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Title	Smallholder agriculture and food and nutrition security: a study from south-eastern Tigray, Ethiopia
Authors	Kahsay, Zenebe Abraha
Publication date	2017
Original Citation	Kahsay, Z. A. 2017. Smallholder agriculture and food and nutrition security: a study from south-eastern Tigray, Ethiopia. PhD Thesis, University College Cork.
Type of publication	Doctoral thesis
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Download date	2026-10-09 09:24:42
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Smallholder Agriculture and Household Food and Nutrition Security: A Study from South-eastern Tigray, Ethiopia

A Thesis Submitted to Department of Food Business and Development

National University of Ireland, Cork

In fulfilment of the requirements for the degree of doctor of philosophy

By

Zenebe Abraha Kahsay

July 07, 2017

Head of Department:

Professor Thia Hennessy

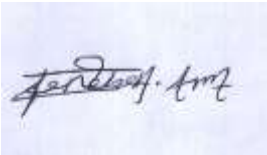
Supervisors: Dr Nick Chisholm

Dr Edward Lahiff

DECLARATION

This is to certify that the work I am submitting is my own and has not been submitted for another degree, either at University College Cork or elsewhere. All external references and sources are clearly acknowledged and identified within the contents. I have read and understood the regulations of University College Cork concerning plagiarism.

Signed,



Zenebe Abraha Kahsay

July 07, 2017

THIS WORK IS DEDICATED TO MY LATE MOTHER TEBERIH TESFAY,

MY BELOVED WIFE

ABEBA ADHANA WOLDU

And

KIDANEMARIAM ABREHA KIDANU,

WHO CAMEOUT SO STRONG IN LIFE

Acknowledgments

First I shall begin with thanking the almighty GOD for bestowing me the strength, courage and determination to finish my work at the time period where I had been faced with a number of problems. Without the full blessing and help from god, this work would not have been finished.

I am deeply indebted to my advisers Dr Nick Chisholm and Dr Edward Lahiff, for their unreserved and excellent scientific guidance, dedication, detailed comments and owning the work as theirs. I am greatly moved by the all-round support I have gotten from you. Your doors for support have been ever present to me during the course of my Thesis work. It is because of you that this work has become into fruition. And, I thank you all from the bottom my heart. In addition to his advising Dr Nick Chisholm was responsible for leading the AgriDiet Project, which fully sponsored my study and I thank him for his excellent overall coordination. Dr Nick was a unique inspiration to me and he consistently made me learn from his guidance and he was a real encouragement to me even during my lows. Dr Nick! Thank you very much.

My sincere regards is due to the people of Ireland, Irish Aid, AgriDiet Project and the National University of Ireland-Cork for providing me this excellent chance of pursuing my PhD, for granting me all the necessary fund to finance my study and providing me all the necessary facilities (office, library) and excellent studying environment. I also thank both the academic and administrative staff of the Department of Food Business and Development of the University College Cork (UCC) for the necessary support during my entire stay at the University. My sincere regards also goes to Dr Stephen Thornhill, Coordinator of the AgriDiet Project, for his excellent coordination and full support in my quest to fulfil my dreams. My heartfelt thanks must also go to Dr Girmay Tesfay, coordinator of the AgriDiet Project at Mekelle University and a good friend and mentor, for his overall support.

I am highly indebted to Dr Edward Lahiff who was a constant enthusiasm throughout my study and who, together with his family, invited me to his house a number of times for dinner and took me to the beautiful rural scenery of county Cork. I owe the family a lot for their kindness and utter hospitality. My many thanks also go to Mike Fitzgibbon, his wife Jackie and daughter Aoife for inviting me to their house for dinner many times and who reached me when I was in trouble in getting accommodation. Also, I must take this opportunity to thank

Dr Kathy Glavanis who invited a group of PhD students, including me, to her house for dinner. She made us feel at home and I thank her for that. Dr Kathy was an inspiration to me who consistently raised relevant research questions and suggesting ways of analysing the questions; she was also extremely helpful while I had been struggling with my back pain, and I thank her for sending me a back pain reliever from Ireland. I used it during the two-round survey data collection sessions.

I duly appreciate the company of my PhD fellow friends Chanyalew Seyoum and Kedir Teji for their heartfelt encouragement and support during our stay at University College Cork (UCC), Ireland. I especially admire and thank Chanyalew Seyoum who has been of a great help to me in many aspects. We were like one family and I thank him very much for that. I also thank the then-senior fellow students Tsega G. Kirstos, Kinfe G. Eqziabher, Anteneh Belachew, Admasu Bogale, Bezalem Sinote, Desalegn Ketema and Zemen Ayalew for their support. My sincere thanks go also to Dr Jemal Yousuf, PhD student Lana Repar, Elias, Meron and John as well as their daughter Maya; Lulit and Merid; Aida and her husband Andy; Mahlet and Gemechu; Daniel and family members; Dr Mesfin and Cork church for letting us use church premises for prayers. I have learnt so many things from all of you and thank you for that.

