primary tool for improving the quality of the diet and for overcoming and preventing malnutrition and nutritional deficiencies" (Thompson, 2007). This approach is based on community involvement in the design and implementation of programs that sustainably increase the production and consumption of nutrient-rich food to support community livelihood (Haddad, 2000). In the case of this study, the focus was on home gardens. Nutrition-sensitive agriculture (NSA) interventions are an important food-based approach. NSA interventions are mostly implemented through participatory appraisal and are community-centered to promote the empowerment of resource-poor communities (Osei et al., 2017). NSA interventions place nutrient-dense foods, food fortification, and dietary diversity at the core of overcoming malnutrition and micronutrient deficiencies (FAO, 2014). NSA interventions promote strategies such as biofortification of cultivated crops production, agricultural training, inputs, irrigation, poultry production, and home gardens (Fiorella et al., 2016). Dietary diversity and home gardens are a central part of NSA interventions and critical to this Ph.D. study.

1.2.4 Dietary diversity

Dietary diversity is defined as the number of different foods or food groups consumed over a given reference period, and it is a qualitative measure of food consumption that reflects access to a variety of foods, therefore, a proxy for nutrient adequacy of the diet of individuals (Kennedy et al.,2010). In this Ph.D. study, dietary diversity scores (DDS) were used to calculate household and individual levels of dietary diversity. Studies have shown that increased dietary diversity is associated with socioeconomic status and household food security (Hoddinott & Yohannes, 2002; Setting et al., 2018). DDS were used to examine the nutritional situation of the Mbororo people, and to test if the home garden intervention under study influenced the nutritional status of the beneficiaries.

1.3 Home gardens and the garden project

Home gardens are small-scale horticultural production systems and sometimes combined with

animal production supplying plants for household consumption (Galhena et al., 2013). This horticultural production system has been a successful way of increasing production, consumption, and income of the rural people, thereby enhancing family nutrition and supporting livelihoods (Gotor & Martin, 2013). Gotor and Martin (2013) noted that, even with the small size, home gardens harbor high biodiversity and can improve nutritional diversity and enhance the livelihood of rural communities. Home gardens have been initiated in countries such as Nepal, Bangladesh, and Cameroon as a tool to fight vitamin A deficiency, alternative source of income, and mitigate poverty (Osei et al., 2017; Patalagsa et al., 2015; Schipani et al., 2002; Weinberger, 2013). Based on their results, the home garden project in this study was initiated in 2017.

The home garden project was named the "Eco-Sustainable Gardens Empowering Mbororo Minority Women." The project was funded by the Stiftung Entwicklungs-Zusammenarbeit (SEZ) through the Association for the Promotion of Teaching and Research for the Tropics and Subtropics at the University of Hohenheim e.V. (PROTUS). The project was a collaboration between the Department of crop science and crop physiology of specialty crops at the University of Hohenheim and the Mbororo Social and Cultural Development Association (MBOSCUDA). The specific aim of the project was to improve on the nutrition and income of the indigenous Mbororo women. The home garden project was initially budgeted to construct home gardens for 60 Mbororo women in 3 communities. However, in the end, the project established home gardens for 114 women in 7 communities as Mbororo men provided material support such as fencing material which helped to reduce the costs of implementing the project. The project gardens included three groups of vegetables: Nutrient-rich (e.g. amaranth, garden egg, okra, and chinese cabbage), high-value (e.g. chili-pepper, waterleaves, and fluted pumpkin), and indigenous vegetables (e.g. jute mallow, "folere," and "caricachee"). Details of the home garden project challenges, potentials, and the outcome are assessed in subsequent chapters.

1.4 The Mbororo community

The Mbororo community is an indigenous minority group often referred to as "a prime example of a stranger population" in Cameroon (Pelican, 2011). The Mbororo are part of the fulbe ethnic group spread over the Sahel in Africa, and in Cameroon, they are divided into the Aku and Jaafun sub-tribes (Pelican, 2008). In the NWR, they make up about 10 % of the population with pastoralism constituting the primary means of livelihood (Pelican, 2012). The Mbororo are found in all the

seven divisions of the NWR since the vegetation is mostly savanna grass, and the highlands are favorable for livestock grazing (Nformi et al., 2014).

1.5 Agricultural risks

Risk is the threat of loss or damage caused by an unfavorable event or other variables to which one is exposed, where the event is uncertain (Kahan & Worth, 2018b). In other words, agricultural risks relate to the probability of a damaging event, such as drought, and the foreseeable consequences of such an event on the food system (Yassin, 2011). As Yassin (2011) notes, risks can be assessed by combining the probability of a consequence and its magnitude. Internal conflicts and climatic changes manifestations through droughts and floods have weaken the food system of many sub-Saharan countries resulting in widespread human, material, economic or environmental losses (Kahan & Worth, 2018a). In sub-Saharan Africa, conflict alone resulted in losses of almost US$52,000 million in agricultural output between 1970 and 1997, and this figure has only increased over time (FAO, 2003). According to a policy brief on information systems in Cameroon, the frequency of occurrence of endemic diseases, price fluctuations, flooding, and drought in Cameroon affects the production and marketing of major crops such as banana, tomatoes, cassava, and cocoa (CEIGRAM/VISAVET, 2016). The situation in Cameroon has worsened due to violence in the Northwest and Southwest Regions of the country, prompting the country to be rated amongst countries most at risk of sliding further into crisis (WFP, 2020).

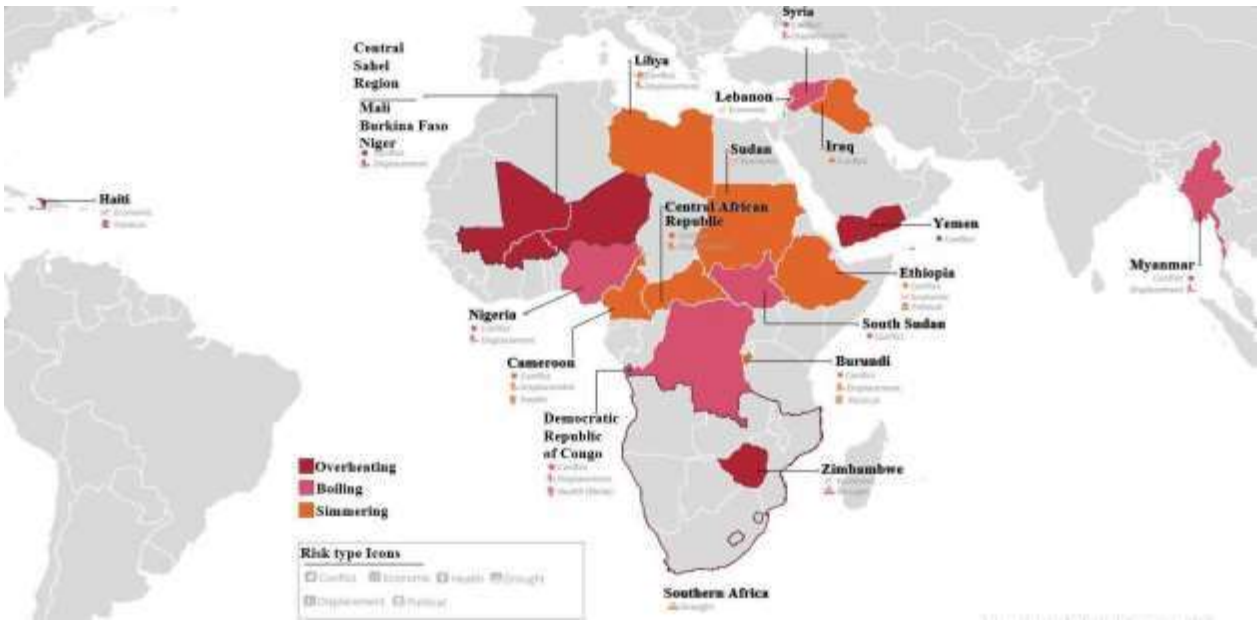

Figure 1.4: *Countries most at risk of sliding into crisis around the world, and Cameroon is one of the global hotspots facing health, conflict, and displacement challenges. (Source: WFP 2020)*

Cameroon, as shown in Figure 1.4, is one of the global hotspots facing conflicts, displacement, and health issues. Projections by the World Food Program in 2020 indicated that 1.1 million people in Cameroon were at risk facing food insecurity by the end of the year, with over 600,000 of these in Northwest and Southwest Regions (WFP, 2020). Given that risks such as conflicts have increased the food and nutrition insecurity in Cameroon, it was deemed critical to assess agricultural risk within the garden project and propose management strategies. Given that limited data is available in facilitating nutritional interventions in developing countries (Anna et al., 2015), the food and nutrition insecurity situation of minority communities such as the Mbororo minority community of the Northwest Region of Cameroon was unknown prior to this Ph.D. study being implemented. No nutritional studies such as dietary diversity and household food insecurity access had previously been carried out to assess the diet quality in this community. Minority communities have been shown to have limited access to basic health infrastructure such as hospitals and clinics that provide nutrient-deficient women and children with nutrition supplements such as vitamin A and iron (Freedman & Bell, 2009). It is critical to examine the potential of a food-based approach to nutrition such as home gardens to provide these nutrients in minority communities as an alternative to health infrastructures. However, like any agricultural intervention, home gardens are bound to encounter some challenges.

Chapter 1

Agricultural risks, especially with recent climate change, manifested through irregular rain and droughts, challenge food-based nutritional interventions such as home gardens. Thus, it is vital to assess this region's agricultural risk to improve the effective implementation of an intervention such as home gardens since there is no available data. Based on these gaps, the following objectives were developed for this thesis.

The specific objectives were:

1 To evaluate the dietary inadequacies of the Mbororo community in the NWR through the dietary diversity score and examine which socioeconomic characteristics affect their nutrition.
2 To assess the garden project for the potential to mitigate food and nutrition insecurity of the beneficiaries through the provision of food, income, and nutrient-rich vegetables for home consumption.
3 To assess the different agricultural risks such as environmental, personal, and market risks that might hinder the effective implementation of the home garden project and other agricultural activities within the community.

1.6 Publications

This doctoral thesis consists of three publications. One of these articles published already (article I) and two submitted (article II and III) in peer reviewed academic journals. Additionally, two other articles were published in conference proceedings, but will not form part of this thesis. In the following chapters, each publication in the peer reviewed academic journals is presented in one chapter. Within each chapter the reference system, figure style and language (American or British English) was applied according to the authors guidelines of the journal to which the publication was submitted.

Article I: Ebile, P.A., Ndah, H.T. and Wünsche, J.N. (2020), "Assessing nutrient inadequacies and influence of socio-economic characteristics on diet quality of the Mbororo minority women in Northwest Cameroon", Nutrition & Food Science, Vol. ahead-of-print No. ahead-of-print. https://doi.org/10.1108/NFS-07-2020-0265

Article II: Ebile, P.A and Wünsche, J.N. (Submitted to Journal of Agroecology)

Home gardens for mitigating food and nutrition insecurity of the Mbororo minority community in Cameroon.

Article III: Ebile, P. A., Ndah, H. T., & Wünsche, J. N. (2021). Agricultural risk assessment to enhance the food systems of the Mbororo minority community in the Northwest region of Cameroon. *Journal of Agriculture and Rural Development in the Tropics and Subtropics (JARTS), 122*(2), 207-217.

Chapter 2

2 Assessing nutrient inadequacies and influence of socio-economic characteristics on diet quality of the Mbororo minority women in Northwest Cameroon[1]

21 Abstract

Purpose – Limited data are available in facilitating nutritional interventions in developing countries. The objective of this study is to assess the mean dietary diversity score (DDS)of Mbororo minority women in the Northwest region of Cameroon.

Design/methodology/approach – The study used the random sampling technique within the Mbororo minority communities (Adorates). A questionnaire on dietary diversity, including 461 Mbororo women, provided information on food consumed using the 24-h dietary recall method.

Findings – Various socio-cultural and economic characteristics of the Mbororo women affected the nutrient level of their diet. Moreover, starchy staples, vitamin-A rich vegetables and palm oil and milk and milk products were consumed by more than half of the Mbororo community. Family herd size showed a positive influence on the dietary habit of the Mbororo population. The mean DDS significantly increased ($p = 0.001$), as herd size increased from below 50 (3.961.1) to above 100 (4.861.2).

Practical implications – Most of the diet consumed by the Mbororo women were low in iron, making them susceptible to nutrition anemia. The diet of the Aku women was more deficient in micronutrients than their Jaafun counterpart. These results indicate suitable areas of intervention for any nutrition program that targets the Mbororo minority group of Northwest Cameroon.

Social implications – DDS can be used in assessing and classifying the population in rural communities according to the deficiencies in micronutrients of their diet.

[1] Published in the Journal of Nutrition & Food Science by Pride Anya Ebile, Hycenth Tim Ndah, Jens Norbert Wünsche, 2020

Originality/value – The use of DDS to assess the nutrient quality of diets is frequently used to evaluate the prevalence of micronutrient deficiencies but has never been applied to Mbororo minority women.

Keywords Nutrition, Dietary diversity, Micronutrient deficiencies

This article should be cited as: Ebile, P.A., Ndah, H.T. and Wünsche, J.N. (2020), "Assessing nutrient inadequacies and influence of socio-economic characteristics on diet quality of the Mbororo minority women in Northwest Cameroon", Nutrition & Food Science, Vol. ahead-of-print No. ahead-of-print. https://doi.org/10.1108/NFS-07-2020-0265

22 Introduction

An estimated 2 billion people around the world suffer from micronutrient deficiencies or hidden hunger and other forms of malnutrition that are related to low intake of essential vitamins and minerals, and this is a challenge for most developing countries (Sibhatu et al.,2015). Though national and international agencies have been working on combatting nutritional insecurity, precise information to aid direct interventions is lacking (Herforth et al., 2015). According to the Food and Nutrition Technical Assistance of the United State Agency for International Development, there is insufficient information on dietary patterns and diet quality of women in many developing countries. Poor dietary diversity not only constitutes a health problem to women but also has development implications on the available working force (Nupo et al., 2013). Consequently, accurate information is essential to address nutritional insecurity in the world and particularly in developing countries.

Chapter 2

This paper focused on the Mbororo indigenous community in Northwest Cameroon, which is characterized by vulnerability to food availability, nutritional insecurity and marginalization of political affiliation and economic development (Pelican, 2008). As an indigenous minority group, the Mbororo community is often referred to as "a prime example of a stranger population" (Pelican, 2011) and this makes it difficult for its inhabitants to have access to basic facilities like food and clean water as opposed to other groups of people in the same locality. Being mostly agro-pastoralist, the Mbororo people depend on cattle as their main source of income. Nevertheless, increasing population pressure and the effects of climate change with longer dry seasons and irregular rains, threaten this source of livelihood for them (Pelican, 2012; Wilhite et al., 2011), leading to other cumulated problems such as the farmer–grazer conflicts around the inhabited region (Nformi et al., 2014).

The study highlighted the dietary diversity score (DDS) as a qualitative measure of food consumption that reflects household access to a variety of food items and nutrient adequacy. Kennedy et al. (2010) reported that DDS has been validated for any age/gender group as proxy measures for macro and micronutrient adequacy of the diet. Moreover, Azadbakht and Esmaillzadeh (2011) used the DDS to show a relationship between diet and obesity among female students at Isfahan University, demonstrating that the higher is the DDS, the lower is the association with obesity. In another study, Azadbakht et al. (2006) established an inverse relationship between cardiovascular risk and DDS, showing that participants with high dietary diversity had a lower cardiovascular risk. These studies all established clear links between dietary diversity and disease incidence. Summarizing the published results on dietary diversity as an indicator of nutrient adequacy in diet, Rani et al. (2010) concluded that "the dietary diversity questionnaire can be a useful tool to give a good indication of nutritional inadequacy of the diet in resource-poor settings."

Diet–disease relationship is just one facet of the usefulness of the DDS. Yohannes and Hoddinott (2002) revealed that DDS is a good measure of household access to food as they found it to be associated with increased food consumption and caloric availability at the household level. Furthermore, DDS has been used to demonstrate that the higher the score the higher the per capita income and caloric energy available to the household (Bwibo and Neumann, 2003). Koppmair et al. (2016) indicated that specific socio-economic characteristics such as education, input technologies and market access could boost the DDS. This score can provide an overview of the essential micronutrient status of communities and individuals and links the degree of food diversity to capital income. Consequently, a DDS questionnaire formed the basis for this study with particular reference to the women minority group of the Mbororo community in Northwest Cameroon.

Limited data are available on micronutrient deficiencies of the Mbororo minority community in the Northwest region of Cameroon. The objectives of this study are as follows:

_ assess the DDS of Mbororo women;
_ highlight the prevalence of micronutrient deficiencies within the region;
_ compare the mean DDS between sub-tribes and among divisions within the region; and
_ assess socio-economic and cultural effects on the nutrient inadequacy.

This study helps to not only raise awareness of micronutrient deficiencies of the women in this community but also makes informed policies and interventions on the nutritional situation of the Mbororo people.

23 Methods

2.3.1 Study location and setting

The Northwest region of Cameroon is divided into seven divisions that are subdivided into 34 sub-divisions. The present study covered all but two sub-divisions since they had no Mbororo communities. The region is located 6°200N and 10°300E and covers an area of about 17,300km^2 with an approximate population of 1.9 million. Agriculture is the principal economic activity (Schrieder and Knerr, 2000) of this region, and its grasslands remain favorable for cattle production and thus attracted the Mbororo tribe to settle here since they are mostly cattle owners (Pelican, 2008). The region is mostly covered by savanna vegetation with an annual rainfall of 1500mm to

2000mm from mid-March to mid-October, while annual temperatures range from 13 to 25°C (Nformi et al., 2014).

2.3.2 Data collection methods

In each of the 32 Mbororo sub-division, one Ardorate (village) was randomly selected and in total 461 Mbororo women at age greater than 15 years were surveyed using an adapted standard FAO dietary diversity questionnaire (Kennedy et al., 2010). In addition, a total of six focus group discussions, each with seven to ten women, were conducted in different Mbororo sub-divisions to identify their traditional and indigenous foods. The women were asked to enumerate food types they usually eat and food types that are present in their communities. An audio recording was used to collect information that was later transcribed and analyzed. Moreover, twelve key informant interviews were conducted with members of the Mbororo Social and Cultural Development Association, the heads of the village called Ardos and household heads that were women. The questions asked were centered around nutritional intervention programs within the Mbororo community.

Specifically, data on the women's DDS were collected using the 24-h dietary recall method (Nupo et al., 2013). The women were asked to recall what food items (e.g. meals, snacks and drinks) they had for the previous 24 h and recording the appropriate food group in the questionnaire (Kennedy et al., 2010). Using one 24-h recall period does not necessarily indicate an individual's habitual diet; however, it provides an assessment of the diet at the population level (FAO, 2007). Despite the use of various recall timeframe for up to one month, the FAO prefers the 24-h recall because it is less cumbersome for the respondent, less subjected to error, and it is used in many DDS studies (FAO, 2007).

The DDS questionnaire is tailored to determine micronutrient inadequacy of the diet in households or by individuals. Nutrition inadequacy occurs when the nutrient intake is less than the nutrient requirement of individuals or at population level (Castro-Quezada et al., 2014). The standard FAO dietary diversity questionnaire has listed 16 food groups for assessing individual and household dietary diversity. The food groups 14, 15 and 16 (oils, fats, sweets, spices, condiments, beverages) are only used when assessing household DDS, thus they were excluded since the focus of the current study was on individual DDS. In addition, local and indigenous foods were integrated into the 13 food groups (Table 2.1). These 13 food groups were then pooled to create nine food groups, which

are best suited for analyzing dietary diversity data of individuals (Kennedy et al., 2010).

Table 2.1: *Thirteen food groups and food examples of the Mbororo people for determining individual dietary diversity.*

Food groups	Food examples
Cereals	Corn/maize, rice, wheat, sorghum, millet, bread, noodles, porridge, spaghetti. local foods, e.g., fufu corn, Koki corn, fufu akra, corn pap, and pufpuf, cornchaff, biscuit
White roots and tubers	Potatoes, yam, cassava, irish potato, cocoyam, white carrot, gari, water fufu, akra cassava, cassava flour, potato flour, potato chips, fufu cassava ("kumkum"), achu, bobolo, plantain
Vitamin-A rich vegetables and tubers	Pumpkin, carrot, sweet potato
Dark green leafy vegetables	Fluted pumpkin, "anchia," huckleberry, bitter-leaves, amaranth, cassava leaves, "folere" chinese cabbage, cabbage, cowpea, pumpkin leaves, "lalo" "caricachee," cocoyam leaves, green beans, broccoli, carrot greens, chili green, lettuce,
Other vegetables	Onion, tomatoes, green, celery, waterleaf, cucumbers, leeks, lettuce, mushroom, green beans, okra, leaks, eggplant, red cabbage red sweet pepper
Vitamin a rich fruits	Mango, cantaloupe, apricot (fresh or dried), papaya, peach, passionfruit, 100% fruit juice made from these fruit crops
Other fruits	Apple, avocados, bush mango, pineapple, Adam fruit, Chinese apple, watermelon, wild berries, banana, tangerine, oranges, guava, lemonade, orange, grape, coconuts flesh
Meat organ	Beef and lamb livers, kidney, heart or other organ meats or blood-based foods
Fresh meat	Beef, pork, lamb, goat, rabbit, game, chicken, duck, other birds, Insects, dog, cow meat, rat mole, squirrel, bush fowl, snake
Eggs	Eggs
Fish and seafood	Fresh or dried fish or shellfish, mudfish, crayfish
Legumes, nuts and seeds	Beans, dried peas, lentils, nuts, groundout, soya beans, cowpea, foods made from these: peanut butter, soya beans milk, groundnut sweets, groundnut soup, beans sauce, cornchaff, koki beans
Milk and milk products	Milk, cheese, yogurt, butter

Notes*: Some of the food groups were pooled for improved representation of the dietary diversity: 1 and 2 to starchy staples; 3 and 6 to other vitamin A-rich fruit and vegetables, including red palm products; 5 and 7 to other fruit and vegetables and 9 and 11 to meat and fish*

2.3.3 Data processing and analysis

The dietary diversity of the Mbororo women was computed in the different subdivisions and in the two sub-tribes (Jaafun and Aku). The DDS was then calculated by adding the number of food groups consumed by an individual during the past 24 h as described by Nupo et al. (2013). The mean of all individual DDS reflects the population DDS.

To assess the effect of sub-tribe, sub-division and socio-cultural and economic characteristics on the DDS of the Mbororo women, the non-parametric tests (Mann–Whitney U test and Kruskal Wallis H test) were used. A chi-square test was done to explore any differences between sub-tribal proportions of foods consumption. Data has been analyzed using SPSS software (version 22 IBM, Armonk, NY, USA). The differences were considered significant at $P \leq 0.05$.

2.3.4 Ethics

The study protocol received ethical clearance from the Ethical review committee of the University of Bamenda Northwest region Cameroon. The protocol was assigned the identification number 2018/0054UBa/FHS/IRA approved on 20/07/2018. Furthermore, informed consent was obtained from all respondents during data collection.

2.4 Results

2.4.1 Socio-cultural and economic characteristics of the Mbororo women and the effect on dietary diversity

The Mbororo women displayed a variety of characteristics that may affect the nutrient level of their diet. Table 2 shows the various socio-cultural and economic characteristics of the Mbororo women. While farm ownership, herd size, the source of food and transhumance significantly affected the mean DDS, other characteristics such as marriage, polygamy, educational level and primary source of income had no significant effect on mean DDS.

It was noticeable that 96.1% of the women were married, with 56.4% being in polygamous marriages. Nearly half of the women were illiterate, whereas those with some formal education had completed primary school (27.1%) and Quranic school (13.3%) and only 0.4% received higher education at university (Table 2.2). The results also showed that less than half of the women cultivated crops (42.1%) and purchased most of their food items (51.5%). The practice of transhumance was still being carried out by 79% of the Mbororo people. The results indicated that

the primary source of income for most women is from their husbands (66.8%), which might make it difficult for them to access food since most do not farm crops. Findings on per capita income showed a positive influence on nutrition because the mean DDS significantly ($p < 0.001$) increased as herd size increased from herd size below 50 (3.961.1) to herd size between 50 and 100 (4.561.1) and, finally, to herd size above 100 (4.861.2). Moreover, the primary source of food procurement, the ability for transhumance and the farm ownership had significant effects on the mean DDS.

