IMPROVING DIETARY DIVERSITY THROUGH ON-FARM PRODUCTION AND NUTRITION EDUCATION IN RURAL HOUSEHOLDS OF TANZANIA

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EXTENDED ABSTRACT

Background: The human body requires nutrients from varieties of food groups for a healthy and productive life. These nutrients primarily are from food crops and livestock products, thus make farm production as an important pathway for improving not only dietary diversity but also good nutrition status of a population. However, availability of foods is one thing but the choice and decision on what to eat, how to prepare and allocate the foods to the family members is governed by several factors including Knowledge, Attitude and Practice. The pathways and mechanisms in which dietary diversity is linked with farm production and nutrition knowledge have not been adequately studied. Given the fact that malnutrition is still a huge challenge especially in rural areas of Tanzania, where farm production activities are mainly taking place, it will be important to explore the pathways and associated factors. This study aimed to establish factors associated with household dietary diversity in the context of farm production and nutrition knowledge. The study intended to measure the associations and predictors of household dietary diversity using different indicators of farm production in addition to nutrition knowledge, socio-demographics, economic and agricultural characteristics.

Methods: The study was conducted in three phases, the baseline (July-August 2016), intervention (September, 2017 to April, 2018) and the end-line phase July-August 2018. The baseline phase involved cross-sectional data collection from 663 women/caregivers in rural households of Dodoma and Morogoro regions. Nutrition education intervention was given for a period of 8 months. It included 10 days group training with six-month individual training follow-ups in the household. Spouses/ adult men were also invited to participate in the intervention. Training contents included: functions of food, food groups, malnutrition, food preparations, food consumption and homestead food production.

Women/caregivers were given pre-test at the baseline and a post-test during the end-line survey to assess the effect of the nutrition education intervention. The end-line-phase involved 577 women/caregivers in rural households of Dodoma and Morogoro regions. Data for household dietary diversity, farm production, nutrition knowledge and other socio-demographic variables were collected using questionnaires. Data were analysed using SPSS version 20. For descriptive statistics, mean and standard deviation were used for parametric data, while median and interquartile ranges were used for non-parametric data. Pearson correlation and Chi-square test were used to determine the correlation and relationship among variables. Mean separation was done by using one-way ANOVA with Tukey's post hoc test, level of significance was set as $P = < 0.05$. Binary logistic regression was applied to identify predictors of the association between dichotomous variables. For non-parametric inferential statistics, Wilcoxon signed ranks test was used for comparison of variables before and after the intervention, Mann–Whitney U test for comparison of two groups and Kruskal Wallis test for comparison of more than two groups. The McNemar test was also applied to establish differences in frequencies between baseline and end-line.

Results: At baseline, the median household dietary diversity score (HDDS) was low (4.2) with less than half (43.7%) of the households reported consuming at least 5 food groups in all the regions. The Median HDDS differed significantly between regions; Dodoma had lower HDDS (interquartile range) of 3.9 (2.9, 5.2) compared to Morogoro region of 4.5 (3.5,5.8). Furthermore, the baseline results revealed a high level of nutrition illiteracy in the two regions. Only 14% of the population had received nutrition education/information prior to the baseline survey. The mean score for nutrition knowledge and practice was 6.9 (±2.6) out of 20 and only 17% of the study population scored above the mean.

At the baseline all households (100%) reported growing at least a single crop and only 52.5% of the households owned at least one type of livestock species. Farm production diversity and growing of specific food groups such as dark green vegetables, other vitamin A rich fruits and vegetables, nuts and seeds had shown to increase HDDS. Despite a mismatch between the proportion of households that reported keeping livestock (52.5%) and those who reported consuming of animal source foods (26%), still livestock keeping had shown to increase HDDS. After adjusting for socio-demographic and other variables in the regression model, the higher farm production diversity, daily food expenditure and nutrition knowledge consistently predicted an increase in household dietary diversity score in both regions. The effect of farm production diversity on HDDS was slightly higher in Dodoma households (ß-coefficient =0.29, t = 5.65, p<0.001) than in Morogoro households (ß-coefficient =0.25, t = 4.62, p<0.001), however, the effects of daily food expenditure on HDDS was more pronounced in Morogoro households (ß-coefficient =0.29, t = 5.87, p<0.001) compared to Dodoma households (ß-coefficient =0.19, t = 3.88, p<0.001).

Results of the end-line phase after implementation of nutrition education intervention, indicated that 96% of mothers/caregivers reported having included at least 5 food groups in their household meal compared to the baseline phase (54%). A significant increase in the frequencies of consumption of vegetables, fruits and legumes were noted from the baseline to the end-line survey (87% vs 98%, 63% vs 69% and 76% vs 87%), p<0.001, respectively. Furthermore, the median scores for both nutrition knowledge and nutrition practice increased significantly at the end-line survey. In particular, the findings revealed that proportions of households knowing the importance of growing fruits and vegetable, importance of including different food groups in a meal, dietary enhancers of iron and recognition of malnutrition signs, increased at the end-line phase. The higher scores were

recorded among those who had received nutrition education, who had frequently been exposed to nutrition education, whose spouses/men participated in the intervention and those with a formal level of education than their counterparts.

Conclusion: The findings of this study entail that any intervention for promoting household dietary diversity should consider farm production diversity, status of nutrition knowledge, household food expenditure and market accessibility. The study has shown that household ability to diversify diets is based on the capacity to produce more varieties of food groups on their farmland. These include production of livestock coupled with production of dark green vegetables, other vitamin A rich fruits and vegetables, nuts and seeds. The importance of exposure to nutrition education came out vividly in this study. Mothers/caregivers who had frequently been exposed to nutrition education had higher household dietary diversity than their counterparts. In addition, household dietary diversity was higher among the households in which their spouses/men participated in nutrition education training than their counterparts. This suggests the necessity of involving men in nutrition education intervention to facilitate the retention of nutrition knowledge and the adoption of desirable dietary practices in households.

Furthermore, other dimensions such as food expenditure and market accessibility appeared to enhance household dietary diversity especially when production diversity in the home-stead farm is limited. The study has also shown that, access to the nearest market and an increase in the household food expenditure diminishes the positive effects of farm production diversity over the household dietary diversity. Therefore, observations from this study call for further research to explore the influence of market accessibility and food expenditure on the household dietary diversity especially in rural areas where market infrastructure is poor and per capital income is low.

LIST OF PUBLICATIONS

1. Bundala N, Kinabo J, Jumbe T, Bonatti M, Rybak C, and Sieber S. (2019). Gaps in knowledge and practice on dietary consumption among rural farming households; a call for nutrition education training in Tanzania. *International Journal of Food Sciences and Nutrition*, 71(3):341-351.
2. Bundala, N. H., Kinabo, J., Jumbe, T., Rybak, C., and Sieber, S. (2019). Does homestead livestock production and ownership contribute to consumption of animal source foods? A pre-intervention assessment of rural farming communities in Tanzania. *Scientific African*, 7:1-12.
3. Bundala, N. H., Kinabo, J., Jumbe, T., Hoffmann, H., Rybak, C., Stuetz, W., and Sieber, S. (2019). Farm production diversity and dietary diversity in rural households of Tanzania: Pathways and associated factors (To be submitted).
4. Bundala, N. H., Kinabo, J., Jumbe, T., Rybak, C., Stuetz, W., and Sieber, S. (2020). A Tailored Nutrition Education Intervention Improves Women's Nutrition Knowledge and Dietary Practices in Farming Households of *Tanzania, Journal of Nutritional Health & Food Science*, 8(1):1-13.

DECLARATION

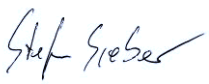
I, Nyamizi Hashim Bundala, do hereby declare to the Senate of the Sokoine University of Agriculture that this Thesis is my own original work and it has neither been submitted nor being concurrently submitted in any other institution.

Nyamizi H. Bundala — 27th October 2020 Date

The above declaration is confirmed by:

Prof. Joyce Kinabo — 27th October 2020 Date

Dr. Theresia Jumbe — 27th October 2020 Date



Prof. Stefan Sieber — 27th October 2020 Date

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DEDICATION

I dedicate this work to my family, my mother Asha Chuma, my late father Hashim Bundala, my husband Ismail Sultan and my four sons; Luqman, Irfan, Ayman and Neyman. In a very special way, I would also dedicate this work to my beloved grandmother Mawazo Mwinyimkuu. I thank them all for their patience, encouragement and unconditional love.

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LIST OF ABBREVIATIONS AND ACRONYMS

ANOVA	Analysis of Variance
ASF	Animal Source Foods
FAO	Food and Agriculture Organization
IDA	Iron Deficiency Anaemia
KAP	Knowledge Attitude and Practice
KP	Knowledge and Practice
MoHCDGEC	Ministry of Health, Community Development, Gender, Elderly and Children
NBS	National Bureau of Statistics
NIMR	National Institute for Medical Research
NK	Nutrition Knowledge
NKP	Nutrition Knowledge Attitude and Practice
NP	Nutrition Practice
TDHS-MIS	Tanzania Demographic and Health Survey and Malaria Indicator Survey
UNICEF	United National Children's Fund
URT	United Republic of Tanzania
VAD	Vitamin A deficiency
WHO	World Health Organization

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background Information

Food insecurity, hunger and malnutrition have remained the major challenges of human development especially in Sub-Saharan African (FAO *et al.*, 2019; IFPRI, 2016). The region has experienced an increase in severe food insecurity from 18% in 2014 to nearly 22% as of 2018 (FAO *et al.*, 2018; FAO *et al.*, 2014). This also holds true for the case of undernourished individuals, where the region has experienced an increase of undernourished individuals from 21% in the year 2015 to nearly 23% as of 2018 (FAO *et al.*, 2019; FAO *et al.*, 2018). In Tanzania, the levels of malnutrition are still high for both women of reproductive age and children below five years of age, with rural areas carrying more burden than urban areas (MoHCDGEC *et al.*, 2018; TDHS-MIS-2015/2016). Currently, stunting affects 31.8% of children below five years of age and the prevalence of overweight and obesity for women of reproductive age has increased from 28% in the year 2015 to 31.7% in the year 2018 (MoHCDGEC *et al.*, 2018; TDHS-MIS-2015/2016). Sub-optimal feeding practices have also been reported in the country; only 30% of children below five years of age are fed the minimum acceptable diet (MoHCDGEC *et al.*, 2018). Malnutrition problems in Tanzania are primarily due to inadequate intake of macro and micronutrients (Kinabo *et al*., 2016; Dror and Allen, 2011). In particular, it is characterized by monotonous consumption of undiversified diets, rich in starchy staples, limited vegetables, little or no animal source foods and fruits.

Different nutrients are needed to nourish the human body. These nutrients are primarily from food crops and livestock products, thus making farm production as an important pathway for improving not only dietary diversity but also good nutrition status of a

population. Farming is undoubtedly, the most important sector in Tanzania, for it employs over 75% of people in the country, provides 95% of food supply and contributes to 70% of overall economic activities (URT, 2013). Apart from its economic contribution, farming plays an important role on attainment of food and nutrition security through crop and livestock production (Mkonda and He, 2018; URT, 2013). Subsistence farming is predominant in rural area; the population depends on their farmland for food production and as a source of livelihood, this in turn, has a profound impact on food availability, accessibility and consumption patterns for the rural communities (URT, 2013). The 2012/13 national panel survey revealed that 50% of all households keep livestock, in which; 62% are from rural households and 23% from urban households. Nevertheless, per capital consumption of Animal Source Foods (ASF) is still low in Tanzania (World Bank 2014; NBS, 2013). Given that rearing of livestock is mainly a rural activity, one would expect a large number of rural residents to consume ASF. However, this is not the case, as the average per capita consumption of ASF in urban households is nearly twice that of rural households. Furthermore, the regions which are known to produce more foods in Tanzania are also experiencing high prevalence of under-nutrition (NBS, 2013).

Adequate production, supply and access to food do not necessarily guarantee consumption of diversified diet (Ng'endo *et al.,* 2018; Keding *et al.,* 2011). Furthermore, the presence of foods alone does not necessarily translate into an optimal dietary intake. However, the choice of what, how, and when to eat is governed by several factors, of which include among others nutrition awareness, attitude and practices (Contento, 2011; FAO, 2014). These factors are considered to be important in acquisition, understanding, perceiving and acting upon nutrition and health related information. In addition, they affect decision on purchasing, handling, cooking, allocating and consuming foods within a household; consequently, affect their nutrition status of its members (Kiboi *et al.*, 2017:

Chege *et al.,* 2015; Ahadi *et al*., 2014). Literature has also indicated that other socio-economic factors especially household income may affect farming activities in rural areas. For example, when farmers experience income poverty, they tend to focus on production of staple crops to sustain dietary energy intake or thus compromising production diversity and so dietary diversity (Jones *et al.,* 2014). These pathways and linkages between household dietary diversity, farm production and other factors such as nutrition knowledge and other socio-economic attributes need to be examined critically in order to understand the relationships.

1.2 Farming and Food Situation in Tanzania

1.2.1 Farming situation in Tanzania

Farming encompasses growing of crops and raising of livestock, traditionally farming has been known to feed and sustain the livelihood of the people especially in rural areas. It affects food availability at the household and at the community levels consequently affects consumption (URT, 2013; Mkonda and He, 2018). Nationally, 60% of Tanzanian households are engaged in crop production followed by mixed crop and livestock production 39% and about 1% is engaged in livestock production only (NBS, 2011). Based on National Sample Census of Agriculture for the year 2012, production of crops is both for consumption and for sale. Tanzania's primary staple crops are maize, rice, millet and wheat. Maize crop dominates all the crops grown and is produced by many households across the country. This is followed by beans, rice, cassava, and cotton (NBS, 2011). The 2012/13 national panel survey revealed that 50% of all households kept livestock; of this proportion 62% of households is rural and 23% is urban. Types of livestock kept included chickens (86%), goats (48%), cattle (35%), pigs (9%), and other livestock (10%) (NBS, 2013).

1.2.2 Food situation in Tanzania

In Tanzania, local food production accounts for 95% of food availability in the country (URT, 2017). Nationally, Tanzania has attained surplus food production with self-sufficiency production ranges between 120 and 125 over the past 6 years from 2012/13 to 2018/19 (URT, 2019). Despite the sufficiency of food production at national level, there are areas in the country with shortage of food supply and experiencing food insecurity. The surplus production is usually counted using total food crops produced including cereals and legumes of which cereals self-sufficiency ratio makes up 103% (URT, 2019). The excess production of cereals can only suffice caloric sufficiency but not necessarily help the population to meet micronutrients requirements, which are mainly derived from diverse foods including fruits, vegetables and animal source foods. Based on demographic and health surveys, the regions which are highly food productive and have attained high self-sufficiency ratio in terms of food production have also high levels of malnutrition including stunting (MoHCDGEC *et al.*, 2018; TDHS-MIS-2015/2016).

1.3 Food Consumption Patterns in Tanzania

A typical diet for majority of rural Tanzanians is characterized by mostly cereal based foods accompanied by vegetables with little or no animal source foods (Kinabo *et al.*, 2016; URT, 2017). The report from Comprehensive Food Security and Nutrition assessment of 2017, revealed that only 67% of Tanzanian households afforded to eat three meals a day (URT, 2017). In addition, 97% of households relied mainly on cereals to meet household dietary needs, consumption of animal source foods such as eggs (5%) and meat (17%) was generally low. Furthermore, 41% of the households consumed less diversified foods and could afford to include up to 3 food groups in their daily meal (URT, 2017).

1.4 Nutrition Situation in Tanzania

Tanzania has continued to make progress in terms of reduction of malnutrition trends, however, the levels of malnutrition are still high (MoHCDGEC *et al.,* 2018). The country is still facing triple burden of malnutrition including high levels of childhood undernutrition, high levels of micronutrients deficiencies among children and women, and increasingly high level of overweight and obesity (MoHCDGEC *et al.*, 2018; TDHS-MIS-2015/2016). At present, stunting affects 31.8% of children below five years of age, overweight and obesity for women of reproductive age has increased from 28% in 2015 to 31.7% in 2018 (MoHCDGEC *et al.,* 2018; TDHS-MIS-2015/2016). Micronutrient malnutrition has remained a challenge for both children below five years of age (58%) and in women of reproductive age (45%) (TDHS-MIS 2015-2016). The national demographic and health surveys showed disparities between rural and urban areas in the prevalence of undernutrition, whereby rural areas carried more numbers of undernourished individuals compared to urban areas (MoHCDGEC *et al.*, 2018; TDHS-MIS-2015/2016).

1.5 Role of Nutrition Education on Modifying Dietary Knowledge and Practices

Over recent years a number of low- and middle-income countries including Tanzania have experienced an increase in the burden of malnutrition (FAO *et al.*, 2019; FAO *et al.*, 2018; MoHCDGEC *et al.,* 2018). The burden of malnutrition is partly contributed by poor understanding of lifestyle factors and undesirable dietary practices that predispose individuals to malnutrition (Musaiger and Al-Hazzaa, 2012). The decision of what, when and how to eat given the diverse food availability is governed by several factors of which appropriate nutrition knowledge and information are important factors (FAO, 2014).