I am very much grateful to Mekelle University and the College of Dryland Agriculture and Natural Resources, my home institute, to grant me a study leave and full encouragement to successfully finish my study. I duly appreciate the all-round full support I got from the Department of Natural Resources Economics and Management, my home base department, and the whole staff, in which it is a long list to mention here. All the Department staff members have been by my side in both bad and good times. I shall not forget their consistent encouragement and support during my long-term illness (back pain) and during my study. I appreciate the support I got from all my department staff past and present; CoDANR staff (Dr Atinkut Mezgebu, the then college dean and Yirga, Muez Gebru, Ayalew Kalayu, Tadesse Asmelash, Hailay, Zemeda, Kidanemariam and all other staff); and the College of Business and Economics and Department of Cooperative Studies staff.

I must take this opportunity to thank all, in Ethiopia as well as abroad, who helped me a lot from financial to moral support, to get back pain treatment in Thailand. The list is over 1000 and it is not possible to mention it here, but to list very few of the architects to my successful

back (lumbar) surgery are Dr Tsega G. Kirstos, Dr. Nigussie Abadi, K. Mariam Abreha, Ataklti Kiros, Tigist Berhane and Mulu G. Egziabher. Dr Beyene Dimtsu, who, despite his very tight schedule of finishing his PhD, spent a number of weeks with me in Thailand giving me an extra ordinary care and affection. I also thank Oil and A and their parents-from Thailand-who helped me a lot to get the necessary backbone treatment. God bless all who supported and cared for me. My daughter, Nouhamin, then-6 years of age, after informed that so many people had helped me said "*Lihagezukha khulom amlak ayemutomy malet iyu* (god will give long life to all who supported you)".

My heartfelt thanks go to Dr Fitsum Hagos, Dr Tsega G. Kirstos and Dr Haile Tesfay, who, despite their busy work schedule and family, have been generous enough to share their academic expertise, in giving valuable comments and suggestions on the methods of data analysis and overall structure of the Thesis.

I would also thank Assefa Hdgot, Ataklti Hailu, Dawit G.Egziabher, Gidey Kidu, G.Selassie Hailu, Haftu Etsay and Kidane Hintsa who collected the data required for the study in two rounds with great patience and accuracy from selected respondents in the study sites. I also thank Amare and Melaku, who were responsible in driving us to and from the field back home safely and in time. I also thank all the respondent farmers, who in two rounds, gave us the required data for analysis and woreda and tabia officials who arranged the survey data collection process.

My utmost thanks go to my beloved wife Abeba Adhana Woldu for her unreserved love, care, determination and commitment in the long journey of my study. She has been responsible for everything in my absence: loving, caring and study follow up of our kids Alula, Michael and Nouhamin Zenebe; and caring my old mother. I shall not forget also what my late mother Teberih Tesfay, who, single-handedly done everything to me following the death of my father at the age of merely four. I thank my kids for their tolerance while I was away from home for my study. I also thank my sister Wunesh Kahsay and her daughter Semhal H.Selassie. My PhD study would not have been finished without the full support and love of all these.

I immensely thank my beloved kids Alula, Michael and Nouhamin; my brother Kalayu H. Selassie and his family Meseret and kid Yared; Martha Michael, Dawit Mesele and kids; Nireya, Tsehaynesh, Zaid, Danu, Merhawit and Temesgen; my sister Helen H. Mariam who

supported me immensely when I was in bad need, Tigist H. Mariam; Abnet Yirdaw and family. I am highly indebted to all of you.

My thanks go to K. Mariam Abreha, Alganesh Araya, Helen Bacha, Melat, Kaleab, Yonathan and Hayat K. Mariam who were my inspiration during my study. Kaleab was responsible for washing my clothes while doing my PhD. Solyana Amsalu, Daniel Amare, Nebyou and Acrosia; Hana Berhane, John, Lucas and Nathan; Ataklti Kiros and Tigist G. Her; Tesfalem Belay and family; Tsegay Lemma and family; Haftu Woldu and Tigist Misgina; Saba Assefa, Abel and family; Hailay Mehari, Bihafta Kidanu and family; Hailu, Alemat and family; H. Selassie Mehari; Shewit and family; Tsehaye; Eleni and family; Eyerusalem Ataklti, TG bunna and family; Meselu Teka; Aklilu Nigusse and Rigbe; Aklilu Haregot and Rutta; Ashenafi Gebre and Mahlet; Yemane Seged and family; Kalayu Gidena; Gidey Abraha and family; Tekle Adhana and family; Tsehay Adhana and family; Mulu Berhe/Rahwa and family; Teka G. her and family; Assefa Sisay and family; Nasra Salih and family; and Meseret Assefa. Thank you all.