Table 2.2: *Effects of socio-cultural and economic characteristics on the mean dietary diversity score of Mbororo women (n = 461)*

Tested characteristics		Mean dietary diversity score ± standard deviation	P-values	%
Married[1]	Married	4.2 ± 1.2	0.87	96.1
	Not Married	4.3 ± 1.4		3.9
Widow[1]	Widow	4.0 ± 1.1	0.08	18.5
	Not widow	4.3 ± 1.1		81.8
Polygamy[1]	Polygamy	4.2 ± 1.3	0.15	54.4
	Not polygamy	4.3 ± 1.1		43.6
Educational level[2]	No education	4.1 ± 1.2	0.17	47.6
	Elementary	3.9 ± 0.9		2.8
	Primary school	4.3 ± 1.1		27.1
	Secondary school	4.8 ± 1.6		4.6
	High school	4.6 ± 1.1		2.0
	University	4.0 ± 1.4		0.4
	Quranic school	4.1 ± 1.3		13.3
	Others	4.4 ± 0.7		2.2
	Own production	4.5 ± 1.2 a*	0.006	42.1
	Purchased	4.0 ± 1.3 b		51.5

Tested characteristics		Mean dietary diversity score ± standard deviation	P-values	%
The primary source of food procurement[2]	Borrowed, bartered, exchanged for labor	4.0 ± 1.2 b		2.2
	Food aid	4.5 ± 0.7 a		0.4
	Others	4.3 ± 1.1 a		3.7
The primary source of income[2]	Husbands	4.2 ± 1.2	0.56	66.8
	Crop production	4.3 ± 1.3		7.2
	Milk sale	4.3 ± 1.1		2.6
	Labor	3.8 ± 1.3		5.4
	Animal sale	4.4 ± 1.3		8.1
	Remittance	4.3 ± 1.3		7.8
Transhumance[1]	Go for transhumance	4.3 ± 1.2 a	0.02	79
	Do not go transhumance	4.0 ± 1.3 b		21
Improve paddocks[1]	Have paddocks	4.2 ± 1.3	0.33	46.4
	Do not paddocks	4.2 ± 1.2		53.6
Family herd size[2]	Below 50	3.9 ± 1.2 c	0.001	45.3
	Between 50 & 100	4.5 ± 1.1 b		35.9
	Above 100	4.8 ± 1.2 a		18.8
Have farms[1]	Have farms	3.7 ± 1.2 b	0.001	33.3
	No farms	4.5 ± 1.2 a		66.7

Notes: *[1]Kruskal Wallis H test or [2]Mann–Whitney U test were used to assess the effect of the various sociocultural and economic characteristics. * Means followed by the same letter (a, b and c) in each characteristic do not differ significantly ($p \leq 0.05$)*

2.4.2 Assessment of the mean dietary diversity scores and comparison of sub-populations

A comparison of the mean DDS of the two Mbororo sub-tribes indicated that the diet diversity of the Jaafun women was higher than that of the Aku women (Table 2.3). Moreover, the mean DDS of the Mbororo women in the different divisions was highly significant ($p < 0.001$) with both Boyo and Menchum divisions having the lowest diet diversity whereas that of the Donga Mantung and Mezam divisions was the highest (Table 2.3).

Table 2.3: *Effect of sub-tribes and regional divisions on the mean dietary diversity score of Mbororo women (n = 461)*

Parameter		Mean dietary diversity score ± standard deviation	P-value	%
Sub-tribes[1]	Aku	3.9 ± 1.2 b*	0.024	23.4
	Jaafun	4.3 ± 1.2 a		76.6
Divisions[2]	Boyo	3.9 ± 1.1 bc	0.001	10
	Bui	4.4 ± 1.1 ab		20
	Donga Mantung	4.5 ± 1.3 a		10.6
	Mezam	4.4 ± 1.3 ab		21.7
	Menchum	3.5 ± 1.2 c		10.2
	Momo	4.2 ± 1.3 ab		13.9
	Ngo-Ketunjia	4.3 ± 1.2 ab		13.6

Notes: *[1]Kruskal Wallis H test or [2]Mann–Whitney U test were used to assess the effect of sub-tribes and divisions. * Means followed by the same letter (a, b and c) in each parameter do not differ significantly ($p \leq 0.05$)*

The mean DDS for each of the seven divisions are visualized in a map by using low to high-density shade, corresponding to low to high DDS, respectively (Figure 2.1).

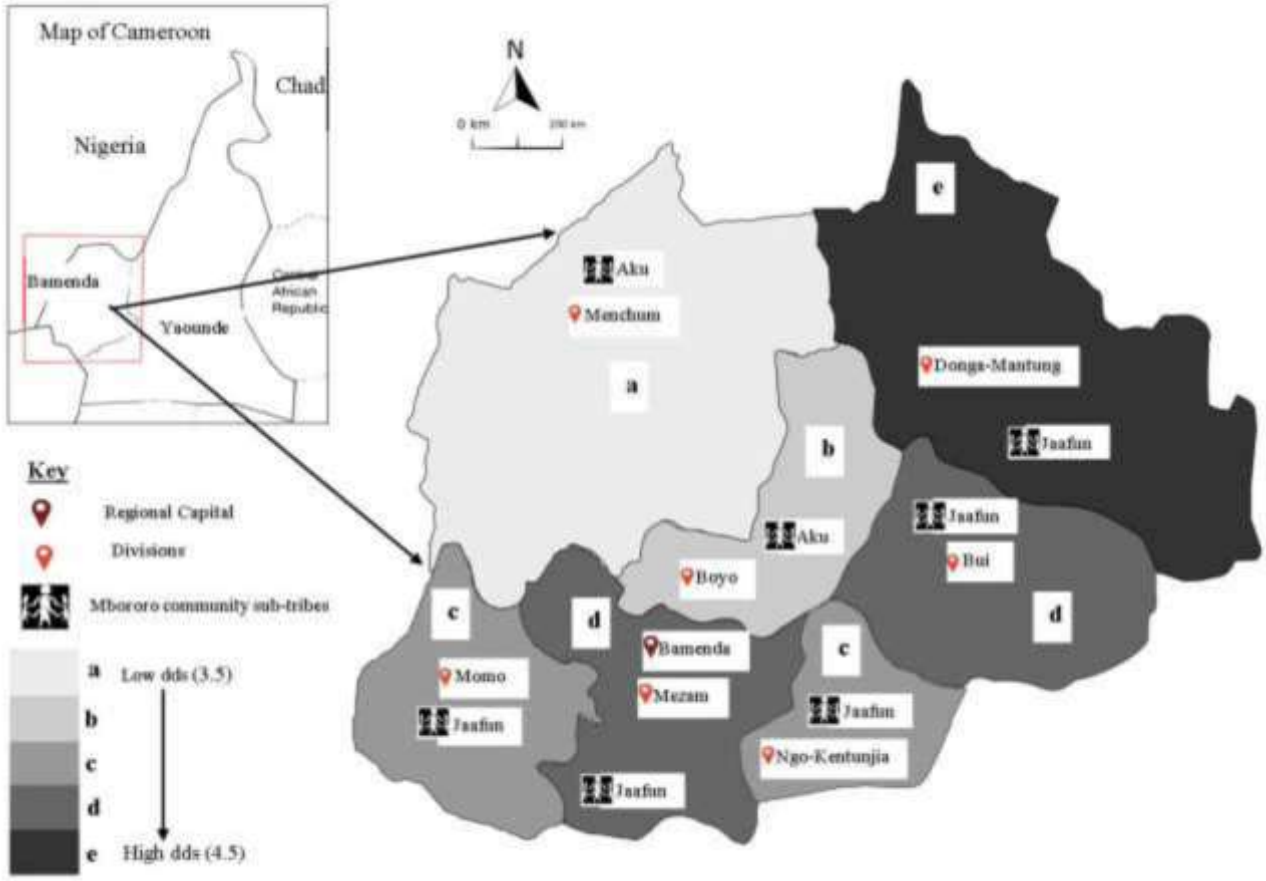

Figure 2.1: *Distribution of the mean diet diversity score of the Mbororo women (n = 461) in North-West Cameroon. (Source: Author's own)*
Note: *The mean DDS is indicated by different shade intensities, ranging from low to high (a-e) and denoted by the 3.5 to 4.5 score range.*

2.4.3 Consumption of food groups by Mbororo women within sub-tribes

The percentages of Mbororo women consuming different food groups in the two sub-tribes are shown in Figure 2.2. Only three food groups were consumed by more than half of the Mbororo community: starchy staples such as maize and cassava, vitamin-A rich vegetables and palm oil as well as milk and milk products.

The focus group discussions revealed that the Mbororos prepare maize in many different ways as for example it was converted to corn flour for fufu, boiled fresh and processed to bean and corn stew. The high value for vitamin A food group is largely due to the consumption of red palm oil that was used for daily cooking of most foods. Interestingly, though the Mbororo kept cattle, animal-source foods rich in iron such as meat organs were consumed by only 6.5% of the population. In contrast, legumes, nuts and seeds as well as dark green leafy vegetables were consumed by about 40% of the population while other fruit and vegetable did not contribute to a large extent to the diet diversity. The Aku subtribe population consumed all food groups to a lesser extent than the Jaafun sub-tribe population, except for meat organs as for example heart, liver and kidney.

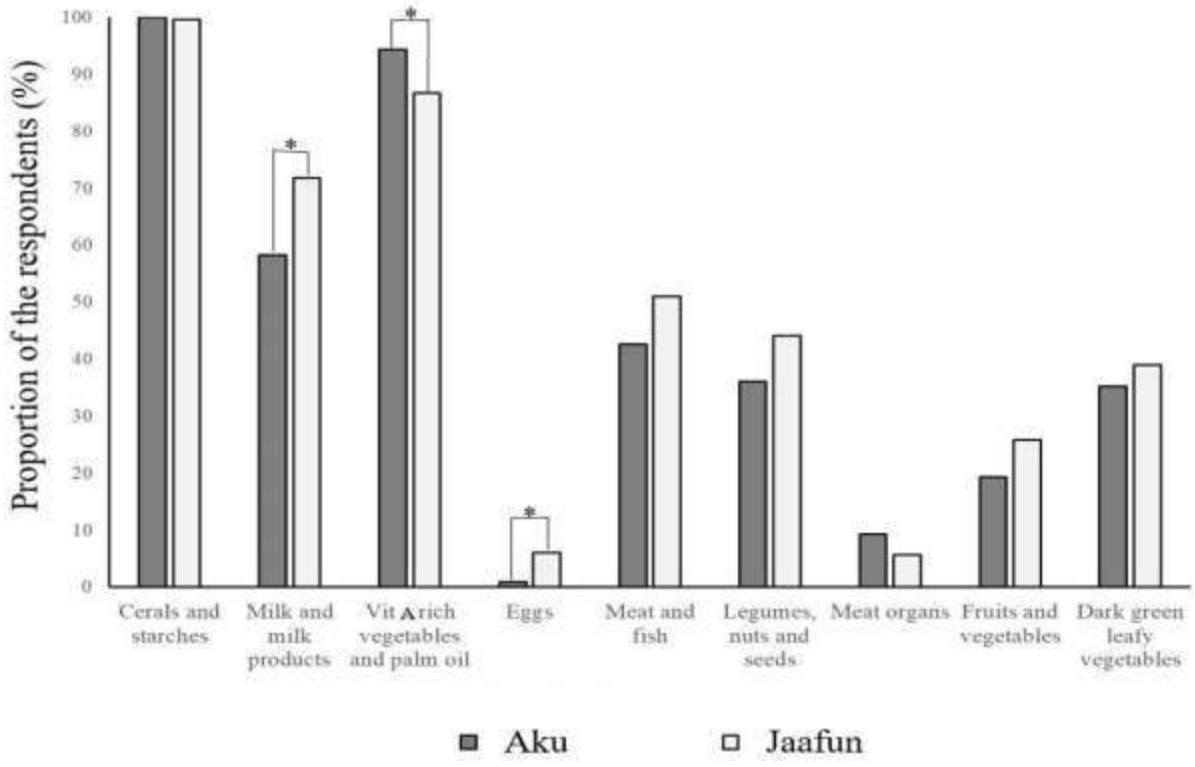

Figure 2.2: *Proportion of Mbororo women respondents (n = 461), consuming nine food groups within the two sub-tribes.*
Note: ** indicates food groups that are significantly different between the Aku and Jaafun sub-tribes (Chi square test, $P \leq 0.05$)*

Chapter 2

25 Discussion

The above socio-cultural and economic results indicated that the Mbororo society is predominantly polygamous. This may be due to their Muslim culture that allows men to marry more than one wife. Financial benefit for the men might also be a reason for polygamy as women come into the marriage with their cattle, but, as stated by Pelican (2012), "she has no direct control over her cattle property." The fact that nearly half of the women were illiterates may also indicate that a low level of education is appreciated in their culture. The Mbororo people do not easily trust people outside their culture and when schools were introduced in their communities, they were skeptical about sending their children to schools (Pelican, 2008).

It was further noticed that the husband typically buys food from the market, which means there is a high dependency of the Mbororo women on their men. Pelican (2012) also noted this dependency of Mbororo women on their men for food and income while carrying out anthropological studies in the Mbororo community. Considering that transhumance is still prevailing within the Mbororo community, it is challenging for women to access food when men are not around since 51.5% of their food procurement is through purchase. Transhumance is the primary source of farmer-grazer conflict in the Northwest region of Cameroon and this conflict occurs when the cattle of the Mbororo people destroy the crops of the local farmers (Nformi et al., 2014). Mbororo social and cultural development programs such as home garden projects are now occurring, aimed at enhancing the livelihood of the women through promoting basic education.

The computed mean DDS provided a snapshot of the food supply of the Mbororo community at the time of the study and render useful when assessing nutritional deficiencies within the region and comparing the dietary status between the two sub-tribes. Although the score may vary with season, Rani et al. (2010) demonstrated that it provides a good indication of the dietary status of a given population at a given time and could be used to evaluate the impact of nutritional intervention

programs. It was previously shown that the DDS is inversely related with obesity (Azadbakht and Esmaillzadeh 2011) and positively correlated with the nutritional value of the diet (Azadbakht et al., 2005).

Generally, the high DDS for the Jaafuns is likely resulting from this tribe living in more developed urban divisions like Mezam and Donga Mantung with improved infrastructure and access to markets, schools and hospitals. In contrast, the Akus are living in the rural divisions of Boyo and Menchum, thus their low DDS is probably due to difficult socio-economic conditions and few options to assure a livelihood. Consequently, the findings enabled the mapping of vulnerable and less vulnerable divisions of the region for nutrition intervention. A study in Malawi also showed that communities with better infrastructures had higher mean DDS (Koppmair et al., 2016). Surprisingly, there was no significant difference in the mean DDS between polygamous and non-polygamous women, which is contrary with results from Nanama and Frongillo (2012), stating that "polygamy makes it very difficult for all members of households to access adequate food due to complexity in decision making relating to food provision, preparation and consumption." Nevertheless, the case of the Mbororos might be different because everyone eats what men like to eat, thus the decision-making process is the same in both polygamous and non-polygamous homes. A significant difference between the mean DDS of Mbororos women and their level of education was not found. In contrast, other studies suggested a positive association between DDS and nutritional education (Berti et al., 2004; Nupo et al., 2013; Koppmair et al., 2016). However, even in developed countries and urban cities with a high level of education, nutritional problems still exist (Befort et al., 2012).

Livelihood and in turn DDS of most Mbororo families depended on cattle and household income was positively related with herd size. In Ruel (2003) reported that income per capita affects

positively mean DDS because when people's income increases, they pay more attention to food diversity. Crop farming did not have an impact on the mean DDS of the Mbororo women. In contrast, in rural Malawi, cultivating crops increased the mean DDS and was in turn affected by greater incomes (Koppmair et al., 2016). However, findings from focus group discussions revealed that crop farming is mostly conducted by poor Mbororo people who do not own cattle.

The Aku and Jaafun sub-tribes have similar socio-cultural characteristics, which might account for the similarities in food habits. However, most Jaafuns are living in urban rich divisions, which might account for the significant difference in the consumption of eggs (P = 0.032) and milk and milk product (P = 0.008). Some beliefs hinder women from eating eggs, and this is more common in rural communities than urban communities in many developing countries (Riang'a et al., 2017). This study found a high percentage of the women respondents (88.5%) using readily available red palm oil for everyday cooking, an excellent source of vitamin A (Kennedy et al., 2010). Red palm oil accounted for the high level of consumption of the "vitamin A-rich vegetables and palm oil food" group rather than vitamin A-rich vegetables. The significant (P = 0.027) difference in the consumption of this food group vitamin A-rich vegetables and palm oil might be due to most modern Jaafun women said they preferred groundnut oil to palm oil. A small proportion of women was found to consume animal sourced vitamin A, suggesting that without red palm oil, the consumption of food products rich in vitamin A will be low in the Mbororo community. The human body depends on vitamin A for tissue repairs, but animal-sourced vitamin A (retinol) is more readily absorbed than the plant-sourced vitamin A (carotene) (Kennedy et al., 2003). Frison et al. (2006) postulate that there is a shift from food diversification to simplified diet consumption in developing countries with rice and maize topping the list, thus a decline in iron intake from legumes and nuts.

2.6 Conclusions and recommendation

With the aimed of providing information that may assist stakeholders to better implement nutritional programs, this study assesses the food consumption of the Mbororo minority women in Northwest Cameroon over a 24-hour period and calculates the DDS to demonstrate dietary differences between sub-tribes and among regional locations. The livelihood of the Mbororo people is centered around cattle; however, few of them consume cattle as a nutrient source. Cattle are used for prestige and times of significant financial needs, explaining the low consumption of iron from

an animal food source. Specifically, the Aku women have lower dietary diversity than the Jaafun women and thus a lower intake of micronutrients. Moreover, nutritionally caused anemia among the Mbororo women is frequently occurring, because less than half of the population consumes meat organs rich in iron and other nutrient-rich foods such as dark green leafy vegetables, meat and fish, eggs, legumes and fruits. Consequently, this study recommends the women of the Aku sub-tribe as a primary target for any dietary interventions programs in this region and emphasizes the need for women to cultivate micronutrient-rich horticultural crops in integrated farming systems (e.g. small-scale gardening with poultry or sheep keeping) to fight against malnutrition and to reduce their dependence on men for food and finances. The study has demonstrated various levels of dietary diversity between sub-tribes and among various sites within the region, differences that are related to socio-cultural and economic characteristics. Future research should validate the current findings by conducting the 24-h recall questionnaire at other times and to investigate the degree of micronutrient shortage and in particular iron deficiencies within these communities.

2.7 Acknowledgments

This publication is an output of a scholarship from the Food Security Center of the University of Hohenheim with the support of Fiat Panis Foundation. And funds provided by the German Academic Exchange Service (DAAD) program “Exceed”.

Declaration of interest statement: There is no conflict of interest content, and or data used for this paper.

2.8 References

Azadbakht, L, Mirmiran, P., & Azizi, F. (2005). Dietary diversity score is favorably associated with the metabolic syndrome in Tehranian adults. *International Journal of Obesity (2005)*, *29*(11), 1361–1367.

Azadbakht, Leila, & Esmaillzadeh, A. (2011). Dietary diversity score is related to obesity and abdominal adiposity among Iranian female youth. *Public Health Nutrition*, *14*(1), 62–69.

Azadbakht, Leila, Mirmiran, P., Esmaillzadeh, A., & Azizi, F. (2006). Dietary diversity score and cardiovascular risk factors in Tehranian adults. *Public Health Nutrition*, *9*(6), 728–736.

Bwibo, N. O., & Neumann, C. G. (2003). Animal source foods to improve micronutrient nutrition and human function in developing countries: The need for animal source foods by Kenyan children. *The Journal of Nutrition*, *133*(5), 3875S-4061S.

Castro-Quezada, I., Román-Viñas, B., & Serra-Majem, L. (2014). The Mediterranean diet and nutritional adequacy: A review. *Nutrients*, *6*(1), 231–248.

FAO. (2007). Guidelines for measuring household and individual dietary diversity. In *Health (San*

Francisco) (Issue 3).

Herforth, A. Dufour, C. and Noack, A.L. (2015), "Designing nutrition-sensitive agriculture investments", In Food and Agriculture Organization of the United Nations (FAO), available at: www.fao.org/documents/card/en/c/6cd87835-ab0c-46d7-97ba-394d620e9f38/

Kennedy, G. L., Ballard, T., & Dop, M. (2010). *Guidelines for measuring household and individual dietary diversity*. FAO. www.foodsec.org

Koppmair, S., Kassie, M., & Qaim, M. (2016). Farm production, market access, and dietary diversity in Malawi. *Public Health Nutrition*, *20*(2), 1–11.

Nformi, M. I., Mary-juliet, B., Engwali, F. O. N. D., & Nji, A. (2014). Effects of farmer-grazer conflicts on rural development: a socio-economic analysis. *Scholarly Journal of Agricultural Science*, *4*(3), 113–120.

Nupo, S. S., Oguntona, C. R. B., Onabanjo, O. O., & Fakoya, E. O. (2013). Dietary diversity scores and nutritional status of women in two seasons in rural areas of Ogun State, Nigeria. *Nutrition and Food Science*, *43*(1), 60–67. https://doi.org/10.1108/00346651311295923

Pelican, M. (2008). Mbororo Claims to Regional Citizenship and Minority Status in North-West Cameroon. *Africa*, *78*(4), 540–560.

Pelican, M. (2011, August). Beyond National Citizenship. *AFRICAN ARGUMENTS*, *2000*, 1–6. http://africanarguments.org/2010/03/08/beyond-national-citizens

Pelican, M. (2012). Friendship Among Pastoral Fulbe in Northwest. *African Study Monographs*, *33*(3), 165–188. https://doi.org/http://dx.doi.org/10.18632/oncotarget.11780

Rani, V., Arends, D. E., & Brouwer, I. D. (2010). Dietary diversity as an indicator of micronutrient adequacy of the diet of five to eight year old Indian rural children. *Nutr. Food Sci.*, *40*(5), 466– 476.

Riang'a, R. M., Broerse, J., & Nangulu, A. K. (2017). Food beliefs and practices among the Kalenjin pregnant women in rural Uasin Gishu County, Kenya. *Journal of Ethnobiology and Ethnomedicine*, *13*(1), 1–16.

Schrieder, G., & Knerr, B. (2000). Labour Migration as a Social Security Mechanism for Smallholder Households in Sub-Saharan Africa: The Case of Cameroon. *Oxford Development Studies*, *28*(2), 223–236.

Sibhatu, K. T., Krishna, V. V., & Qaim, M. (2015). Production diversity and dietary diversity in smallholder farm households. *Proceedings of the National Academy of Sciences of the United States of America*, *112*(34), 10657–10662.

Wilhite, Mannava V. K., Sivakumar Raymond P., Motha Donald A., Debora A. Wood (2011).

Agricultural Drought Indices Proceedings of an expert meeting (Issue June 2010).

Yohannes, Y., & Hoddinott, J. (2002). Nutrition Technical Dietary Diversity as a Household Food Security Indicator : Technical Appendix John Hoddinott Indicator : Technical Appendix (Vol. 136, Issue May). http://www.fantaproject.org/research/dietary-diversity-household-food-security

Received 13 July 2020

Accepted 1 September 2020

Chapter 3

3 The role of home gardens in empowering minority women and improving food and nutrition insecurity: a case of Mbororo community in Cameroon's Northwest region

3.1 Abstract

This study documents the impact of a gender-sensitive home garden project initiated to mitigate the food and nutritional insecurity of 114 households in seven Mbororo communities in Cameroon's Northwest region. Key lessons learned regarding the empowerment of the Mbororo women; socio-economic and nutritional health benefits derived by Mbororo households from the cultivation of nutrient-rich, high market-value, and indigenous vegetables; and challenges faced during the project lifecycle are outlined. It is envisaged these lessons will support public, private, and civil society actors initiating similar home garden projects to address the food and nutrition insecurity of other minority groups in Sub-Saharan Africa.

Keywords: nutrient-rich vegetables, indigenous vegetables, gender-sensitive, nutrition-sensitive agricultural interventions, food-based approach, home garden, food security

[1] This chapter has been submitted to Journal of Agroecology, by Ebile, P.A, Lisette P, and Wünsche, J.N

Chapter 3

3.2 Introduction

Micronutrient deficiencies are a significant problem amongst women and children and add to the existing food insecurity burden in developing countries (Low et al., 2017). Home gardens, backyard or homestead gardens that are adjacent to human settlements offer a food-based approach to combat nutrition insecurity within the concept of nutrition-sensitive agriculture (NSA) interventions (Galhena et al., 2013; Fiorella et al., 2016). Home gardens constitute NSA interventions of great importance in developing countries (Ruel et al., 2018). Resource-poor communities consume primarily starchy foods, and their diets are typically low in some essential micronutrients such as vitamin A and iron (Faber and Jaarsveld, 2007). As such, introducing home gardens to these communities can bring about dietary diversification.

Home gardens generate social, financial, ecological, and nutritional benefits. For example, home gardens mitigate food and nutritional insecurity and help empower women in rural communities (Patalagsa et al., 2015). Empowerment is defined as the process of increasing people's ability to make choices, especially for those who have been denied this ability, and empowerment has other dimensions such as social, economic and self-esteem (Patalagsa et al., 2015). Other social benefits of home gardens include social cohesion and the sharing of information amongst participants, resulting in the garden community's general education (Weinberger, 2013). The sales of crops from home gardens can provide income, which could be used to meet household needs, such as buying food and paying for education and health services (Patalagsa et al., 2015; Fiorella et al., 2016; Pandey et al., 2016). Furthermore, home gardens, can promote the diversity of vegetables in a given community (Shisanya & Hendriks. 2011; Weinberger. 2013; Ruel et al. 2018). Home garden interventions increase households' production of fresh vegetables, and the availability and consumption of vegetables, which in turn enhances the nutrient content and quality of a household's diet (Berti et al., 2004).

A home garden project will, however, only translate into a community's enhanced food and nutrition status if it is initiated in conjunction with the target population (Bryson 2016). Moreover, it must be accompanied by a robust capacity-building component, for example, provision of education relating to nutrition and horticultural management methods to ensure that project activities translate into a community's enhanced food and nutrition security status (Faber and Jaarsveld, 2007). In the absence of a capacity building component, stakeholders such as government agencies and economic organizations may also be skeptical of the potential of home garden projects to generate positive

nutritional outcomes for project beneficiaries and less likely to create an enabling environment which is key to the successful initiation of such an intervention (Berti et al., 2004; Waage et al., 2013; Webb & Kennedy, 2014).

This study documents the initiation of a home garden project in Cameroon's Northwest region. This project targeted a minority population known as the Mbororo – a minority population of the Fulbe ethnic tribe, scattered from East to West along the African savanna belt (Pelican 2008) – as their food and livelihood security is increasingly threatened by climate change and conflict (Ebile et al., 2020).