Nutrition education has the potential to raise awareness and facilitate informed dietary choices thus modulating dietary practices (Du *et al.*, 2017; FAO, 2014).

1.6 Justification of the Study

In Tanzania, farming production is mainly taking place in rural areas, despite the recent increase in quantitative food production nationally; rural areas have more undernourished individuals than urban areas. The diet of people living in rural areas are less diversified, they are characterised by over reliance on cereals staples, limited portions of vegetables, little or no animal source foods and fruits (URT, 2017; Kinabo *et al.,* 2016). Furthermore, the intake of meat, poultry, and dairy in urban households is twice more that of rural households, despite the fact that rearing of livestock is mainly taking place in rural areas (World Bank, 2014; Covarrubias *et al.*, 2012). Given the afore-mentioned reasons, it is important that linkages and associations between food production and consumption are examined critically in order to understand their relationships and impacts of the population groups.

It should be noted however, that food production is not the solely factor to address adequate food consumption. Other factors such as limited knowledge related to food consumption may have some effect on dietary practices (FAO *et al.,* 2019; FAO, 2014). Studies regarding the positive impact of nutrition education on behaviour/change exist in Tanzania; (Kinabo *et al.,* 2017; Pillai *et al.,* 2016; Ruhembe *et al.,* 2015; Kulwa *et al.,* 2014). However, the focus has been on the child feeding and nutrition status (Kinabo *et al.*, 2017; Kulwa *et al.*, 2014), and when the household level is addressed, the focus has been mainly in urban households (Pillai *et al*., 2016; Ruhembe *et al.,* 2015). Effect of nutrition education on overall household dietary practices has not been given much attention especially in rural parts of the country where the burden of malnutrition is high.

Therefore, the present study aimed to establish the relationship between on farm production and household dietary diversity by measuring associations and predictors of household dietary diversity using different indicators such as socio-demographics, economic, nutrition knowledge and agricultural characteristics. The study has focused on the entire household dietary diversity approach rather than individual dietary diversity. In addition, the study has considered nutrition aspects in food production by including nutritional functional groups of foods produced. It is envisaged that the study will contribute to the existing efforts of reducing levels of malnutrition through nutrition sensitive agriculture production.

1.7 Study Objectives

1.7.1 Overall objective

To examine the effects of on-farm production and nutrition education on household dietary diversity in rural households of Chamwino and Kilosa districts in Tanzania.

1.7.2 Specific objectives

i) To assess status of nutrition knowledge and dietary practices in rural households of Chamwino and Kilosa districts in Tanzania
ii) To identify correlates and determinants of dietary practices in rural households of Chamwino and Kilosa districts in Tanzania
iii) To examine the pathways and associated factors between farm production, nutrition education and dietary diversity
iv) To assess effect of nutrition education on dietary knowledge and practices in rural households of Chamwino and Kilosa districts in Tanzania

1.8 Organization of the Thesis

This thesis contains three chapters; the first chapter is an introductory chapter, which lay the foundation of the thesis. The chapter explains the basic concepts related to the study including the nutrition situation, farm production and dietary consumption. Furthermore, the chapter describes key concepts used, the theoretical framework underlying the study and presents the connection and contribution of papers towards the overall objective of the thesis. Additionally, chapter one presents, methodological description including study design, sampling, data collection tools and approaches. The second chapter presents the publications that resulted from the study; these include three published papers and one manuscript (to be submitted). These publications contribute to the specific objectives highlighted in the study. Chapter three gives the overall conclusions and recommendations regarding the contribution of farm production diversity, nutrition education and household dietary diversity.

1.9 Description of the Commonality of the Concepts

1.9.1 Definition of key concepts

Nutrition knowledge: it refers to an individual's awareness, understanding and acquisition of nutrition related information. It can also be described as individual's ability to understand, remember and recall food- and nutrition-related terminology, specific pieces of information and facts (FAO, 2014).

Dietary practice: is defined as the ability to act upon or engaging on nutrition related information. It is the observable actions of an individual that could affect his/her or others' nutrition, such as eating, feeding, washing hands, cooking and selecting foods. If a practice is sustained for a long time, or commonly practices it becomes of behaviour (FAO, 2014).

Nutrition education: is defined as any combination of educational strategies accompanied by environmental supports, designed to facilitate the voluntary adoption of food choices and other food and nutrition-related behaviour conducive to health and well-being (Contento, 2011).

Dietary diversity: Dietary diversity is often used as an indicator of the food quality and is constructed from the sum of unique foodstuffs consumed in a specified period of time (FAO, 2011; Swindale and Bilinsky, 2006). Dietary diversity can be measured at individual or households' level. The household dietary diversity is meant to reflect, the economic ability of a household to access a variety of foods while the individual household dietary diversity reflects nutritional adequacy of an individual's diet (Swindale and Bilinsky, 2006).

Farm production diversity: is the practice of producing a variety of crops or animals, or both, on a farm, as distinguished from mono-culture production in which a single commodity is produced. Farm production diversity is measured using different indicators such as simple count of different types of crops grown and or livestock kept, which is known as richness. It can also be measured using evenness by considering number of farm species and distribution of the area occupied by species (Jones *et al.*, 2014; Simpson, 1949).

Crop variety richness: is a measure which involve a simple count of different types of crops cultivated in a farmland (Bellows *et al.*, 2019; Jones *et al.*, 2014; Sibhatu *et al.*, 2015).

Farm diversity richness (FDR): is a measure of different types of crops cultivated in a farmland and livestock keeping (Bellows *et al.,* 2019; Jones *et al.,* 2014; Sibhatu *et al.,* 2015).

Crop functional richness (CFR): is the measure of the number of functional nutrition food groups of crops produced in the farmland (Bellows *et al.,* 2019; Jones *et al.,* 2014; Sibhatu *et al.,* 2015).

Farm diversity functional richness (FPR), a composite indicator includes functional nutrition food groups of crops and household production of meat, egg and milk (farm diversity functional richness).

Market is a place where people meet to facilitate the exchange of goods and services. The market may be physical for example building, open place and retail outlet, where people meet face-to-face, or can be virtual for example an online market, where there is no direct physical contact between buyers and sellers (Mandal and Rosenberg, 1981). In the context of this study, market referred to physical including a premise or a common open place, where individuals meet for selling or purchasing foods and other products.

Household: is defined as an individual or group of people living in the same roof and sharing the meals (FAO, 1994).

Rural households: are the households which live closer to their environment and depend directly on the resources available in their closest environment such as land, forest, water, etc. for sustainability of their livelihood (FAO, 1994).

1.9.2 Theoretical framework

The study was grounded on two theories; the first theory is the theory of Planned Behavior and the second one is the Social Cognitive Learning Theory (SCLT). Both these theories stress the role of knowledge in acquiring sets of skills needed for performing a certain behavior. The Social Cognitive Learning Theory stresses that people are partly the product of their personal factors, behavior and existing environment and that their choices are influenced by their beliefs and capabilities. The interaction between an individual and his/her environment can act as barrier or enabler to the specific behavioral practice (Bandura, 1997). In this study the SCLT theory was applied to explore the linkages between the dietary practices of the household members with personal factors such as caregivers' nutrition knowledge, dietary skills and capabilities. The theory was also applied, to explore supportive environmental factors for attaining household dietary diversity e.g. farm production, market access, income, etc.

The theory of Planned Behavior explains that individual's behaviour can be predicted from a person's intention, or willingness, to perform the behavior (Ajzen, 1985). The intention and motivation to perform a specific behaviour is influenced by self-efficacy, capabilities and peer influences. In addition, an intention to perform a particular behavior will not be achieved if the barriers both at individual level and outside individual level are not addressed. In this study, the theory of Planned Behavior was applied during baseline survey and in the nutrition education training and follow-up visits. At baseline the study identified specific gaps and barriers to optimal dietary practices. Thereafter, clear strategic actions were formulated and implemented to improve the identified dietary shortcomings via nutrition education and follow-up sessions. The training was intended to enhance women's nutrition knowledge, skills and capabilities to act upon the new nutrition information acquired. In addition, the study invited men or heads of households to

participate in nutrition education training in order to support their spouses/women hence facilitate retention of nutrition knowledge at the households.

1.9.3 Conceptual framework of hypothesized linkages between farm production and household dietary diversity

The conceptual framework in Figure 1.1, illustrates the linkages between farm production and household dietary diversity. It is hypothesized that individual factors such as nutrition information, knowledge, skills, practices can influence desirable dietary practices and enhanced knowledge on the importance of farm production diversity and household food expenditure. Farm production also, influences household dietary diversity through direct consumption of diverse farm produces or indirectly, through market-oriented production which increases household income from sale of agricultural produce and hence greater food expenditures. Access to farm land, household income and market accessibility are enabling environment for attaining household dietary diversity.

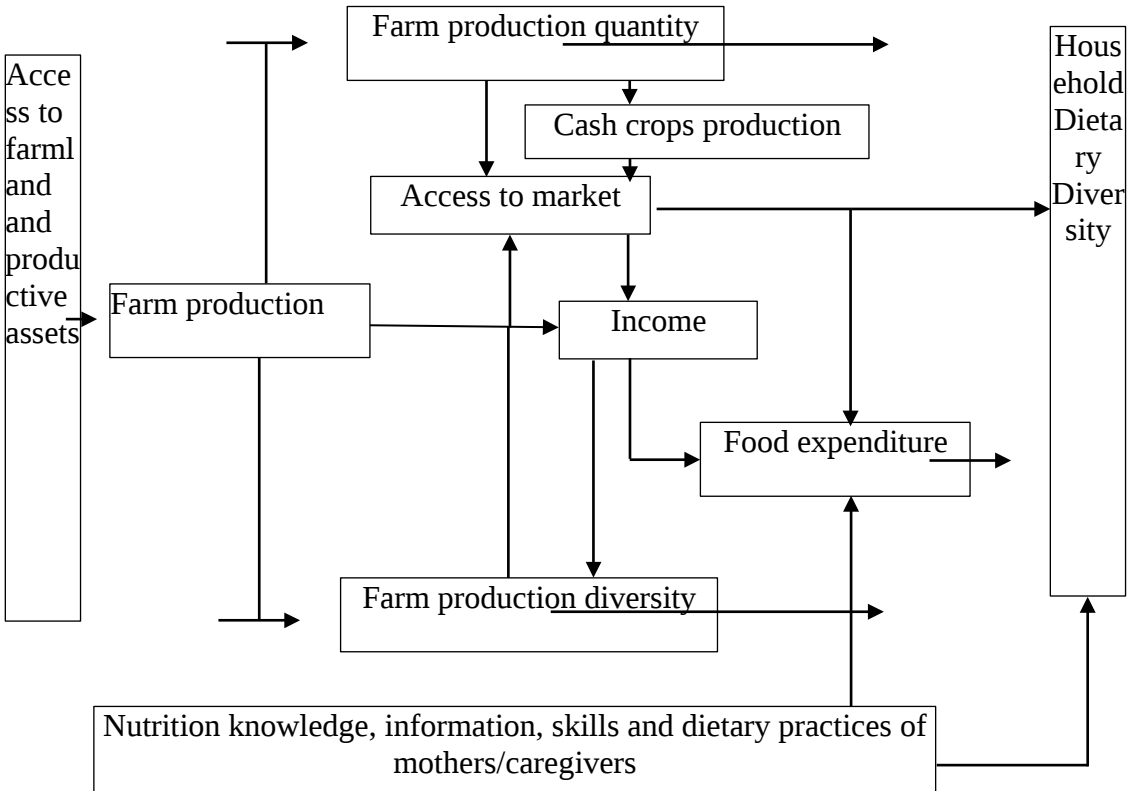
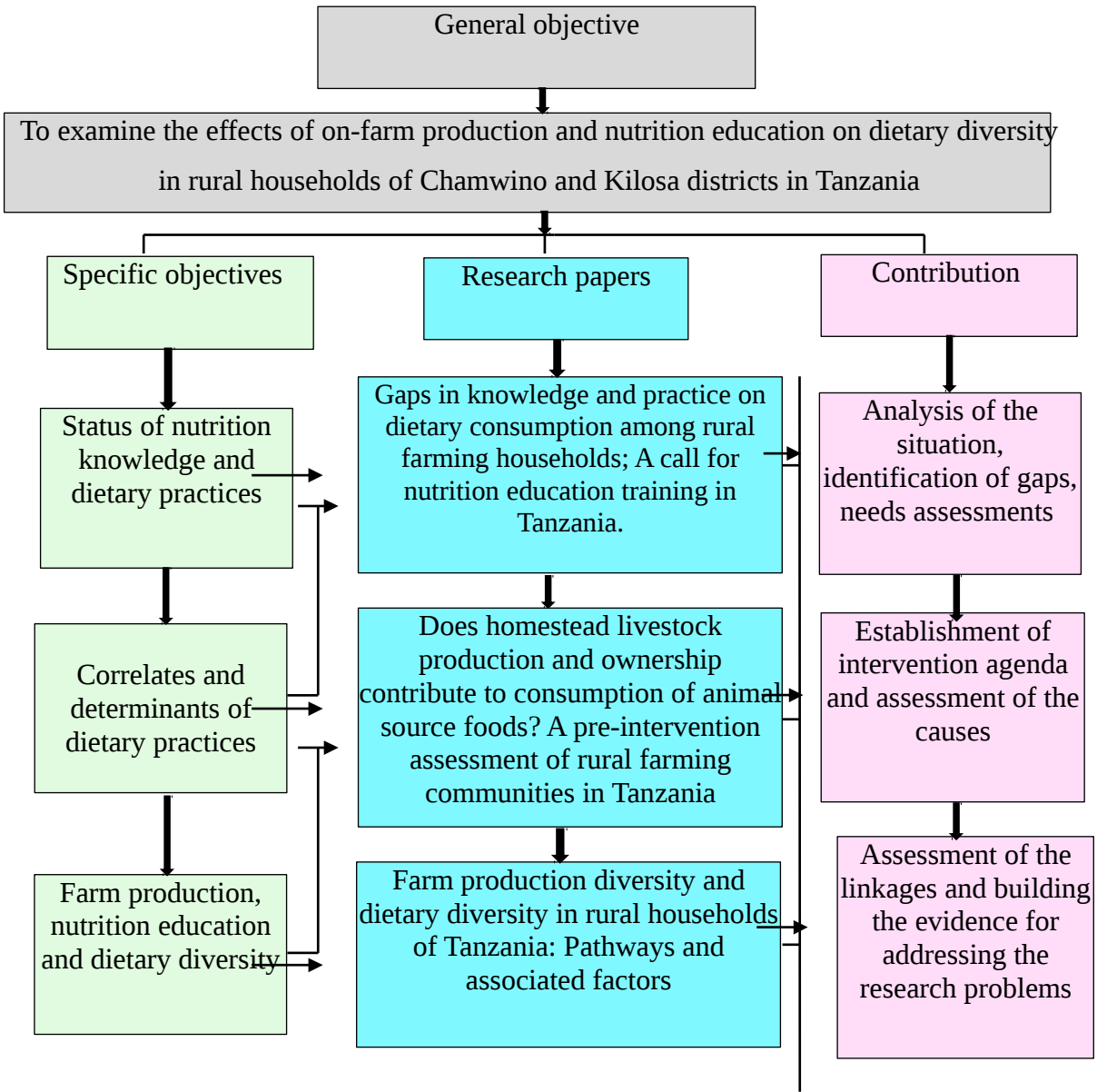


Figure 1.1: Conceptual presentation of the linkages between farm production, nutrition knowledge and household dietary diversity

1.9.4 Connection of research papers and their contributions

Figure 1.2 represents connection of research papers and their contributions to the study. The papers are presented systematically to inform the general objective of the thesis.



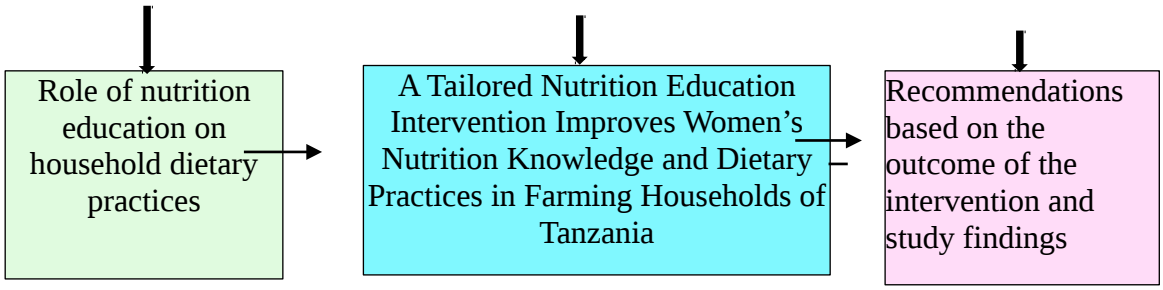


Figure 1.2: Connection of research papers and their contributions

1.10 Methodology

1.10.1 Study design

The study employed a pre-post semi longitudinal design, where data were collected in three phases namely; baseline, intervention and end-line phase. The baseline data were collected between July and August 2016, followed by nutrition education intervention which was implemented together with individual household follow-ups for a period of 8 months (September 2017 to April 2018) and the end-line data collected two years later after the baseline (July-August 2018).