My special thanks go to Soliana Amsalu, Daniel Amare, Ataklti Kiros, Tigist G. Her, Dr. Haile Tesfay and Aynalem Gessesse for their all-round support and consistent encouragement before and during my study. I appreciate and will carry all your kindness. Thank you all.

Zenebe Abraha Kahsay
University College Cork, July 07, 2017

Abstract

Smallholder agriculture is the mainstay of the economy of Tigray, northern Ethiopia. Households in the districts of Enderta and Hintalo-Wajerat, located in the food insecure south-eastern zone, rely on agriculture for their livelihood. Farmers in the area grow mainly cereal crops specifically for home consumption, rear small numbers of animals, and sell part of their crop and livestock produce to fulfil other food and non-food needs. Supplementary income is obtained from a range of off-farm and non-farm activities. Despite the concentration on food production, households in the area consume a restricted diet, dominated by cereals, with generally low levels of consumption of high value foods such as fruit, vegetables, meat, milk and eggs. This, combined with periodic food shortages, particularly in the pre-harvest period, suggests that the food and nutrition requirements of farming households in the area may be severely compromised. Ethiopian government policy is heavily focused on boosting agricultural production, but gives less attention to the nutritional needs of households. The need arises, therefore to better understand the livelihoods of smallholders, how their agricultural and non-agricultural activities impact on household diets, and the extent to which nutrition features in their decision making.

This study examines smallholder agriculture and food and nutrition security of rural households using survey data collected in two rounds (in the post- and pre-harvest seasons) from 400 randomly selected households across four villages in two districts. Documentary analysis, focus group discussions, key informant interviews and direct observations were also used to provide additional information on conditions in the study area. The study first explores the basis of agricultural production, in terms of land and livestock ownership, cropping strategies, yields, and disposal of produce in terms of direct consumption and sales. This provides the basis for further analysis of food availability and access at household level, over two seasons. Particular attention is given to differentiation between households, for both production and consumption, particularly in terms of gender of the household head and location. Following this, the study focuses on the specific pathways by which agriculture (and the broader livelihood system) influences food and nutrition security, with a particular focus on production-for-own consumption and income effects. Women's empowerment as another pathway is also briefly examined. The thesis also examines differences in vulnerability of households to food and nutrition insecurity through disaggregation of households into wealth groups, income quartiles and analysis by gender of head of household. Descriptive statistics, content analysis of qualitative interviews, multiple regression analysis and probit model analysis were used in this regard.

The findings of the study show that households in the study area own small areas of land (average landholding size only 0.8 ha), but with important differences across study villages and between female-headed households (FHH) and male-headed households (MHH), thereby influencing food availability. Ownership of livestock also varies across villages and particularly between MHH and FHH: the former own on average 4.51 Tropical Livestock Unit (TLU) compared with 1.61 TLU for FHH. These differences also influence both production and consumption: lack of oxen is one of the reasons why a high proportion of FHH rent-out their land. Cereals dominate both production and consumption, and nutrient-rich foods are generally produced only in small quantities. There are however variations in

both production and consumption of such foods by wealth and income groups: wealthier households (generally correlated with higher income groups) both produce and consume more nutrient-rich food items. On an adult-equivalent basis FHH consume more cereals than MHH, but somewhat less of nutrient-rich foods.

Although agriculture is the main livelihood activity, off/non-farm income is also important, particularly for FHH, and in the pre-harvest season: off-farm income comprises 47% of MHH income but 74% of FHH income.

A number of food security indicators were calculated –Household Dietary Diversity Score (HDDS), Food Consumption Score (FCS), Household Food Insecurity Access Scale (HFIAS) and Coping Strategies Index (CSI) – by village, season and gender of household head. With some variations, these indicators generally showed that food insecurity is higher in the pre-harvest season and amongst FHH. Location (village), TLU and household income were significantly associated with the main food security indicators. Education level of mothers was associated with better food security in the pre-harvest season, supporting women's empowerment as one important pathway to improved nutrition.

Analysis of the link between farming practices and dietary diversity identified that farming practices influence dietary diversity through a combination of production for own-consumption and income effects; the strongest associations were found with the production of pulses, sheep and goats, poultry and beekeeping.

The study concludes that there is a need to develop policy and specific agricultural interventions to promote more nutrition-sensitive agriculture. This implies a range of actions, including promotion of small-scale irrigation, increased availability of seeds to produce nutrient-rich foods, improved support from extension services, promotion of co-operative approaches, improved market information, and other measures. A number of measures to promote women's empowerment are also required, given the importance of women, as evidenced in the study, in the promotion of good household nutrition. There is a need for enhanced promotion of information and knowledge at household level to encourage greater dietary diversity. Multi-sectoral policy making and implementation needs to be strengthened.