Similar to other agro-pastoralist and semi-nomadic minority communities across the globe (Kuhnlein. 2009), the Mbororo have had to significantly change their seasonal transhumance practices in recent decades as a consequence of climate change (Amadou, 2017; Pelican, 2012). Grazing conditions are no longer suitable due to the extended dry seasons experienced and, as a consequence, Mbororo communities such as the Banjah, situated near Bamenda – the regional capital of the Northwest region – have been driven to travel further in search of grazing land (Pelican, 2008). Other communities have accepted that they can no longer depend on seasonal transhumance and extensively grazing their livestock herds in lowland areas for their food and livelihood security; women in some communities have turned to selling milk or butter and small animals, such as chickens, for an additional source of income (Ebile et al., 2020).

Although most Mbororo women come with their cattle into marriages, they are dependent for money and food on their husbands who are engage in livestock production and sell the cattle for income in order to buy food from the market (Kingah, 2014). Women's dependence on men for food and income, and their limited decision-making power over the purchase of food, adversely impacts household food security, particularly during the dry season (Lister, 1990). Many Mbororo households experience difficulties accessing food during the dry season and depend on dry foods such as maize and rice during the period when their husbands go for seasonal transhumance (Nformi, 2014; Ebile et al., 2020). In contrast, during the rainy season, the Mbororo people's diet is based on starchy foods such as maize and cassava, which are converted to corn flour for "fufu," (a traditional porridge stew), consumed with indigenous vegetables such as *folere* (*Hibiscus sabdariffa*), but also supplemented by a small amount of milk and butter from their cattle (Ebile et al., 2020). In some Mbororo communities, women also cultivate food crops such as maize and beans for home consumption.

Chapter 3

Accounting for around 10% of Cameroon's Northwest region's population and encompassing the Aku and the Jaafun sub-tribes, the Mbororo people are often referred to as "a prime example of a stranger population"; a socioeconomically marginalized population made to feel unwelcome by their "Grassfield" neighbours (Pelican, 2011). They lack access to basic infrastructures, such as clean water and health care clinics (Pelican, 2001) and their poor health status is exacerbated by their food insecurity during the dry season; given the fact that their diet is low in micronutrients such as iron, regardless of the season, anaemia is widely prevalent among women and children (Ebile et al., 2020).

The Mbororo people in Cameroon's Northwest region urgently require nutrition-sensitive agricultural intervention and food-based approaches to respond to and address their food and livelihood insecurity. This study contributes to a growing area of research relating to the potential of home gardens to mitigate the food and nutrition insecurity faced by minority communities. Firstly, this study 1) assesses factors that contribute to ensuring the successful establishment of home gardens in Mbororo communities; provides evidence of the usefulness of home gardens in enhancing food and nutrition. Secondly, it identifies key challenges encountered during the implementation of the project. Thirdly, it assesses successes as regards influencing the availability, accessibility, consumption, and sale of fresh vegetables in the study sites and increasing awareness of nutrient-rich foods through nutrition-related education and the introduction of horticultural management techniques. Finally, it proposes recommendations, based on lessons learned, for similar projects.

3.3 Materials and methods

3.3.1 Study sites

The home garden project targeted Mbororo communities in two divisions of Cameroon's Northwest region (6°20′N 10°30′E), namely, Mezam and Menchum. The communities in Mezam included Akum mile 9, Banjah, Sabga, and Ntambang, while those in Menchum included Upkwa, Lugere, and Njinjam (Figure 1). The vegetation of the Northwest region is mostly savanna grass, covering escarpments and hills with an annual rainfall ranging from 1500 to 2000 mm (Neba, 2009). The study area has two seasons, the rainy season begins in April and ends in November; the months between December and March are the dry season, while yearly temperatures range from 15 to 27°C (Nformi et al., 2014). (Figure 3.1).

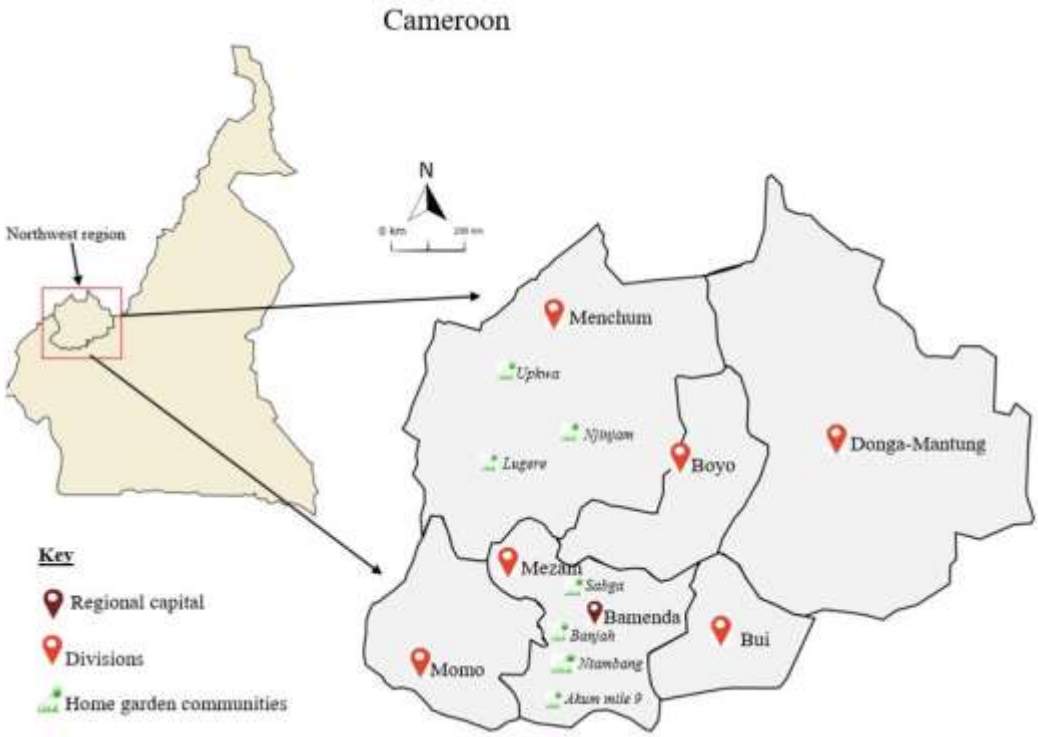

Figure 3.1: *A map of Cameroon and the map of the Northwest region, showing the study sites in Mezam and Menchum divisions where the home garden project was initiated to involve seven communities (Source: Author's own)*

3.3.2 The Mbororo Community

The Mbororos are a minority community from the Fulbe ethnic tribe scattered from East to West of the African Savana belt (Pelican. 2008). In Cameroon, the Mbororos are subdivided into the Aku and the Jaafun sub-tribes; socioeconomically, they are mostly agro-pastoralist and semi-nomads, who mainly depend on cattle for their livelihood (Pelican. 2012). The Mbororo form around 10% of the Northwest region's population and are often referred to as "a prime example of a stranger population." They feel marginalized and not always welcome by their "Grassfields" neighbors in the same locality (Pelican. 2011). The Northwest is primarily grassland and favorable for cattle production (Ebile et al. 2020); thus, the Mbororo people settle on suitable grazing hills found around the region. Mbororo settlements vary in size ranging from five to hundreds of households in some settlements (Pelican. 2008). Studies by Pelican (2008) have shown that most of the other small rural communities, such as the Banjah next to the capital city of Bamenda, break out from the Sabga community searching for better grazing land. The Mbororo community is complex as the settlements differ from each other. Although most Mbororo women come with their cattle into marriages, the women still depend on their husbands for money and food because they are

responsible for caring for and selling the cattle (Kingah. 2014). The dependency of women on men for food and income affects households' food security because women have less decision-making power over food purchases (Lister. 1990).

Although some of these women sell milk and small animals, such as chickens, for income, it becomes difficult for them to access food when the men go on transhumance during the dry season (Nformi. 2014). The Mbororo practice extensive grazing and seasonal transhumance, which is when men leave for long periods with the cattle. When the grass gets dry and scarce, the men take the cattle into the lowlands far from the communities for weeks at a time to look for fresh grazing areas (Amadou. 2017; Pelican. 2012b). The men mainly depend on cattle sales for income and typically buy food from the market, which means when the men go for transhumance, food procurement becomes difficult for the women (Ebile et al., 2020). Most women can only depend on dry food such as maize and rice bought and stored in the house when the husband was still around. In some Mbororo communities, such as the Aku sub-tribe, the women carry butter to sell to the “Grassfield” people and use the money to buy food. The Mbororo community lacks access to basic infrastructures, such as clean water and clinics, compared to other communities in the same locality and is vulnerable to food insecurity (Pelican. 2011).

The Mbororo people's diet is mainly based on starchy foods such as maize and cassava with indigenous vegetables such as *folere* (*Hibiscus sabdariffa*) and some milk and butter from their cattle (Ebile et al. 2020). Ebile et al. (2020) further revealed that the Mbororos prepare maize in several different ways; for example, it was converted to corn flour for "fufu," a traditional porridge stew. Recent trends have shown that indigenous vegetables in Africa are seriously threatened by the mono-cropping of high market value vegetables such as carrots and celery (Adebooye & Opabode. 2004), and this cropping practice was also found in the study region. Maize, beans, and even folere are replaced by high market value vegetables such as potatoes and spices for urban cities (Mengui et al. 2019). Some Mbororo in these communities also cultivate a few food crops such as maize and beans for home consumption; they often rely on the assistance of their “Grassfields” neighbors for the labor; they pay them to till the soil (Pelican. 2012).

3.3.3 The home garden project

The University of Hohenheim, in collaboration with an NGO called Mbororo Social and Cultural Development Association (MBOSCUDA), initiated a home garden project for seven Mbororo communities in Cameroon’s Northwest region.

Three university graduates, trained in agriculture and marketing, were responsible for supervising the day-to-day activities of the home garden project. These graduates provided horticultural training for the Mbororo women, including nursery and garden management practices, and explained the work the women had to carry out, such as planting and weeding the gardens. One of the graduates, a Mbororo woman, was also responsible for translation of communication between the researchers and the community.

In total, the garden project engaged a total of 114 households as direct beneficiaries. Gardens and nurseries were established in the seven target communities in Mezam and Menchum (Table 1), with three categories of vegetables cultivated based on a household needs assessment. The women were supported in planting vegetables that they could sell; indigenous or traditional vegetables; and vegetables they considered nutrient-rich. The three categories of vegetables selected for planting were (i) high-market value vegetables such as chili-pepper (*Capsicum annuum*), fluted pumpkin (*Telfairia occidentalis*), and waterleaf (*Talinum fruticosum*); (ii) indigenous vegetables traditionally cultivated by the Mbororo such as *folere* (*Hibiscus sabdariffa*), *lalo* (*Corchorus olitorius*), and *caricachee (Sesamum radiatum)*; and (iii) nutrient-rich vegetables such as amaranth (*Amanaranthus spp.)*, eggplant (*Solanum melongena*), okra (*Abelmoschus esculentus*) , and Chinese cabbage (*Brassica rapa subsp. Pekinensis*).

The project led to the establishment of two types of gardens: individual and community gardens. Most individual gardens were established by women next to their homes, and only community gardens which would be tended by a group of women, i.e. more than four women, were located about 1 km away from the houses. The women selected the land where the gardens were to be constructed together with their husbands and were advised to select plot sizes that they would be able to easily manage. It is important to note that where additional labour was required or the workload was judged to be heavy, activities such as fencing and tilling of the garden were covered by the project budget, allowing women to engage in other household activities. The average garden size varied in each community (Table 1). Individual gardens were small in size, while community gardens – many of which were managed by between 6 and 30 women – were more expansive.

Table 1: Garden surface area cultivated (in m^2), number of women, and communities involved in the project
* Community gardens

Community	Number of gardens	Number of female participants	Smallest garden area (m^2)	Biggest garden area (m^2)	Total garden area (m^2)
Akum mile 9	18	20	68	420	2234
Banjah	9	9	75	255	1055
Ntambang	1*	6	-	-	1900
Sabga	6	6	336	1242	4188
Upkwa	4 and 1*	13	320	1089	2547
Lugere	1*	30	-	-	2500
Njinjam	6*	30	810	3828	13,244
Total	46	114	-	-	27,668

3.3.4 Data collection methods

This study used qualitative research methods to collect data, including semi-structured and informal interviews, focus group discussions and participant observation. Specifically, data were collected on (i) factors that facilitated the establishment of the gardens in these communities; (ii) how the garden enhanced food security of the beneficiaries; and (iii) some of the challenges the project faced in trying to meet its goals. Observations about the growth conditions and management of the vegetables and challenges faced by the women were made from the initiation of the garden project through harvesting, consumption, and sale of fresh vegetables from the beneficiaries' gardens over two harvest cycles. The fieldwork was conducted between March 2017 - October 2018 reflecting the fact that the home garden project ended two years after its initiation due to political unrest in the region. The university graduates working on the project training farmers eventually had to leave because of insecurity, and could not transport the vegetables produced to the market anymore on behalf of the women as it was risky to do so. However, it is important to note that, while the project and data collection activities ended, the women continued to cultivate vegetables in their individual and community gardens for household consumption purposes.

3.3.4.1 The project conceptualisation, design and implementation process

The different components of the project conceptualization, design and implementation process, and the challenges faced in planting, growing, and managing the garden crops were examined through informal and formal interviews. Both informal and formal interviews were carried out by the researchers. In total, interviews were conducted with 114 women and 36 men from the beneficiary communities; five members staff of the NGO MBOSCUDA; two collaborators from the government; and three-member staff of the project. Interview questions were open-ended, and focused on the selection procedure of the beneficiaries

from other members of the communities, the type of vegetables to be planted in the gardens, why these particular vegetables were selected, and the contributions which beneficiaries had to make to the project.

As beneficiary participation is key to the success of any project, this study looked to evaluate the involvement of the beneficiaries in decision-making from the outset. Informal interviews were used to investigate the attitudes of the beneficiaries prior to the project being initiated and during the project implementation phase. Questions centred on the garden type, size, crops, management, and the contributions of the gardens to the livelihood of the beneficiaries. The study also assessed the outcome of capacity-building activities implemented, including the benefits of nutrition-related education provided to the women regarding the micronutrient contents of the garden crops.

Informal interviews were also used to elicit technical information about the concepts and implementation of the garden project from the project staff during the project implementation phase. Specifically, project staff were asked questions relating to the management techniques adopted to control for pest incidence and, more broadly, care for the garden crops cultivated in nurseries constructed in each community.

Formal interviews were used to elicit information regarding the project from collaborators, such as the Ministry of Agriculture and the Northwest region extension and advisory service, to analyse the impact of support provided to the project, i.e. inputs and advisory services.

Observations, focus group discussions, and interviews were used to assess the project activities carried out by all stakeholders during the project implementation phase. Observations facilitated the collection of data relating to the interaction between the project staff and the beneficiaries, the behavior of the beneficiaries, garden activities and the impact of environment events as well as crop management challenges that occurred, such as rains and pests, on the performance of garden crops and, by extension, intended project outcomes such as households' food security.

Focus group discussions, involving 8 to 12 women, were held regularly in the seven communities. The women deliberated and reached consensus on challenges faced in working in the gardens and the importance of capacity-building activities. Focus group discussions were frequently combined with participatory observation and garden visits to assess activities such as capacity building during nursery and garden constructions while the project was running. Each community was visited on three or more occasions every month over the two years during which the project was implemented, with visits only reduced or even suspended during the dry seasons due to a lack of rainwater which impacted the performance of the gardens. These repeated visits were helpful to build trust between the researchers and the project beneficiaries, but also gain insight into the benefits of the project and challenges encountered by the staff members and project

beneficiaries in the implementation of the project. Focus group discussions and observations also were used to examine important processes and outcomes of projects, including women's empowerment, as defined by Patalagsa et al. (2015b), related to decision-making, control over resources, and income in the women's empowerment process.

3.3.5 Data Analysis

The data collected through the interviews, focus group discussions, and observation, such as field notes and transcribed audio recordings, were analysed through a thematic content analysis process. Frequently used words, phrases and concepts in the organized data related to the research objectives were identified, and the researcher's notes regarding project beneficiaries' and project staff's attitudes and behaviours, taken during participant observations and garden visits, were also organised. Words, phrases and concepts were further organized into codes and relations between these established, and key quotes from the transcribed interviews identified. These codes were subsequently collapsed into five key objective-related research themes: usefulness of the home gardens in enhancing food and nutrition; challenges encountered during project implementation; project successes; food and nutrition insecurity; and empowerment. usefulness of; identifies key challenges of the project; and proposes recommendations, based on lessons learned, for similar projects.

3.4 Results

3.4.1 Factors that led to the successful implementation of the home garden project

3.4.1.1 The lifestyle and cultural factors

The Mbororo people do not traditionally cultivate crops; however, the data indicated that many Mbororo women were open to the idea of crop cultivation for two key reasons. Firstly, due to their nomadic lifestyle, the Mbororo agro-pastoralist and nomads reported being in constant conflict with non-Mbororo crop farmers neighbouring communities who they perceived as encroaching into their grazing lands. Half of the respondents said that reduced availability of grazing land, and long and harsh dry season conditions impacted on fodder availability and forced them to look for grazing lands at far distance from their homes and spend more time away from their homes than in the past. Secondly, the Mbororo women welcomed the project being initiated due to the rising cost of food in local markets. In addition to reporting that it was difficult to get money to buy food when their husbands went for transhumance, women indicated that Mbororo indigenous vegetables, such as *lalo* and *caricachee*, were becoming difficult to find in the market. Most women and men welcomed the project becuase the project included their indigenous vegetables.

"*I welcome the project if my wife can plant folere and make money from her garden*".

A male participant, Akum mile 9 community (April 2017)

More than 75% (90 households) of the interviewed participants (women and men) were of the opinion that the gardens provided women an excellent opportunity to earn an income and supplement household food supply; the gardens did not require much space, labor, and the cow dung as fertilizer was free and abundant from their herds.

3.4.1.2 The selection process of garden vegetables

Three broad categories of vegetables were selected for planting in the gardens (Table 3.2). Although advised to plant vegetables within these categories, participants were free to choose which varieties of vegetables they wanted to plant in their gardens. In each established garden, the project staff grouped the vegetables planted by category to facilitate the management of the project.

Table 3.2: *The different varieties of vegetables cultivated in the gardens grouped under main categories*

Income generation	**Nutrient-rich**	**Indigenous**
Fluted pumpkin (*Telfairia occidentalis*)	Eggplant (*Solanum melongena*)	Jute mallow, *lalo* (*Corchorus olitorius*)
Hot pepper (*Capsicum frutescens*)	Amaranth (*Amaranthus*)	*folere* (*Hibiscus sabdariffa*)
Waterleaf (*Talinum triangulare*)	Okra (*Abelmoschus esculentus*)	*caricachee* (*Sesamum radiatum)*
	Chinese cabbage (*Brassica rapa*)	
	"Bitter leaves" (*Vernonia amygdalina*)	

Notes: *The indigenous vegetables' traditional names are in inverted comma, while the scientific names are in italics. Many of the vegetables in table 3-2 have multiple categories, such as jute mallow that are indigenous and nutrient-rich.*

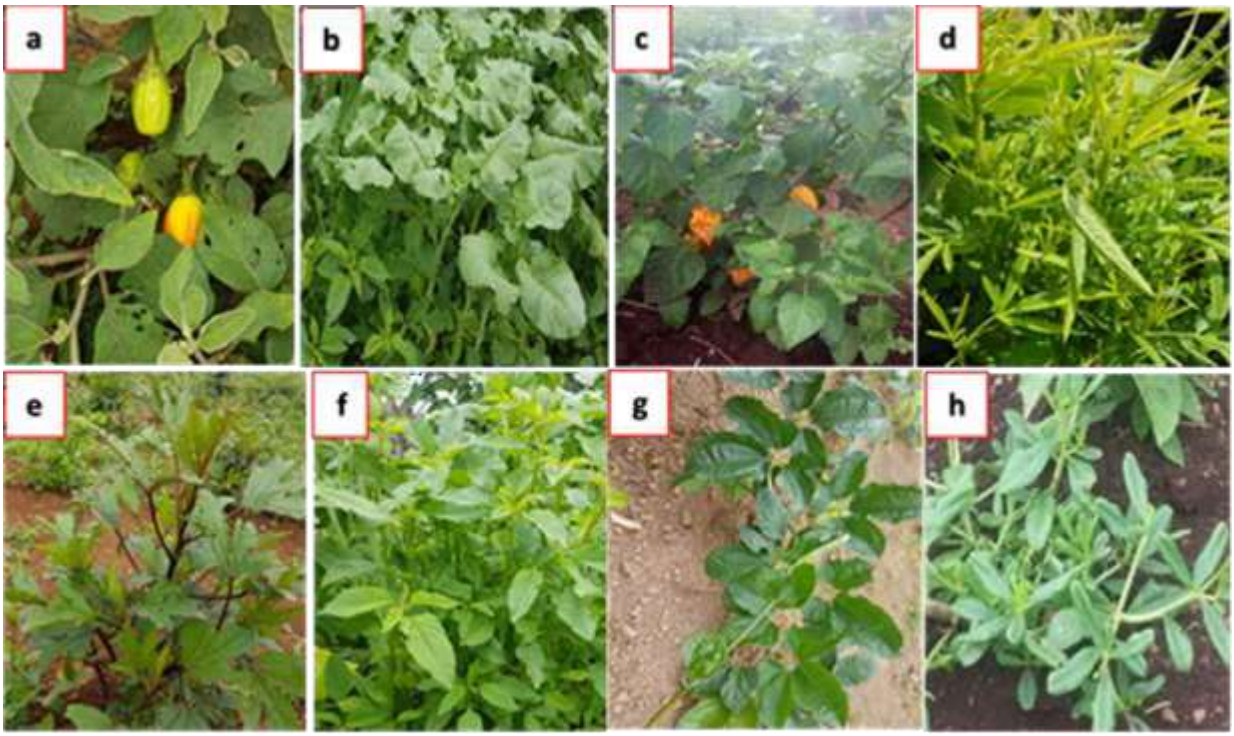

Figure 3.1: *Garden vegetables planted in the project, eggplant (3.2a), chinese cabbage (3.2b), chili-pepper (3.2c), "caricachee" (3.2d), fluted pumpkin (3.2g), amaranth (3.2f), "Folere" a Hibiscus (3.2e), and waterleaf (3.2h) (Photos credit to the author)*

Figure 3.1 indicates some of the varieties widely planted by the women in the gardens established by the project. The proportion of plants varied from one garden to another; however, observations suggested pepper accounted for the largest area planted in most gardens. Indigenous vegetables such as *folere* were the most desired by the women, and nutrient-rich vegetables were the least abundant in the gardens after planting.

The role of key collaborators

The key collaborators in the project facilitated implementation of activities, with each collaborator having a clearly defined role in advancing the project. MBOSCUDA helped with the introduction of the project to the various Mbororo communities, assisted with logistics, and helped to mediate in the field as they were versed in the culture and traditions of the Mbororo people. The Ministry of Agriculture and the Northwest region extension and advisory service provided technical support to the project staff members. The University of Hohenheim and the College of Technology in Bamenda helped with data collection and also provided ongoing project support. The data indicates that, although the project targeted Mbororo women, the project design facilitated men's involvement at two levels. The voluntary involvement of a number of men from the communities reduced project costs and made it possible to increase the number of beneficiaries. Firstly, due to their material contribution to fencing to keep the cattle and other domestic animals like sheep and goats

out of the gardens, the project was able to expand into four additional communities. Secondly, communities, such as Njinjam, where men and women actively worked together, had more vegetable produce for sale in the market than other communities, such as Upkwa, where there was little interaction between men and women during gardening.

3.4.1.3 The involvement of beneficiaries in decision making

The women beneficiaries of the project were directly involved in all project activities, from designing the gardens to selecting vegetables, managing the gardens, and harvesting the crops. Interestingly, the women took responsibility for the capacity-building sessions regarding garden management and nutritional education. In each community, women were informed by the project staff that participation in the garden project was voluntary. The women made decisions about work plans and decided to work together in a community garden or individually in their own garden, and the project staff helped in the implementation of these decisions. In the case of community gardens, the women selected their friends to work with as a group. They created groups based on friendship and family ties. Whereas they required assistance in the first year to establish their gardens, most women prepared their gardens in the second year of the project, and were just waiting for seeds to plant.

> *"I want to plant early, so I have already prepared my garden,* [..] *I want to have many harvests this year*". Said one of the women in Akum mile 9 community (March 2018)

3.4.1.1 New source of income generation from the sale of vegetables

The most significant incentive for the women to join the project and a factor which ensured the success of the project was the income generated from the sale of vegetables. In interviews, women expressed their satisfaction and the advantages of keeping and managing the funds themselves. In Banjah community, the women had a slogan regarding the money they made from the sale of vegetables: "*No money is small money*". From the sales of vegetables, the women bought other items for cooking, such as oil and salt. To sell their vegetables, the Mbororo women frequently contacted the “Grassfield” women who were small scale vegetable traders, commonly called "buy and sellam”, in advance; these traders buy and sell foodstuffs and other items in small quantities daily. In other cases, the project staff connected the Mbororo women with the traders in the local markets to facilitate the selling of their vegetables.

The sale of chili pepper, water leaves, and fluted pumpkin provided the women with an income which enabled them to buy other food items, such as cooking oil and salt. Although the Mbororo women are known for selling milk and traditionally made butter, the women observed that their cattle were not producing enough milk. Consequently, they regarded the new income generated from the gardens to be a safety net.

For most women, the money they made from the sale of vegetables during the rainy season was used in the dry season to purchase food when their husbands engaged in transhumance.

3.4.1.2 Acquisition of new knowledge through complementary project activities

Most Mbororo women did not appreciate the value of cow dung as a fertiliser, but their opinion changed as they learned that it was a good source of nutrients for their vegetables.