1.10.2 Study area and population

The study was part of the Scaling-up Nutrition project (scale-N), the project was implemented in Dodoma and Morogoro regions, Tanzania [Scale-N, 2016]. These regions were selected because of the high levels of micronutrient malnutrition, especially anaemia (TDHS-MIS-2015/2016). Two districts namely, Kilosa and Chamwino were purposively chosen from each region, Kilosa in Morogoro region and Chamwino in Dodoma. The two districts have diverse agro-ecological conditions; Morogoro has sub-humid climate and Dodoma has semi-arid climate, (NBS 2015; Scale-N 2016). Two villages were randomly selected from each district, namely; Tindiga and Mhenda in Kilosa district, Morogoro and Mzula and Chinoje in Chamwino district, Dodoma.

The total sample size of 669 households was computed using Fisher's formula (Fisher, 1973; Fisher *et al.*, 2002). Due to less variations in the size of populations between the study villages, the obtained sample size was equally divided into four villages, which gave an average of 167 households for each village. The inclusion criteria for a household to qualify to participate in the study was that, it should have a mother or a caregiver of a school-going child with the age of 6-9 years. Households excluded in the study were those which did not have a school-going child of 6-9 years of age and those in which mothers or caregivers were not present. All the eligible households were listed from the village registry and subjected to ENA for SMART software for randomization. This particular study was able to reach 663 out of 669 participants who completed the questionnaires for baseline assessment. Households that participated in the survey were; 167 from Mzula and 166 from Chinoje villages in Dodoma; and 164 from Mhenda and 166 from Tindiga villages in Morogoro.

1.10.3 Data collection tools and approaches

Questionnaires and Focus Group Discussion guides were used to collect data. The questionnaires were administered by field assistants through face to face interviews with 663 sampled mothers/caregivers. For focus group discussion a sub-sample women or caregivers were randomly chosen from 663 households. Each of the woman/caregiver selected was required to come with her husband/spouse or any adult man living in the same household. The focus group discussions were then held separately for men and women. Total number of focus group participants varied from 60-120 as shown in the individual papers presented in chapter two of this thesis. The survey team comprised 10 field assistants and 2 field supervisors. The field assistants received training of the survey tools and participated in pre-testing of the tools before embarked on the survey. The data

were checked in the field to ensure the missing information was re-collected and /rectified before leaving the field. The study collected information on socio-demographic characteristics, nutrition knowledge, food production and food consumption practices. The tools used are presented in Appendix 1.1 and 1.2. Description of the collected information is as follows;

1.10.3.1 Socio-demographic and economic characteristics

The first part of the questionnaire comprised demographic and economic characteristics of the study population. It included information on age of the mother/caregiver, age of the household's head, marital status, sex of head of household, education level of mother/caregiver, literacy level of the mother/caregiver, household size, monthly income earned in the household, food expenditure and distance to the nearest market (Appendix 1).

1.10.3.2 Nutrition knowledge and practice

This section of nutrition knowledge and practice comprised semi-structured questions to test both basic nutrition knowledge related to dietary consumption and its corresponding practices. The collected information related to nutrition knowledge included: (i) Exposure to nutrition education (received or not), (ii) Description of malnutrition signs and symptoms, (iii) Dietary preventive measures of anaemia, (iv) Food groups and dietary diversity, (v) Importance of orange colored fruits, (vi) Importance of fibre-rich foods, (vii) Importance of consuming foods which enhance iron absorption, (viii) Identification of iodized salt, (ix) Importance of homestead livestock production for household consumption and, (x) Importance of homestead vegetable production for household consumption.

The questions of nutrition practice measured the actual implementation of the knowledge responses, it included the following information: (i) Implementation of nutrition messages, (ii) Seeking professional help to address malnutrition conditions, (iii) Taking measures to prevent anaemia, (iv) Consumption of at least 5 food groups 24 hours prior to the survey date, (v) consumption of orange colored fruits at least four times a week, (vi) Consumption of fibre rich foods in 24 hours prior to the survey date, (vii) Consumption of citrus fruits at least four times a week, (viii) Use iodized salt for household's cooking in 24 hours prior to the survey date, (ix) Consumption of poultry and poultry products at least four times a week, and (x) Consumption of vegetables in 24 hours prior to the survey date.

1.10.3.3 Food production

Agricultural characteristics included the total size of land cultivated in acreage, types of crops produced, ownership of livestock, and number of livestock species kept by the household as well as status of household production of meat, eggs and milk. Information on the sources of food item consumed either from household production or purchases was also collected. Production diversity was assessed using a simple count of crop species (crop variety richness), crop count and livestock keeping (farm diversity richness), the number of functional food groups of crops produced (crop functional richness), as well as a composite indicator which included functional food groups of crops produced with household production of meat, egg and milk (farm diversity functional richness)

1.10.3.4 Food consumption

Data on food consumption was collected by two different methods. The first method was through food frequency questionnaire and the second one was through a 24-hour dietary recall. These data were later used to compute household dietary diversity score.

Frequency of food consumption

Data for the frequency of food consumption was collected by asking a woman/caregiver responsible for food preparations in the household as to how frequently a specific food items was consumed in the household. The reference period was seven days (a week). Each food item consumed was given a number depending on the frequency of consumption. A score of zero was given if food item was not consumed at all in a week, 1 was given if a food item was consumed once per week, 2 for twice a week, 3 for three times a week, 4 for four times a week, 5 for five times a week, 6 for six times a week and 7 for seven times a week or daily.

A 24-hour dietary recall

Foods and drinks consumed by households' members within 24 hours prior to the survey were recalled by a woman/caregiver responsible for food preparations in the household. In addition, a description of the ingredients used in preparation of a specific meal were recorded.

Household dietary diversity

Information of household dietary diversity was obtained by two ways. The first way involved the counting of food groups reported in the 24-hour dietary recall and the second way was by counting the number of food groups consumed from frequency of food consumption data. Food items consumed outside the households were not counted as part of household diet. The itemized foods from 24-hour dietary recall and frequency of food consumption data were categorized into 12 or 10 food groups as shown in Table 1.1 and 1.2 and described in individual papers in chapter two of this thesis.

Table 1.1: The 10 food groups included in household dietary diversity

1	Starchy staple foods
2	Pulses (beans, peas and lentils)
3	Nuts and seeds
4	Dark green leafy vegetables
5	Other vitamin A rich fruits and vegetables
6	Other vegetables
7	Other fruits
8	Meat, Poultry and Fish
9	Dairy
10	Eggs

Table 1.2: The 12 food groups included in household dietary diversity

1	Cereals (e.g. rice, maize, millet, wheat, sorghum)
2	Roots, tubers, plantains and green banana
3	Vegetables
4	Fruits
5	Meat and meat products (e.g. beef, lamb, chicken, organ meat)
6	Eggs
7	Fish and sea foods (e.g. fresh or dried fish or shellfish, sardines)
8	Beans, peas, lentils and nuts
9	Dairy and dairy products (e.g. cheese, yogurt, milk0
10	Fats and oil
11	Sugar and honey
12	Condiments

1.10.3.5 Development and implementation of nutrition education intervention

A stepwise approach was taken in designing and implementing the nutrition education intervention in the study areas. Initially, a conceptualization process took place, where a network of factors affecting the dietary practices was drawn. Thereafter, clear strategic actions were formulated in an action plan to improve the identified dietary shortcomings in collaboration with the community (participatory). This first step was followed by the development and design of tailored nutrition education materials. By applying tools of community participation, the designed materials were subsequently tested so as to contextualize them and to assess their overall impact on the local level. After optimization

of the designed materials, a communication strategy was developed to identify appropriate channel of conveying nutrition messages to the targeted community. Prior to the implementation of nutrition education training to the target group, capacity building was done by training the community facilitators. These facilitators were the trusted community members including men and women identified during participatory meetings. After the training of trainers, community facilitators were able to train the targeted households including women/caregivers and their spouses or any adult men living in the targeted households. After the two weeks of training, six months follow-up visits were made to individual households to discuss challenges and negotiate for behaviour change. Detailed description of each step followed is presented in chapter two, paper four in this thesis.

1.10.3.6 Ethical clearance

This study was approved by National Institute of Medical Research of Tanzania with reference number (NIMR/HQ/R.8a/Vol.IX/2226). Written and verbal consent was sought from eligible household members including mothers/caregivers and heads of households to participate in the study activities.

1.10.3.7 Data analysis

Data were analysed using SPSS version 20. For descriptive statistics mean and standard deviation were used for parametric data while median and interquartile ranges were used for non-parametric data. Pearson correlation and Chi-square test were used to determine the correlation and relationship among variables. Mean separation was done by using one-way ANOVA with Tukey's post hoc test, level of significance was set as ($p = < 0.05$). Binary logistic regression was applied to identify predictors of the association between dichotomous variables. For non-parametric inferential statistics; Wilcoxon signed ranks

test were used for comparison of variables before and after intervention, Mann–Whitney U, for comparison of two groups and Kruskal Wallis test for comparison of more than two groups. The McNemar test was also applied to establish differences in frequencies during baseline and end-line.

CHAPTER TWO

Paper One

Gaps in knowledge and practice on dietary consumption among rural farming households: A call for nutrition education training in Tanzania

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Paper Two

Does homestead livestock production and ownership contribute to consumption of animal source foods? A pre-intervention assessment of rural farming communities in Tanzania

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Paper Three

Farm production diversity and dietary diversity in rural households of Tanzania: Pathways and associated factors

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2.0 Abstract

Farm production diversity is widely perceived to influence dietary diversity. However, the pathways and mechanisms are not adequately known. A cross-sectional data from 663 households were collected in the semi-arid area of Dodoma region and the sub-humid area of Morogoro region in Tanzania. Production diversity was assessed using a simple count of crop species (crop variety richness), crop count and livestock keeping (farm diversity richness), the number of functional food groups of crops produced (crop functional richness), and a composite indicator which combined functional food groups of crops produced with household production of meat, egg and milk (farm diversity functional richness). A seven-day frequency of food consumption data was used for the computation of household dietary diversity score (HDDS). Multiple linear regression was applied to examine the associations and predictors of HDDS. The Median HDDS differed significantly between the two regions ($p<0.001$); The HDDS for Dodoma was lower (interquartile range) 3.9 (2.9, 5.2) than that for Morogoro region 4.5 (3.5, 5.8). Close to 44% of the households in both regions consumed at least 5 food groups. After adjusting for socio-demographic, agriculture and nutrition characteristics, the regression model consistently predicted an increase in household dietary diversity with high farm diversity functional richness, daily food expenditure and nutrition knowledge in both regions. The effect of farm diversity functional richness on HDDS was slightly higher in Dodoma (ß-coefficient =0.29, t = 5.65, $p<0.001$) than in Morogoro (ß-coefficient =0.25, t = 4.62, $p<0.001$), however, the effects of daily food expenditure on HDDS was more pronounced in Morogoro (ß-coefficient =0.29, t = 5.87, $p<0.001$) compared to Dodoma (ß-coefficient =0.19, t = 3.88, $p<0.001$). Furthermore, the decrease of the distance to the nearest market slightly predicted an increase in HDDS in a pooled result, (ß-coefficient = -0.08, t = -2.33, p= 0.02). Livestock keeping and production of dark green vegetables, other vitamin A rich fruits and vegetables and nuts and seeds increased HDDS. Farm production diversity influenced positively household dietary diversity especially when various food groups are produced in the farms in addition to production of livestock. Other factors such as food expenditure, nutrition knowledge and market accessibility should be considered in any intervention for promoting dietary diversity in rural households.

Keywords: Production diversity, crop diversity, dietary diversity, food consumption

2.1 Introduction

Food insecurity, hunger and malnutrition are continuously affecting a large proportion of the population in Sub-Saharan Africa (FAO, 2017). While quantitatively increasing agricultural production has been frequently cited as the major means to address the outlined challenges, dietary energy sufficiency and problems of monotonous crop production are rather neglected (Mango *et al.,* 2018; Pingali, 2015; Pellegrini and Tasciotti, 2014). To ensure that agriculture is contributing to balanced human nutrition, several factors need to be considered, with this we should also have diversified crops and livestock production, to guarantee adequacy and diversity of nutrients for optimal human health (Pellegrini and Tasciotti, 2014). Globally one in three individuals are malnourished with at least one form of malnutrition (Development Initiatives, 2017; FAO, 2015). In Tanzania, micronutrient deficiencies are highly prevalent especially in rural areas where the majority of the population lives (MoHCDGEC *et al.*, 2016). At national level 33% of children below five years of age are stunted and more than 50% of children below five years of age are anemic. Anemia is also highly prevalent in the adult population with obesity being on the rise (MoHCDGEC *et al.*, 2016).

Recent studies have examined the association between agricultural production diversity and dietary diversity (Chegere and Stage 2020; Lovo and Veronesi, 2019; Guo *et al.,* 2019; Bellows *et al.,* 2019 Kissoly *et al.,* 2018; Mango *et al.,* 2018; Sibhatu and Qaim 2018; Azupogo *et al.,* 2018; Murendo *et al.,* 2018; Jones 2017; Romeo et al 2016; Kavitha *et al.,* 2016; Sibhatu *et al.,* 2015; Luckett *et al.,* 2015; Kumar *et al.,* 2015 and Jones *et al.,* 2014). Some of these studies have shown that other factors such as household socio-economic status and market access diminished the direct effects of production diversity to HDDS (Bellows *et al.,* 2019; Guo *et al.,* 2019; Kissoly *et al.,* 2018; Sibhatu and Qaim

2018; Azupogo *et al.,* 2018). Furthermore, the approaches used in some of these studies have focused on individual dietary diversity hence the reflection of the entire household picture is lacking (Lovo and Veronesi, 2019; Boedecker *et al.,* 2019; Azupogo *et al.,* 2019; Guo *et al.,* 2019; Bellows *et al.,* 2019). In addition, some studies have focused on a single aspect of production diversity by considering only crop diversification, leaving out a composite indicator for measuring both crop and livestock production diversification hence limiting the effects of crop and livestock production on household dietary diversity (Mango *et al.,* 2018; Kavitha *et al.,* 2016; Pellegrini and Tasciotti 2014; Rajendran *et al.,* 2014). Additionally, methodological variations were also noted, in the mentioned studies, especially on the use of different food groups in measuring dietary diversity (Chegere and Stage, 2020; Azupogo *et al.,* 2018; Murendo *et al.,* 2018; Kissoly *et al.,* 2018; Jones, 2014). Given the highlighted variations on approaches and methodologies, this study has therefore not only considered crop diversity as an indicator of production diversity but also its nutritional functional groups and an additional composite indicator of livestock, egg and milk production. The study has also focused on the entire household dietary diversity approach rather than individual dietary diversity. Additionally, it has taken into account a 7-day measure of food intake as a reflective of habitual food consumption patterns rather than a 24-hour dietary recall in establishing HDDS.

The aim of this study was to examine the effect of farm production diversity on household dietary diversity by measuring associations and predictors of household dietary diversity using different indicators of farm production diversity in addition to socio-demographics, economic, nutrition knowledge and agricultural characteristics. By examining the changes in regression coefficients of covariates, it was possible to establish the pathways and associated factors on the linkage between production diversity and household dietary diversity. It is envisaged that the findings of this study will contribute to the existing

efforts aimed at promoting agriculture productivity for alleviating food and nutrition insecurities in the population. In this, regard, data on the diversity of household diet, crops, and livestock production was examined among 663 farming households in rural areas of Dodoma and Morogoro regions of Tanzania.

2.2 Subjects and Methods

Description of the study area

This study involved two regions of Tanzania namely; Morogoro and Dodoma regions. The selection of the study sites was previously described in (Bundala *et al.,* 2019). Two districts namely, Kilosa in Morogoro region and Chamwino in Dodoma region were purposively chosen based on agro-ecological differences. Chamwino district is located in the semi-arid zone of the country, characterized with high rainfall ranging from 600-800 mm (URT, 2002), while Kilosa district is located in the semi-humid zone with low rainfall ranging from 650-500 mm (URT, 2003). The climate in Chamwino district, supports more drought tolerant crops such as millet and sorghums while the climate in Kilosa, the climate supports varieties of crops. Based on districts socio-economic profiles, Kilosa has accessibility to different markets while Chamwino has limited access to markets. Given the scope of this study, these differences were considered suitable for exploring some of the contributing factors to food production and consumption.