Key terms: post- and pre-harvest seasons, off/non-farm activities, access to food, food and nutrition security, HDDS, FCS, HFIAS, CSI, village (tabia), Tigray, Ethiopia

Table of Contents

Acknowledgments i

Abstract v

Table of Contents vii

List of tables xi

List of figures xiv

List of acronyms xv

1. INTRODUCTION AND OVERALL AIMS 1

1.1. Background 1

1.2. Statement of the problem 4

1.3. Aim, objectives and research questions 5

1.4. Contribution of the thesis 8

1.5. Layout of the thesis 8

2. SMALLHOLDER LIVELIHOODS AND FOOD AND NUTRITION SECURITY OF RURAL HOUSEHOLDS: A LITERATURE REVIEW 11

2.1. Introduction 11

2.2. The evolution of the concept of food and nutrition security 12

2.3. Sustainable livelihoods and the livelihoods framework 17

2.4. Agriculture, food security and poverty reduction 23

2.5. Agriculture-nutrition linkages and pathways 26

2.6. Seasonality of agricultural production 32

2.7. Food production, food consumption and dietary diversity 33

2.8. Conceptual framework 36

2.9. Summary 40

3. POVERTY, FOOD SECURITY, AND POLICIES IN ETHIOPIA 41

3.1. Introduction 41

3.2. Ethiopia: policies and strategies related to food security and poverty 42

3.2.1. Productive safety net programme (PSNP) 44

3.2.2. Nutrition strategy of Ethiopia 45

3.2.3. Tigray: policies and strategies related to food security and poverty 46

4. DATA AND METHODS 48

4.1. Introduction 48

4.2. Study area description 48

4.2.1. Tigray regional overview 48

4.2.2. The study area, sampling design and survey setting 49

4.3. Description of the data and methods of data collection 55
4.3.1. Data type and sources 55
4.3.2. Methods of data collection 55
4.4. Methods of data analysis 61
4.4.1. Comparison: FHH and MHH 64
4.4.2. Measurement of food security and agriculture-nutrition linkages 64
4.5. Summary and conclusion 69
5. AGRICULTURAL PRODUCTION, PRODUCT DISPOSAL, AND EXPENDITURE 70
5.1. Introduction 70
5.2. Household demography and assets 71
5.3. Rural households and productive assets 73
5.3.1. House and housing conditions 73
5.3.2. Livestock 74
5.4. Land: area, ownership and management 75
5.4.1. Land holding 75
5.4.2. Farmland ownership 77
5.4.3. Land rent and rental arrangements 78
5.4.4. Decisions on land, land security and arrangement 79
5.5. Agricultural production 81
5.5.1. Area cultivated 81
5.5.2. Crop production 83
5.5.2.1. Cultivated area of major crops by village (in ha) 83
5.5.2.2. Cultivated area of major crops by gender 84
5.5.2.3. Average production of major crops by gender (ha/HH) 84
5.5.2.4. Cereal production 85
5.5.2.5. Pulse production 86
5.5.2.6. Vegetable production 87
5.5.2.7. Fruit and trees production 88
5.6. Disposal of agricultural products 90
5.7. Farm production decisions 93
5.8. Access to and use of institutional services 94
5.8.1. Household participation in extension and related activities 94
5.8.2. Credit and saving 95
5.9. Income earned by households 96

5.9.1. Farm income 97
5.9.1.1. Crop income 97
5.9.1.2. Livestock income 99
5.9.2. Off/non-farm income 101
5.9.3. Rural household income 103
5.9.3.1. Total household income by location 103
5.9.3.2. Total household income by gender 104
5.10. Household expenditure 105
5.10.1. Agricultural input expenditure 105
5.10.2. Food consumption and expenditure 106
5.10.2.1. Food consumption 106
5.10.2.2. Food expenditure 109
5.10.3. Non-food expenditure 111
5.11. Income and expenditure by wealth group 112
5.12. Disaggregation by household income quartiles 116
5.13. Analysis of factors influencing yield and consumption from own produce 118
5.13.1. Factors influencing cereal yields 118
5.13.2. Factors influencing consumption from own production 120
5.14. Comparison: Selected local, national and international socio-economic characteristics 121
5.15. Conclusions 122
6. CONSUMPTION AND FOOD SECURITY STATUS OF RURAL HOUSEHOLDS 127
6.1. Introduction 127
6.2. Household food consumption 128
6.3. Sources of food for consumption 132
6.3.1. Cereal consumption 132
6.3.2. Pulse consumption 133
6.3.3. Vegetable consumption 133
6.3.4. Fruit consumption 133
6.3.5. Milk and milk products consumption 134
6.4. Food security status of rural households 138
6.4.1. Household dietary diversity score 138
6.4.1.1. Overall DDS by season 138
6.4.1.2. Village level dietary diversity score (DDS) 139
6.4.1.3. HDDS by gender 139