> "*We will no longer give our cow dung to the "Grassfield" women for free; we shall keep it and use it in our gardens next year*". Women in Banjah community (April 2018)

Observations during the nutritional education activity also revealed that women's perceptions of food changed during the project. They no longer looked at vegetables as "*just soup*", making their meals delicious, but rather regarded vegetables as a source of the nutrients required to prevent them, their husbands, and their children from getting sick. Realizing the importance of vitamins derived from vegetables the women we motivated to take special care of their gardens.

> "*I tell my children every day to cut the garden eggs from the garden and to eat them because I learned in the meetings it is good for health*". A female participant from Njinjam community (September 2017)

The knowledge acquired on horticultural or garden management was new to most women in the first year. However, during the second year of the project, the women did not need as much assistance in managing their gardens.

The Mbororo women depended on the project staff for guidance in undertaking garden-related activities as, for most, it was their first time to get involved in gardening. The women were also educated on good horticultural practices, such as establishing nurseries (Figure 3.2), and planting, mulching, watering, and harvesting of vegetables. Moreover, the project staff took responsibility for sourcing seeds from other regions of the country, such as the West Region, and hired labourers to help the Mbororo women with garden activities, such as tilling of the soil. The staff also arranged educational meetings for the Mbororo women with other stakeholders such as the government ministries.

In addition, the project staff and collaborators helped the Mbororo women to understand the importance of vegetables for their health through the provision of nutrition and health education. After education the women valued vegetables produced in their home and community gardens more and their perception of vegetables as soup or condiments for staple foods such as "fufu" was positively changed reflecting appreciation the role of vegetable-derived nutrients in their diet. The women were taught, using flashcards

and drawings, about the impact of nutrient deficiencies on their health and, specifically, the relationship between nutrient deficiencies and diseases.

Figure 3.2: *Capacity building of women by project staff for establishing a pepper and eggplants nursery. Plantlets will be gotten from this nursery and distributed to the women to plant in their gardens. (Photo credit to the author)*

3.4.2 The usefulness of the garden project to enhance food and nutrition security

3.4.2.1 Women's empowerment

Three components of women's empowerment were observed from the commencement of the garden project related to: (1) production decisions, (2) control over resources, and (3) control over income generated from the gardens. Different women sought out different vegetables for their gardens, reflecting the dietary preferences of their families. During a meeting held to select the type of vegetables to be planted in the gardens, each woman knew what vegetable they wanted and why.

> "*I need more of the pepper; it grows fast, I can sell and use the money to buy salt and oil for cooking*".
> A female participant in Akum mile 9 community (May 2017)

Decision-making extended beyond the choice of vegetables to the size of the gardens to be managed. Most women considered aspects such as the time required to produce vegetables, work that would be involved,

and potential yields prior to making their decisions.

"*my children do not like eggplant, so I will not waste my energy to plant them*".

A female participant in Akum mile 9 community (September 2017)

The women were in a position to ask questions about the cultivation of different vegetables during focus group discussions and this enabled them to assess the amount of risk involved before deciding which vegetables to plant in their gardens. In one focus group meeting held in the Akum mile 9 community, the women debated extensively whether they should cultivate fluted pumpkin as one of their market crops or refrain from doing so given the length it would take to grow this vegetable and the requirements to build wooden support structures for the plant. Some women had to ask their husbands for land to build their gardens; however, once they obtained this land, they owned it and were in position to make all decisions related to their gardens. The women spent income generated from the gardens to support their families, including supporting their husbands financially when needed. Some women also gave away vegetables from their excess harvest as gifts to members of their family in non-garden communities.

3.4.2.2 Reintroduction of native vegetables

The women were enthusiastic when members from the NGO MBOSCUDA asked them during the project design meeting to incorporate indigenous or native vegetables.

"*I can cook folere every day because my husband and children love to eat it*".

A female participant the Njinjam community stated (April 2017)

Women reported their husbands and children preferred eating the indigenous vegetable as they were more acquainted with the taste. Most women considered the indigenous vegetables easy to prepare as their parents had taught them how to cook these vegetables. The women immediately named the three traditional vegetables that they wanted to be included in the project. They regarded obtaining the seeds of these indigenous vegetables, however, as a challenge. Seeds of these indigenous vegetables are not commercialized because they do not have as high a market value as seeds of exotic vegetables such as celery and carrots. Consequently, seeds had to be sourced from other regions, such as the West Region. Even after the seeds had been sourced, not all project beneficiaries received seeds of the indigenous vegetables in the project's first year as the seeds were still not enough. Interestingly, of all the vegetables planted, the indigenous vegetables were the most consumed by the women and their households.

3.4.3 Challenges encountered during the implementation of the gardens

3.4.3.1 Lack of knowledge regarding the health benefits of vegetable consumption

Interviews with the women generated two key insights: (1) combating hunger and gaining money were critically important, and (2) the absence of knowledge on the importance of nutrient-rich foods. When the project was initiated, the women were not particularly interested in nutrition or nutrient-rich vegetables; they solely perceived the vegetables as an additional source of food and income which would facilitate the purchase of other foodstuffs for cooking. However, their attitudes gradually changed after they participated in several focus group discussions on nutrition, diet, and health. Towards the end of the second year of the project, most women were aware of the link between blindness and fatigue and a lack of vitamins. Some women reported that, though they did not like to cook eggplant, they cooked and encouraged their children to eat the vegetable as they recognised it was good for their eyesight.

3.4.3.2 Gender norms

Meetings between project staff and men in the Menchum division revealed that they felt they should be the primary beneficiaries as the primary providers of income and food to their families.

> "*I am already giving money to my wife; why build the gardens for the women? It should be for the men*". A male participant in Menchum division (April 2017)

Following consultative discussions, the men agreed to support the women. They accepted the justification of women being the target beneficiaries as they would be responsible for preparing food for their families, particularly during the period when the men would go for transhumance, leaving the women and children behind. In some communities such as the Njinjam community, the men were highly supportive of their women, resulting in well-managed gardens and nurseries. In other communities, where the men were not supportive, some gardens were not well-managed which led to a poor yield of crops such as waterleaf. At the start of the project, some men prevented their wives participating in the project activities; they said they had money and did not need their wives to work. However, when they observed other women making money from the sale of vegetables, the same men began asking if their women could re-join/participate in the project. Regardless of whether they were allowed to participate, the women respected the decisions taken by their husbands.

3.4.3.3 Irregular weather patterns and poor soil quality

The irregular rainfall during the rainy season constituted a production challenge. Irregular rains resulted in dry soils and poor growth of the young plants transplanted from the nurseries to the gardens, despite the

women irrigating the plants using watering cans. To compensate for the occurrence of these irregular rainfall events, additional vegetable seedlings were purchased to enable the women to replace failed crops with new seedlings. At other times, there was no precipitation for an extended period, and when the rain finally set in, it was heavy and destroyed the vegetables and led to soil erosion in the gardens.

As Mbororo communities are typically located in hilly areas, one of the constraints faced was that fertile topsoil had been washed away to the valleys and, due to the remaining thin humus layer, the soil in many of the gardens established was deficient in nutrients. Although manure was applied in all of the gardens, some of the young plants, especially fluted pumpkin, initially had yellow and twisted leaves. Most plants, however, grew well due to the continuous application of cow dung.

3.4.3.4 Seeds scarcity and labour availability

As sourcing seeds locally was a challenge, the project staff procured seeds in small quantities from areas where Mbororo communities resided across the country, including the West Region. As seeds procured from agro-shops did not germinate well, pepper and eggplant seedlings were purchased from rural markets. Seeds that were locally-sourced generally performed better. Women participated in training sessions regarding seed production. This training resulted in an increase in the availability of seeds of indigenous vegetables such as *folere* which were scarce in the project's first year.

The project staff faced difficulty hiring laborers to clear the field, till, and fence the gardens. Some laborers collected money without fulfilling the work tasks within the required time, while others would collect payment in advance and were subsequently reluctant to work.

3.4.3.5 Infrastructure and pest management

The road infrastructure to gain access to the garden communities, especially those in the Menchum division, was terrible. The roads got worse when the rains gradually increased during the rainy season, making it difficult to fulfill work tasks as planned in these communities and to transport the marketable vegetables on time from the communities to the markets. The harvested produce often deteriorated before the women could sell these. Women in Menchum commonly transported pepper on motorbikes to the markets for sale.

3.4.3.6 Problem with pest management

Poor road infrastructure posed a challenge undermining access to the garden communities, particularly those located in Menchum division. The roads were inaccessible during the rainy season, making it difficult to fulfil work tasks as planned in these communities and transport the vegetables on time from the communities

to the markets. Women in Menchum division commonly transported pepper on motorbikes to the markets for sale. However, the other harvested vegetables often deteriorated before the women could sell their produce.

The women implemented mixed cropping and intercropping methods as they were taught by the project staff. Nevertheless, several insect pests attacked and damaged the seedlings in the nursery and gardens. Caterpillars were the most common insect pest, eating the soft leaves of the seedlings, while beetles were observed as damaging the leaves of okra plants. Project staff were concerned about the women pest management practices as the use of pesticides required literacy and good horticultural skills to follow the recommendations on the label. Consequently, the project staff administered the pesticides themselves to demonstrate to the women how to do it. Despite this pest control performed by project staff, pests were continuously observed in the gardens. No organic or integrated pest management options were implemented as part of the project at the time of the study.

3.5 Discussion

The home garden project was introduced into the Mbororo minority community to empower women and improve food and nutrition insecurity. Therefore, the objective of this study was to assess factors that contributed to ensuring the successful establishment of home gardens in this community. Furthermore, the study assesses successes as regards influencing the availability, accessibility, consumption, and sale of fresh vegetables. The study also provides evidence of the usefulness of home gardens in enhancing food and nutrition within minority communities.

The initiation of the garden project in the communities generated awareness among the women in the Mbororo communities regarding their capacity to engage in gardening and enhance their livelihood and food security. The women realised that they could grow their vegetables and, moreover, that they could generate income by selling vegetables. Their self-esteem increased, while their sense of ownership over the garden project and its positive outcomes on their livelihoods and food security led to pride as the women realized they could support their families. The production of vegetables in the gardens increased Mbororo households' access to nutrient-rich fresh food.

Moreover, an unforeseen, additional benefit of the project was that it also promoted the formation of strong social bonds and improved interaction at a community level, as the women who participated in the project shared excess produce with families and friends within other communities. The contribution of community gardens to food production, social interaction through food-sharing, and positive social relationships at the

community level has also been reported by Michelini et al. (2018), Breuste & Artmann (2015), and Rasmussen (2013).

Increased access to nutrient-rich foods is a proxy for dietary nutrient adequacy (Rathnayake et al., 2012). Prior to the initiation of the project, only a minority of the Mbororo women cultivated vegetables in their homesteads. The seeds of indigenous vegetables were largely unavailable in the Mbororo communities, confirming the findings of Adebooye et al. (2005), who noted that a significant constraint to the widespread cultivation of indigenous vegetables is the lack of access to seeds. In the past, the Mbororo women primarily purchased indigenous vegetables from the "Grassfield" crop farming communities; however, few "Grassfield" women were observed to grow these indigenous vegetables during the project's duration. Recent trends have shown that African indigenous vegetables are seriously threatened by the mono-cropping of high market value exotic vegetables such as carrots and celery (Adebooye & Opabode. 2004); this cropping practice was also found in the study region. Local maize, beans, and even *folere* are being replaced by high market value vegetables such as potatoes and spices for urban cities (Mengui et al. 2019). The home garden project taught women to produce and conserve seeds obtained from the indigenous vegetables planted during the first year of the project, and these seeds were distributed in the second year to other women who did not initially plant the indigenous vegetables. This directly contributed to the success of the gardens project over the two-year period.

Several other factors positively contributed to the successful implementation of the garden project in the Mbororo communities. The women primarily joined the project as there was no cost involved in participation and in response to the peer pressure they faced to participate from their husbands and friends. Regardless of whether they joined willingly or as a consequence of pressure, the women's participation in the project led to their empowerment, defined as the increased ability to make choices (Patalagsa et al. 2015). The women enjoyed having the opportunity to make their own money and enhance their households' financial and food security. Prior to the project being initiated, the Mbororo women were highly dependent on their husbands and, consequently, highly vulnerable to food insecurity during the dry season; similar findings have also been documented by other studies of the Mbororo sociocultural lifestyle by Pelican, (2012). This newly found source of income is significant because it demonstrates that the garden are providing some level of financial independence for the Mbororo women.

Participation in the project enabled the women to buy foodstuff with the money made from the sale of the vegetables. In agreement with the present study's findings, previous studies have demonstrated that empowering women enhances food and nutrition security and fosters the development of whole communities

(Anju et al., 2002). The income from the first sale of vegetables made the women more conscious of their situation and made them eager to improve their livelihoods. Other studies have shown that vegetable sales enhance smallholder livelihoods (Aku et al., 2018). Enhancing their livelihoods is vital to these women because women who did not make much money from their first sale started asking questions from the project staff on improving production.

Initially, the women were not aware of the nutrition benefits generated by the project as they regarded hunger as a more pressing problem. However, during the project, the women took part in educational activities on nutritional and health benefits derived from the consumption of vegetables; this changed their attitudes toward the crops they were cultivating in their gardens. There are similarities between the attitudes expressed by Mbororo women in this study regarding the positive benefits of vegetables on their health status and that of their families, and those described by Berti et al. (2004), who indicated that nutritional education which they received led to a greater diversification of food supply at the household level.

Gender role was one of the significant challenges and essential to the success of the project. Otte et al., (2018) reported that gender role needs to receive special consideration in their study on a solar fruit drying project in Mozambique as way of improving efficiency. Gender is a sensitive issue, and women and girls have been shown to be at higher nutritional risk than men and boys (Johnston et al., 2015). During meetings, the project staff continuously addressed the men to educate them on gender issues and the importance of accepting and facilitating women's roles in decision-making at the household level, especially concerning food purchase and preparation. The significance of considering gender roles and educating participants in a project is that better yields and enhanced livelihood of participants were achieved, as in the case of the project.

Irregular rains were found to be another challenge to the success of the project. The changing rainfall patterns are associated with climate change (Mougou et al., 2011). As the gardens were rain-fed, they were not managed during the dry season, impacting the year-round vegetable supply. Using cheap irrigation and low-cost water harvesting systems might increase the efficiency of the gardens. Implementing agroecological strategies such as water harvesting, nitrogen-fixing cover crops, perriania crops like moringa have increased resilience in crop production (Altieri & Nicholls, 2017).

Another challenge to the project's success was the unreliability of unskilled labour during the implementation phase of the project. Limited and unreliable labour has been shown to be a challenge to the implementation of many other projects in the agricultural sector (Mfitumukiza et al., 2020). A comprehensive study on the

labor market operations around smallholder farmers is significantly important to help address these challenges.

Pests constituted an additional challenge as the project staff could not visit all the villages on time to teach the women how to apply pesticides, for most of them might misuse the pesticides. The reasoning of the project staff was justified as other studies have shown that farmers ignore the technical information on pesticide usage, which could endanger their health (Nchanji et al. 2018). The project staff had plans to teach the women about local integrated pest management methods – such as using neem plants to mitigate pests. Some studies have shown that neem is effectively used to manage pests in poor communities (Gajalakshmi & Abbasi, 2004). However, at the time of this study, the project established only mixed and intercropping systems. Therefore, integrating mixed and intercropping systems with integrated pest management methods such as using neem plants shall significantly improve the project's sustainability, as Gajalakshmi & Abbasi (2004) also found.

The participants in this project did not consider nutrition a problem. This finding contradicts Ebile et al. (2020), who reported nutrition insecurity problems in the Mbororo community. This contradiction could be due to or related to lack of knowledge on nutrition, as also suggested by (Melaku et al., 2018). The women wanted more income-generating vegetables than nutrient-rich vegetables as they perceived lack of money and hunger as constituting more significant problems than nutrition.

3.6 Conclusion

Food-based approaches to combat nutrition insecurity, such as home gardens, can enhance food and nutrition security in marginalised rural communities such as the Mbororo community. This study outlines how a home garden project established in Cameroon’s Northwest region increased the availability and consumption of various nutrient-rich vegetables in the communities with gardens. The sale of vegetables provided a source of income for women to buy other kinds of food for household consumption. Gardens improved the biodiversity of vegetables in rural communities by reintroducing indigenous varieties, whose use had declined due to mono-cropping systems. The project enhanced the Mbororo women’s knowledge regarding the establishment of home and community gardens, management of nurseries and the gardens, and demonstrated the importance of nutrients and vitamins from vegetables. Moreover, the women were taught to generate and manage income so as not to be financially dependent on their husbands. Including a component on nutrition education throughout the project changed the women's perception of the nutrient value of vegetables by the end of the second year.

The project generated a number of policy-relevant lessons. Firstly, for similar garden projects to be effective, their objectives should be flexible as the projects progress. Garden projects should accommodate new ideas and adapt their goals from one harvest cycle to the next. Secondly, many programs targeting women do not include men in their activities or agenda. A key lesson from this project was that households where men were actively involved in project activities and helped with labour-intensive activities such as fencing, the gardens were well-managed and there were fewer weeds and pest problems.

Equally, a combination of different negative factors such as drought, limited pasture, and low milk production positively influenced participants' involvement and engagement in this project. Positive factors such as the prospect to make money and the introduction of indigenous vegetables also attracted the women to participate in the project and led to its success. Education and capacity-building activities such as the provision of nutrition education and good horticultural management strategies were essential to the effective completion of the project. The women improved their crop production and yield in the second year as they learned from their experience producing vegetables during the first year of the project.

This study offers guidance for implementing similar garden projects and contributes to the body of literature concerning the role of garden projects in improving the nutrition and livelihoods of the beneficiaries in the minority community.

Declaration of interest statement

The authors declared that they have no conflict of interest content, and or data used for his paper.

3.7 Acknowledgments

This publication is an output of a scholarship from fiat panis through the Food Security Center of the University of Hohenheim, with funds provided by the German Academic Exchange Service (DAAD) program “Exceed”.

Ethics approval

The study protocol received ethical clearance from the Ethical review committee of the University of Bamenda Northwest region Cameroon. The protocol was assigned the identification number 2018/0054UBa/FHS/IRA approved on 20/07/2018. Furthermore, informed consent was obtained from all respondents during data collection.

3.8 References

Adebooye, O. C., & Opabode, J. T. (2004). Status of conservation of the indigenous leaf vegetables and fruits of Africa. *African Journal of Biotechnology*, *3*(12), 700–705. https://doi.org/10.5897/AJB2004.000-2133

Aku, A., Mshenga, P., Afari-Sefa, V., & Ochieng, J. (2018). Effect of market access provided by farmer organizations on smallholder vegetable farmer's income in Tanzania. *Cogent Food & Agriculture*, *4*(1), 1560596. https://doi.org/10.1080/23311932.2018.1560596

Algert, S. J., Baameur, A., Diekmann, L. O., Gray, L., & Ortiz, D. (2016). Vegetable Output, Cost Savings, and Nutritional Value of Low-Income Families' Home Gardens in San Jose, CA. *Journal of Hunger and Environmental Nutrition*, *11*(3), 328–336. https://doi.org/10.1080/19320248.2015.1128866

Altieri, M. A., & Nicholls, C. I. (2017). The adaptation and mitigation potential of traditional agriculture in a changing climate. *Climatic Change*, *140*(1), 33–45. https://doi.org/10.1007/s10584-013-0909-y

Amadou, J. M. (2017). The Mbororo Problem in North West Cameroon a Historical Investigation. *American Scientific Research Journal for Engineering, Technology, and Sciences (ASRJETS)*, *33*, 37–48.

Anju Malhotra, Sidney Ruth Schuler, C. B. (2002). Measuring Women's Empowerment as a Variable in International Development. In *world bank*. https://doi.org/10.1007/s003470050244

Berti, P. R., Krasevec, J., & FitzGerald, S. (2004). A review of the effectiveness of agriculture interventions in improving nutrition outcomes. *Public Health Nutrition*, *7*(05), 599–609. https://doi.org/10.1079/PHN2003595

Breuste, J. H., & Artmann, M. (2015). Allotment Gardens Contribute to Urban Ecosystem Service: Case Study Salzburg, Austria. *Journal of Urban Planning and Development*, *141*(3). https://doi.org/10.1061/(ASCE)up.1943-5444.0000264

Bryson, J. M. (2016). Critical Factors Affecting the Planning and Implementation of Major Projects Authors (s): John M . Bryson and Philip Bromiley Published by : Wiley Stable URL : http://www.jstor.org/stable/2486820 REFERENCES Linked references are available on JSTOR for t. *Strategic Management Journal*, *14*(5), 319–337. https://www.jstor.org/stable/2486820 Accessed:

Ebile, P. A., Ndah, H. T., & Wünsche, J. N. (2020). Assessing nutrient inadequacies and influence of socio-economic characteristics on diet quality of the Mbororo minority women in Northwest Cameroon. *Nutrition and Food Science*. https://doi.org/10.1108/NFS-07-2020-0265

Faber, M., & Jaarsveld, P. J. Van. (2007). The production of provitamin A-rich vegetables in home-gardens as a means of addressing vitamin A deficiency in rural African communities. *Journal of the Science of Food and Agriculture*, *377*(July 2006), 366–377. https://doi.org/10.1002/jsfa

Fiorella, K. J., Chen, R. L., Milner, E. M., & Fernald, L. C. H. (2016). Agricultural interventions for improved nutrition: A review of livelihood and environmental dimensions. *Global Food Security*, *8*, 39–47. https://doi.org/10.1016/j.gfs.2016.03.003

Gajalakshmi, S., & Abbasi, S. A. (2004). Neem leaves as a source of fertilizer-cum-pesticide vermicompost. *Bioresource Technology*, *92*(3), 291–296. https://doi.org/10.1016/j.biortech.2003.09.012

Galhena, D. H., Freed, R., & Maredia, K. M. (2013). Promising Aproach. *BioMed Central*, 1–13. https://doi.org/10.1186/2048-7010-2-8

Johnston, D., Kadiyala, S., Stevano, S., Malapit, H., & Hull, E. (2015). *Agriculture, Gendered Time Use, and Nutritional Outcomes: A Systematic Review* (No. 01456; Issue August).

Low, J. W., Mwanga, R. O. M., Andrade, M., Carey, E., & Ball, A. M. (2017). Tackling vitamin A deficiency with biofortified sweetpotato in sub-Saharan Africa. *Global Food Security*, *14*(January), 23–30. https://doi.org/10.1016/j.gfs.2017.01.004

Melaku, Y., Dirar, A., Feyissa, G. T., & Tamiru, D. (2018). Optimal dietary practices and nutritional knowledge of school adolescent girls in Jimma Town, South West Ethiopia. *International Journal of Adolescence and Youth*, *23*(3), 299–307. https://doi.org/10.1080/02673843.2017.1369889

Mengui, K. C., Oh, S., & Lee, S. H. (2019). The technical efficiency of smallholder irish potato producers in santa subdivision, Cameroon. *Agriculture (Switzerland)*, *9*(12), 1–13. https://doi.org/10.3390/agriculture9120259

Mfitumukiza, D., Barasa, B., Kiggundu, N., Nyarwaya, A., & Muzei, J. P. (2020). Smallholder farmers' perceived evaluation of agricultural drought adaptation technologies used in Uganda: Constraints and opportunities. *Journal of Arid Environments*, *177*. https://doi.org/10.1016/j.jaridenv.2020.104137

Michelini, L., Principato, L., & Iasevoli, G. (2018). Understanding Food Sharing Models to Tackle Sustainability Challenges. *Ecological Economics*, *145*(July 2016), 205–217. https://doi.org/10.1016/j.ecolecon.2017.09.009

Mougou, R., Mansour, M., Iglesias, A., Chebbi, R. Z., & Battaglini, A. (2011). Climate change and agricultural vulnerability: A case study of rain-fed wheat in Kairouan, Central Tunisia. *Regional Environmental Change*, *11*(SUPPL. 1), 137–142. https://doi.org/10.1007/s10113-010-0179-4

Nchanji, E. B., Hope, L., Nchanji, Y. K., Abia, W. A., Donkoh, S. A., & Schareika, N. (2018). Pest Management among Smallholder Cabbage Growers. *International Journal of Vegetable Science*, *24*(6), 510–525. https://doi.org/10.1080/19315260.2018.1443189

Neba, N. E. (2009). Cropping Systems and Post-Cultivation Vegetation Successions: Agro-Ecosystems in Ndop, Cameroon. *Journal of Human Ecology*, *27*(1), 27–33. https://doi.org/10.1080/09709274.2009.11906188

Nformi, M. I., Mary-juliet, B., Engwali, F. O. N. D., & Nji, A. (2014). Effects of farmer-grazer conflicts on rural development : a socio-economic analysis. *Scholarly Journal of Agricultural Science*, *4*(3), 113–120.