Data collection tools and approaches

The baseline data was collected in July-August 2016. The data included a total of 663 households, in which 333 households were from Dodoma and 330 from Morogoro. The respondents were mothers/caregivers of school aged children. A detailed description of how households were selected is explained in Bundala *et al.,* 2019. A questionnaire was administered by field enumerators through face-to-face interviews with women

responsible for household food preparation, cooking, and consumption. The questionnaire comprised socio-demographic details of respondents, nutrition knowledge, food production and household food consumption. The food production section entails information on the status of crops production, types of crops cultivated, total land available for agriculture, livestock keeping, egg and milk production. The reference period was based on the 12 months agricultural season (July 2015-July 2016), preceding the survey date. The food consumption section included questions related to the frequency of food consumption based on the reference period of 7 days preceding the survey date, other aspects included food expenditure, access to market and nutrition knowledge.

Measurement of agriculture production diversity

Four different measures of production diversity were used in the analyses. The first measure involved a sum of different types of crops cultivated in a household farm i.e. crop variety richness, (CVR). The second measure involved varieties of crops cultivated with additional of livestock keeping i.e farm diversity richness (FDR). The third and the fourth measures involved nutritional functional groups, computed to reflect the food groups included in the dietary diversity score. The measures included; crop functional richness (CFR) and farm diversity functional richness (FDFR). Crop functional richness was created by grouping different types of crops grown based on the 7 food groups these are; (i) Starchy staples (cereals roots and tubers), (ii)pulses (beans, peas and lentils), (iii) nuts and seeds, (iv) dark green leafy vegetables, (v) other vitamin A rich fruits and vegetables, (vi) other vegetables and (vii) other fruits. The measure of farm diversity functional richness (FDFR), entailed a combination of crop functional richness with meat, egg and milk production. The FDFR aligned with the 10 food groups included in the dietary diversity score, these groups were; (i) Starchy staples (cereals roots and tubers), (ii) pulses (beans, peas and lentils), (iii) nuts and seeds, (iv) dark green leafy vegetables,

(v) other vitamin A rich fruits and vegetables, (vi) other vegetables, (vii) other fruits, (viii) meat, (ix) dairy and (x) eggs. The functional groups used for calculating production diversity in this study, have also been used previously in other studies to measure production diversity and dietary diversity (Boedecker *et al.,* 2019, Bellows *et al.,* 2019; Sibhatu and Qaim 2018; Koppmair *et al.*, 2017; Jones 2016).

Measurement of Household Dietary Diversity (HDDS)

Household dietary diversity was calculated using a 7day frequency of food consumption, this is a modified approach that has previously been used in other studies especially when a 24-hour dietary recall has not been done repetitively or is not available for use (Bellows *et al.,* 2019; Zack *et al.,* 2018; Jones, 2016). In our study we collected the data for a 24 hour recall only once, hence it is not sufficient to provide a reflective habitual dietary diversity, this is the reason of using a 7day frequency of food consumption instead of a 24-hour dietary recall for computation of HDDS. Data for the frequency of food consumption was collected by asking a woman/caregiver responsible for food preparations in the household, how frequently a specific food items is consumed in the household. The reference period was seven days (a week). Each food item consumed was given a number depending on the frequency of consumption. A score of zero was given if food item was not consumed at all in a week, 1 was given for food item consumed once per week, 2= twice a week, 3=three times a week, 4=four times a week, 5=five times a week, 6= six times a week and 7=seven times a week or daily. We considered the use of 10 food groups in calculating HDDS as opposed to the usual 12 food groups. The ten food groups are the same as those included in women's dietary diversity score, because they are widely accepted to contribute to the micronutrient components of the diet (Jones, 2016). The 12 food groups are known to include sugar, oil and condiments as individual food groups which in turn reflect the

economic access and not micronutrient adequacy of the household diet (Swindale and Bilinksky, 2006). The ten food groups include Starchy staples (cereals roots and tubers), pulses (beans, peas and lentils), nuts and seeds, dark green leafy vegetables, other vitamin A rich fruits and vegetables, other vegetables, other fruits, meat, dairy and eggs. For the analytical purpose a score of 1 was given if the food group was consumed daily (seven times a week) in the household and a score of zero if the food group was not consumed daily (seven times a week) in the household. This made a score range of 0-10 food groups for HDDS.

Measurement of other variables

Other variables such as households' demographics, agricultural characteristics and nutrition knowledge, were also collected. Demographic information included age of mother/caregivers, years in schooling, household size and household daily food expenditure and access to market. Agricultural characteristics included the total size of land cultivated in acreage, types of crops produced, ownership of livestock, number of livestock species kept, household production of meat, egg and milk. Information on the sources of food item consumed either from household production or purchases were also collected. We also included information related to nutrition knowledge by scoring the responses related to five selected aspects of nutrition knowledge. The selected variables were related to the topic under the study, these include; (i) Any previous exposure to nutrition education, (ii) Ability to mention at least one sign of malnutrition, (iii) Can name at least 2 food groups or can define food groups (iv) Can explain the importance of homestead livestock production and (v) Can explain the importance of homestead vegetable production. The analysis of nutrition knowledge involved a scoring response as described in FAO 2014. Each of the responses from the stated questions was assigned a specific score based on the response. A score of 1 was given for

a correct response and a score of zero was assigned to an incorrect response or if the respondent indicated not being familiar to the question asked. The score from each response was then summed up to obtain a total score with a maximum range of 5 and a minimum of 0.

Analysis

Households' demographic, socio-economic, dietary, nutrition knowledge and agricultural characteristics, were presented using medians and interquartile ranges (25% and 75% percentile). Variables for production diversity and daily food expenditure were shown not to follow a normal distribution; hence they were transformed into square roots. Categorical variables were presented in frequencies and percentages, medians (interquartile ranges) were used to present continuous variables. Differences in median HDDS across categories of socio-demographic, nutrition knowledge and agricultural characteristics were computed using Mann–Whitney U and Kruskal Wallis test as appropriate. The effects of factors associated with HDDS were determined using multiple linear regression (stepwise) and adjusted for age of mother/caregivers, years in schooling, nutrition knowledge score, household size, the total size of land cultivated, distance to the nearest market, daily food expenditure, number of livestock species kept, crop variety richness, crop nutritional functional richness, farm production richness, farm diversity functional richness. The changes in regression coefficients were examined to establish the effect of each covariate on the outcome variable (HDDS). Multicollinearity effect was checked for minimum inflation factor of covariates (< 5). SPSS software version 20 was used for the analysis of all variables under the study.

2.3 Results

Socio-demographic and agricultural characteristics of the study regions

Table 2.1 represents socio-demographic and agricultural characteristics in the study regions. All households (100%) participated in crop production. About 53% of the households own at least one type of livestock specie. The median scores for crop variety richness, farm diversity richness, and farm diversity functional richness were higher in Morogoro households than in Dodoma households, Table 2.1.

Table 2.1: Socio-demographic and agricultural characteristics disaggregated by regions

	Chamwino-Dodoma		Kilosa-Morogoro		Total	
	*Median/ **Frequency	***IQR/ ****Percentages	*Median/ **Frequency	***IQR/ ****Percentages	*Median/ **Frequency	***IQR/ ****Percentages
Socio-demographic						
Household size	6.0	5.0,7.0	5.0	4.0,6.3	5.0	4.0,7.0
Daily food expenditure (TZS)	3000	2000,4500	4 000	2475,5000	3500	2000,5000
Years of schooling	7.0	0.0,7.0	6.5	0.0,7.0	7.0	0.0,7.0
Distance to the market (km)	14	7.8,23.4	1.5	0.4,2.6	4.8	1.5,14.0
Agricultural characteristics						
Size of agricultural land owned (Acre)	5.3	4.0,7.5	7.0	5.7,9.3	6.3	4.5,8.3
Participate in crop production (1=yes)	333	100	330	100	663	100
Livestock ownership (1=yes)	149	44.7	199	60.3	348	52.5
Crop varietal richness	3.0	2.0,4.0	9.0	7.0,10.0	6.0	3.0,9.0
Crop nutritional functional richness	3.0	2.0,3.0	3.0	3.0,4.0	3.0	3.0,4.0
Farm diversity richness	4.0	3.0,5.0	9.0	8.0,10.0	6.0	3.0,9.0
Farm diversity functional richness	4.0	3.0,5.0	5.0	3.0,6.0	4.0	3.0,6.0

Continuous variables are presented as *median and ***IQR (interquartile ranges), categorical variables are presented as **frequency and ****percentages.

Household Dietary characteristics in the study regions

The median HDDS score (interquartile ranges) was higher in Morogoro households 4.5 (3.5, 5.8) than in Dodoma households 3.9 (2.9, 5.2). About 44% of the households reported consuming at least the recommended 5 food groups in their daily meals. Consumption of starchy staples and dark green vegetables was similarly high across the two regions, while consumption of animal sources food groups such as meat, milk and eggs were notably low in all the study regions, (Table 2.2).

Table 2.2: Dietary characteristics disaggregated by regions

	Chamwino-Dodoma		Kilosa-Morogoro		Total	
Characteristics	*Median/ **Frequency	***IQR/ ****Percentages	*Median/ **Frequency	***IQR/ ****Percentages	*Median/ **Frequency	***IQR/ ****Percentages
Nutrition knowledge score	2.0	1.0,2.0	2.0	1.0,2.0	2.0	1.0,2.0
Consume 5 food groups (1=yes)	124	37.2	166	50.3	290	43.7
Household dietary diversity score	3.9	2.9,5.2	4.5	3.5,5.8	4.2	3.0,5.5
Starchy staple foods	7.0	7.0, 7.0	7.0	7.0, 7.0	7.0	7.0, 7.0
Pulses (beans, peas and lentils)	3.0	1.0, 6.0	7.0	4.8, 7.0	5.0	2.0, 7.0
Nuts and seeds	7.0	2.0,7.0	3.0	1.0,7.0	4.0	2.0, 7.0
Dark green leafy vegetables	7.0	4.0, 7.0	7.0	6.0, 7.0	7.0	5.0, 7.0
Other vitamin A rich fruits and vegetables	1.0	0.0, 5.1	6.0	1.0, 7.0	3.0	0.0, 7.0
Meat, Poultry & Fish	0.0	0.0, 1.9	3.0	1.0,6.0	1.0	0.0, 4.0
Dairy	0.0	0.0, 0.0	0.0	0.0, 0.0	0.0	0.0, 0.0
Eggs	0.0	0.0, 0.0	0.0	0.0, 0.0	0.0	0.0, 0.0

Continuous variables are presented as *median and ***IQR (interquartile ranges), categorical variables are presented as **frequency and ****percentages.

Comparison of household dietary diversity score based on household characteristics

Generally, there was a variation in HDDS across different group categories as shown in Table 2.3. Dodoma region had significantly lower HDDS of 3.9 compared to 4.5 of Morogoro region, ($p<0.001$). The proportion of households spending less than 5km to reach the nearest market had a higher HDDS of 4.7 compared to 3.7 for those who travelled more than 5 km, (<0.001). Furthermore, households that had a daily food expenditure of above 3500 Tanzanian shillings had higher median HDDS of 4.7 than their counterparts, ($p>0.001$). No significant differences were reported across the age of mother/caregiver, marital status, household size, education level, and size of agricultural land available to the household.

Table 2.3: Comparison of HDDS based on household characteristics

Characteristics	Description	Median HDDS	P-value
Districts**	Chamwino-Dodoma	3.9	<0.001
	Kilosa-Morogoro	4.5	
Age of mother/caregiver***	18-30 years	4.1	0.682
	31-45 years	4.3	
	45 and above	4.3	
Marital status of mother/caregiver***	Married/cohabited	4.1	0.618
	Single/Separated	4.4	
	Widowed	4.2	
Household size***	1-4 people	4.3	0.638
	5-7 people	4.2	
	8 and above	4.0	
Education level of mother/caregiver**	Had formal education	4.3	0.748
	Had no formal education	4.2	
Distance to the nearest market (km)**	< 5 km	4.7	<0.001
	> 5 km	3.9	
Household food expenditure per week in Tanzanian Shillings (TZS)**	< 3500 TZS	3.9	<0.001
	> 3500 TZS	4.7	

Values are presented as median; **Mann–Whitney test was used for comparison of two group categories; ***Kruskal Wallis test was used for comparison of more than two group categories

Comparison of HDDS based on nutrition knowledge and agricultural characteristics

The higher HDDS was observed among households with higher nutrition knowledge scores than their counterparts (5.3 vs 4.0, p<0.001). Households that reported having an increased farm diversity functional richness had higher HDDS. In addition, proportions of households growing food crops such as nuts and seeds, dark green vegetables and other vitamin A rich fruits and vegetables had a higher HDDS. Likewise, households that own animals for meat, eggs and milk have shown to have higher median household dietary diversity than households that did not own animals for meat, eggs and milk Table 2.4.

Table 2.4: Comparison of HDDS based on nutrition knowledge and agricultural characteristics

Characteristics	Description	Median HDDS	P-value
Nutrition knowledge score**	0-2 scores	4.0	<0.001
	3-5 scores	5.3	
Size of agricultural land owned (Acre)***	1-4 acres	4.2	0.977
	4.1-8.0 acres	4.2	
	8.1 and above	4.3	
Household cash crop production**	Yes	4.0	0.851
	No	4.7	
Farm diversity functional richness***	1-2 varieties	3.1	<0.001
	3-5 varieties	4.1	
	6 and above varieties	5.3	
Growing of beans, peas and lentils**	Yes	4.2	0.283
	No	4.4	
Growing of nuts and seeds**	Yes	5.2	0.004
	No	4.1	
Growing of dark green vegetables**	Yes	4.5	<0.001
	No	3.4	
Growing of other vitamin A rich fruits and vegetables**	Yes	5.1	<0.001
	No	3.9	
Household meat production**	Yes	4.8	<0.001
	No	3.7	
Household dairy production**	Yes	4.9	0.040
	No	4.1	
Household eggs production**	Yes	3.8	<0.001
	No	5.0	

Values are presented as median; **Mann–Whitney test was used for comparison of two group categories; ***Kruskal Wallis test was used for comparison of more than two group categories

Proportion of food groups consumed by the households from own farm production

Figures 2.1 and 2.2 show the percentages of various food groups produced and consumed by the households in Dodoma (Figure 2.1) and Morogoro (Figure 2.2) regions. Nearly all households in Dodoma and Morogoro regions reported producing and consuming starchy staple foods. Likewise, the production of dark green vegetables in Dodoma (64%) and Morogoro (79%) reflected its level of consumption in both regions; 62% in Dodoma and 76% in Morogoro. Low proportion of households in Dodoma region (21%) and none of the households in Morogoro region (0%) grew nuts and seeds. However, consumption of nuts and seeds was high both regions (Dodoma; 57% and Morogoro; 29%) Furthermore, there was a mismatch in proportions of households reported producing and consuming animal source foods such as meats and eggs in all regions. For example, nearly 45% of households in Dodoma and 60% of households in Morogoro reported producing livestock but, only 3% and 19% of the households consumed meat in Dodoma and Morogoro, respectively.