6.4.2. Food consumption score (FCS) 141
6.4.2.1. Overall and village level FCS by season 141
6.4.2.2. Household level FCS by season 143
6.4.3. Household food insecurity access scale 144
6.4.4. Coping strategies index (CSI) 147
6.4.4.1. Overall and village level CSI by season 147
6.4.4.2. Household level CSI by season 149
6.5. Household food security indicators: comparisons 150
6.6. Food security status and household wealth 152
6.7. Food security status and household income 153
6.8. Regression analysis: OLS estimation of factors influencing food consumption and dietary diversity 155
6.9. Conclusions 160
7. HOUSEHOLD AGRICULTURAL PRODUCTION, FOOD SECURITY AND NUTRITION LINKAGES 164
7.1. Introduction 164
7.2. Methods of analysis 165
7.3. Production and consumption diversity by food group 166
7.4. Association between agricultural practices and dietary diversity 171
7.4.1. Food diversity indicators and evenness of consumption 171
7.4.2. Farm practices diversification and diet diversification 173
7.5. Conclusions 179
8. CONCLUSIONS AND RECOMMENDATIONS 181
8.1. Introduction 181
8.2. Summary of main conclusions 182
8.2.1. Agricultural production and livelihoods 182
8.2.2. Household food consumption and food security 184
8.2.3. Pathways linking household livelihood systems and food and nutrition security 186
8.2.4. Household vulnerability to food and nutrition insecurity 187
8.3. Recommendations and implications for policy and practice 188
8.4. Contribution to the academic literature 190
8.5. Limitations and future research 190
9. REFERENCES 193
Appendix I: Household survey questionnaire 215
Appendix II: Focus Group Discussion (FGD) questions: Households 243

Appendix III: Key Informant Interview (KII) questions: Agriculture and health DAs and village officials 243
Appendix IV: Selected photos that describe respondent households and part of the study villages 244
Appendix V: Approval letters for data collection 245

List of tables

Table 2.1: Comparison of food-first versus sustainable livelihood approaches to household food security 16
Table 2.2: Wealth categorization of rural households 23
Table 2.3: Undernutrition rates by major region for selected years 26
Table 4.1: Village and gender-wise sample size 54
Table 4.2: Summary of required data, data sources, and tools for analysis 62
Table 5.1: Household characteristics 72
Table 5.2: House and housing conditions 74
Table 5.3: Livestock resources (2013/14 agriculture year) 75
Table 5.4: Land holding by *Tabia* and gender (in ha) 76
Table 5.5: Land ownership of households by land size (in ha) 77
Table 5.6: Land ownership 78
Table 5.7: Land rent and rental arrangement 79
Table 5.8: Land ownership and security 81
Table 5.9: Area cultivated at main season, 2013/14 agriculture year (in ha) 82
Table 5.10: Cultivated area of major crops by village 83
Table 5.11: Average cultivated area of major crops by gender (ha/HH) 84
Table 5.12a: Average production of major crops by gender (Kg/HH) 85
Table 5.12b: Average yield of major crop groups by gender (Kg/ha) 85
Table 5.13: Cereal production 86
Table 5.14: Pulse and oilseed production 87
Table 5.15: Vegetables production at post-harvest season 88
Table 5.16: Major fruit and trees production (Kg) 88
Table 5.17a: Average yield (Kg/ha) for selected crops (2013/14 agriculture year) 89
Table 5.17b: Average yield of major crop groups by village (Kg/ha) 90
Table 5.18: Average disposal of major crops and livestock from own production at post-harvest season 92
Table 5.19: Crop and livestock production decision making 94

Table 5.20: Participation in extension and related activities 95
Table 5.21: Credit and saving by rural households 96
Table 5.22: Average crop sales income at post-harvest season 98
Table 5.23: Average crop sales income at pre-harvest season 98
Table 5.24: Average livestock income at post-harvest season 99
Table 5.25: Average livestock income at pre-harvest season 100
Table 5.26: Participation in and control over income from off/non-farm activities, by location 101
Table 5.27: Participation in off/non-farm activities, by gender 102
Table 5.28: Off/Non-farm average income at post- and pre-harvest seasons, by location 103
Table 5.29: Average farm input expenditure at the post-harvest season, by location 106
Table 5.30: Average food expenditure per household, by village 111
Table 5.31: Average annual non-food expenditure of rural households, by location 112
Table 5.32: Average annual non-food expenditure of rural households, by gender 112
Table 5.33: Mean results of selected household characteristics by wealth group 114
Table 5.34: Mean yield, income and product disposal of own produce at post-harvest season, by wealth group 115
Table 5.35: Mean results of selected expenditure types by wealth group 116
Table 5.36: Means of selected household characteristics by household income quartile 117
Table 5.37: Means of farm expenditure and food consumption by household income Quartile 118
Table 5.38: Summary statistics of variables used in regression for cereal yield 119
Table 5.39: Multiple regression analysis results for variables associated with cereal yield 120
Table 5.40: Multiple regression analysis results for variables associated with proportion of quantity of consumption from own produce 121
Table 5.41: Comparisons of selected household socio-economic characteristics of smallholder farm households in various countries 122
Table 6.1: 30-day average food consumption, by season 128
Table 6.2: Average monthly adult-equivalent food consumption, by season and location (Kg) 129
Table 6.3: Proportion of average monthly food consumption by season and location (%) 130
Table 6.4: Average monthly food consumption, by season and gender 131
Table 6.5: Proportion of average monthly food consumption by season and gender (%) 132