Otte, P. P., Tivana, L. D., Phinney, R., Bernardo, R., & Davidsson, H. (2018). The importance of gender roles and relations in rural agricultural technology development: a case study on solar fruit drying in Mozambique. *Gender, Technology and Development*, *22*(1), 40–58. https://doi.org/10.1080/09718524.2018.1444442

Pandey, V. L., Mahendra Dev, S., & Jayachandran, U. (2016). Impact of agricultural interventions on the nutritional status in South Asia: A review. *Food Policy*, *62*, 28–40. https://doi.org/10.1016/j.foodpol.2016.05.002

Patalagsa, M. A., Schreinemachers, P., Begum, S., & Begum, S. (2015). Sowing seeds of empowerment: effect of women's home garden training in Bangladesh. *Agriculture & Food Security*, *4*(1), 24. https://doi.org/10.1186/s40066-015-0044-2

Pelican, M. (2008a). Mbororo Claims to Regional Citizenship and Minority Status in North-West Cameroon. *Africa*, *78*(4), 540–560. https://doi.org/10.3366/E0001972008000430

Pelican, M. (2008b). Mbororo Claims to Regional Citizenship and Minority Status in North-West Cameroon. *Africa*,

78(04), 540–560. https://doi.org/10.3366/E0001972008000430

Pelican, M. (2011, August). Beyond National Citizenship. *AFRICAN ARGUMENTS*, *2000*, 1–6. http://africanarguments.org/2010/03/08/beyond-national-citizens

Pelican, M. (2012a). Friendship Among Pastoral Fulbe in Northwest. *African Study Monographs*, *33*(3), 165–188. https://doi.org/http://dx.doi.org/10.18632/oncotarget.11780

Pelican, M. (2012b). *From Cultural Property to Market Goods : Changes in the Economic Strategies and Herd Management Rationales of Agro-Pastoral Fulbe in North West Cameroon* (A. M. K. and G. Schlee (ed.)). Berghahn Book. www.berghahnbooks.com

Rasmussen, R. (2013). Think globally, act locally. *SMT Surface Mount Technology Magazine*, *28*(5), 8–11. https://doi.org/10.5415/apallergy.2013.3.2.77

Rathnayake, K. M., Madushani, P., & Silva, K. (2012). Use of dietary diversity score as a proxy indicator of nutrient adequacy of rural elderly people in Sri Lanka. *BMC Research Notes*, *5*, 2–7. https://doi.org/10.1186/1756-0500-5-469

Ruel, M. T., Quisumbing, A. R., & Balagamwala, M. (2018). Nutrition-sensitive agriculture: What have we learned so far? *Global Food Security*, *17*(September 2017), 128–153. https://doi.org/10.1016/j.gfs.2018.01.002

Shisanya, S. O., & Hendriks, S. L. (2011). The contribution of community gardens to food security in the Maphephetheni uplands. *Development Southern Africa*, *28*(4), 509–526. https://doi.org/10.1080/0376835X.2011.605568

Waage, J., Hawkes, C., Turner, R., Ferguson, E., Johnston, D., Shankar, B., McNeill, G., Hussein, J., Homans, H., Marais, D., & Haseen, F. (2013). Current and planned research on agriculture for improved nutrition: A mapping and a gap analysis. *Proceedings of the Nutrition Society*, *72*(May), E317. https://doi.org/http://dx.doi.org/10.1017/S0029665113003509

Webb, P., & Kennedy, E. (2014). Impacts of agriculture on nutrition: Nature of the evidence and research gaps. *Food and Nutrition Bulletin*, *35*(1), 126–132. https://doi.org/10.1177/156482651403500113

Weinberger, K. (2013). Home and community gardens in Southeast Asia: Potential and opportunities for contributing to nutrition-sensitive food systems. *Food Security*, *5*(6), 847–856. https://doi.org/10.1007/s12571-013-0299-z

Chapter 4

4 Agricultural risk assessment to enhance the food systems of the Mbororo minority community in the Northwest region of Cameroon[2]

4.1 Abstract

Increasing population pressure, coupled with the effects of climate change manifested by longer dry seasons, wildfires, and conflicts, threatens the food systems of minority communities. In the case of the Mbororo minority community of Northwest Region of Cameroon, these threats are exacerbated by already existing problems of marginalisation. This study assesses agricultural risks in the global context of food distribution and gross domestic product that also poses a specific threat to the food system of the Mbororo people. The study aims to (1) assess the types of agricultural risk encountered by the Mbororo community, (2) examine the likelihood and severity of these risks, and (3) appraise local risk management strategies adopted to minimise the negative impacts of these risks on the food system. The study makes use of a mixed method approach for data collection. Findings have revealed animal diseases (83%), absence of infrastructures (83.6%), price variation (76.6%), and drought (75.8%) as the most encountered risks in the case study area. Especially, drought, political insecurity, pest and rodent, farmer-grazer conflict, and crop and animal diseases emerged as the highest intensity or priority risks with the need for urgent management strategies intervention. Agricultural risk assessment is frequently used to assess and prioritize risks but has hardly been used in the case of minority groups such as the Mbororo community of Northwest Cameroon.

Keywords: Coping strategies; diseases; frequent drought; risk prioritization; mitigation

[2] This chapter has been published Journal of Agriculture and Rural Development in the Tropics and Subtropics (JARTS)), by Ebile, P.A., Ndah, H.T. and Wünsche, J.N.

Chapter 4

4.2 Introduction

Global food systems are marked by tensions, threats, and conflicts (Tim, 1999), leading to increasing agricultural risk. Such risk may originate from many sources and practices, including crop management, markets and environmental impact and often lead to financial losses (Antón, 2009; Wilhite, 2011) for the affected farm and farming communities. Evidence suggests that such risks hinder farmers' ability in making long-term decisions towards becoming risk-averse (Hans, 1983; Singh, 2018). Defined as "*the threat of loss or damage caused by an unfavourable event or other variables to which one is exposed to, but which event is uncertain*" (Kahan & Worth, 2018 p. 35), agricultural risks also add to other existing challenges facing food systems such as population pressure and internal conflicts (Thornton et al., 2011).

Given these imminent threats to the food system, assessing agricultural risks in sub-Saharan African (SSA) countries is key to managing these threats and improving coping strategies in these countries (Dercon, 2002; World Bank Group, 2016). A closer look at the case of Cameroon as one of SSA countries shows that human and social capital are intensely affected by climate-related agricultural risks (Bang et al., 2017). In highlighting the effect of climate-related risk in Cameroon, Bang et al. (2017) reported that, in the North region alone, 373,176 people were severely affected by floods between 2000 and 2015. Furthermore, climate-related risks affect mostly smallholder farmers because they heavily depend on rain-fed farming (Witt & Waibel, 2009). Due to climate change, farmers are finding it challenging to use their traditional knowledge of weather patterns to mitigate against agricultural risk (Witt & Waibel, 2009) therefore increasing their exposer and vulnerability to its negative consequences. Food insecurity, for instance, is a recurrent agricultural risk problem that affects most minority communities such as the case of the Mbororo minority community of the Northwest region of Cameroon (Booth & Smith, 2001).

The pastoral lifestyle of the Mbororo community (characterised by transhumance) makes them vulnerable, and vulnerable groups of people face the additional challenges of an economic downturn (FAO, 2012; Kimani-Murage et al., 2011). Moreover, the Mbororo minority community's food insecurity situation is made worst because of limited access to basic needs including, clean drinkable water, health centres, electricity, and grazing land for their cattle (Ebile et al., 2020). Enhancing the food system of the Mbororo community is essential to improve their food insecurity situation and agricultural risk management is one strategy to do so. According to

Kahan & Worth (2018), risk can be avoided or its effects mitigated through pre-emptive actions. Furthermore, the authors state that understanding agricultural risk is a fundamental element in enhancing the food system.

The Mbororo community in Cameroon is part of the Fulbe ethnic tribe that spreads from East to West of the African Savana belt (Pelican, 2008). As reported by Pelican (2012), this ethnic tribe is divided into the Aku and the Jaafun sub-tribes. In Cameroon, socioeconomically, they are mostly agro-pastoralist and semi-nomads, and depend mainly on cattle for their livelihood (Pelican 2012; Ebile et al. 2020). Besides, this community forms around 10% of the population in Northwest Cameroon and is often referred to as a stranger population (Pelican. 2012). The Northwest region is characterised by grasslands which is favourable for cattle production (Ebile et al. 2020), therefore, the Mbororo people settle on isolated and suitable hill tops around the region. Their settlements vary in sizes and usually range from five to hundreds of households (Pelican. 2008). This study focuses on the Mbororo minority community of Northwest Cameroon as the case study area. It uses an exploratory action research approach comprising of qualitative and quantitative interviews, as well as focus groups discussions to (1), assess the types of agricultural risk encountered by the Mbororo community, (2) examine the gravity of these risks and their frequency and (3) evaluate the local mitigation and coping strategies adopted towards managing the negative impact of such risks on the food system.

4.2.1 Conceptual Framework

This study makes use of the risk assessment and management cycle based on the "Platform for Agricultural Risk Management" by Kahan & Worth (2018), which consist of 5 stages: i) identification of potential risks, ii) analysis of the risk data, iii) identification of tools, iv) implement risk management tools and, v) monitor and result. In this study, we have modified, directly used, as well as added new stages, to design an adapted framework that is suited for our study as illustrated in Fig. 4.1. The adapted version (Fig. 4.1) has 4 stages instead of 5 and these include: risk environment, evaluation of the risks, tools to manage risks, and recommendations.

For this study, the various types of risks encountered by the Mbororo community were evaluated based on these stages.

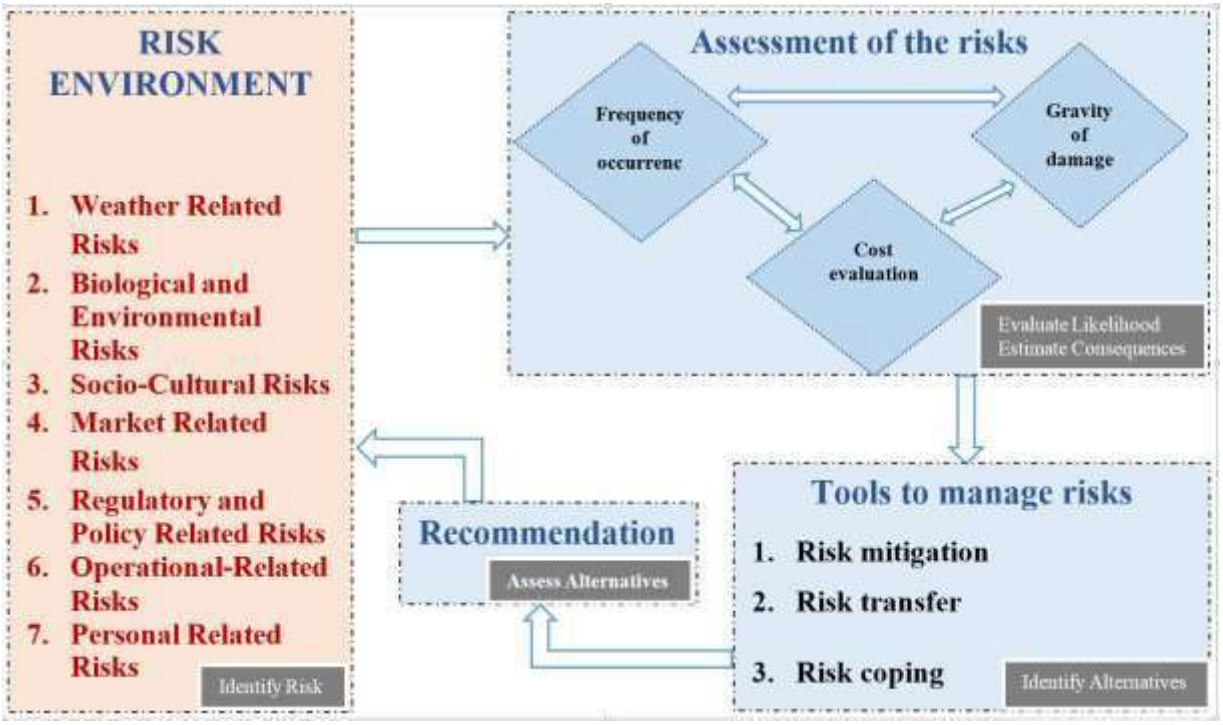

Figure 4.1: *Conceptual risk assessment and management framework cycle, adapted from the Platform for Agricultural Risk Management (Worth and Kahan, 2018). (Source: Author's own)*

Specifically, the framework identifies seven types of risks to be assessed as indicated under the risk environment stage: (a) weather-related risks as, e.g., floods and droughts, (b) biological and environmental risks as, e.g., diseases, pests, wild animals, (c) socio-cultural risks as, e.g., political insecurity, farmer-grazer conflicts, protected area, (d) market-related risks as, e.g., price variations, market information, crop losses during production, processing, and storage and high production cost, (e) regulatory and policy-related risks that have to do with the absence of public infrastructures, (f) operational-related risks related with poor management and organizational structures, and (g) personal-related risks involving the death of a family member, illness, work accident, and family instability. Risk assessment requires monitoring the (a) frequency or the likelihood that the risks will occur, (b) severity or gravity of damage and (c) cost evaluation of the

risk by estimating the consequences of the risks. Risk management tools are usually based on mitigation, transfer, and coping strategies. This study identifies which tool is already in use and recommends alternative tools to enhance the food system of the Mbororo community in Northwest Cameroon. Besides, it assesses the types of agricultural risk encountered by the Mbororo community and examines the gravity of these risks, their frequency and severity.

In the subsequent sections of the paper, section 2 dwells on the methodology, highlighting the case study location, data collection and data analysis approaches. Section 3, elaborates the findings of the study closely followed by section 4 that discusses these findings. The paper ends with section 5, that concludes as well as makes specific recommendations based on findings from the entire work.

4.3 Material and Methods

4.3.1 Study setting and location

The study was carried out in the Mbororo minority communities of the Northwest region of Cameroon. The region covers approximately 17,300 km² with a total population of about 2 million inhabitants, and is divided into seven divisions which in turn are comprised of 34 sub-divisions (Fig. 4.2). The agro-ecological condition of this region is characterised by a mixed of dense vegetal cover and hilly grasslands, with an annual rainfall of 1500 to 2000 mm (Neba, 2009) and temperature ranges of 13 to 25°C (Nformi et al., 2014) depending on the period of the year. Traditionally, the indigenous Mbororo people are divided into two sub-tribes (i.e. the Jaafun and the Aku) and comprise peri-urban dwellers[3], agro-pastoral and nomadic socioeconomic groups (Pelican, 2008). All three groups practice different forms of pastoralism, whereby pastoralism with

[3] Peri-urban dwellers: These are people or communities located mostly at the outskirts of the cities, but retain rural characteristics in their way of life, and in this case, by keeping livestock with the primary target of supplying to the urban market. Sometimes, these dwellers might live in the cities and keep livestock in these areas as part time farming activities to supplement their income(Žlender & Ward Thompson, 2017).

cattle rearing constitutes the sole means of livelihood and primary economic activity (Pelican, 2012).

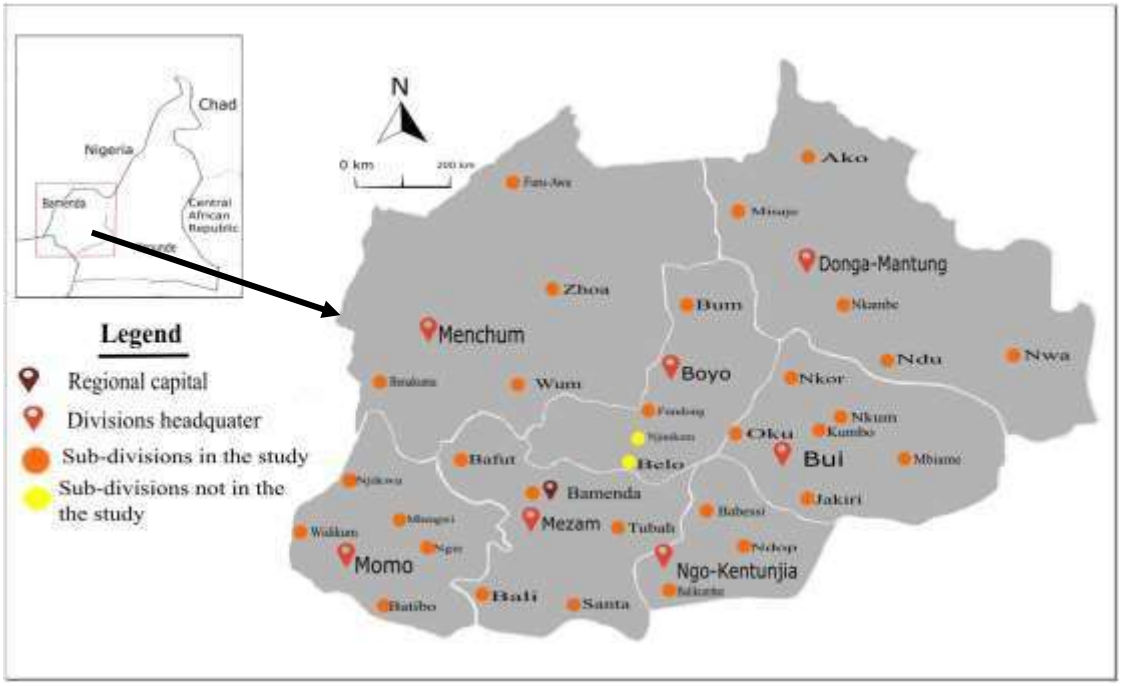

Figure 4.2: *The map shows the divisions and sub-division in the Northwest region of Cameroon. Data was collected from sub-divisions in orange, while those in yellow had no Mbororo communities hence no data was collected from them. (Source: Author's own)*

4.3.2 Sampling and data collection approach

For data collection which took place from April 2017 to July 2018, we made use of a mixed method approach comprising of a quantitative survey, a semi-structured qualitative interview guide, as well as focus group discussions.

For the quantitative survey, questionnaires were administered to men or women that were household heads (i.e. women household heads in this case were windows) in case study communities. Firstly, all Mbororo communities and their ethnic names in the sub-divisions were identified in collaboration with an NGO called the Mbororo Social and Cultural Development Association to allow for randomization. Secondly, 32 of these Mbororo communities, villages or

"Ardorates" (i.e. one from each sub-division) were randomly selected for administering the questionnaire by trained students from a nearby University (Bamenda University) and five NGO paralegals[4]. In total, 265 Mbororo men and women household heads were surveyed.

For qualitative data collection, we conducted 26 semi-structured qualitative interviews with community leaders and members of NGOs working within the Mbororo communities and administered 7 focus group discussions. Guided questions in the interviews centred around risk-mitigating opportunities related to insurance policies and microloans. Focus group discussions were held on key issues relating to mitigation, copping, and transfer strategies to managing risks. Because the livelihood of most Mbororo families is dependent on men who are directly responsible for the cattle, we had separate focus groups discussions with women and men in order to capture their respective perspectives. This decision for separating both groups was influenced by the traditional values of the Mbororos, which prohibits joint discussions between men and women in one setting.

4.3.3 Analysis and characterization of agricultural risks

We analysed data on agricultural risks within the Mbororo community according to different parameters and techniques such as i) the damage caused by the risk, ii) the frequency of occurrence, and iii) the monetary cost of the risks, to account for the different agricultural risks encountered by farmers in their everyday lives (Fig. 4.1). The seven identified agricultural risks (Fig. 4.1) were first presented as percentages of the farmers who encountered these risks.

[4] Paralegals are people, qualified through education, training or work experience to perform substantive legal work that requires knowledge of legal concepts.

Overall impact of a given risk factor on the whole community was derived by combining the risk frequency and severity[5] responses from 265 respondents within the various sub-divisions. Risk frequency of occurrence was recorded at three levels; rare, often, and permanent.

For analysis and quantification of damage, the severity of risk was allocated a percentage to represent the damage caused by that risk. The percentages range from 0-30%, 31-60%, and above 61-100%, representing rare, often, and permanent levels of damage caused by the risk, respectively. The method for combining frequency and severity to get impact is based on a risk matrix for prioritization (Fig. 3), as initially proposed by Kahan & Worth (2018). However, we have modified the matrix level from five to three levels to fit the objectives of this study. Following Kahan & Worth (2018), using a matrix with a limited number of levels helps in categorizing agricultural risks and making decisions on risk management strategies. Using the frequency of occurrence and severity risk matrix, the weather, biological and environmental, and socio-cultural risks, respectively, were assessed.

[5] The severity of risk refers to the damage of farmers' losses due to certain agricultural risks at a given time such as those outlined in the conceptual framework (Fig. 1).

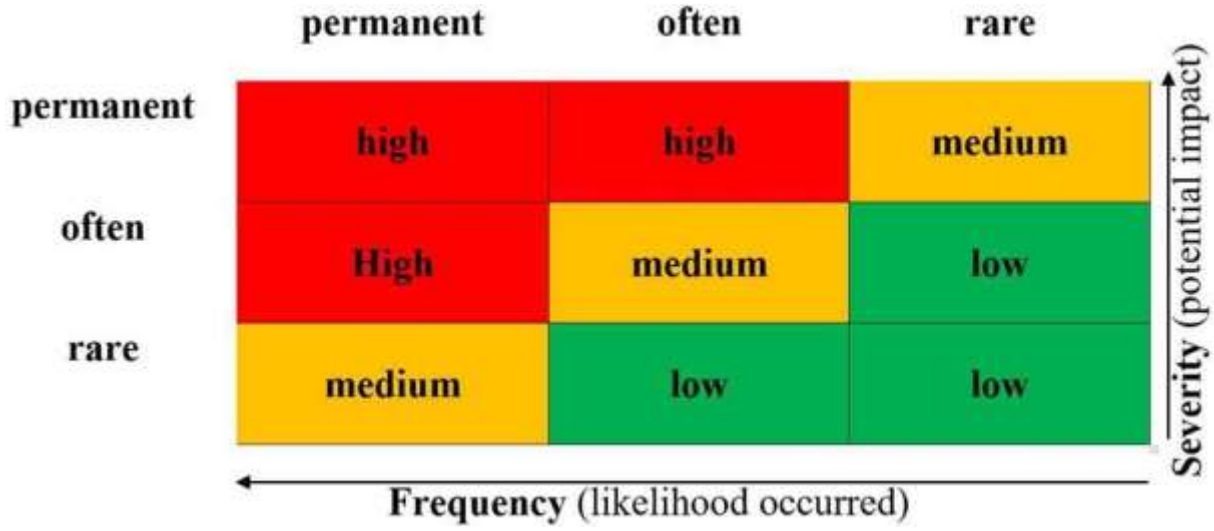

Figure 4.3: *Risk matrix, combining severity of damage and frequency of occurrence, adapted from the Platform for Agricultural Risk Management (Worth and Kahan, 2018). (Source: Author's own)*

Note: *The direction of the arrow shows an increase in frequency and severity*

The red color in the matrix indicates that a given risk requires an immediate management strategy for reducing the average frequency and/ or average severity of the risks to reduce its impact. The orange color indicates that risk might be acceptable but needs monitoring. In contrast, the green colour indicates a low risk that may not be managed because it is sufficiently controlled.

Market-related, regulatory and policy-related, operational-related, and personal-related risks were not analyzed using the risk matrix since these did not have a severity component or damage on crops or animal production. These risks were assessed individually, and the results were presented separately. Market-related risks were assessed using the frequency of occurrence and loss of income experienced by the respondents. The risk frequency was assessed using three levels: rare, often, and permanent. The study computed the percentages of the respondents that lost income due to different market-related risks such as price variation, and access to market information.

Operational risk categories critical to the Mbororo community, such as access to finances, infrastructure, and human resources, were assessed using focus group discussions. Participants were asked to rank these risks according to their perceived adverse impact. The first four types of risk within each category are presented in the results. Personal-related risks are either human-induced or natural and include illness, work accidents, death of a family member, or family instability. The study assessed the percentages of the respondents that have encountered the various forms of personal risks, and some strategies are taken to manage these risks.

4.3.4 Data analysis

SPSS software (version 22, IBM, Armonk, NY, USA) was used to analyse quantitative data to determine the percentage of the respondents that encountered various risks. The frequencies of occurrence and the severity of the risks were ranked and combined using a risk matrix system. MS-excel spread sheet was used for graphically displaying the data from SPSS.

4.4 Results

4.4.1 General observations

Based on our findings, the livelihood of a typical Mbororo household is centred around livestock and most, own between 20-200 cattle and other livestock species such as sheep, horses, and chicken. Horses are a sign of prestige and used in transportation but do not rank close or equal to the cattle in terms of importance. While cattle are mostly owned and controlled by men, women mostly own and control the chicken and sheep. However, when it comes to selling, a woman is expected to consult the husband for approval. The food system of the Mbororo community is, therefore, mostly supported by animal production, implying any risk affecting the animals will, in turn, threaten the whole food system. However, some families with less cattle and equally less financially viable who are settled in their present locations do practise subsistence crop farming.

4.4.2 Agricultural risk encountered by the Mbororo community

The Mbororo communities encountered, to varying degrees, all the seven agricultural risks outlined in the framework of the study. Table 4.1 shows an overview of the percentages of the Mbororo respondents that have encountered these agricultural risks.

Table 4.1: *The percentage of the Mbororo population that have encountered agricultural risks (N = 265).*

Risk Category	Risk	%
Weather-related risk	Flood	18.9
	Drought	75.8
	Heavy wind and hailstones	48.3
	Other shocks (earthquakes, landslide)	13.1
Biological and environmental risk	Crop and animal diseases	83.0
	Pest and rodents	78.1
	Low-quality inputs (chemicals and planting materials)	49.6
	Wild animal invasion	28.8
Socio-cultural risk	Political insecurity	70.1
	Farmer grazer conflict	56.9
	Protected area	20.2
Market related risk	Price variation	76.6
	Lack of access to market information	52.3
	Production, processing and storage loss	54.4
	Higher production costs	56.7
Regulatory and policy-related risks	The absence of public infrastructures (water, electricity, warehouse, tarred road)	83.6
Operations related risks	Poor management and organizational structure risks	34.2
Personal related risks	Personal risks (illness, work accidents, death or family instability)	60.1

The weather-related risks most encountered by the Mbororo population are drought (75.8%), while animal and crop diseases (83%) are the most encountered biological and environmental risks. Moreover, political insecurity is the most encountered socio-cultural risk (70.1%), while price

variation (76.6%) is observed to be the most encountered market-related risks. The absence of infrastructures is rated as high risk (83.6%). Operations related risks like poor management are observed as the least encountered type of agricultural risks.