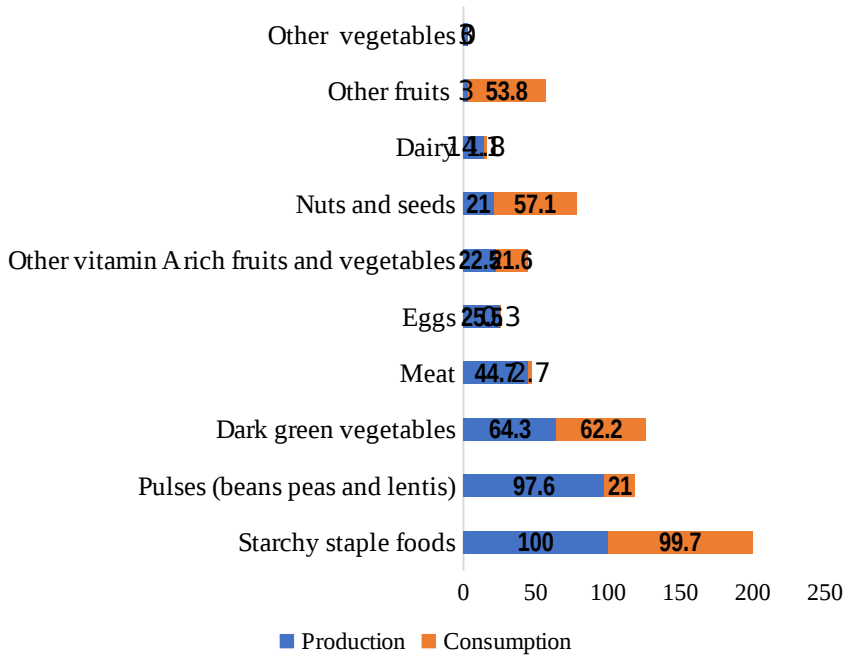

Figure 2.1: Proportion of food groups consumed by the households from own production in Dodoma

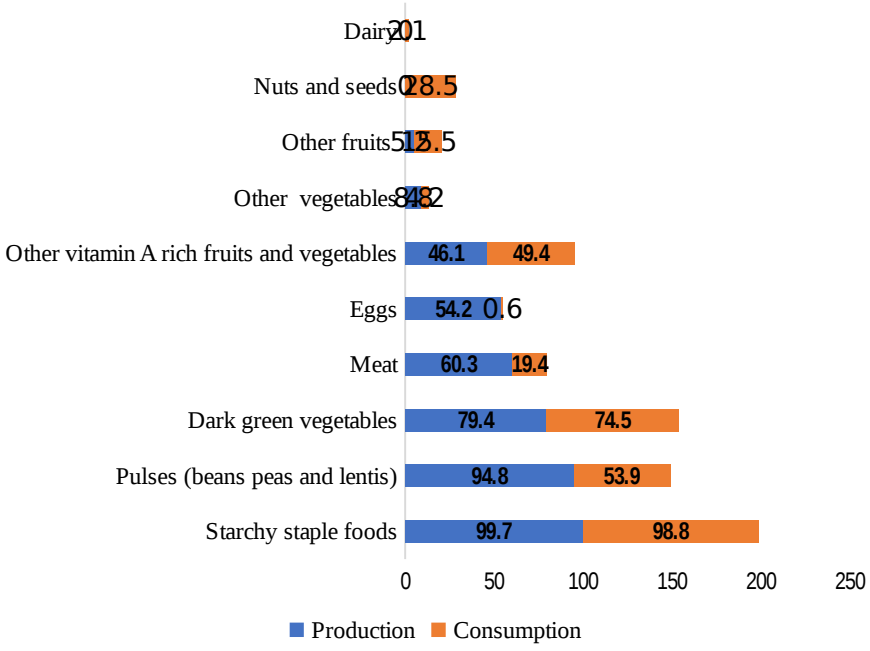

Figure 2.2: Proportion of food groups consumed by the households from own production in Morogoro

Predictors of household dietary diversity

Results from multiple linear regression on the associated factors and potential predictors for HDDS are presented in Table 2.5. The findings established that an increase in farm diversity functional richness, daily food expenditure and nutrition knowledge consistently predicted an increase in household dietary diversity score in both Dodoma and Morogoro regions. The effect of production diversity functional richness on HDDS was slightly higher in Dodoma households (ß-coefficient =0.29, t = 5.65, p<0.001) than in Morogoro households (ß-coefficient =0.25, t = 4.62, p<0.001). The effects of daily food expenditure on HDDS was more pronounced in Morogoro households (ß-coefficient =0.29, t = 5.87, p<0.001) compared to Dodoma households (ß-coefficient =0.19, t = 3.88, p<0.001). Furthermore, the short distance to the nearest market predicted an increased HDDS after pooling the results in two regions, however the effect was relatively small compared to FPDR (ß-coefficient = -0.08, t = -2.33, p= 0.02), Table 2.5.

Table 2.5: Predictors of household dietary diversity

	B	SE	Beta	*t*	95% CI (Lower, upper bound)	Sig.
Pooled						
Farm diversity functional richness	1.15	0.15	0.28	7.42	0.84 – 1.45	< 0.001
Daily food expenditure	0.03	0.004	0.26	7.58	0.02 – 0.35	< 0.001
Nutrition knowledge score	0.39	0.07	0.22	5.94	0.26 – 0.52	< 0.001
Distance to the nearest market	-0.01	0.005	-0.09	-2.65	-0.02 – (-0.004)	0.008
Dodoma						
Farm diversity functional richness	1.12	0.19	0.29	5.65	0.73 – 1.51	< 0.001
Daily food expenditure	0.02	0.005	0.19	3.88	0.01 – 0.03	< 0.001
Nutrition knowledge score	0.39	0.09	0.25	4.67	0.23 – 0.57	< 0.001
Morogoro						
Farm diversity functional richness	1.14	0.25	0.25	4.62	0.66 – 1.63	< 0.001
Daily food expenditure	0.03	0.005	0.29	5.87	0.02 – 0.04	< 0.001
Nutrition knowledge score	0.37	0.10	0.19	3.55	0.16 – 0.57	< 0.001

Multiple linear regression (stepwise), B; unstandardized regression coefficient, SE; standardized error, Beta; standardized coefficient. dependent variable was HDDS; independent variables were; age of mother/caregivers, years in schooling, nutrition knowledge score, household size, distance to the nearest market, daily food expenditure, total size of land cultivated, number of livestock species kept, crop variety richness, crop functional richness, farm diversity richness, farm diversity functional richness. Variables for daily food expenditure, crop variety richness, crop nutritional functional richness, production diversity functional richness were transformed and presented as square roots. Probability of F: entry was set at 0.01, removal 0.05. Dodoma (R=0.52, R^2=0.27); Morogoro (R=0.56, R^2=0.30); Pooled (R=0.56, R^2=0.31).

The linkages between farm production and HDD based on the result framework

Household dietary diversity was positively influenced by farm production diversity, high levels of nutrition knowledge of mothers/caregivers, short distance to the nearest market and an increase in household's food expenditure. Households with greater farm production diversity, consumed larger proportions of foods from their own production and less from purchases, hence low food expenditure compared to households that had less farm production diversity. However, increased household food expenditure and short distance to the nearest market appeared to affect positive HDDS, thus reduced positive effects of farm production diversity over the household dietary diversity. Levels of nutrition knowledge of mothers/caregivers consistently predicted an increase of household dietary diversity score. An increase in overall household income did not predict an increase in household dietary diversity but influenced positively through an increase in food expenditure i..e amount of money allocated for buying food (Fig. 2.3).

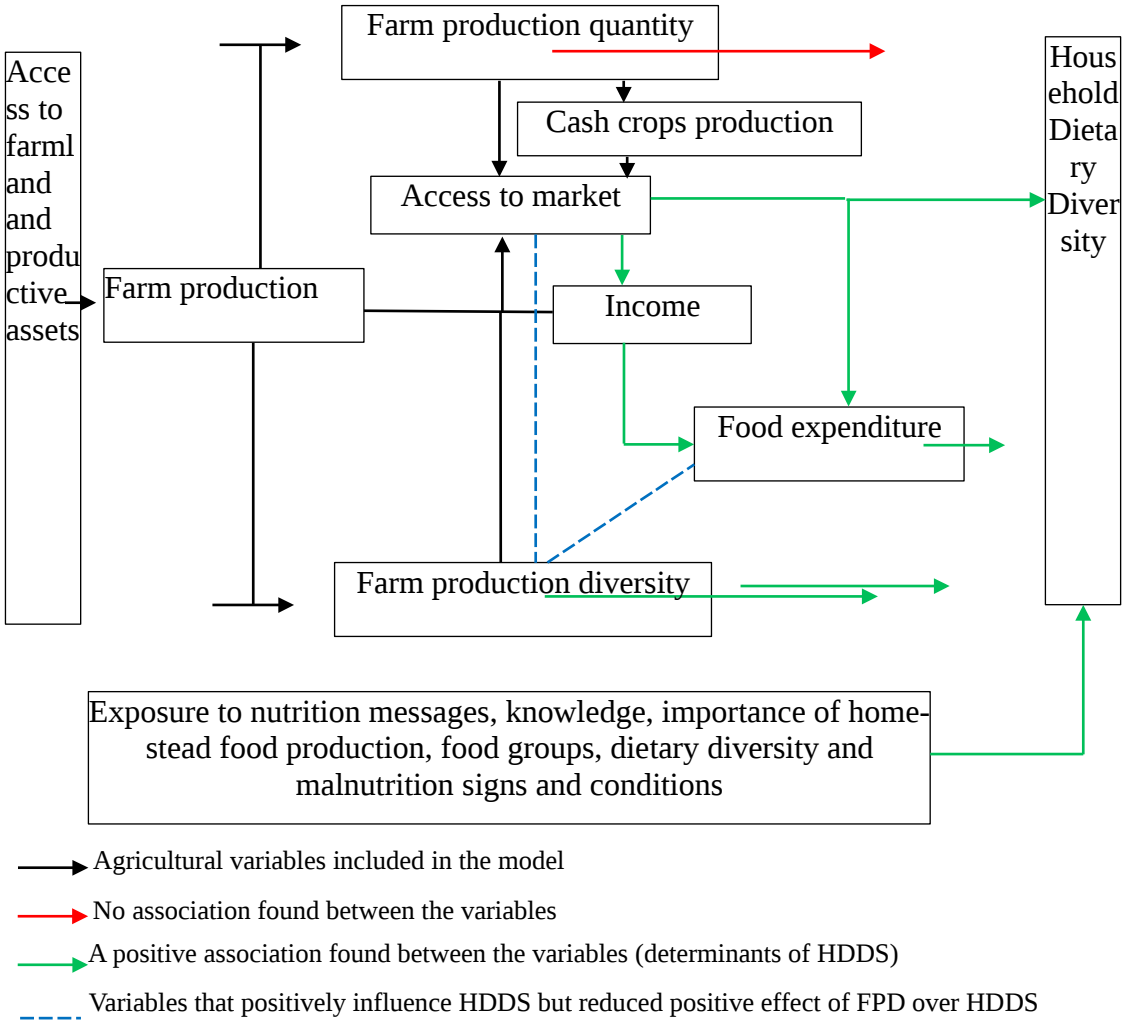

Figure 2.3: A result framework for the linkages between farm production and household dietary diversity

2.4 Discussion

This study explored the contribution of farm production diversity on dietary diversity by examining the pathways and associated factors in farming households of Chamwino (Dodoma) and Kilosa (Morogoro) regions in Tanzania. The findings have shown that an increased farm production diversity based on a diverse of nutrition groups of crops and livestock products resulted in an increased household dietary diversity in the studied population. Households which produced an average of 6 food groups in a farm, had an ability to have 5 food groups or more in their daily household meal compared to households that were not able to produce more crops. This observation suggests that household ability to diversify diets is partly based on the capacity to produce more varieties of food groups on their farmland. Therefore, multiple rather than mono-cropping is beneficial to households; considering that the level of income and accessibility to markets was shown to be a challenge for some households to enable them to attain high dietary diversity. Other studies (Chigere and Stage 2020; Koppmair *et al.*, 2017 and Luckett *et al.*, 2015, observed that household dietary diversity increased with an increase in different food groups produced in the farms. Nevertheless, in the present study, there was more potentiation of household dietary diversity when diversification of on-farm crops was coupled with production of livestock products such as eggs, meat and milk. A positive effect of livestock production on household dietary diversity could be partly explained through direct consumption of different animal source foods from home-stead production or indirectly through an increased purchasing power of different food items as a result of selling livestock and livestock products.

In order to improve household dietary diversity, it is important to promote production of crops and livestock at household level. This will enhance accessibility of these food groups at a short distance and short value chain. This is critical especially in rural areas

where market infrastructure is poor, and income is low. Similar observation was made in other studies where, a combination of farm crop and livestock count predicted an increased household dietary diversity in Malawian households (Jones *et al.,* 2014) and ownership of livestock was strongly associated with an increased women dietary diversity score in Rufiji basin of Tanzania (Bellows *et al.,* 2019). Nevertheless, ownership of livestock in the Rufiji study did not predict an increased daily consumption of animal source foods, but rather on income generation, which in turn led to increased household purchasing power.

The on-farm production diversity was not the sole factor for increased dietary diversity, the regression model indicated that other correlates such as food expenditure, distance to the nearest market and pre-existing nutrition knowledge of caregivers were identified to influence positively HDDS. For example, in our findings, we have seen that the effect of food expenditure on household dietary diversity was more pronounced in Morogoro region than in Dodoma region. This implies that households in Morogoro region depend largely on purchasing foods to complement farm production while households in Dodoma region mainly depend on their farm production. Findings from previous studies have also shown that household dietary diversity is influenced by other factors apart from farm production diversity (Bellows *et al.,* 2019; Kisolly *et al.,* 2018; Hirvonen *et al.,* 2017; Jones 2016; Sibhatu *et al.,* 2015). Kisolly *et al.*, 2018 reported that the diversity of food consumed in rural households was positively associated with food consumption expenditure particularly among the households that relied on the market for food purchase in Kilosa district. The pooled regression results indicated that the lesser the distance to the market the higher the diversity of household diet, the effect was small, but significant. This concurs with the finding from Sibhatu *et al.,* 2015 who found that, access to the market was positively associated with dietary diversity and to some extent

diminished the positive effects of farm production diversity over the household dietary diversity. Access to market is not only linked with access to varieties of foods in the market but also with the avenue for generating cash income from selling household's agricultural products (Kisolly *et al.*, 2018 and Sibhatu *et al.*, 2015; Luckett *et al.*, 2015). In the present study there was no linkage between cash crop production and household dietary diversity, there was no statistical difference in the median HDDS between those who participated in cash crop production and those who did not.

Pre-existing nutrition knowledge on food groups, dietary diversity and the importance of homestead food production was also found to be an important predictor of household dietary diversity in the present study. Households with low nutrition knowledge score also had low household dietary diversity (less than five food groups) and those who had high nutrition knowledge score had high household dietary diversity (above 5 food groups). Previous studies regarding determinants and correlates of dietary diversity have associated better nutrition knowledge of caregivers/women with higher dietary diversity (Bundala *et al.*, 2019; Huluka and Wondimagegnhu, 2019; Hirvonen *et al.*, 2017; Kiboi *et al.*, 2017). Only one study that has examined pre-existing nutrition knowledge and farm production diversity jointly as among the factors that influence positively household dietary diversity (Murendo *et al.*, 2018). However, the majority of the studies established the evidence on the effect of formal education or number of years spent in schools on production diversity or dietary diversity (Gitagia *et al.*, 2019; Chigere and Stage 2020; Jones *et al.*, 2014). Despite the mentioned evidence from previous studies documenting the importance of caregiver's education levels or the number of years spent in schools on diversity of household diet, in this study there was no correlation between the number of years spent in school by the mother/caregivers and household dietary diversity. However, our results indicated that better nutrition knowledge of mothers/caregivers is associated

with an increased household dietary diversity as mentioned earlier. This finding signifies the favorable effect of nutrition knowledge on guiding not only food production choices but also food consumption choices.

Production of specific food groups in a household farm led to a significant increase in household dietary diversity. For example, growing food crops such as nuts and seeds, dark green vegetables and other vitamin A rich fruits and vegetables increased household dietary diversity. Likewise, households that own animals for meat, eggs and milk had a higher median household dietary diversity than their counterparts. These findings not only explain the importance of household food production but also the interplay of production, market and consumption. Some of the food groups were not adequately produced by the households but were consumed in a large proportion by the households because they could be accessed through the market. For example, 21% of households in Dodoma region and (0%) of the households in Morogoro region were producing nuts and seeds but the proportions of households reported consuming nuts and seeds were higher both Dodoma (57%) and Morogoro; 29% regions.

Some food groups from animal sources such as meat were highly produced but poorly consumed for example, 45% of households in Dodoma and 60% of households in Morogoro reported producing livestock however, only 3% and 19% of households reported daily consumption of meat in Dodoma and Morogoro, respectively. A similar trend was reported in the previous study, that despite the high household dietary diversity observed among livestock keepers in Dodoma and Morogoro regions, consumption of animal source food was low (Bundala *et al.*, 2019). Bellows *et al.*, 2019, observed that, some food groups such as pulses and meat were highly produced but not significantly associated with consumption because they were sold to get income to purchase other food

items. Additionally, in our study, we found that some of the demographic variables such as age, marital status and household size did influence household dietary diversity.

2.5 Conclusion

Farm production diversity influence positively household dietary diversity especially when different food groups are produced in the farms in addition to livestock products. The study underscores the contribution of other factors that influenced the diversity of household diet including; food expenditure, distance to the nearest market and nutrition knowledge of mothers/caregivers. A mismatch between production and consumption of some food groups such as meat, eggs, nuts and seeds and also an increase of food expenditure calls for further research on exploring the interplay of production, consumption and market. The findings entail that any intervention for promoting household dietary diversity should not only consider farm production diversity as a sole measure but also other factors such as nutrition knowledge, household food expenditure and market accessibility.

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Paper Four

A tailored nutrition education intervention improves women's nutrition knowledge and dietary practices in farming households of Tanzania

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Summary of the Key Findings from Papers based on the Study Objectives

Study Objectives	Key Findings	Key messages
1. Status of nutrition knowledge and dietary practices	High levels of nutrition illiteracy coupled with sub-optimal dietary practices	Low coverage of nutrition education was an obstacle for attaining adequate nutrition knowledge and optimal dietary practices
2. Status of nutrition knowledge and dietary practices	**Correlates**: NK, CP, LK, food expenditure, market access, land size, education levels. **Determinants**: NK, FPD, food expenditure & market access	Nutrition education & FPD are the key for improving rural HDD Access to market influences positively HDD
3.Pathways & associated factors of farm production, nutrition education & HDD	Farm production diversity & NK increase HDD Food expenditure & market accessibility reduce effect of FPD	Improving HDD in rural households requires integration of farm FPD, nutrition education and market proximity
4. Effect of nutrition education on dietary knowledge and practices	Exposure to Nutrition education intervention & participation of men improved NK and NP	Increasing exposure, coverage & participation of men in nutrition education is the key for improving NK & dietary practices

NK; Nutrition Knowledge, NP; Nutrition Practice, CP; Crop production, LK; Livestock Keeping, FPD; Farm Production Diversity; HDD; Household Dietary Diversity;

Figure 2.4: Summary of the key findings from papers based on the study objectives

CHAPTER THREE

3.0 General Conclusions and Recommendations

3.1 Conclusions

The current study was set to examine factors affecting household dietary diversity by measuring associations and predictors of household dietary diversity using different indicators of farm production diversity in addition to nutrition knowledge, socio-demographics, economic, and agricultural characteristics. The study revealed that, household dietary diversity is associated with several factors including levels of nutrition knowledge of mothers/caregivers, farm production diversity, food expenditure and distance to the nearest market.