Table 6.6: Monthly consumption of major food items by season and source 135
Table 6.7: Responses of households to selected food security issues 137
Table 6.8: Village level DDS by season 140
Table 6.9: Village level FCS by season and gender 143
Table 6.10: Household level FCS at high and pre-harvest seasons 144
Table 6.11: Village level HFIAS by season and gender 146
Table 6.12: Distribution of households by level of food insecurity as measured by HFIAS 147
Table 6.13: Village level CSI by season 148
Table 6.14: Village-wise coping strategies practiced by households 149
Table 6.15: Household level CSI by season 150
Table 6.16: Spearman's rho correlations between food security indicators, at post-harvest season 151
Table 6.17: Spearman's rho correlations between food security indicators, at pre-harvest season 151
Table 6.18: Results of multivariate regression models, post-harvest season 152
Table 6.19: Food security indicators by wealth group, at post- and pre harvest seasons 153
Table 6.20: Food security indicators by farm income quartile, at the post-harvest season 153
Table 6.21: Food security indicators by farm income quartile, at the pre-harvest season 154
Table 6.22: Food security indicators by household income quartile, at post-harvest season 154
Table 6.23: Food security indicators by household income quartile, at the pre-harvest season 155
Table 6.24: Multiple regression analysis results for variables associated with HDDS at post- and pre-harvest seasons 156
Table 6.25: Multiple regression analysis results for variables associated with FCS at post- and pre-harvest seasons 157
Table 6.26: FCS versus selected variables at post-harvest season, by category of FCS 159
Table 6.27: Multiple regression analysis results for variables associated with HFIAS at post- and pre-harvest seasons 160
Table 7.1: Percent of households producing specific food groups at the post-harvest season, by income quartile 166

Table 7.2: Percent of households consuming specific food groups at the post-harvest season, by income quartile 167
Table 7.3: Percent of households producing specific food groups at the post-harvest season, by wealth group 168
Table 7.4: Percent of households consuming specific food groups at the post-harvest season, by wealth group 169
Table 7.5: Percent of households consuming specific food groups at the pre-harvest season, by income quartile 169
Table 7.6: Percent of households consuming specific food groups at the pre-harvest season, by wealth group 170
Table 7.7: Food diversity indicators at post-harvest season, by village 173
Table 7.8a: OLS multivariate regression analysis of crop and livestock production practices on household diet diversity, at the post-harvest season 175
Table 7.8b: OLS multivariate regression analysis of AES on household diet diversity at post-harvest season 176
Table 7.9: Binary probit analysis: Individual crop and livestock practices by incidence of HDDS food groups, at the post-harvest season 178

List of figures

Figure 2.1: Sustainable Livelihoods Framework (DFID, 1999) 19
Figure 2.2: Household-agriculture-livelihoods-nutrition linkages and pathways framework 39
Figure 4.1: Location map of the study *tabias* 52
Figure 4.2: Sampling procedure of the household survey 54
Figure 5.1: Average total income by source, season and village 104
Figure 5.2a: Average income of households at post-harvest season, by gender 105
Figure 5.2b: Average income of households at pre-harvest season, by gender 105
Figure 5.3a: Monthly proportions of food consumption at the post-harvest season (%) 107
Figure 5.3b: Monthly proportions of food consumption at the pre-harvest season (%) 108
Figure 5.3c: Average monthly retail price (ETB/Kg) of major crops at Mekelle market 108
Figure 5.4a: Proportion of monthly food expenditure by households at the post-harvest season (%) 110
Figure 5.4b: Proportion of monthly food expenditure by households at the pre-harvest season (%) 110
Figure 6.1: HDDS score by season 141
Figure 6.2: Mean HFIAS scores by village and season 145

List of acronyms

ADBG	African Development Bank Group
ADLI	Agriculture Development Led Industrialization
AES	Agriculture Enterprise Score
AGP	Agriculture Growth Programme
ANOVA	Analysis of Variance
BoARD	Bureau of Agriculture and Rural Development
BoFED	Bureau of Finance and Economic Development
CDI	Crop Diversity Index
CFS	Committee on World Food Security
CFW	Cash-for-Work
CSA	Central Statistical Agency
CSI	Coping Strategies Index
DFID	The Department for International Development
ETB	Ethiopian Birr
EWOARD	Enderta Woreda Office of Agriculture and Rural Development
FANTA	Food and Nutrition Technical Assistance
FAO	Food and Agriculture Organization of the United Nations
FCS	Food Consumption Score
FDRE	Federal Democratic Republic of Ethiopia
FFW	Food- for-Work
FGD	Focus Group Discussion
GDP	Gross Domestic Product
GoE	Government of Ethiopia
GNI	Gross National Income
GRDP	Gross Regional Domestic Product
GTP	Growth and Transformation Plan
Ha	Hectare
HDDS	Household Dietary Diversity Score
HFIAS	Household Food Insecurity Access Scale
HH	Household
HWWOARD	Hintalo-Wajerat Woreda Office of Agriculture and Rural Development
IFAD	International Fund for Agricultural Development
IFP	Individual Farming Practice
IFPRI	International Food Policy Research Institute
IMF	International Monetary Fund
KII	Key Informant Interview
MEDHS	Mini Ethiopia Demographic and Health Survey
MDGs	Millennium Development Goals
masl	Metres above sea level
MoARD	Ministry of Agriculture and Rural Development
MoFED	Ministry of Finance and Economic Development
NNS	National Nutrition Strategy
OFSP	Other Food Security Programmes