4.4.3 Prioritizations of risk categories

The resulting impact from combining the frequency of occurrence and severity using the risk matrix is given below (table 4.2).

Table 4.2: *Risks impact levels from the combination of average severity and frequency.*

Risk	Average Severity	Average Frequency	Combined impact
Weather-related risk			
Flood	**rare**	**rare**	**low**
Drought	**permanent**	**often**	**high**
Heavy wind and hailstones	**often**	**often**	**medium**
Other shocks (earthquakes, landslide)	**rare**	**rare**	**low**
Biological and environmental risk			
Crop and animal diseases	**permanent**	**permanent**	**high**
Pest and rodents	**permanent**	**permanent**	**high**
Low-quality inputs (chemicals and planting materials)	**often**	**often**	**medium**
Wild animals invasion	**often**	**rare**	**low**
Socio-cultural risk			
Political insecurity	**permanent**	**permanent**	**high**
Farmer-grazer conflict	**permanent**	**often**	**high**
Protected area	**rare**	**rare**	**low**

Note: *The risk Matrix combines frequencies levels and severity levels to give the impact of the various risks. The colors are used to indicate the strength of the impact and facilitate prioritization.*

Table 4.2 indicates that drought is the most critical weather-related risk encountered by the Mbororo people, followed by heavy wind and hailstones, while flood and other shocks have the least threatening impact. For biological and environmental risks, crop and animal diseases and pests and rodents were the most critical risks encountered, whereas low-quality inputs had a medium impact, and wild animal invasions had little to no effect. Considering that: socio-cultural risks, political insecurity and farmer-grazer conflict were most critical; however, threats from the

administration (e.g. in form of penalties or fines) arising because encroachment with cattle in to protected areas was low. In summary, of the eleven agricultural risks assessed using the risk matrix and prioritization method, five of them were of priority 1, two of priority 2, and four of priority 3.

4.4.4 Market, regulatory, policy, operations and personal risks

4.4.4.1 Market-related risk

Figure 4.4 represents the frequency levels of occurrences rare, often, and permanent for market-related risks.

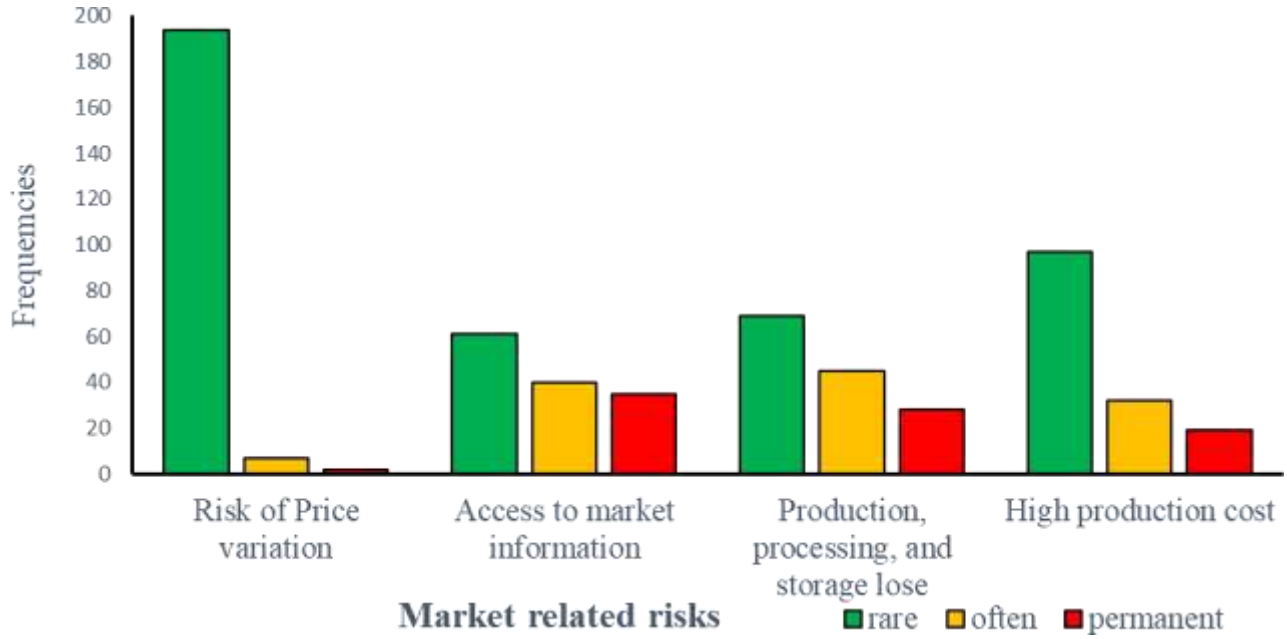

Figure 4.4: *The levels of frequencies of occurrence of market-related risks*

In this study, 203 respondents encountered all the market-related risks. From the 203 respondents that encountered the risk of price variation, 194 respondents said they encountered the risk rarely, 7 said often, and 2 said they permanently encountered this risk. Access to market information and production, processing, and storage loss are the most critical market-related risks encountered by the respondent as a high number of the respondent permanently encounter these risks.

The respondents indicated that they lost income due to price variation (35.5%), lack of market information (37.4%), processing and storage loss (46%), and high production cost (50%) negatively impacting their profits.

4.4.4.2 Regulatory and policy-related risks

The presence or absence of public infrastructures like water, electricity, warehouse, and proper roads affected agriculture in the Mbororo community. Examining the frequencies of occurrence, 74.4 % of the respondents indicated that the lack of infrastructure was a constant problem, whereas 12.8 % of the respondents said they encounter challenges with an infrastructure often or rarely, respectively. The results showed that 58.3% of the respondent thought that the absence of public infrastructure resulted in low profits, 34.9% felt that it limited their access to the markets, and 6.9% did not feel it had an impact on either of the two categories.

4.4.5 Operations-related risks

Findings showed that for operations related risks encountered by the Mbororo people, 32.6 % of respondents encountered finance challenges, 47.2% faced infrastructure challenges, and 20.2% encountered human resource problems. Four risks with the most negative impact under the different sub-groups of operations-related risks are:

4.4.5.1 Finance.

(1) Insufficient funds to pay workers at times and to respond to higher pay demands; (2) lack of funds for animal vaccination and welfare; (3) difficulty to receive microfinance from banks; and (4) prices of inputs for animal care is increasing annually.

4.4.5.2 Infrastructure.

(1) Lack of tools and good seed quality for crop farming; (2) increasing cost for fencing material; (3) cattle destroy farmer's crops because of no fence; and (4), not enough grazing land.

4.4.5.3 Human resource.

(1) workers do not want to go for transhumance because of a long dry season; (2) lack of trust since workers steal cattle and sell; (3) reluctance of the workers for taking cattle to graze on far-off land with better grass, and (4) shortage of workers since most of them have moved to the city.

4.4.6 Personal related risks

Results on personal-related risks indicated that respondents of the Mbororo people had encountered

illness (50 %), work accidents (17.7 %), death of a family member (26.6 %), and other types of risks such as instability related to movement and separations (5.7 %).

4.4.7 Local risk management strategies adopted to solve risks frequently encountered by the Mbororo community

Table 4.3 shows the various management strategies the Mbororo people used in trying to manage the multiple risks their food system often encountered.

Table 4.3: *The percentage of the population that implemented management strategies*

Agricultural risks	**Management strategies put in place by respondents**	**Percentage of respondents (%)**
Weather-related risks	• Nothing	90
	• Weather forecast	5
	• Insurance	5
Biological and environmental-related risks	• Nothing	38
	• Used Chemicals	35
	• Use improved inputs	4
	• Build a fence	23
Socio-cultural related risks	• Nothing	98
	• Cope	2
Market-related risks	• Nothing	45
	• Cope	55
Infrastructural related risks	• Nothing	29
	• Cope	71
Personal related risks	• Nothing	30
	• Use home treatment	26
	• Seek medical assistance (hospital)	41

Notes: *Cope or copping are the different mechanisms to deal with risks that could not be mitigated or transferred. For example, borrowing of money and selling of goods and properties. Some of the management strategies do not apply to some risks*

Table 4.3 shows that most of the respondents did nothing when they encountered particularly socio-cultural risks (98%) and weather-related risks (90%). However, in the case of wreathe related risk, cattle owners gave away cattle as insurance to their herds men in addition to the payment they receive for taking care of the castle. The results clearly revealed a high level of coping, market and infrastructural risks categories. Coping mechanisms for socio-cultural risks were mainly the use of guard dogs to increase security against cattle theft. For infrastructure-related risks coping mechanisms were related to the purchase of cheap portable solar lamps, purchasing inputs from big cities at lower prices, paying for a fence construction around their farms to avoid conflicts, and sowing grass (forage) as supplements for feeding cattle during the dry season. For market-related risk, the mechanisms included meetings to stabilize the sales price for cattle, take advice from veterinarians, and introduce new animal species that produce more milk. Some individuals stated that they bought animals in the dry season when cattle were cheaper and sold during festive periods such as Ramadan and Christmas at high prices.

Adaptation or coping mechanisms for managing finance-related operation risks included selling cattle to buy inputs and to pay for labour, purchasing inputs when prices are low during the off-season and borrowing money from friends and family. Managing human-resource-related operation risks (e.g. to avoid stealing of cattle) included i) cattle owners (especially the rich and settled ones with herds men taking care of their cattle) accompanying their herds men in transhumance activities, and ii) making unannounced control visits to check their cattle. Some participants believed that personal-related risks such as illness were the most difficult to manage

because of the insufficient health care system; thus, 26% of the respondents turn to home treatment using herbs and traditional medicines.

4.5 Discussion

4.5.1 Agricultural risk encountered by the Mbororo community

Agricultural risks may negatively impair the food system of many communities depending on the intensity of the risk (Hans, 1983; Singh, 2018). Findings from the current study showed that the respondents have encountered all seven risks under investigation. Furthermore, a high percentage of respondents encountered these risks, which indicates that the Mbororo community's food system is under pressure. These threats to the food system of the Mbororo community might also negatively affect other communities as for instance urban cities that depend on meat and milk from the Mbororo community (Tim, 1999). Specifically, the results have shown that the livelihood of the Mbororo community is centred especially on cattle, though a few of these families' substitute home consumption by practising subsistence crop farming. For this reason, a high percentage of the community experiencing drought, pests and animal diseases related risks implies their source of livelihood at risk. Other studies in Cameroon have also found pests to be a threat to crop production in other localities such as Ndop and the West region (Pouokam et al., 2017; Fai et al., 2019). These results suggest that the Mbororos find it challenging to sustain their food system due to prolonged droughts with not enough pasture for cattle grazing. However, respondents feared most the foot-and-mouth cattle disease. Recent research has shown that the disease is very contagious, with a high morbidity rate (Spickler, 2015).

The global impact of foot-and-mouth disease is enormous due to the large numbers of animals affected causing direct losses due to reduced production or indirect losses caused by control costs (Knight-Jones & Rushton, 2013). Schmitz (2005) holds the view that constraints within the value

chain negatively impact the food system. Since market-related risks and risks associated with a lack of infrastructure were shown to be high in the current study, this means the cattle value chain within the Mbororo community is threatened. Commercialisation provides a source of income for many households globally to overcome credit-related challenges and mitigate shocks (Strasberg et al., 1999), and if this is threatened, their whole livelihood is at risk. The findings of the current study are consistent with those of Phillip et al. (2009), who showed that challenges in marketing, processing, and lack of cold storage facilities in abattoirs constrain the livestock value chain in Nigeria and negatively impacted the food system.

4.5.2 Prioritizations of agricultural risk

Managing agricultural risk necessitates the prioritization of potential risks according to their intensity, and risks with a high priority should be handled urgently (Kahan & Worth, 2018a). It is necessary to prioritize risks so that solid and holistic strategies can be developed to mitigate their potential effects on agricultural systems. Agricultural risk management is continuously evolving and differs depending on country factors such as form of government, economy, infrastructure and culture, (Székely & Pálinkás, 2009). Thus, providing data on different local management strategies helps mitigate similar risks in different localities. Drought, crop and animal diseases, pests and rodents, political insecurity, and farmer grazer conflict, were the high priority risks that threaten the food system of the Mbororo people. These priority risks are similar to those reported in other studies within the context of agriculture in sub-Saharan Africa (e.g., Nchanji et al., 2018; Thornton et al., 2011). In contrast, some risks that were of low priority in the current study, such as floods, were of a high priority in other studies in different localities (Bang et al., 2017; Witt and Waibel, 2009). Thus, it is important to provide data of the risks faced by many different communities to

construct an agricultural risk scenario for the whole country and to formulate management recommendations.

4.5.3 Risk management strategies

Risks are managed either by mitigating, coping with, or transferring the impact of the risks (Antón, 2009). Risk management strategies require a detailed assessment of the intensity and severity of the encountered risk. This study demonstrated that most Mbororo people did nothing to manage the risks they encountered, with over 90% of the people taking no action related to weather and 98% for socio-cultural related risks, mainly due to lack of knowledge and insufficient support from the local government authority. Nevertheless, a smaller portion of the action (2%) could be observed from the part of local leaders via conflict management (e.g. farmer grazer-conflicts). These results agree with earlier findings, stating that minority communities have limited access to basic infrastructures than their counterparts in the same locality (Booth & Smith, 2001), which might be why most respondents did nothing against these risks. For instance, following Awazi et al (2019), most non-Mbororo farmers in this same region have proper access to meteorological data from locally stationed government weather stations. However, some respondents used one of the three methods to manage risks discussed in the next section.

4.5.3.1 Risk mitigation

Risk mitigation refers to actions taken before a risk event occurs to reduce the likelihood of risk or reduce the severity of losses (Kahan & Worth, 2018a). Few Mbororo people started diversifying their food system from cattle to crop farming as a mitigation strategy; however, the majority of the population is still reluctant to practice crop cultivation. Other research has proven that diversification is an excellent risk-mitigating tool in many communities worldwide because it brings resilience to rural communities (Herforth, 2013). Moreover, the Mbororo people mitigated biological and environmental-related risks by using drugs (e.g. animal vaccination and treatment of ticks) to treat their cattle and improve pasture land by sowing Guatemala (*Tripsacum laxum*) and Bracharia (*Brachiaria eruciformis*) grass seed for cattle forage (Mtengeti et al., 2001). Improved pastures were only recently introduced in the Mbororo community, however, it is being used in many other communities for mitigating drought (Vrieling et al., 2016). Generally, environmental threats are often tilted against areas that are already vulnerable and have the least resources for adaptation (Myers et al., 2017).

4.5.3.2 Risks transfer

Risk transfer considers contractual shifting (removal) of risk from one party (e.g., the farmer) to another party (e.g., an institution such as an insurance company) that is better able to cope with the risk (Kahan & Worth, 2018). However, risk transfer was not a common management strategy amongst the Mbororo people because only 5% of the population were involved in any form of insurance (e.g. giving away cattle to ensure that herdsmen are more effective in carrying out their duty). In some countries like Nigeria, private and government insurances try to help farmers better cope with their risks, but these institutions are not efficient (Epetimehin et al., 2011). Interestingly, the Mbororo have a traditional form of partial risk transfer by guaranteeing the herdsman, in addition to his salary, a certain number of cattle if he works well for a certain length of time. The deal helps the owner to ensure that the herdsman will take care of the cattle as his own. The low percentage of the Mbororo population using insurance is confirmed by other research, showing that agricultural insurance in Africa is not reliable and people do not trust these companies (Njegomir & Demko-Rihter, 2018). Though other studies have shown possibilities for positive insurance application (Ndagijimana et al. 2020), insurance institutions in Africa need much work to gain the trust of farmers. Besides, Ntukamazina et al. (2017) have recommended strong public-private partnerships, and improved quality as well as availability of weather data as options towards improving risk management strategies.

4.5.3.3 Risk copping

Some risks cannot be mitigated or transferred, and in such cases, people need coping strategies that help absorb the impact of the risk (Kahan & Worth, 2018a). Coping strategies in the Mbororo community were mainly related to the sale of cattle when financial losses were experienced. For instance, cattle owners are often forced to sell their cattle to pay for crop destruction cause by their cattle. This tallies with the findings of Strasberg et al. (1999), who state that selling assets is still one of the most basic forms to cope with agricultural risks around the world. Moreover, NGOs are also helping the Mbororo cope with conflict-related risks by resolving the conflict between farmers and grazers on their platform called “in search of common ground” (Valentine, et al., 2014). NGOs play a crucial role in mitigating risks across many different situations such as natural disasters, hunger, poverty and conflicts, and essential in mitigating agricultural risks (Nikkhah & Redzuan, 2010).

Chapter 4

4.6 Conclusions and recommendations

Considering that enhancing the food system of rural communities will improve agricultural production and livelihood, this study aimed to assess agricultural risks affecting the food system of the Mbororo community and propose management strategies. The study found that the food system of the Mbororo community is (1) heavily reliant on livestock production, (2) fragile because it suffers from all agricultural risks under investigation, (3) facing high priority agricultural risk such as drought, crop and animal diseases, pest, insecurity and farmer-grazer conflict that need urgent intervention, and (4) unstable due to their inability to mitigate or transfer some of these risks. It is recommended to prioritize risks for effective and sequential management of potentially detrimental impacts on the food system. Risks of high priority such as drought, animal and crop diseases, and farmer-grazer conflict should be urgently managed because their impact is not only on the food system but also on livelihood. For example, drought increases the likelihood of farmer- grazer conflicts that negatively impact the Mbororo people's food system. Since the Mbororo community's food system is anchored around livestock production, foot-and-mouth disease was the main threat to cattle production without any practical solution in place. Furthermore, improved access to agricultural risk management tools such as microfinance, insurance, and training would mitigate these risks for the Mbororo community. The study recommends that already existing management strategies used by a minor proportion of the Mbororo people should be encouraged and promoted. These strategies include:

- introducing grass varieties such as Guatemala and Bracharia for cattle forage primarily for dry seasons though this might incur addition cost for fencing and other management strategies, but the overall benefit outweighs the cost.
- diversification of farming systems through gardening for food security;
- improving milk production through the acquisition and adoption of high milk-producing cow breeds;
- developing microfinance and insurance schemes to mitigate risk induced vulnerability;
- The local government should enforce the power of the platform, “in search of common ground” in resolving the conflict between farmers and grazers within the region.

4.7 Acknowledgments

This publication is an output of a scholarship from Fiat Panis through the Food Security Center of

the University of Hohenheim, with funds provided by the German Academic Exchange Service (DAAD) program “Exceed”.

Ethics approval

The study protocol received ethical clearance from the Ethical review committee of the University of Bamenda Northwest region Cameroon. The protocol was assigned the identification number 2018/0054UBa/FHS/IRA approved on 20/07/2018. Furthermore, informed consent was obtained from all respondents during data collection.

Declaration of interest statement: The authors declared that they have no conflict of interest content, and or data used for his paper.

4.8 References

Aizen, M. A., Aguiar, S., Biesmeijer, J. C., Garibaldi, L. A., Inouye, D. W., Jung, C., Martins, D. J., Medel, R., Morales, C. L., Ngo, H., Pauw, A., Paxton, R. J., Sáez, A., & Seymour, C. L. (2019). Global agricultural productivity is threatened by increasing pollinator dependence without a parallel increase in crop diversification. *Global Change Biology*, *25*(10), 3516–3527. https://doi.org/10.1111/gcb.14736

Antón, J. (2009). Managing risk in agriculture: A holistic approach (Vol. 9789264075). OECD.

Archer, D. W., Dawson, J., Kreuter, U. P., Hendrickson, M., & Halloran, J. M. (2008). Social and political influences on agricultural systems. *Renewable Agriculture and Food Systems*, 23(4), 272–284.

Bang, H., Miles, L., & Gordon, R. (2017). The Irony of Flood Risks in African Dryland Environments: Human Security in North Cameroon. *World Journal of Engineering and Technology*, *05*(03), 109–121. https://doi.org/10.4236/wjet.2017.53b013

Booth, S., & Smith, A. (2001). Food security and poverty in Australia -- challenges for dietitians. Australian Journal of Nutrition & Dietetics, 58(3), 150-156 7p.

http://search.ebscohost.com/login.aspx?direct=true&db=cin20&AN=106966090&site=ehost-live

Codjoe, S. N. A., & Owusu, G. (2011). Climate change variability and food systems: Evidence from the Afram Plains, Ghana. *Regional Environmental Change*, *11*(4), 753–765. https://doi.org/10.1007/s10113-011-0211-3

Dillon, A., Mueller, V., & Salau, S. (2011). Migratory responses to agricultural risk in northern Nigeria. *American Journal of Agricultural Economics*, *93*(4), 1048–1061. https://doi.org/10.1093/ajae/aar033

Dercon, S. (2002). Income risk, coping strategies, and safety nets. *The World Bank Research Observer*, 17(2), 141–166.

Ebile, P. A., Ndah, H. T., & Wünsche, J. N. (2020). Assessing nutrient inadequacies and influence of socio-economic characteristics on diet quality of the Mbororo minority women in Northwest Cameroon. Nutrition and Food Science. https://doi.org/10.1108/NFS-07-2020-0265

Epetimehin, P. F. M., & Joseph Ayo Babalola University Ikeji. (2011). AGRICULTURAL INSURANCE IN NIGERIA AND THE ECONOMIC IMPACT. *International Journal of Current Research*, *3*(12), 260–265.

Fai, P. B. A., Ncheuveu, N. T., Tchamba, M. N., & Ngealekeloeh, F. (2019). Ecological risk assessment of agricultural pesticides in the highly productive Ndop flood plain in Cameroon using the PRIMET model. *Environmental Science and Pollution Research*, *26*(24), 24885–24899. https://doi.org/10.1007/s11356-019-05592-2

FAO, W. and I. (2012). *The State of Food Insecurity in the World 2012. Economic growth is necessary but not sufficient to accelerate reduction of hunger and malnutrition*. FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS. https://doi.org/ISBN 978-92-5-107316-2

Fraser, E. D. G., Dougill, A. J., Mabee, W. E., Reed, M., & McAlpine, P. (2006). Bottom up and top down: analysis of participatory processes for sustainability indicator identification as a pathway to community empowerment and sustainable environmental management. *Journal of Environmental Management*, 78(2), 114–127.

Hans P Binswanger, D. A. Si. (1983). Risk adversion and credit constraints in farmers' decision making: A reinterpretation. *Journal of Development Studies*.

Hao, A. (2010). Uncertainty, risk aversion and risk management in agriculture, farmer; uncertainty; risk aversion; risk management. *Agriculture and Agricultural Science Procedia*, 1, 152–156.

Herforth, A. (2013). Synthesis of guiding principles on agriculture programming for nutrition. Rome: FAO. Retrieved from http://www.fao.org/docrep/017/aq194e/aq194e.pdf

Herrero, M., & Thornton, P. K. (2013). Livestock and global change: Emerging issues for sustainable food systems. *Proceedings of the National Academy of Sciences of the United States of America*, *110*(52), 20878–20881. https://doi.org/10.1073/pnas.1321844111

Johnston, D., Kadiyala, S., Stevano, S., Malapit, H., & Hull, E. (2015). Agriculture, gendered time use, and nutritional outcomes: *A Systematic Review* (No. 01456). London.

Kahan, D., & Worth, S. (2018a). Agricultural risk management tools. PARAM/IFAD Rome. Retrieved from www.p4arm.org

Kahan, D., & Worth, S. (2018b). Understanding the risk environment in agriculture. Rome.

Kimani-Murage, E. W., Holding, P. A., Fotso, J. C., Ezeh, A. C., Madise, N. J., Kahurani, E. N., & Zulu, E. M. (2011). Food security and nutritional outcomes among urban poor orphans in Nairobi, Kenya. *Journal of Urban Health*, *88*(SUPPL. 2), 282–297. https://doi.org/10.1007/s11524-010-9491-z

Knight-Jones, T. J. D., & Rushton, J. (2013). The economic impacts of foot and mouth disease - What are they, how big are they and where do they occur? *Preventive Veterinary Medicine*, *112*(3–4), 161–173. https://doi.org/10.1016/j.prevetmed.2013.07.013

Motha, R., Wilhite, D., & Wood, D. (2011). *Agricultural Drought Indices. Proceedings of an Expert Meeting: 2-4 June, 2010, Murcia, Spain*. M. V. Sivakumar (Ed.). WMO.

Mpandeli, S. (2014). Managing Climate Risks using seasonal climate forecast information in Vhembe district in Limpopo Province, South Africa. *Journal of Sustainable Development*, *7*(5), 786b – 787. www.ccsenet.org/jsd

Mtengeti, E. J., Urio, N. A., & Mlay, G. D. (2001). Research note: Intensive fodder gardens for improving forage availability for smallholder dairy production in Hai district, Tanzania. In *Tropical Grasslands* (Vol. 35, Issue 2, pp. 124–127).

Myers, S. S., Smith, M. R., Guth, S., Golden, C. D., Vaitla, B., Mueller, N. D., Dangour, A. D., & Huybers, P. (2017). Climate Change and Global Food Systems: Potential Impacts on Food Security and Undernutrition. *Annual Review of Public Health*, *38*, 259–277. https://doi.org/10.1146/annurev-publhealth-031816-044356

Neba, N. E. (2009). Cropping Systems and Post-Cultivation Vegetation Successions: Agro-Ecosystems in Ndop, Cameroon. *Journal of Human Ecology*, *27*(1), 27–33. https://doi.org/10.1080/09709274.2009.11906188

Nchanji, E. B., Hope, L., Nchanji, Y. K., Abia, W. A., Donkoh, S. A., & Schareika, N. (2018). Pest Management among Smallholder Cabbage Growers. *International Journal of Vegetable Science*, *24*(6), 510–525. https://doi.org/10.1080/19315260.2018.1443189

Nformi, M. I., Mary-juliet, B., Engwali, F. O. N. D., & Nji, A. (2014). Effects of farmer-grazer conflicts on rural development: a socio-economic analysis. *Scholarly Journal of Agricultural Science*, *4*(3), 113–120.