The study also revealed high levels of nutrition illiteracy among mothers/caregivers, coupled with low exposure to nutrition education and sub-optimal dietary practices. Generally, the majority of participants who had low levels of nutrition knowledge also had low dietary diversity, limited consumption of vegetables (low portion size), inadequate consumption of fruits. In addition, they were not able to translate nutrition messages into practice. However, for those who had high level of nutrition knowledge also had high household dietary diversity coupled with optimal dietary practices such as adequate consumption of fruits and vegetables. Furthermore, the use of health facilities, as a platform for delivery of nutrition education, was perceived to exclude men and other community members who are not the target for antenatal services. This has contributed to low coverage of nutrition education, high levels of nutrition illiteracy and poor adoption of best nutrition practices at the household level.

Household dietary diversity was also influenced by farm production, especially when different food groups are produced in the farms in addition to livestock products. Households that were owning livestock and growing food crops such as nuts and seeds, dark green vegetables and other vitamin A rich fruits and vegetables had higher household dietary diversity than their counterparts. Nevertheless, farm production alone is not sufficient to insure dietary diversity but it is vital to consider nutrition varieties of functional food groups produced in a household farm for improvement of dietary diversity especially for those households which mainly depend on their own farm for food. Despite the fact that livestock production influences household dietary diversity, the level of consumption of animal source foods has remained low even after the intervention. This calls for further investigation to address the challenges of consumption of animal source foods in the areas.

Food expenditure and distance to the nearest market also influenced the diversity of household diets. Increased food expenditure translated into an increase in household dietary diversity. This indicates that the more the portion of household income is allocated to food expenditure the more the accessibility of diverse foods in the household. Despite the positive effect of food expenditure on dietary diversity seen in the present study, generally an increase in overall household income did not predict an increase in household dietary diversity. This suggests that, having high income does not necessarily translate into consumption of diversified diet, unless that income is spent on purchasing diversified foods. The effect of food expenditure on household dietary diversity was more pronounced in Morogoro region than in Dodoma region. Households in Morogoro region depended largely on purchasing foods to complement farm production and households in Dodoma region mainly depended on their farm production. The study has shown that accessibility to the nearest market and the increase in the household food expenditure

diminishes the positive effects of farm production diversity over the household dietary diversity.

In this regard there is a need for further research to explore the influence of market accessibility on the dietary diversity especially in rural areas where market infrastructure is poor, and per capital income is low.

The findings after implementation of nutrition education intervention showed the positive effect of nutrition education in the promotion of nutrition knowledge and desirable dietary practices. Specifically, household dietary diversity, consumption of vegetables, fruits, and legumes increased significantly after the intervention, suggesting that, nutrition education intervention provided the desired changes in the studied population. The findings entail that any intervention for promoting household dietary diversity should not only consider farm production diversity as a sole measure but also other factors such as nutrition knowledge, household food expenditure and market accessibility.

3.2 Recommendations

The following are the recommendations emanated from this study:

1. Establish community nutrition cadres should be a priority in order to increase coverage of nutrition education in the community. This will ensure inclusion of other people who are not the primary beneficiaries of antenatal programs in the community
2. The target groups for most of nutrition interventions in the country should be re-defined to accommodate the less prioritized groups such as adult men. The tendency of prioritizing only women of reproductive age and children below five years of age in nutrition education interventions exclude other groups and compromises the adoption of desirable dietary practices at the household levels.

3. Agriculture programs implemented in rural areas should not only focus on the quantitative increase in food production, but also should integrate the aspect of farm production diversity with the focus of promoting production of vegetables, fruits and rearing of livestock to enable availability of and access to nutritionally diversified foods. For this, it is essential to build capacity to the agriculture extension workers to be able to promote farm production diversity in rural households
4. Capacity building on allocation of household food budget should be done especially for households with limited farm production diversity and depend on purchasing foods
5. Good quality of food marketing facilities should be established in each village to ensure food availability accessibility.
6. Decrease distance to the nearest market has shown to affect household dietary diversity, this calls for further research to explore the linkages between market diversity of food items and the dietary diversity in the rural households of Tanzania.

3.3 Limitations of the Study

1. Data were collected at one point in time; hence the study did not capture the seasonal variations of production and consumption. However, the influence of variations in seasons was controlled by conducting the baseline and end-line survey in the very same period (after harvesting)
2. Changes in behavior usually takes time, this study was designed to include the individual household's follow-up visits for six months, in order to emphasize nutrition messages and to negotiate for behavior change.

3. There were challenges related to weather conditions. e.g. floods occurred in Tindiga villages during follow-up period. Households were displaced; however the study was able trace the displaced households and continued with follow-up visits

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APPENDICES

Appendix 1: Questionnaire for baseline survey

Scaling-up nutrition: Implementing potentials of nutrition-sensitive and diversified agriculture to increase food security

Note to enumerator: The questions in this survey are designed for the mothers/caregivers. If the mother/caregiver is not available in the household, an appointment should be made for next visit.

(Please fill in the consent form, tick if agreed and let the interviewee sign/put thumb print on the consent form) □

Section I: Basic and Demographic Information

Basic information				**BI**
BI01 Date of survey: _____/_____/_____ – *(DD/MM/YYYY)*	BI02a Name of interviewee _____ BI02b Status of interviewee (select appropriate) Mother Caregiver	BI03a Interviewee position in the household_____ 1.Household head 2.Wife of HH head 3.Relative 4.Other (specify)___ BI03b Sex of the interviewee _____	BI04 Name of the enumerator _____	BI05 Village name _____
BI06 Village code 1= Mzula 2. Chinoje 3= Tindiga 4= Mhenda *Enter/select appropriate code*	BI07 Hamlet name _____	BI08 Household ID code _____	BI09 Start time _____	BI 10 End time _____

Demographic information DI		
DM01	Household Head Name (Decision maker)	
DM02	Household head sex (select one)	1=Male 2=Female

DM03	Household Head Age (in complete years)	Enter age in years _____
DM04	Household mother's/caregiver's Age	Enter age in years _____
DM05	Marital Status of the mother/caregiver (select one that apply)	1=Married monogamous 2=Married Polygamous 3= widowed 4=Divorced 5=Single 6=Co-habited
DM06	Which of the following statements best describes your level of literacy? (Show the written text to the interviewee to read and select the appropriate literacy status)	1=Not able to read or write 2=Can read and write to some extent 3=I can read and write
DM07	What is your education level?	Select the option 0=No formal education 1=Adult education 2=Some primary school 3=Primary education 4=Secondary school 5=College/Diploma/certific ate 6=University
DM07b	Based on the mentioned level of education in question DM7a above, were you able to complete the specified level of education?	1= Yes 2= No
DM07c	What was the number of years spent in school?	Enter number of years spent in school) ……..
DM08	What is your source of livelihood? (Multiple response allowed)	1=Farmer 2=Employed in formal sector 3= Employed in informal sector (casual labour) 4=Business 5=Self employed 5=House wife / mother 88=Other (specify).....
DM08b	What is the total average income earned by the household per month (Probe to estimate amount earned in TZS)	Specify in terms of TZS
DM08c	Who earn the specified amount of income	1=Male/husband 2=Yourself 3=Both 4=Other specify……
DM09	How many people live in this Household? (Including visitors stayed over 3 months)	Enter number
DM10	What is the total number of children in this household?	Enter number
DM11	What is the number of children in the following age categories? 1. 0-2 Years 2. 2-5 Years 3. 5-15 Years (school children) 4. 15-18 Years	Enter number ☐ ☐ ☐ ☐

DM12	What is the name of the school child (pick the youngest school child: 6-10 years)?	Write name……
DM13	Sex of the child (school child) (select appropriate)	1= Male 2=Female
DM14	How old is she/he (school child)?	Enter date of birth……
DM15	How many children did you deliver? (Number of born children)	Enter number
DM16	Are you pregnant? *If the answer is no go to section 2 question WS01*	1= Yes 2= No
DM17	***If yes***, How many months old?	Enter number of months
DM18	If yes, which trimester? First: conception to week 13, Second: week 14 to week 27 Third: week 28 to week 40	Enter number

Section II: Nutrition knowledge and practices

	A. General Nutrition knowledge attitudes, perceptions and practices GN			
GN 01	Have you received any education and/or training about nutrition before? *If 'no' go to question GN 04*		1= Yes 2= No	
GN 02	If yes where and when, how many times and by whom was the education offered		Please specify: Where…….…… When …….. Who…… How many times……..	
GN 03	What major topics were covered? (Probe for more response)		Please specify topics:	
GN 03b	From the above topics taught, what were the things/issues that you were able to put into practices, and what were the main motives		Main issues	Motives/Enablers
GN 03c	From the above topics taught, what were the things/issues that you were not able to put into practices, and what were the main challenges		Main issues	Challenges/Constraints

GN 05	What is the typical serving size of fruits in adults' members of your household? *(One serving could be, for example, an orange or a handful of chopped carrots)*		1=One 2= Two 3=Three 4= Four 5= Five 99= Do not know	
GN 06	What is the typical serving size of vegetables in adults' members of your household? *(One serving could be, for example, an orange or a handful of chopped carrots)*		1=One 2= Two 3=Three 4= Four 5= Five 99= Do not know	
GN 07	What is the typical serving size of fruits for your children? in the household? *Reference children are school children* (*One serving could be, for example, an orange or a handful of chopped carrots)*		1=One 2= Two 3=Three 4= Four 5= Five 99= Do not know	
GN 08	What is the typical serving size of vegetable for your children? in the household? *Reference children are school children* (*One serving could be, for example, an orange or a handful of chopped carrots)*		1=One 2= Two 3=Three 4= Four 5= Five 99= Do not know	
GN 9	What is balanced diet?		1= a diet rich in protein 2= a diet poor in fat 3= a diet without carbohydrates 4= a diet containing all required nutrients in proper quantities 5= Eat many different kinds of foods 99= Do not know	
GN 10	Do you know kinds of foods that must be eaten to increase dietary intake of fibre? *If yes, please give an example. If no go to question GN 13*		1=Yes 2= No	
GN 11 a	If yes (with correct examples)			

GN 11 b	If yes (with no or wrong examples)			
GN 12	Do you know any kinds of food groups? *If 'no' go to question GN 16*		1= Yes 2= No	
GN 13	***If yes***, can you name them? *Do not read the responses, let the respondent mention* *(Multiple responses allowed)*		1= Cereals, 2= roots, tubers, plantain, 3=plant protein 4=Animal protein 5=oils and fat, 6=vegetables, 7=fruits 8= beverages (alcoholic and non-alcoholic) 9=Does not know the correct groups 88= Other (mention).....	
GN 14	List three foods included in each food group *(Probe if necessary)*		1= 2= 4= 5= 6= 7= 8= 9= 88= Other (mention)..... 99= Do not know	
GN 15	Green leafy vegetables and orange coloured fruits or vegetables are healthy foods. Do you know the reason for it?		1= they are rich in protein 2= they are rich in vitamin A 3= they are rich in iron 4= they are rich in many nutrients 88= other (mention) …… 99= do not know	
GN 16	What is the most important consideration for you when you choose what to eat?		1=Taste 2=Quantity 3=Availability 4=Price 5=Culture 6=Social	

GN 17	How can you recognize that a child is not having enough food? *Do not read the responses, Probe if necessary:* *What are the signs of undernutrition? (Multiple responses allowed)*		1= Lack of energy 2= Becomes ill easily or becomes seriously ill 3=Loss of weight/thinness 4= growth faltering) 5= Less physically active 88= Other…….. 99= Don't know	
GN 18	To whom do you seek advice and opinion about whether your baby is growing well or not? *Do not read the responses, Probe if necessary:* *Who can help the mother to find out if the baby is growing well? Where can she go?*		1=Health centres (talk to health professionals) 2=Relatives (grandmothers, in-laws) 3=Peers/friends 88=Others, specify …….. 99=Do not know	
	C: Iron deficiency and anaemia ID			
ID 01	Have you ever heard about anaemia? *If 'no' go to sub-section D question FC 01*		1= Yes 2= No	
ID 02	If Yes: Can you tell me how you can recognize someone who has anaemia? (Multiple responses allowed)		1= Less energy/weakness 2= Paleness/pallor 3= Spoon nails/bent nails 4= More likely to become sick (less Immunity to infections) 88= Other 99= Don't know	
ID 03	In your opinion, what do you think causes anaemia? (Multiple responses allowed)		1=Lack of iron in diet 2=Inability to absorb iron 3=Blood loss 88=Other (specify) …… 99=Don't know	
ID 04	Can you list examples of foods rich in iron?		1= Organ meat 2=Flesh meat 3= Dark green leafy vegetables 4= Beans 5=Insects (eg. grasshoppers) 6= Fish and sea foods 88= Other 99= Don't know	

ID 05	Do you know any foods that when taken during meals, help the body absorb and use iron? *If 'no' go to question ID 07*		1= Yes 2= No	
ID 06	If yes, what are those foods?		1= Vitamin-C-rich foods, such as fresh citrus fruits (orange, lemons, etc.), tomatoes, leafy vegetables 88= Other (specify) …… 99= Don't know	
ID 07	Do you know any foods that when taken during meals, decrease iron absorption? *If 'no' go to question ID 10*		1= Yes 2= No	
ID 08	If yes, what are those foods?		1= Coffee 2= Tea 88= Other (specify) …… 99= Don't know	
ID 09	In the last 6 months have you or (Name of the school child) ever used iron tablets/syrup?		**Mother/Caregiver** 1= Yes 2= No	**Child** 1= Yes 2= No
ID 10	Have you or your child received any deworming medication within 90 days? (Reference child is school child)		1= Yes 2= No	1= Yes 2= No
ID 11	**If yes,** what was the last time you and your child used deworming medication		Enter date, month and year or (month and year, year or Do not remember)	
	D: Food Production, distribution and Consumption in the household			**FC**
FC 01a	What is the total size of land available for agriculture production to your household (in acre). ***Probe this include rented land*** *If do not have skip to question FC 01d*		Record total size of land available for agriculture production in acre	……..
FC 01b	Who own the land, and how is it apportioned?		Specify land ownership and portion size of land owned in acreage 1=household head 2=Your self 3=Relative 4=Rented 5=Other, specify……	1= 2= 3= 4= 5=

FC 01c	Has the size of land available for your household changed in the last 2 years?		1=Remained the same 2=Increased (give reason) 3=Decreased (give reason)	Specify option
FC 01d	What food crops grow best in your area? (Multiple response)		1=Cereals 2=Roots 3=Tubers 4=Plantains 5=Fruits and Vegetables 6=Legumes 7=Nuts 88=Other (specify) ……	
FC 02	Who decide what to produce in the household?		1=Head of Household 2= Husband 3= Wife 4=Child/children 5=all members 88=Other (specify) ……	
FC 03	What types of crops your household produces in the previous agricultural season (past 12 months)		Specify type crop produced and acreage	
FC 03b	Do you apply intercropping farming system? From the crops mentioned in Qn FC 03 (*If no skip to Qn. FC 04)*		1= Yes 2= No	1= Yes 2= No
FC 03C	If yes, specify the intercropped crops and acreage size for each crop		**Acreage**	**Intercropping status**
FC 04	What do you do with the produced crops?		1=Mainly for consumption 2=Mainly selling 3=About equally consumption and selling 88=Other uses (specify)	
FC 05	Generally how many food groups are included in your typical diet during lean season?		1=2 2=3 3=4 4=5 5=More than 5 groups 6= Do not know	

FC 06	Generally how many food groups are included in your typical diet during grace/harvesting season?		1=2 2=3 3=4 4=5 5=More than 5 groups 6= Do not know	
FC 07	What factors usually influence your consumption of different foods in a meal? *(Circle appropriate answer, multiple responses allowed)*		1=Availability 2=Affordability/price 3=Knowledge 4=Accessibility 5=Preparation time 6=Taste 7=Preference 88=Other (specify)	
FC 08	Who decide what to be cooked in the household?		1=Head of the household 2=Wife 3=Husband 4=Both wife and Husband 5=In-laws 6=Children 7=All members	
FC 09	Do household keep any type of livestock?		1=Yes 2=No	
FC 10	If yes what types of livestock do you keep? *(Circle appropriate answer, multiple responses allowed)*		1= Sheep 2=Goat 3=Cattle 4=Small ruminants (e.g rabbit) 4= chicken 5=Duck 6=Pigeon 88=Other specify	
FC 11	Who own the livestock in your household? *If it is multiple responses, specify the type of livestock and indicate who own e.g. husband, wife, children*		1=Head of the household 2= Wife 3=Husband 4=Both wife and husband 5=In laws 6=Child/children 7= All members 88=Other specify……..	
FC 12	Who decided which livestock to keep?		1=Head of Household 2=Wife 3=Husband 4=Both wife and Husband 5=In-laws 6=Children 7=All members 88=Other (specify) ……	

FC 13	What is the main reason for keeping the the livestocks?		1=Mainly for consumption 2=Mainly selling 3=About equally consumption and selling 4=Mechanization and animal traction 88=Other uses (specify)	
FC 14	How much money by the household in purchasing foods (in TZS)		State the amount in TZS	

FC 14	Could you describe in terms of priority how food is distributed in your households based on different groups of people e.g. children, adults, head of household, caregivers		Husband	Mother	Children	Other Adults	Equal distribution for all HH members
		Meat					
		Milk					
		Eggs					
		Fruits					
		Vegetables					
		Legumes					

FC 15	Give reasons as to why food is distributed that way (specify reasons based on different members of households					
	E: Consumption of Iodised salt CI					
CS 01	Is the salt used in your household iodized?		1=Yes 2=No 3= Do not know			
CS 02	May I see the salt used to cook the main meal eaten by members of your household last night *Use Iodine testing kit to test salt* *Protocol for iodine test*		1=Iodized (If test is positive for iodine) 2=Not iodized 1=No salt in home			Record Outcome

CS 03	Type of salt used by the household *Use the salt in CS 01 above, observe and touch the salt to see and feel the texture*		1=Granular (loose, Crystal) 2=Fine granules sold in 50kg bags 3=Fine granules (packed in 100 - 500gm plastic bags) Other (specify)	Record type of salt
CS 04	What are the reasons for using this kind of salt?		1=Affordability 2=Availability 3=Good for health 4=No reason 88= Other (specify) ……..	