OLS	Ordinary Least Squares
PASDEP	Plan for Accelerated and Sustainable Development to End Poverty
PIF	Policy and Investment Framework
PIP	Policies, Institutions and Processes
PRSP	Poverty Reduction Strategy Paper
PSNP	Productive Safety Net Programme
SAP	Structural Adjustment Programme
SDPRP	Sustainable Development and Poverty Reduction Programme
SEZAO	South Eastern Zone Agriculture Office
SLF	Sustainable Livelihoods Framework
SNNPR	Southern Nations and Nationalities People's Region
SPSS	Statistical Package for Social Sciences
SSA	Sub-Saharan Africa
TBoFED	Tigray Bureau of Finance and Economic Development
TLU	Tropical Livestock Unit
UN	United Nations
USD	United States Dollars
VIF	Variance Inflation Factors
WFP	World Food Programme
WHO	World Health Organization

CHAPTER ONE

INTRODUCTION AND OVERALL AIMS

1.1. Background

Agriculture is the main source of food and income for the majority of rural households in the developing world. It is the primary source of calories and essential nutrients and, at present, 70% of the world's poor get their income mainly from agriculture (World Bank, 2017). Agriculture clearly has a link with nutrition. As a result, it could be claimed that agriculture is a key sector for most people to get the nutrition they need (Chung, 2012; Fan and Brzeska, 2012; Headey, 2012; Webb and Kennedy, 2012). In many poor countries, agriculture is highly labour intensive, and productive agriculture requires healthy and well-nourished people. However, more than half of the world's poorest people live in farming communities suffering from malnutrition (Wiggins and Keats, 2013).

It is clear that agriculture can make a major contribution to attainment of food security. In recent years, there has been an increased interest in how to leverage agriculture to maximize its impacts on nutrition (Chung, 2012; Fan and Brzeska, 2012; Gillespie and Kadiyala, 2012; Hoddinott, 2012; Collier and Dercon, 2009). These concerns with the role of agriculture in achieving food security and improving nutrition have converged in recent years. The concept of food security has evolved from food availability (the supply side of food) in the early 1940s to the importance of access to food (the demand side of food) since the 1980s, and then to nutritional quality. In the early 1940s securing food was understood to come mainly from maximization of agricultural production and productivity (CFS, 2012). As a result, in the 1950s and 1960s the focus of food and agricultural policies in many developing countries was on increasing the production, productivity and marketing of mainly staple crops. In 1966 the United Nations added equitable distribution of food as an important dimension to the already existing concept of food security. With this, nutrition was recognized as an important dimension (CFS, 2012).

The conception of food availability as the major aspect of food security continued until the 1970s. Since the 1980s new understanding on food and nutrition security has been developed. In 1981 Amartya Sen developed the concept of household entitlements to food while focusing

on consumption. This highlighted the fact that food security also requires physical and economic access to food.

Consumption is a direct intake of food by an individual or member of a household at a time. Food consumption by itself does not tell about whether the food being consumed is nutritious or not (Babu *et al*., 2014). It does not show the type and quantity of food eaten by an individual or by a household member. On the other hand, nutrition is the consequence of the utilization of nutrients of the food consumed or eaten. Nutrition is secured when the food utilized delivers adequate macro- and micro-nutrients that the body requires (CFS, 2012). Good nutrition is the result of utilizing the required amounts and mix of dietary energy and nutrients. Whereas, according to CFS (2012), food security is about *physical, social and economic access to sufficient, safe and nutritious food to meet* all people's *dietary needs and food preferences for an active and healthy life*, fulfilling also *food and care-related aspects of good nutrition*.

In recent years a more integrated understanding of food and nutrition security has developed. FAO (2011) states that "*Food and nutrition security exists when all people at all times have physical, social and economic access to food of sufficient quantity and quality in terms of variety, diversity, nutrient content and safety to meet their dietary needs and food preferences for an active and healthy life, coupled with a sanitary environment, adequate health, education and care*". The understanding of micronutrient deficiency and nutritional quality of food has now come to the forefront of nutrition programmes and strategies (Ghattas, 2014; Ecker and Breisinger, 2012).