Nikkhah, H. A., & Redzuan, M. Bin. (2010). The Role of NGOs in Promoting Empowerment for Sustainable Community Development. *Journal of Human Ecology*, *30*(2), 85–92. https://doi.org/10.1080/09709274.2010.11906276

Njegomir, V., & Demko-Rihter, J. (2018). The problem of the demand for crop insurance: The case of Serbia. *Ekonomika Poljoprivrede*, 65(3), 995–1014.

Novickytė, L. (2019). Risk in agriculture: An overview of the theoretical insights and recent development trends during last decade – a review. *Agricultural Economics (Czech Republic)*, *65*(9), 435–444. https://doi.org/10.17221/11/2019-AGRICECON

PARM. (2017). Evaluation des risques agricoles au Cameroun. *Information Systems for Agricultural Risk Management*. Rome.

Pelican, M. (2008). Mbororo claims to regional citizenship and minority status in North-West Cameroon. Africa, 78(4), 540–560.

Pelican, M. (2011, August). Beyond National Citizenship. *AFRICAN ARGUMENTS*, *2000*, 1–6. http://africanarguments.org/2010/03/08/beyond-national-citizens

Pelican, M. (2012). Friendship Among Pastoral Fulbe in Northwest. *African Study Monographs*, *33*(3), 165–188. https://doi.org/http://dx.doi.org/10.18632/oncotarget.11780

Phillip, D., Nkonya, E., Pender, J., & Oni, O. A. (2009). Constraints to Increasing Agricultural Productivity in Nigeria: A Review. IFPRI-ABUJA.

Pouokam, G. B., Album, W. L., Ndikontar, A. S., & Sidatt, M. E. H. (2017). A pilot study in cameroon to understand safe uses of pesticides in agriculture, risk factors for farmers' exposure and management of accidental cases. *Toxics*, *5*(4), 1–15. https://doi.org/10.3390/toxics5040030

Schmitz, H. (2005). *Value chain analysis for policy-makers and practitioners*. International Labour Organization.

Seekell, D., Carr, J., Dell'Angelo, J., D'Odorico, P., Fader, M., Gephart, J., Kummu, M., Magliocca, N., Porkka, M., Puma, M., Ratajczak, Z., Rulli, M. C., Suweis, S., & Tavoni, A. (2017). Resilience in the global food system. *Environmental Research Letters*, *12*(2). https://doi.org/10.1088/1748-9326/aa5730

Sheahan, M., Barrett, C. B., & Goldvale, C. (2017). The unintended consequences of agricultural input intensification: Human health implications of pesticide use in Sub-Saharan Africa (No. 234). *African Economic brief* (Vol. 8). Abidjan.

Singh, Jagadish. (2018). Managing risk and uncertainty in Indian agriculture. *UPUEA Economic Journal*: 14th Annual Conference.

Spickler, A. R. (2015). *Foot and Mouth Disease* (Issue April 2014). http://www.cfsph.iastate.edu/DiseaseInfo/ factsheets.php./References

Strasberg, P. J., Jayne, T. S., Yamano, T., Nyoro, J., Karanja, D., & Strauss, J. (1999). EFFECTS OF AGRICULTURAL COMMERCIALIZATION ON FOOD CROP INPUT USE AND PRODUCTIVITY IN KENYA. *Agricultural Economics*.

Székely, C., & Pálinkás, P. (2009). Agricultural risk management in the European Union and the USA. *Studies in Agricultural Economics*, *109*(109), 55–72.

Thornton, P. K., Jones, P. G., Ericksen, P. J., & Challinor, A. J. (2011). Agriculture and food systems in sub-Saharan Africa in a 4°C+ world. *Philosophical Transactions of the Royal Society A: Mathematical, Physical and Engineering Sciences*, *369*(1934), 117–136. https://doi.org/10.1098/rsta.2010.0246

Tim, L. (1999). The complexities of globalization: The UK as a case study of tensions within the food system and the challenge to food policy. *Agriculture and Human Values*, *V16*(2), 169. http://dx.doi.org/10.1023/A:1007542605470

Valentine, N., Che, M., Precillia, I. T., & Chi, N. (2014). *"In search of common ground" for farmer-grazer conflicts in the* (Issue October). https://doi.org/10.13140/2.1.1912.4163

Vikram Kumar, Shaktibala, S. K. (2017). Importance of weather prediction for sustainable agriculture in Bihar, India. *Archives of Agriculture and Environmental Science*, 2(2), 105–108.

Vrieling, A., Meroni, M., Mude, A. G., Chantarat, S., Ummenhofer, C. C., & de Bie, K. C. A. J.

M. (2016). Early assessment of seasonal forage availability for mitigating the impact of drought on East African pastoralists. *Remote Sensing of Environment*, *174*, 44–55. https://doi.org/10.1016/j.rse.2015.12.003

Wilhite, Mannava V.K. Sivakumar Raymond P. Motha Donald A. Deborah A. Wood. (2011). *Agricultural Drought Indices Proceedings of an expert meeting* (Issue June 2010).

Witt, R., & Waibel, H. (2009). Climate risk and farming systems in rural Cameroon (No. 423). Hannover.

World Bank Group. (2016). Agriculture global practice discussion paper 10 agricultural sector risk assessment: *Methodological*. Washington DC. Retrieved from http://www-wds.worldbank.org/external/default/WDSContentServer/WDSP/IB/2016/01/20/090224b0840d17bf/1_0/Rendered/PDF/Agricultural0s0ce0for0practitioners.pdf

Worth, S., and Kahan, D. (2018). Managing risks to improve farmers' livelihood. PARM/IFAD Rome.

Chapter 5

5 General discussion

Despite the progress made in fighting food and nutrition insecurity in the last decay, the world hunger situation is presently not getting better, especially in sub-Saharan African (SSA) countries. These countries have over 59.3% of the over 135 million acutely food-insecure people around the world (FSIN, 2020). Different food and nutrition interventions are being used to mitigate the deteriorating situation exacerbated by continue internal conflicts in these regions (McGuirk & Burke, 2020).

However, concise data on the food and nutrition insecurity in these regions is lacking to aid these practitioners' interventions in this sector (Drimie & Ruysenaar, 2010; de Haen et al., 2011). This doctorate study provides data from a minority community and used a method that facilitates food and nutrition interventions through research at the rural community level. The study further validates the use of DDS questionnaire as a useful research tool to assess the diet's nutrient inadequacies in resource-poor settings as proposed by Rani et al. (2010).

Providing supplements such as vitamin A and iron to the population is more efficient in addressing nutrition-related ailments (Feyrer et al., 2017). However, in many rural communities, few health centers are available to administer these supplements to most women and children that might be critically in-need (Hamer & Keusch, 2015). Due to the lack of these medical facilities in many rural communities to mitigate nutrition-related challenges, it is vital to search for alternative methods to address these issues. Food-based approaches, such as biofortification, feeding school children, fish farming, and gardening, have been suggested as alternative means to mitigate food and nutrition insecurity in rural communities (Thompson, 2007). This study examined a garden project within the Mbororo minority community to see if home gardens can mitigate food and nutrition insecurity

of the rural communities as suggested by Firth et al., (2011), and thus contribute to the global fight against food and nutrition insecurity at the community level in SSA countries.

However, there are numerous challenges to this fight against food and nutrition insecurity, such as the individual countries' policy, governance challenges, donor motivations, and risks (Dodo, 2016). Given that most SSA depend heavily on agriculture for their development and growth, and most of their food systems are fragile as a result of poor supporting infrastructure and institutions such as crop insurance and subsidies (Gómez et al., 2013), this study examined agricultural risks as a challenge to mitigating food and nutrition insecurity using food-based interventions such as home gardens. The study identifies specific agricultural risks that might hinder the food system and proposed recommendations to facilitate these interventions at the community level.

5.1 Food and nutrition insecurity

In this study, we examined the dietary diversity of the Mbororo minority women's diet to identify various foods present in their diet. We were using the 24-hour recall method to administer the dietary diversity questionnaire. We found that the starchy staples food group with corn and cassava items were the most consumed food, while food groups rich in vitamins and micronutrients such as meat organs, dark green vegetables, and eggs were the least consumed. Starchy staples are high-calorie foods that are vastly distributed in many SSA communities (Atehnkeng et al., 2008; Bratanova et al., 2016). High-calorie foods have been well researched, promoted, and distributed in the last four decades to fight hunger and poverty (Cépède, 1984). The use of high-calorie foods to fight hunger might be why this study and other studies found high-level consumption of starchy staples than other nutrient-rich food groups (Azadbakht and Esmaillzadeh, 2011; Hatly et al., 1998; Rani et al., 2010). The lack of nutrient-rich foods in the diet of the Mbororo women and many other women in rural communities might be a reason for the high prevalence in vitamin A deficiency

with over 190 million children and about 19 million pregnant women affected, and iron deficiency with approximately 1.62 billion people affected in the world (Alzaheb & Al-Amer, 2017; Islam et al., 2016).

The study further examined a home garden's impact on the food and nutrition insecurity of the Mbororo minority community in chapter 3. This examination was to assess home gardens as a mechanism mitigate food and nutrition insecurityin rural communities. Through a combination of interviews, focus group discussions, and participatory observations, the study found that the home gardens increased the availability and accessibility to a variety of vegetables for home consumption in all participatory households. The women were also able to generate money from the sale of waterleaf and pepper. Availability and accessibility are two of the four pillars of food security (Aborisade & Bach, 2014). Availability of food has to do with food production (Quisumbing et al., 1996), and these Mbororo women in the garden project were able to produce a variety of vegetables. Food accessibility is related to physical access to food such as transportation, or economic access that has to do with income or money to buy food (Castetbon, 2017). A previous study demonstrated that increasing women's income empowers the household to be more food secured (Haddad, 1992). Thus, these home gardens contributed to the community's food security and are consistent with other findings that have shown home gardens to increase household consumption of nutrient-rich vegetables (Gotor & Irungu, 2010; Joshi et al., 2006).

However, it was challenging to implement a home garden project to mitigate food and nutrition security in many rural communities. This study found that the community encountered many agricultural risks. Using the PARM agricultural risk assessment method, we identify drought, pest, and insecurity as a high threat to this community's food and nutrition. In the garden study, the long dry season affected the crop growth, and insecurity (political conflict) made it difficult for the women to market their produce. Agricultural risk is one of the contributors to food and nutrition

insecurity in many agrarian rural communities as this affects crops, animals, humans, and the environment (Premanandh, 2011). These risks influence farmers' perception and modify their behavior and action towards crop and animal production (Sulewski & Kłoczko-Gajewska, 2014). Losses incurred in the previous year due to agriculture-related risks might cause some farmers not to plant crops resulting in a shortage of available food in these communities. In contrast, market-related risks such as price variation might cause some farmers not to bring their produce to the market resulting in high prices. Farmers worldwide encounter different types of threats; in this study, drought was the most experienced risk, while in other countries like Sudan, the flood was the principal agricultural risk encountered (Elsafi, 2014). However, these farmers' different agricultural risks make them risk-averse and thus negatively impact the food and nutrition security globally.

5.2 Malnutrition and micronutrient deficiencies

Given that malnutrition is a serious condition that happens when your diet does not contain the right amount of nutrients (Meijers et al., 2010), this study found imbalances in the Mbororo community's diet. This community's diet was principally composed of starchy foods, with a small proportion of the population (6.5%) consuming iron-rich food groups such as meat organs. Deficiencies in micronutrients such as iron and vitamin A can result in ailments such as night blindness, anemia, and even maternal-infant morbidity and mortality (Allen, 2000). Previous studies have also demonstrated high dietary imbalances in many rural communities such as Mali and Burkina Faso (Bukania et al., 2014; Kennedy, 2009; Nupo et al., 2013; Rani et al., 2010; Steyn et al., 2014). Based on this study, and in conjunction with other studies on dietary diversity, malnutrition, and micronutrient deficiencies are highly prevalent and present potential severe health threats in rural communities.

Chapter 5

This study examined the women's vegetable preference in the home garden community and found that the women preferred their indigenous vegetables such as “Folere” and “Lalo” or jute mellow more. Jute mallow, native to Africa, is a nutrient-rich vegetable and grows in various climates and soil (Palada & Chang, 2003). African indigenous vegetables are nutrient-rich and provide essential micronutrients in rural communities (Abukutsa-Onyango et al., 2010; Gernah et al., 2012; Habwe et al., 2009; Shackleton et al., 2009). However, this study found out that the indigenous vegetables were very scarce in the Mbororo community, and seeds had to be sourced from different regions of the country to be planted in the gardens. Other studies have found massive genetic erosion of many African indigenous vegetables in some rural communities as these vegetables have been neglected by research and development programs (Keller et al., 2005). The gradual loss of indigenous vegetables in rural communities results in malnutrition challenges and in a loss in biodiversity and the ecosystem's resilience (Gotor & Irungu, 2010; Zimmerer, 1992). The resilience of local ecosystems due to these indigenous vegetables' reintroduction might help mitigate some of the agricultural risks such as pest and drought encountered in the Mbororo community.

5.3 Interesting and additional findings

The Mbororo people keep cattle, sheep, goats, horses, and their livelihood dependent on cattle; surprisingly, in chapter 2, this study found that the proportion of the population consuming meat and meat organs were low. Meat and meat organs are a rich food source for nutritional iron essential to prevent anemia (Thomas G.DeLoughery, 2017). However, the Mbororo community, like other pastoralist communities, do not keep the cattle for food but as a source of wealth and prestige (Berleant-Schiller, 1977; Pelican, 2012). Chapter 4 results showed that the Mbororo use the cattle to mitigate risk, such as when a family member falls sick, and money is needed for medication, they will sell the cattle to cover the expenses.

Some studies on household food security have shown that polygamous households are more food and nutritionally insecure than non-polygamous households because of the complexity in decision making when it comes to food purchase, preparation, and consumption (Nanama & Frongillo, 2012). However, in this study and another study by Megersa et al. (2014) on the livestock diversification to ensure the food security of the Borana community in Ethiopia, both studies found that polygamy interestingly did not affect the dietary diversity of the respondents. In the Mbororo community, the study found that the men mostly went to the market to buy food, which means both

polygamous and monogamous households will eat what their husbands bought.

The Food and Agriculture Organization of the United Nations actively fighting food and nutrition insecurity have recommendations such as incorporating nutrition as one of the objectives of nutrition-sensitive interventions (Anna Herforth & Charlotte Dufour, 2015). Most participants in this study did not consider nutrition or micronutrient as a problem; hunger and money were more of a problem than worrying about micronutrients or vitamins. In one garden preparatory meeting in Akum mile 9, a woman said, “I want more of the pepper so I can sell and use the money when my husband goes for transhumance.” Nutrition alone was not a strong incentive to motivate the women to join the project; the prospect of making money was a stronger incentive. However, as the project went on, and the project staff carried out more nutrition educative meetings, the women became aware of the importance of vegetables to their health.

5.4 Limitations of the study

- Unwilling participants in the random sample and missing values created problems. Some women selected in the random sample refused to be administered questionnaires because their husbands were not around. Also, some of the women shy away from a question about finances; they considered this private. For example, many women in the study in chapter 2 did not want to answer the number of cattle their families had.
- Interviewees were holding back on some questions. It was challenging to get all the women's answers during the interviews, particularly with the subject, such as traditional beliefs and empowerment or decision making in the household. During focus group meetings on nutrition education, some women did not feel comfortable talking about how and what they used in preparing meals. When asked about how they will use the money from the garden produce, most held back their reply and smiled timidly.
- Using the dietary diversity questionnaire to collect data on nutrient inadequacy gave us a snapshot of the Mbororo people's diet only at that point in time. This questionnaire could not account for changes in the diet that might occur during the year due to seasonal variations. For example, the study administered the questionnaires during the rainy season when food and vegetables are abundant; however, when the dry season comes, these vegetables are difficult to grow or expensive to buy.
- The ongoing Anglophone conflict in the study region hampered the garden project and the

collection of data. Insecurity made it challenging to collect useful data on the amount of vegetables harvested from all the garden communities for quantitative assessment of the garden produce. The figure from quantification might have given the average quantity of each vegetable consume per week and the women's average income from sales.

- Time was a limitation. The garden project ran just for two years, the first year was the construction and establishment of the garden, and most participants did not enjoy a good harvest. The second-year saw improvements in yields, the reintroduction of indigenous vegetables in most gardens, and good garden management practices. If the project were to go on for four to five years, more significant outcomes would have been recorded, particularly nutrition outcomes.

Chapter 6

6 General conclusions and recommendations

6.1 Conclusions

The Mbororo community is food insecure, with a food system threatened by several agricultural risks. The diet of the Mbororo community is predominantly starchy based, leading to high dietary imbalance. Mbororo people living in urban areas with some basic infrastructures such as markets, hospitals, and good-roads had better food security situations than their rural localities counterparts.

Home garden interventions are effective in the fight against food and nutrition insecurity in rural areas and could be easily adapted to include indigenous crops of these different communities. If well implemented, home gardens will enhance the availability and accessibility of nutrient-rich food in the implementing community. Indigenous vegetables are critical in getting better nutrition and production outcomes when carrying out a rural community garden project. The people in these communities prefer eating their indigenous vegetables, and the vegetables are environmentally adapted to grow in these localities.

Agricultural risks are some of the challenges faced when implementing nutritional interventions such as home gardens in rural communities. These risks might vary in different regions and depending on the type of intervention, but the risks are always present. Thus the incorporation of potential agricultural risks in the project design is critical for a more positive outcome.

Nutrition insecurity and micronutrient deficiency were not considered a problem by the garden project community; hunger and money were more of a problem. The challenges that the research and development community might consider and prioritize in rural communities; these communities might not consider them essential.

6.2 Future research implications

Using the dietary diversity questionnaire in this study has shown that iron-rich food groups such as meat organs and dark green vegetables were low within the population. Further research on nutritional anemia has to be carried out to validate that iron deficiencies is prevalent in the Mbororo minority community. Nutrition anemia is the outcome of a lack of iron in the red blood hemoglobin. Only after carrying out biochemical measurements can one truly state the nutritional status

concerning iron deficiency of the Mbororo community.

Home gardens have been shown to increase the DDS of the participant in many projects. This study showed how a home garden project increased the availability and accessibility of the community's nutrient-rich vegetables. However, DDS is just a proxy to nutrition status and cannot be used to state with certainty the nutrition status of individuals. Combining both anthropometry and biochemical measurements will present a better result. Furthermore, it would be of interest to establish a concrete link between DDS and nutrient deficiencies of some micronutrients. A future study might look at correlating high DDS with a low prevalence of anemia and low DDS with a high prevalence of anemia as an example of a micronutrient. The study could go a step further to examine individual that consumed any of the micronutrient-rich food sources to find out if there is a correlation with their biochemical results.

The garden project increased the availability and accessibility of nutrient-rich vegetables in the communities. However, the quantity of vegetables and the duration for participating households to consume these vegetables to enhance nutrition status might better help organize nutrition interventions and education. A longitudinal quantitative research project might be useful to validate the home garden's impact on the nutritional status of the participants.

6.3 Policy recommendations

This study found that the Mbororo community of the Northwest Region of Cameroon was facing food and nutrition insecurity challenges such as dietary imbalance in their diet. This imbalance is severe in rural areas such as the Menchum division, with most of the Aku sub-tribe than in the urban area such as Mezam, with most of the Jaafun sub-tribe. Suppose this food and nutrition situation is unresolved; it might result in serious health problems within the Mbororo community. Some of these problems are; high prevalence of nutritional anemia because of the low consumption of iron food sources such as meat organs, dark green vegetables, and eggs within these communities, and night blindness because of lack of vitamin A. Given that the rural areas lack basic health infrastructures such as health centers, and this study has demonstrated the benefits of home gardens in some Mbororo communities. This study recommends that home gardens be up-scaled and out-scaled within the Mbororo communities, and this should start with the Aku sub-tribes in the rural areas. Furthermore, home gardens and other NSA interventions should be incorporated in the government already existing agricultural policy such as agricultural extension

service.

Given that agricultural risks such as drought and pests threaten the food system of the Mbororo community, and indigenous vegetables are both nutrient-rich and environmentally adapted to local climatic conditions. This study recommends that the government and other practitioners in the field of nutrition, environment, and health, should research and promote the reintroductions of these vegetables into these communities.

Chapter 7

7 General References

Aborisade, B., & Bach, C. (2014). Assessing the Pillars of Sustainable Food Security. *European International Journal of Science and Technology*, *3*(4), 117–125. www.eijst.org.uk

Abukutsa-Onyango, M., Kavagi, P., Amoke, P., & Habwe, F. O. (2010). Iron and Protein Content of Priority African Indigenous Vegetables in the Lake Victoria Basin. *Journal of Agricultural Science and Technology*, *4*(4), 67–69.

Allen, L. H. (2000). *Ending Hidden Hunger: The History of Micronutrient Deficiency Control*. http://www.ceecis.org/iodine/01_global/01_pl/01_01_other_1999allen.pdf

Alzaheb, R. A., & Al-Amer, O. (2017). The Prevalence of Iron Deficiency Anemia and its Associated Risk Factors Among a Sample of Female University Students in Tabuk, Saudi Arabia. *Clinical Medicine Insights: Women's Health*, *10*(June 2016), 1179562X1774508. https://doi.org/10.1177/1179562x17745088

Anna Herforth, Charlotte Dufour, A.-L. N. (2015). Designing nutrition-sensitive agriculture investments. In *Food and Agriculture Organization of the United Nations (FAO)*. http://www.fao.org/documents/card/en/c/6cd87835-ab0c-46d7-97ba-394d620e9f38/

Atehnkeng, J., Ojiambo, P. S., Donner, M., Ikotun, T., Sikora, R. A., Cotty, P. J., & Bandyopadhyay, R. (2008). Distribution and toxigenicity of Aspergillus species isolated from maize kernels from three agro-ecological zones in Nigeria. *International Journal of Food Microbiology*, *122*(1–2), 74–84. https://doi.org/10.1016/j.ijfoodmicro.2007.11.062

Azadbakht, L., & Esmaillzadeh, A. (2011). Dietary diversity score is related to obesity and abdominal adiposity among Iranian female youth. *Public Health Nutrition*, *14*(1), 62–69. https://doi.org/10.1017/S1368980010000522

Berleant-Schiller, R. (1977). The Social and Economic Role of Cattle in Barbuda. *Geographical Review*, *67*(3), 299. https://doi.org/10.2307/213724

Bratanova, B., Loughnan, S., Klein, O., Claassen, A., & Wood, R. (2016). Poverty, inequality, and increased consumption of high calorie food: Experimental evidence for a causal link. *Appetite*, *100*, 162–171. https://doi.org/10.1016/j.appet.2016.01.028

Bukania, Z. N., Mwangi, M., Karanja, R. M., Mutisya, R., Kombe, Y., Kaduka, L. U., & Johns, T. (2014). Food insecurity and not dietary diversity is a predictor of nutrition status in children within semiarid agro-ecological zones in Eastern Kenya. *Journal of Nutrition and*

Metabolism, *2014*. https://doi.org/10.1155/2014/907153

Castetbon, K. (2017). Measuring food insecurity. *Sustainable Nutrition in a Changing World*, *February 2010*, 35–41. https://doi.org/10.1007/978-3-319-55942-1_3

Cépède, M. (1984). The fight against hunger. Its history on the international agenda. *Food Policy*, *9*(4), 282–290. https://doi.org/10.1016/0306-9192(84)90064-2

de Haen, H., Klasen, S., & Qaim, M. (2011). What do we really know? Metrics for food insecurity and undernutrition. *Food Policy*, *36*(6), 760–769. https://doi.org/10.1016/j.foodpol.2011.08.003

Dodo, M. K. (2016). Understanding Africa's Food Security Challenges. In *Intech* (Issue tourism). https://doi.org/http://dx.doi.org/10.5772/intechopen.91773

Drimie, S., & Ruysenaar, S. (2010). The integrated food security strategy of South Africa: An institutional analysis. *Agrekon*, *49*(3), 316–337. https://doi.org/10.1080/03031853.2010.503377

Elsafi, S. H. (2014). Artificial Neural Networks (ANNs) for flood forecasting at Dongola Station in the River Nile, Sudan. *Alexandria Engineering Journal*, *53*(3), 655–662. https://doi.org/10.1016/j.aej.2014.06.010

Feyrer, J., Politi, D., & Weil, D. N. (2017). The cognitive effects of micronutrient deficiency: Evidence from salt iodization in the United States. *Journal of the European Economic Association*, *15*(2), 355–387. https://doi.org/10.1093/jeea/jvw002

Firth, C., Maye, D., & Pearson, D. (2011). Developing "community" in community gardens. *Local Environment*, *16*(6), 555–568. https://doi.org/10.1080/13549839.2011.586025

FSIN. (2020). GLOBAL REPORT ON FOOD CRISES: Acute food insecurity and malnutrition forecasts for 2020. In *Food Security Information Network*. https://www.wfp.org/publications/2020-global-report-food-crises

Gernah, D., Atolagbe, & Echegwo. (2012). Nutritional composition of the African locust bean (Parkia biglobosa) fruit pulp. *Nigerian Food Journal NIGERIAN*, *25*(1), 1–8.