Section III: Measurements of consumption patterns

A: 24-hour dietary recall- mother/woman caregiver responsible for food preparation

Note to Enumerator*: *Explanation to interviewee: *Please describe everything that you ate and drank yesterday during the day or night, whether at home or outside the home. Record the amount on the 24-hour recall sheet using household equipment. Be sure to probe until the respondent says nothing else. If the respondent mentions mixed dishes like porridge, sauce or stew, probe what ingredients were in that mixed dish.* **DDS**						
Was the reference day :1= normal day(usual intake) 2= special day (festival, funeral)						
Meal time	Type of Meal	Description /ingredients of food eaten	Amount served (household measure)	Amount consumed (household measure)	Net grams served	Net gram consumed
B/F						
Snacks						
Lunch						
Snacks						
Dinner						
Snacks						

B: Food Frequency Questionnaire

Ask for frequency of consumption of different foods available in the community. Take note of where does food come from (major source) and seasonal variations (Note: ask for usual consumption in the household) **FF 01**							
Food item	Frequency of consumption					Major source	Availability (Seasonal variation)
	Per day	Per week	Per Month	Rare	Never	e.g. 1.Own production 2=Purchase 3=Own production and purchase 4=Gifts 5=Others specify…etc.	1=Rainy season 2=Dry season 3=Both rainy and dry season

Cereals								
Maize								
Sorghum								
Finger millet								
Bulrush millet								
Wheat								
Rice								
Roots, tubers, plantain								
Cassava								
Sweet potatoes								
Round potatoes								
Yams								
Green banana								
Legumes								
Beans								
Peas (Njegere)								
Cowpeas (kunde)								
Pigeon peas (Mbaazi)								
Green grams (Choroko)								
Chickpeas (Dengu)								
Soybeans (soya)								
Bambara nuts (Njugumawe)								
Lablab bean (fiwi)								
Nuts and seeds								
Groundnuts								
Coconut								
Cashew nut								
Other seeds								
Meat poultry fish and egg								
Cow-beef								
Liver								
Other organ meats								
Goat								
Sheep-lamb								

Ask for frequency of consumption of different foods available in the community. Take note of where does food come from (major source) and seasonal variations

FF 01

Food item	Frequency of consumption	Major source	Availability (Seasonal variation

	Per day	Per week	Per Month	Rare	Never	e.g. 1.Own production 2=Purchase 3=Own production and purchase 4=Gifts 5=Others specify…… etc	1=Rainy season 2=Dry season 3=Both rainy and dry season	
Poultry-chicken/duck								
Eggs								
Fresh-water fish								
Sea fish								
Dried fish								
Sardines								
Sea foods								
Milk and milk products								
Cow's milk (whole)								
Goat's milk (whole)								
Processed & packed milk								
Yoghurt								
Butter/lard								
Ghee								
Cheese								
Oil and Fat								
Sunflower oil								
Red palm oil								
Korie oil								
Ground nut oil								
Other oil or fat (mention)								
Vegetables								
Cabbage								
Amaranth leaves								
Sweet potato leaves								
Cassava leaves								
Pumpkin leaves								
Carrots								
Pumpkin fruit								
Tomatoes								
Spinach								
Chinese cabbage								
African eggplant								
Eggplant								
Cowpea leaves								
Ilende								
Sagula sagula								
Chiwandagulu								

Any other vegetables Specify								
Ask for frequency of consumption of different foods available in the community. Take note of where does food come from (major source) and seasonal variations **FF 01**								
Food item	Frequency of consumption					Major source	Availability (Seasonal variation)	
	Per day	Per week	Per Month	Rare	Never	e.g. 1.Own production 2=Purchase 3=Own production and purchase 4=Gifts 5=Others specify…… etc	1=Rainy season 2=Dry season 3=Both rainy and dry season	
Fruits								
Citrus e.g oranges								
Mangoes								
Passion fruit								
Water melon								
Bananas								
Pineapple								
Papaya								
Avocado								
baobab								
Ukwaju								
Other indigenous fruits								
Any other fruit Specify								
Beverages								
Coffee								
Tea								
Juice								
Milk								
Local brew								
Beer								
Soda								
Other beverages (mention)								

C: Household Dietary Diversity Score (24-hour dietary)

From the list of foods consumed in the 24-hour dietary recall above, score 1 if any of the food items within a food group was consumed and 0 if the food item was not consumed in the past 24 hours.

DD 01

DD01	*Score 1 if any of the food item within a food group was consumed and 0 if the food item was not consumed in the past 24 hour and its frequency of consumption*	*1=Consumed* *0=Not consumed*
	a) Any *(*Bread, rice, or other foods made from grains, oats, maize, barley, wheat, sorghum, millet or other grains? *(Other locally available grain)*?	a.
	b) Any potatoes, yams, cassava or any other foods made from roots or tubers?	b.
	c) Any vegetables?	c.
	d) Any fruits?	d.
	e) Any beef, pork, lamb goat, rabbit, wild game, chicken, duck or other birds, liver, kidney, hear or other organ meats?	e.
	f) Any eggs?	f.
	g) Any fresh or dried fish or shellfish?	g.
	h) Any food made from beans, peas, lentils or nuts?	h.
	i) Any cheese, yogurt, milk or other milk product?	i.
	j) Any foods made with oil, fat or butter?	j.
	k) Any sugar or honey?	k.
	l) Any other foods such as condiments, coffee or tea?	l.

D: Household Dietary Diversity Score (food frequency)

From the list of foods consumed in the food frequency recall above, score 1 if any of the food items within a food group was consumed in daily for a 7-day period and 0 if the food item was not consumed in the previous 7 days **DD 01**		
DD01	*Score 1 if any of the food item within a food group was consumed and 0 if the food item was not consumed in the past 24 hour and its frequency of consumption*	*1=Consumed* *0=Not consumed*
	a) Any Starchy staple foods *(grains, roots, tubers or other locally available grain)*?	a.
	b) An Any food made from beans, peas, lentils	b
	c) Nuts and seeds	c
	d) Dark green leafy vegetables	d.
	e) Other vitamin A rich fruits and vegetables	e.
	f) Other vegetables	f.
	g) Other fruits	g.
	h) Any Meat, Poultry and Fish	h.
	i) Any cheese, yogurt, milk or other milk product?	i.
	j) Any eggs	j.

Appendix 2: Description of the study to research participants

My name is Nyamizi Bundala from Sokoine University of Agriculture (SUA) currently I am a student at Sokoine University of Agriculture (SUA), I am going to give you information and inviting you and your household to participate in this study. You are welcome to ask questions whenever you feel that you need clarifications.

About this study

The study is trying to examine factors affecting household dietary diversity. The researchers hope to establish the current dietary practices and influences of different factors in the context of farm production. In this research we will ask you questions related to basic nutrition knowledge, key dietary practices, food consumption pattern, and food production practices. The interview is voluntary, your participation in this study will take about 50 minutes to 1 hour.

Study population

This study will involve 666 households in Kilosa and Chamwino districts.

Benefits of participating in the study

There will be no direct benefits to you. The study will contribute to understanding on how essential fatty acids have a role in growth and the high rates of malnutrition specifically stunting in our country. This information will therefore be used to emphasize on importance of these nutrients at an early age.

Privacy and confidentiality

Information that you give will be treated as confidential and no names will be included in the reports. During data collection, your information will be linked to your name, however once the data is collected it will be coded and the information will be kept without identity of names

Who to contact?

If you have concerns or questions about this study, please contact the researcher (Nyamizi Bundala) through a phone number 0767694854 or the research supervisors (Prof. Joyce Kinabo) through mobile number 0754439324 and (Dr. Theresia Jumbe) through mobile number 0754804010. Alternatively, you can contact us through the following address; Sokoine University of Agriculture, Department of Food Technology, Nutrition and Consumer Sciences. PO. Box 3006, Morogoro

Costs and compensation

You will bear no cost by choosing to participate in this study. However, a small token will be given to you as an appreciation and compensation for your time and voluntary participation.

Appendix 3: Consent form

I (Caregiver/mother's name) ……..…have been invited to participate in this research

1. I declare that I have read/ have heard and understood the research objectives
2. Have asked all questions related to the research and I am satisfied with the answers
3. I understand that any information about my household and family members will be treated and kept with required confidentiality
4. I understand that I am participating in this research voluntarily and that I can decide to answer or not answer some of the research questions, and that at any given time I can decide not to continue participating in this research
5. I am ready to continue participating in further research and that if I am required to do so I will receive enough information, and any of my questions will be answered before I choose to participate

The signature below means that I voluntarily agree to participate in this research study.

_____ _____

Signature and/or thumbprint mother/caregiver Date

Appendix 4: Summary of the content of nutrition education training manual

Sessions	Topics	Sub-topics	Tools and materials used
Session 1	Introductory session	Aim and objective of the training Importance of good nutrition to the individuals, households and community	Pictorial demonstrations of healthy vs unhealthy individuals
Session 2	Malnutrition	Malnutrition and its different forms	Posters and picture cards of malnutrition-related signs
		The magnitude of malnutrition in the study villages	Graphical presentations of the magnitude of malnutrition
		Effects of malnutrition to the individuals	Picture cards of malnutrition-related signs
		Preventive measures of malnutrition	Graphical presentations of different measures
Session 3	Food preparations and cooking	Ways of preserving nutrients during food preparations	Picture cards of different methods of food preparation. Demonstrations of how to prepare foods
		Ways of preserving nutrients during cooking	Picture cards of poor vs good cooking practices
Session 4	Food consumption	Food groups	Poster of different pictures of food groups
		Functions of each food group	Poster of different pictures of food groups
		How much to eat	Posters and picture cards of portion sizes for each food group
		Intra-household food allocation	Poster of food allocation based on individual nutritional requirements
Session 5	Household food production	Ways of producing foods at the homestead level	Poster of different food production methods at households
		Importance of homestead food production for household consumption	Poster of how to use homestead produced foods

Appendix 5: List of community facilitators for each study village

Chinoje village

S/n	Name	Title	Age	Sex	Contact
1	Lucy Mgalonje	Standard seven	42	F	0789680362
2	Mayola Sutuchi	Standard seven	32	M	0717589991
3	Bertha Machinye	Secondary (O-level)	24	F	0789680362
4	Christopher Maloda	Secondary (O-level)	27	M	0682987177
5	Wilson Ndojeti	Standard seven	42	M	0710256474
6	Grace Baraka	Standard seven (CHW)	48	F	0686296473
7	Egla Goima	Standard seven	44	F	0687787998

Mzula village

S/n	Name	Education level	Age	Sex	Contact
1	Victoria Lungwa	Standard seven	32	F	0717648932
2	Molen Mbalyo	Standard seven	35	F	0718666135
3	Juma Maloda	Standard seven	30	M	0716732412
4	Agness Mtyani	Standard seven	35	F	0719538348
5	Donald Mwita	Standard seven	34	M	0713634812
6	Zakaria Ndalu	Standard seven	40	M	0654625498

Mhenda/Kitunduweta-village

S/n	Name	Education level	Age	Sex	Contact
1	Emilian Pascal	Standard seven	45	M	0714867281
2	Mustafa	Standard seven	52	M	0717266227

	Ngakatile				
3	Hawa Katukunda	Standard seven	24	F	0677217695
4	Fransiska Isaya	Standard seven PHCW	40	F	0714501314
5	Ally Taruke	Secondary (O-L) CHW	27	M	0675026354
6	Aidan Erasto	Standard seven	23	M	0714084962
7	Suzana Thobias	Standard seven	35	F	Dropped
8	Maulid Mustafa	Standard seven	76	M	Dropped

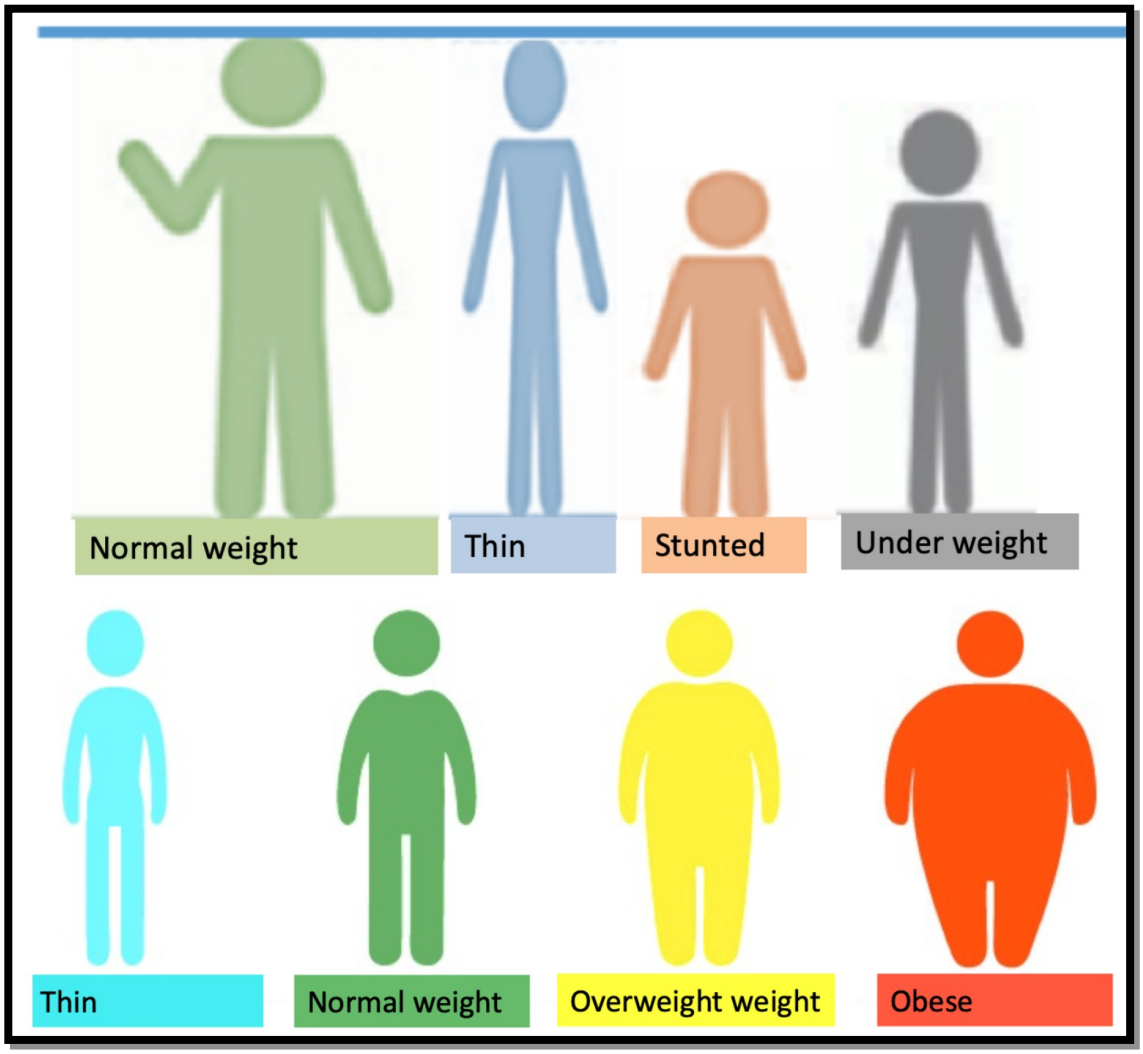
Tindiga village

S/n	**Name**	**Education level**	**Age**	**Sex**	**Contact**
1	Anthonia Michael	Standard seven	26	F	0716546259
2	Ally Matimbwa	Standard seven		M	0719313181
3	Juma Kolomwanda	Standard seven		M	0715119261
4	Malisela Michael	Secondary (O-level)	24	F	0714520398
5	Ashura Kitwanga	Secondary (O-level)		F	0684837349
6	Saidi Msahalah	Secondary (O-level)		M	0716696780

Appendix 6: Nutrition education training posters

Malnutrition signs

Different types of malnutrition conditions in children for and adults



Sub-optimal food preparation practices

Sub-optimal food preparation practices

Excessive cutting of green leafy vegetables

Exposing vegetables under the sunlight prior to cooking

Washing by soaking green leafy vegetables after cutting

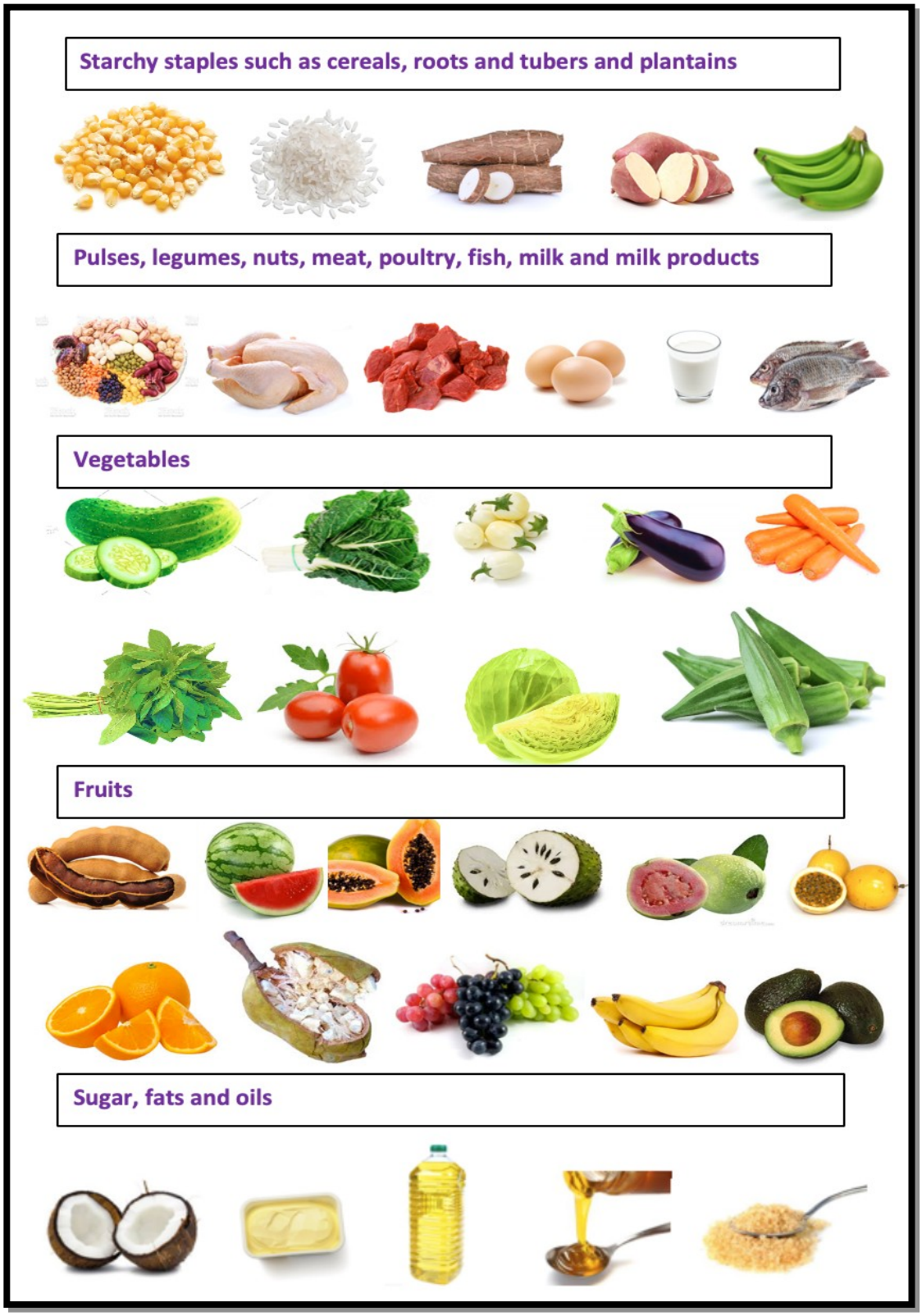
The use of high amount of oil in cooking Vs use of low amount of oil

Uses of high Vs low amount of oil in cooking meat

Uses of high Vs low amount of oil in cooking vegetables

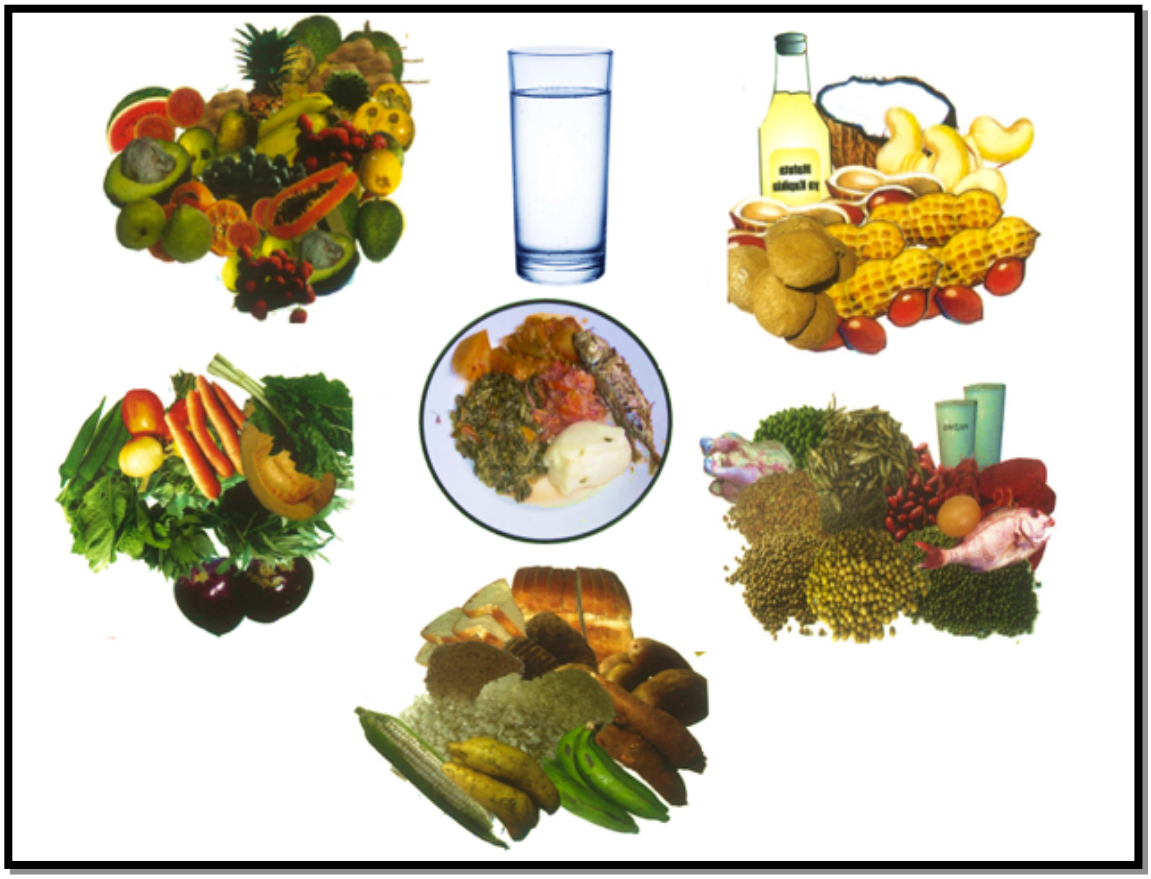
Uses of high Vs low amount of oil in cooking bites

Food groups



Estimation of portion sizes for individual foods

Example of a diversified meal



Different types of vegetable gardens

Importance of home-stead food production

a. Nutrition tips based on specific gaps identified in the study population (Translated in Swahili)

Ujumbe kuhusu ufahamu wa afya, lishe na ulaji bora

1. Lishe duni hudhohofisha mfumo wa kinga ya mwili dhidi ya magonjwa mbalimbali, hivyo hupelekea magonjwa ya mara kwa mara.
2. Hali ya ukondefu, udumavu na uzito mdogo hutokana na lishe duni isiyokidhi mahitaji ya mwili.
3. Magonjwa kama kisukari, shinikizo la damu na baadhi ya saratani hutokana na ulaji uliopitiliza mahitaji ya mwili na mfumo wa maisha ambao hauzingatii kanuni za afya (unywaji pombe kupita kiasi, kuvuta sigara, kula vyakula vya mafuta mengi, n.k.

4. Mlo bora ni mlo wenye kuzingatia uwiano wa mchanganyiko wa makundi mbali mbali ya vyakula

5. Makundi ya vyakula yanajumuisha vyakula vikiwemo; (i) nafaka/mizizi/viazi/ndizi (ii) vyakula ya jamii ya kunde na vyenye asili ya Wanyama (iii) Mboga za majani na Mboga-mboga; (iv) Matunda (v) mafuta na sukari.

6. Vyakula vyenye asili ya wanga ni kama mahindi, uwele, mchele, mihogo n.k, vyakula vya protini ni kama mikunde kunde, nyama, samaki, mayai, n.k na vyakula vyenye asili ya madini na vitamini ni kama mboga mboga na Matunda

7. Ni vizuri kula nafaka ambazo hazijakobolewa, ili kupata viinilishe vilivyomo katika ganda la nje la nafaka na kurahisisha msukumo wa chakula tumboni, hivyo ni muhimu katika kuzuia tatizo la kutopata choo

8. Chagua asusa zenye ubora, zingatia kula asusa bora kiafya mfano kipande cha tunda, karanga, maziwa, juisi halisi ya matunda. Punguza unywaji wa soda, pombe chipsi, chokoleti, biskuti n.k.

9. Watu waishio mbali na bahari wapo katika hatari ya kupata upungufu wa madini joto? Hivyo ni muhimu kutumia chumvi yenye madini joto

Ujumbe kuhusu mtazamo juu ya afya, lishe na ulaji bora katika jamii

1. Mboga za majani na mbogamboga nyingine ni muhimu kwa kila mtu na ulaji wa mbogamboga hauhusiani na umasikini au hali ya kipato katika kaya

2. Matunda si chakula cha hiari, ni muhimu yakachukuliwa kama sehemu muhimu ya mlo wa kila siku kwa watoto na watu wazima pia.
3. Ni vyema kutambua kuwa lishe si vyakula vya watoto, bali ni mchakato unaojumuisha hatua mbalimbali za jinsi mwili unavyokitumia chakula kilicholiwa ili kuleta matokeo ya kiafya mwilini.
4. Watoto walio katika umri wa kukua wanahitaji protini na virutubisho vingine ili kuchochea ukuaji, hivyo ni vyema wapewe kipaumbele katika ulaji wa vyakula venye asili ya protini kama vile maziwa, mayai,samaki, maharage, n.k.
5. Udumavu si hali ya kuwa mfupi tuu, bali ni matokeo ya muda mrefu wa lishe duni, ambayo huanza tangu mtoto akiwa tumboni

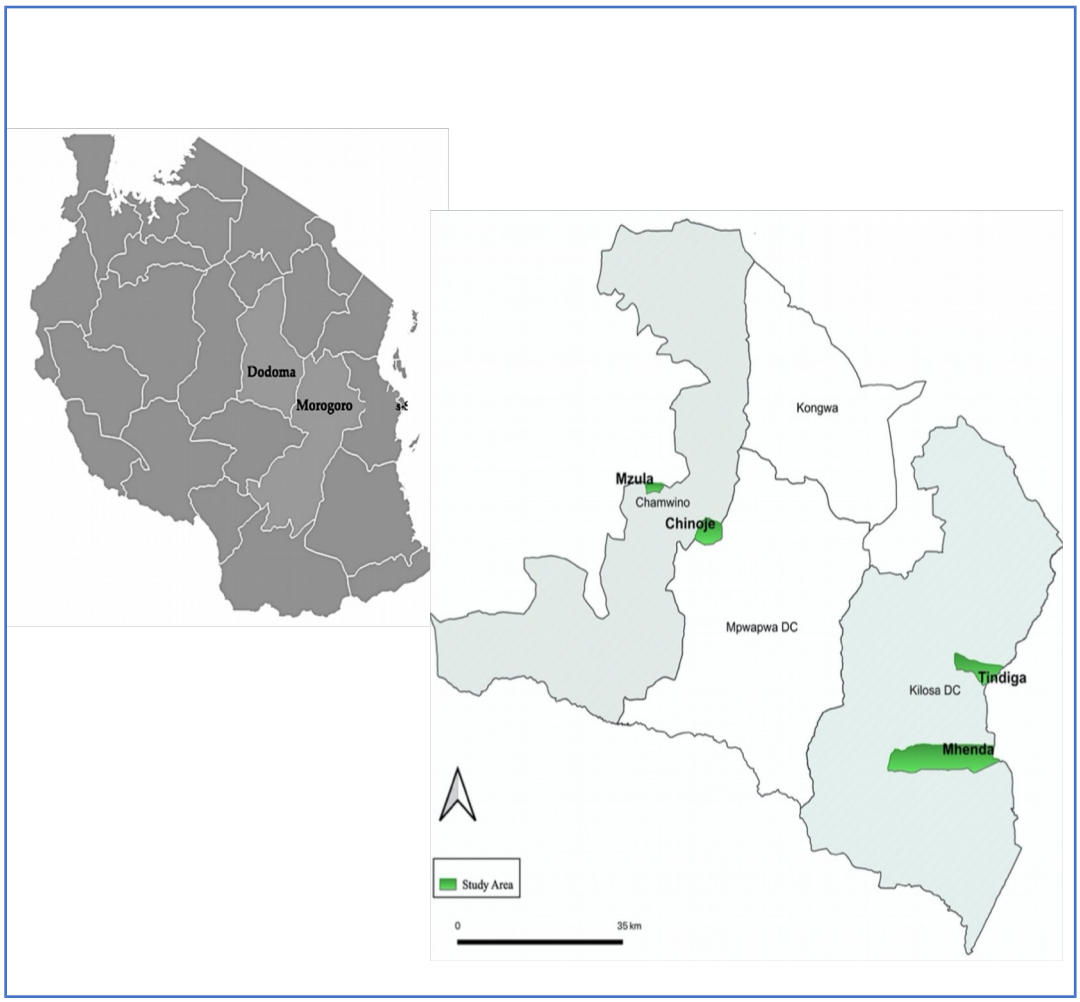
6. Uharibifu unaotokana na udumavu haurekibishiki, baada ya miaka miwili ya kuzaliwa kwa mtoto, hiyo ni muhimu sana kuzuia utapiamlo kwa mama mjamzito na kwa watoto wadogo walio chini ya miaka miwili
7. Uzito/unene uliozidi si mzuri kiafya, hupelekea kupata magonjwa kama kisukari, shinikizo la damu, maumivu ya miguu na baadhi ya saratani

8. Ulaji wa vyakula bora hauhitaji gharama kubwa, kula vyakula vinavyopatikana katika eneo lako na vilivyo katika msimu

Ujumbe kuhusu mazoea juu lishe na ulaji bora katika jamii

1. Mgawanyo wa chakula katika kaya uzingatie makundi yaliyo katika hatari ya kupata utapiamlo kama vile watoto wadogo, wajawazito na kinamama wanaonyonyesha na wagonjwa
2. Kumbuka ni vizuri watoto wakatengewa chakula katika sahani zao, kama ikibidi kula pamoja na watu wengine katika kaya, wasimamiwe ili kuhakikisha wanakula kiwango kinachikidhi mahitaji yao ya kimwili
3. Kumbuka kila unapokula mlo mkuu, kiasi cha nafaka au wanga katika sahani yako kiwe na ujazo sawa na mbogamboga

Appendix 7: A map of study regions, districts and villages


Dodoma
Morogoro
Kongwa
Mzula
Chamwino
Chinoje
Mpwapwa DC
Tindiga
Kilosa DC
Mhenda
Study Area
0
35 km