Gómez, M. I., Barrett, C. B., Raney, T., Pinstrup-Andersen, P., Meerman, J., Croppenstedt, A., Carisma, B., & Thompson, B. (2013). Post-green revolution food systems and the triple burden of malnutrition. *Food Policy*, *42*, 129–138. https://doi.org/10.1016/j.foodpol.2013.06.009

Gotor, E., & Irungu, C. (2010). The impact of Bioversity International's African Leafy Vegetables

programme in Kenya. *Impact Assessment and Project Appraisal*, *28*(1), 41–55. https://doi.org/10.3152/146155110X488817

Habwe, F. O., Walingo, M. K., Abukutsa-Onyango, M. O., & Oluoch, M. O. (2009). Iron content of the formulated East African indigenous vegetable recipes. *African Journal of Food Science*, *3*(12), 393–397. http://www.academicjournals.org/ajfs

Haddad, L. (1992). The impact of women's employment status on household food security at different income levels in Ghana. *Food & Nutrition Bulletin*, *14*(4), 341–344. https://doi.org/10.1177/156482659201400402

Hamer, D. H., & Keusch, G. T. (2015). Vitamin a deficiency: Slow progress towards elimination. *The Lancet Global Health*, *3*(9), e502–e503. https://doi.org/10.1016/S2214-109X(15)00096-0

Hatly, A., Torheim, L. E., & Oshaug, A. (1998). Food variety--a good indicator of nutritional adequacy of the diet? A case study from an urban area in Mali, West Africa. *European Journal of Clinical Nutrition*, *52*(12), 891–898. https://doi.org/10.1038/sj.ejcn.1600662

Islam, S. N., Nusrat, T., Begum, P., & Ahsan, M. (2016). Carotenoids and β-carotene in orange fleshed sweet potato: A possible solution to Vitamin A deficiency. *Food Chemistry*, *199*, 628–631. https://doi.org/10.1016/j.foodchem.2015.12.057

Joshi, P. K., Joshi, L., & Birthal, P. S. (2006). Diversification and Its Impact on Smallholders: Evidence from a Study on Vegetable Production. *Agricultural Economics Research Review*, *19*(December), 219–236. https://core.ac.uk/download/pdf/6397004.pdf

Keller, G. B., Mndiga, H., & Maass, B. L. (2005). Diversity and genetic erosion of traditional vegetables in Tanzania from the farmer's point of view. *Plant Genetic Resources*, *3*(3), 400–413. https://doi.org/10.1079/pgr200594

Kennedy, G. L. (2009). Evaluation of dietary diversity scores for assessment of micronutrient intake and food security in developing countries. [Wageningen University]. http://www.cabdirect.org/abstracts/20103004634.html

McGuirk, E., & Burke, M. (2020). The economic origins of conflict in Africa. *Journal of Political Economy*, *128*(10), 3940–3997. https://doi.org/10.1086/709993

Megersa, B., Markemann, A., Angassa, A., & Valle Zárate, A. (2014). The role of livestock diversification in ensuring household food security under a changing climate in Borana, Ethiopia. *Food Security*, *6*(1), 15–28. https://doi.org/10.1007/s12571-013-0314-4

Meijers, J. M. M., van Bokhorst-de van der Schueren, M. A. E., Schols, J. M. G. A., Soeters, P. B., & Halfens, R. J. G. (2010). Defining malnutrition: Mission or mission impossible? *Nutrition*, *26*(4), 432–440. https://doi.org/10.1016/j.nut.2009.06.012

Nanama, S., & Frongillo, E. A. (2012). Altered social cohesion and adverse psychological experiences with chronic food insecurity in the non-market economy and complex households of Burkina Faso. *Social Science and Medicine*, *74*(3), 444–451. https://doi.org/10.1016/j.socscimed.2011.11.009

Nupo, S. S., Oguntona, C. R. B., Onabanjo, O. O., & Fakoya, E. O. (2013). Dietary diversity scores and nutritional status of women in two seasons in rural areas of Ogun State, Nigeria. *Nutrition and Food Science*, *43*(1), 60–67. https://doi.org/10.1108/00346651311295923

Palada, M. C., & Chang, L. C. (2003). Suggested cultural practices for jute mallow. *International Cooperator Guide*, *2*(14), 1–4.

Pelican, M. (2012). From Cultural Property to Market Goods : Changes in the Economic Strategies and Herd Management Rationales of Agro-Pastoral Fulbe in North West Cameroon (A. M. K. and G. Schlee (ed.)). Berghahn Book. www.berghahnbooks.com

Premanandh, J. (2011). Factors affecting food security and contribution of modern technologies in food sustainability. *Journal of the Science of Food and Agriculture*, *91*(15), 2707–2714. https://doi.org/10.1002/jsfa.4666

Quisumbing, A. R., Brown, L. R., Feldstein, H. S., Haddad, L., & Peña, C. (1996). Women: The Key to Food Security. *Food and Nutrition Bulletin*, *17*(1), 1–2. https://doi.org/10.1177/156482659601700116

Rani, V., Arends, D. E., & Brouwer, I. D. (2010). Dietary diversity as an indicator of micronutrient adequacy of the diet of five to eight-year-old Indian rural children. *Nutr. Food Sci.*, *40*(5), 466–476. https://doi.org/10.1108/00346651011076974

Shackleton, C. M., Pasquini, M. W., & Drescher, A. W. (2009). African indigenous vegetables in urban agriculture. In *Earthscan publishes in association with the International Institute for Environment and Development* (Issue June). https://doi.org/10.4324/9781849770019

Steyn, N. P., Nel, J., Labadarios, D., Maunder, E. M. W., & Kruger, H. S. (2014). Which dietary diversity indicator is best to assess micronutrient adequacy in children 1 to 9 y? *Nutrition*, *30*(1), 55–60. https://doi.org/10.1016/j.nut.2013.06.002

Sulewski, P., & Kłoczko-Gajewska, A. (2014). Farmers' risk perception, risk aversion and

strategies to cope with production risk: an empirical study from Poland. *Studies in Agricultural Economics*, *116*(3), 140–147. https://doi.org/10.7896/j.1414

Thomas G.DeLoughery. (2017). Iron Deficiency Anemia. *Medical Clinics of North America*, *101*(2), 319–332. https://doi.org/10.1016/J.MCNA.2016.09.004

Thompson, B. (2007). Food-based approaches for combating iron deficiency. *Nutritional Anemia*, 337–358.

Zimmerer, K. S. (1992). The loss and maintenance of native crops in mountain agriculture. *GeoJournal*, *27*(1), 61–72. https://doi.org/10.1007/BF00150635

Appendix

Figures from the home garden project implementation and activities

Figure Ap 1: *Focus group discussions with Mbororo women and men.*
Note: *Discussions were held before introducing the garden project in their community and regularly during the project. Discussions with the men and women-centered around the type of vegetables they wanted to grow, land for the gardens, responsibilities, etc.*

Appendix

Figure AP 2: *Egg plant seed preparation for the nursery*
Notes: *The project staff taught the women how to prepare planting material (seeds) for the nursery. In this case, they used home-grown eggplant to be nursed in the nursery in the Akum mile 9 community. The back of the plant is peeled, exposing the seeds inside. The seeds are exposed, then be dried, and could be stored if not needed.*

Appendix

Figure Ap 3: Nursery preparation and established plantlets in the nursery
Note: *In figure 8.2a, the agricultural technician is building the shade of the nursery. Figure 8.2b shows the mulching of the nursery bed, so the seeds are protected below. Finally, figure 8.2c shows pepper plantlets growing and will be divided into the women for transplanting.*

Figure Ap4: *Individual and community gardens.*
Note: *Figure 8.4a is an individual home garden in Banjah community, and the garden is dominated by the okra plant. Figure 8.4b, eggplants dominate a community garden in Njinjam community. The women decided what vegetables they wanted most in their gardens*

Figure Ap 5: *Vegetables harvesting from the garden be sold in the market*
Note: *Figure 8.5a shows a child helping the mother carry waterleaf harvested from the garden to the project meeting point to be taken to the market for sale. Figure 8.5b shows chili pepper in bags at the market for supply to "petty-traders." Figure 8c shows harvested fluted pumpkin that is waiting to be transported to the market. These vegetables are for income generation.*

Appendix

Figure Ap 6: *Pest challenges in some gardens*
Note: *Figure 8.6a shows beetles (locally called smelly beetle) eating the leaves of Okra. Figure 8.6b shows a caterpillar eating the leave of fluted pumpkin. In many communities, we found different types of pets in the gardens and nurseries.*

General summary

Despite significant efforts and achievements made by development and research organizations to globally combat food and nutrition insecurity, many people, especially in sub-Saharan Africa, are still acutely food-insecure. The situation is made worst as over two billion people suffer from micronutrient deficiencies or hidden hunger. Hidden hunger leads to many health challenges, particularly in poor communities with no health infrastructures such as health centers, clinics, and hospitals. Against this backdrop, research attempts were made to investigate home gardens' impact and challenges in combating food and nutrition insecurity in the Mbororo minority community in the Northwest Region of Cameroon.

The publications used in this thesis focus on i) micronutrient deficiencies within the Mbororo community, ii) assessing the garden project for food and nutrition outcomes, and iii) assessing agricultural risks within the Mbororo community as a challenge to their food system and the garden project.

The study on micronutrient deficiencies was carried out to provide missing data on nutrition insecurity and inform policymakers to recommend effective nutrition interventions. The study used the 24-hour dietary recall method to collect data on the dietary diversity of the Mbororo women in the Northwest Region. Mean dietary diversity scores were used to investigate the impact of socio-cultural and economic characteristics of the Mbororo women on the quality of their diet. The study found that while some of these characteristics such as herd size significantly impacted the diet, others, such as education, had no impact. Iron-rich foods were the least consumed, indicating that nutritional anemia might be very high within the community. The Mbororo are made of two sub-tribes; the Aku sub-tribe was more vulnerable than their Jaafun counterparts.

A home garden project was aimed to empower the Mbororo women by cultivating nutrient-rich vegetables for income and home consumption. Women from 114 households and seven

communities took part in the project and gardens were built for all. The women were provided with material, educational and financial support during the implementation of the project. Three groups of vegetables were included in the project: nutrient-rich such as amaranth, high market-value such as chili-pepper, and indigenous such as "caricachee". The home garden project was evaluated as a tool to mitigate food and nutrition insecurity within the Mbororo community, thus potentially serving as a blueprint for other minority communities. Qualitative research methods such as in-depth interviews, focus group discussions and observations formed the basis for evaluating the outcome of the project. The garden project increased the vegetable variety in the seven communities. The women harvested nutrient-rich vegetables for home consumption and the high market-value vegetables such as chili-pepper were sold for extra income. It is interesting to note that the household preferred indigenous vegetables for home consumption such as okra and eggplant. Although the garden project was successful in mitigating food and nutrition insecurity within the vulnerable communities, it also faced some challenges such as prolonged dry season and political instability in the region.

The last study evaluated agricultural risks as an impediment to the Mbororo community's food system. The study aimed at assessing the type of risks encountered, their frequency and severity and what management strategies are being used to mitigate these risks. The study used an action research approach with interviews, semi-structured questionnaires and focus group discussions. It was found that the food system of the Mbororo community was fragile because it was threatened by all risks under consideration. The most critical risks were drought, crop and animal diseases, political insecurity and price variation in the market. It was challenging for the Mbororo people to develop any meaningful mitigation strategies because they lack the required financial resources. However, they mostly sell their cattle as a coping strategy when money is needed to manage financial difficulties.

In conclusion, the garden project and the research findings provided meaningful information on combating food and nutrition insecurity. The garden project study showed that home gardens can increase vegetable biodiversity, leading to an increased availability and accessibility of nutrient-rich vegetables in the Mbororo communities that may help for example to alleviate existing iron-related health deficiencies. However, the assessment of agricultural risks indicates that drought and pests are challenges for implementing and managing home gardens. Nevertheless, home gardens, if well managed, can mitigate food and nutrition insecurity in resource poor communities such as the Mbororo minority group. However, these gardens should include indigenous vegetables since they are of high preference among the Mbororo people and could also help to buffer some of the agricultural risks.

Zusammenfassung

Trotz beträchtlichen Anstrengungen und erzielten Erfolgen von Entwicklungsorganisationen und Forschungsinstitutionen Nahrungsmittel- und Ernährungsunsicherheit global zu bekämpfen, sind nach wie vor viele Menschen, speziell in Subsahara-Afrika, davon betroffen. Die Situation wird dadurch verschlimmert, dass über zwei Milliarden Menschen an Mikronährstoffmangel oder verstecktem Hunger ("Hidden Hunger") leiden. Versteckter Hunger führt zu vielen gesundheitlichen Problemen, besonders in armen Gemeinden ohne Infrastrukturen wie Gesundheitszentren, Kliniken und Krankenhäusern. Unter diesem Aspekt wurden Forschungsversuche durchgeführt um den Einfluss von Hausgärten („Home Gardens") sowie die Herausforderungen bei der Bekämpfung von Ernährungsunsicherheit in der Mbororo Minderheitsgemeinschaft in der Region Nordwest in Kamerun zu untersuchen.

Die Publizierungen dieser Thesis konzentrieren sich auf i) Mikronährstoffmängel in der Gemeinschaft der Mbororo, ii) Beurteilung des Garten Projektes nach Nahrungsmittel- und Ernährungsergebnissen iii) Bewertung landwirtschaftlicher Risiken innerhalb der Gemeinschaft der Mbororo in Bezug auf ihr Ernährungssystem und das Garten Projekt.

Die Studie über Mikronährstoffmangel wurde durchgeführt um fehlende Daten zur Nahrungsunsicherheit zu erhalten, welche zur Information politischer Entscheidungsträger in der Empfehlung effektiver Ernährungsmaßnahmen genutzt werden können. Die Studie nutzte das 24-Stunden-Erinnerungsprotokoll um Daten zur Nahrungsmittelvielfalt der Mbororo Frauen in der Region Nordwest zu erheben. Die durchschnittlichen Nahrungsmittelvielfaltpunkte wurden verwendet, um den Einfluss soziokultureller und ökonomischer Eigenschaften der Mbororo Frauen auf die Qualität ihrer Ernährung zu untersuchen. Die Studie zeigte, dass manche dieser Eigenschaften, wie die Familiengröße, signifikant die Ernährung beeinflusste. Andere Eigenschaften, wie Bildung, hatten keinen Einfluss. Eisenhaltige Nahrungsmittel wurden am

wenigsten konsumiert, was darauf hindeutet, dass ernährungsbedingte Anämie innerhalb der Gemeinschaft sehr hoch sein könnte. Die Mbororo setzen sich aus zwei Unterstämmen zusammen. Der Unterstamm der Aki war gefährdeter als der Unterstamm der Jaafun.

Ein Hausgarten Projekt zielte darauf ab, Mbororo Frauen durch den Anbau nährstoffreicher Gemüsearten, die für den Eigenkonsum und/oder zur Generierung von Einkommen genutzt werden können, zu stärken. Frauen aus 114 Haushalten aus sieben Gemeinschaften nahmen an dem Projekt teil. Für alle wurden Gärten errichtet. Den Frauen wurden Material, fachliche Beratung und finanzielle Hilfen während der Durchführung des Projektes zur Verfügung gestellt. Drei Gruppen von Gemüse wurden in das Projekt einbezogen: Nährstoffreiches Gemüse, wie Amarant, Gemüse mit einem hohen Marktwert, wie Chili-Paprika und einheimisches Gemüse wie "Caricachee". Das Hausgartenprojekt wurde als eine Möglichkeit zur Reduzierung von Nahrungsmittel- und Ernährungsunsicherheit in der Mbororo Gemeinschaft bewertet, welche wiederum als potentieller Entwurf für andere Minderheitengemeinschaften dienen kann. Qualitative Forschungsmethoden, wie beispielsweise ausführliche Interviews, Fokusgruppen-Interviews und Beobachtungen bildeten die Basis zur Bewertung des Ergebnisses des Projektes. Das Garten-Projekt erhöhte die Vielfalt an Gemüsesorten in den sieben Gemeinden. Die Frauen ernteten nährstoffreiche Gemüsesorten für den Eigenverbrauch. Gemüsesorten mit hohem Marktwert, wie Chili-Paprika, wurden zur Generierung zusätzlichen Einkommens verkauft. Eine interessante Beobachtung war, dass der Haushalt einheimische Gemüsesorten, wie Okra und Aubergine, für den Eigenverbrauch bevorzugte. Wenngleich das Gartenprojekt in Bezug auf die Verminderung der Nahrungsmittel- und Ernährungsunsicherheit innerhalb der gefährdeten Gemeinschaften erfolgreich war, wurde es mit Problemen, wie eine verlängerte Trockenzeit oder politische Unsicherheit in der Region, konfrontiert.

Die letzte Studie bewertete landwirtschaftliche Risiken als Beeinträchtigungsgrund für das Ernährungssystem der Mbororo Gemeinschaft. Die Studie bewertete die aufgekommenen Risiken nach ihrer Häufigkeit, Schwere sowie der genutzten Managementstrategien um diese zu vermindern. Die Studie nutzte den Ansatz der Aktionsforschung mit Interviews, semi-strukturierten Fragebögen und Fokusgruppendiskussionen. Es wurde herausgefunden, dass das Ernährungssystem der Mbororo Gemeinschaft fragil war, weil es durch alle berücksichtigten Risiken gefährdet wurde. Die kritischsten Risiken waren Dürre, Pflanzenkrankheiten, Tierseuchen, politische Unsicherheit und Preisschwankungen auf dem Markt. Aufgrund der benötigten finanziellen Mittel war es schwierig für die Mbororo sinnvolle Strategien zur Risikoverminderung zu entwickeln. Um finanzielle Schwierigkeiten zu bewältigen, verkauften sie meistens ihre Rinder. Zusammenfassend lässt sich sagen, dass das Gartenprojekt und die Forschungsergebnisse wertvolle Informationen zur Bekämpfung von Nahrungsmittel- und Ernährungsunsicherheit lieferten. Die Gartenprojekt-Studie zeigt, dass Hausgärten die Biodiversität von Gemüsesorten fördern können, was wiederum die Verfügbarkeit und den Zugang zu nährstoffreichen Gemüsesorten in den Mbororo Gemeinschaften erhöht. Dies kann beispielsweise dabei helfen, mit Eisenmangel verbundene Gesundheitsprobleme zu mildern. Die Bewertung landwirtschaftlicher Risiken deutet jedoch darauf hin, dass Dürren und Schädlinge Herausforderungen bei der Umsetzung und dem Betrieb von Hausgärten sind. Dennoch können Hausgärten, wenn sie gut betrieben werden, Nahrungsmittel- und Ernährungsunsicherheit in ressourcenarmen Gemeinden, wie die der Mbororo, vermindern. Allerdings sollten in diesen Gärten auch einheimische Gemüsesorten angebaut werden, da diese eine hohe Präferenz bei den Mbororo haben und dabei helfen können manche der landwirtschaftlichen Risiken zu reduzieren.

Author's declaration

I hereby declare that this doctoral thesis is a result of my own work and that no other than the indicated aids have been used for its completion. All quotations and statements that have been used are indicated. I did not accept assistance from any commercial agency or consulting companies. Furthermore, I assure that the work has not been used, neither completely or in parts, for achieving any other academic degrees.

Stuttgart, July 11 2021

Pride Anya Ebile

Curriculum vitae

Personal data

Name	Pride Anya Ebile
Address	Fleinsbach Straße 6, 70794 Filderstadt
Telephone	+49(0)17675892138
Skype name	Pride Ebile
Email	pebile@gmail.com
Nationality	Cameroonian

Professional experience

02/2015 – Present — **Project director of Eco-Sustainable Gardening project**

Stuttgart – Region (Cameroon) — *University of Hohenheim* Stuttgart, Germany

- The project seeks to empower women the Mbororo Minority in Northwest Region Cameroon by growing nutrient rich vegetables and generating accessible cash through the establishment of ecologically sustainable gardens and the local commercialization of the harvested products.
- Establishing and coordinating the stakeholder network to secure the production and commercialization of garden products.
- Capacity building: organizing nutrition workshops for the women in garden communities.
- Capacity building: trainings on good hoticultural management practicies.
- Developing of market strategies to commercialize vegetable from gardens.
- Field research on nutrition and food security within the garden communities.
- Fundraising targeting local and international donors.

11/2018 - 08/2019 — **External consultant at the Kigeme Refugee Camp**

Kigeme, Rwanda — *Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH*

- Assessing challenges such as hygiene, cultural, food/water, and energy supply faced by the refugees at the camp in Kigeme Rwanda.

- Proposing sustainable small business solutions such as biogas from organic waste, local soap, and gardening to reduce the dependency of the refugees on the subsidies from donors and local communities.
- Capacity building among refugees in sustainable small business management.
- Designed an enabling platform with the catholic church for the cooperation and collaboration between the refugees and the local communities.

01/2014 – 12/2015 **Research Associate**

Nigeria, Ibadan *International Institute of Tropical Agriculture (IITA), University of Ibadan, University of Hohenheim*

- Assessing the cassava value chains under the B*iomass value web* project
- Developed the cassava "*Value web"* (multi-directional) concept including all by-product of cassava from the value chain (uni-directional) concept with only one product
- Identification and mapping of private and public institutions that can promote the cassava sector to help smallholders (value web maps)
- Identification of institutional and governance challenges within the Cassava value web (qualitative research method)

Education

01/2016 – Present **Doctorate in food and nutrition insecurity**

Stuttgart *University of Hohenheim, Stuttgart,Germany*

- Focus: Food insecurity, micronutrients deficiencies or hidden hunger, nutritional status and nutritional health within rural communities in West Africa (qualitative and quantitative research methods)
- Final grade: pending defense

10/2012 – 09/2015 **Master of Science (MSc) in Agricultural Sciences in the Tropics and Subtropics**

Stuttgart *University of Hohenheim, Stuttgart,Germany*

- Focus: Impacts of the expansion of agricultural production, supply chains in rural development, globalization on smallholders in the tropics and subtropics
- Final grade: 2.0

Additional education

10/2018	**Nutritional Health Training**
	USAID and Johns Hopkins Bloomberg School of Public Health

- Challenges in rural communities nutrition, public health in developing countries
- Approaches to combat nutrition health amongst vulnerable groups
- Data collection and analysis in Public Health (qualitative and quantitative research methods)

04/2016	**RuralInvest course**
	Food and Agriculture Organization (FAO)

- Management of projects and investments (income and non-income generating) in rural communities
- Assessing, monitoring, and evaluating rural investment projects

07/2014	**Biogas expert Training**
Germany	*(B)energy*

- Technical knowledge (e.g., installation and maintenance) and the promotion of cheap cooking biogas in rural Africa
- Capacity building: entrepreneurial concepts for business as small projects (worked in Mali and Cameroon)

Additional qualifications

Languages	English – Mother tongue
	French – Business fluent
	Chinese Mandarin – fluent
	German – Basic proficient
IT-skills	MS-Office: Word, Excel, PowerPoint - Very good
	Statistics software: STATA, SPSS, SAS, Visualyzer, Nvivo – Very good
	Geographic Information Systems: ArcGIS – Good

Fellowships and Grants

10/2015 - Present	Stiftung Entwicklungs-Zusammenarbeit Baden-Württemberg (SEZ) grant to Eco-Sustainable Gardens: Empowering Minority Women in Cameroon".
05/2015 - Present	First Price in Barilla Center for Food and Nutrition Award, for the co-written project

	"Eco-sustainable Gardens: Empowering Minority Women in Cameroon"
07/2015 - Present	First Price at BMBF Status Seminar PLANT 2030, for the project "Governance and Institutional Challenges in Biomass base Agricultural Development."
11/2014 – Present	First Price at Scientific Student Conference WARSAW for the presentation of the results of my cassava project in Nigeria

Publications

- ***peer-review***

Ebile, P.A., Ndah, H.T. and Wünsche, J.N. (2020), "Assessing nutrient inadequacies and influence of socio-economic characteristics on diet quality of the Mbororo minority women in Northwest Cameroon", Nutrition & Food Science, Vol. ahead-of-print No. ahead-of-print. https://doi.org/10.1108/NFS-07-2020-0265

Ebile, Pride Anya, Hycenth Tim Ndah, and Jens Norbert Wünsche. "Agricultural risk assessment to enhance the food systems of the Mbororo minority community in the Northwest region of Cameroon." Journal of Agriculture and Rural Development in the Tropics and Subtropics (JARTS) 122.2 (2021): 207-217.

- ***Not peer-reviewed, conference paper***

Ebile Pride, A., Wünsche Jens, N (2021), "Indigenous vegetables for improving nutrition security in the rural Mbororo community in Cameroon" the International Symposium on Human Health Effects of Fruits and Vegetables, Stuttgart.

Ebile Pride, A., Wünsche Jens, N (2020), "From Nutrition-Sensitive to Nutrition-Specific interventions: The Case of "Eco-Sustainable Gardens Empowering Mbororo Minority Women" in the Northwest Region of Cameroon" 3rd Home Gardens for Resilience and Recovery (HG4RR), Bonn.

- ***Poster presentation***

Ebile, P.A. Tagu, N.N. and Wunsche, J.N. (2019), "Contributions of Home Gardens to Vegetable Biodiversity: A Case Study of EcoSustainable Gardens Empowering Minority Women in Cameroon", Tropentag, September 18-20, 2019, Kassel.
https://www.tropentag.de/2019/abstracts/links/Ebile_E9FLKXXx.pdf,
https://www.tropentag.de/2019/abstracts/posters/412.pdf

Ebile, P.A. Nkaanah, F.I.I. and Wunsche, J.N. (2019), "Constraints of Home Gardens to Impact Nutritional Anemia: A Case Study of Eco-Sustainable Garden Empowering Mbororo Women in Cameroon", Tropentag, September 18-20, 2019, Kassel.
https://www.tropentag.de/2019/abstracts/abstract.php?code=EhNhWElY,
https://www.tropentag.de/2019/abstracts/posters/690.pdf

Filderstadt, on 11th July 2021