Despite these advances in understanding, in some developing countries, including Ethiopia, food availability is still taken as the major pillar of food security in terms of agricultural development programmes.

This thesis sets out to explore and analyse the relationship between agriculture-based livelihoods and food and nutrition security in the Tigray Region of Ethiopia where the issues mentioned above are highly relevant. Ethiopia is a country with continued high dependence on agriculture, high levels of chronic and transitory food insecurity and high (though improving) levels of undernutrition. As such, the linkages between agriculture and food and nutrition security are important to the country's overall development process.

The population of Ethiopia is estimated at about 90 million in 2015 (CSA, 2016). According to the IMF's World Economic Outlook (2014), agriculture in Ethiopia provides 47% of the GDP, 81% of employment and 85% of foreign exchange. Being a predominantly agrarian economy underlines the country's continued heavy dependence on agriculture. Ethiopia's GNI per capita is USD 570 in purchasing power parity: one of the lowest in the world (IMF, 2014).

As the result of poor performance of the agriculture sector, coupled with many other problems and challenges, there is widespread poverty and malnutrition in the country. For instance, the 2016 Mini Ethiopia Demographic and Health Survey (MEDHS) shows that 38.4% of children under the age of 5 were stunted, of whom 17.6% were severely stunted (CSA and ICF, 2016). The GoE estimated that 28% of all child mortality in Ethiopia was associated with malnutrition in 2013 (GoE, 2013).

Ethiopia adopted a Growth and Transformation Plan (GTP) in 2010. The first five year GTP intended to reduce poverty by boosting economic growth of the country. The Agriculture Growth Program (AGP) is a major component of the GTP. Strategically, the AGP gives priority to agricultural production and commercialization as well as development of infrastructure in rural areas (IFPRI, 2013; MoARD, 2013). Nutrition aspects were not incorporated, indicating a poor link between agriculture and nutrition at policy level (Woldehanna, 2014). The National Nutrition Strategy (NNS), developed in 2008, on the other hand, had no focus on the potential contribution of agriculture to improving nutrition. Subsequently, the government moved to integrate agriculture, health, education and poverty reduction policies and the NNS was revised in 2013 in line with this multisectoral approach. The NNS now includes agriculture as one major way of ensuring better nutrition outcomes. Until very recently, however, the strategy and implementation in the agriculture sector has continued to focus on maximizing production and productivity without considering implications for nutrition. Also, there has been weak coordination among relevant sectors and unclear responsibility of actors (Woldehanna, 2014).

Tigray, where the research was conducted, is the northern most region of Ethiopia. The region, with a population of over 4 million, is predominantly rural and engaged in subsistence rain-fed agriculture. Rainfall is erratic and is highly variable both temporally and spatially. According to reports from the Tigray Bureau of Agriculture and Rural Development (2013),

the region's total arable land constitutes about 19.2% of its total geographical area. At present, about 0.9 million hectares of the total area (87.4%) is estimated to be under cultivation. The regional average size of holding is one hectare per household.

Agriculture is the mainstay of the economy of the Tigray region. It is largely smallholder based, characterized by traditional use of hand tools and farm oxen. Total crop production as well as productivity per unit area has suffered from declining land holding size, fertility loss and a traditional farming system reliant on ox-plough. The sector contributes about 53.3% of the Gross Regional Domestic Product (GRDP) and 83% of the region's population are engaged in and dependent on agriculture (TBoFED, 2013). Over the past few decades, Tigray has experienced high frequency of manmade and natural calamities. Even in good years, many farmers cannot produce enough to cover their subsistence needs. In the region, 29% of households live in poverty while the stunting and underweight rates for children under the age of 5 are 51% and 35%, respectively, one of the highest in the country. About 40% of women in the region are undernourished, higher than the national average of 27% (CSA, 2014).

The South-eastern zone is the most drought-prone and food insecure area of Tigray Region. It was selected for the study on the basis of vulnerability and food insecurity criteria. Dry climatic conditions dominate the zone, and crop and livestock production are the main economic activities.

1.2. Statement of the problem

According to Fan and Pandya-Lorch (2012) tremendous progress has been made in meeting the world's food demand. However many parts of the developing world continue to suffer from undernutrition. Many assume that economic growth has a positive impact on people's nutrition through increased incomes and food expenditures, but this has not translated into improved nutrition in a large number of countries: growth may be necessary to improve nutrition but it is not sufficient. The impact on nutrition differs from country to country: in a developing country where agriculture has a larger share of the economy and the majority of the poor are dependent on farming, growth can improve nutrition (Ecker *et al*, 2011).

As noted above, agriculture and nutrition are strongly linked. However, the precise nature of the linkage is not clear and requires detailed study in specific contexts. Haddad (2013)

explains that there is increased agreement that the linkage is important and that it requires further study to identify ways in which agriculture can make a larger contribution to improved nutritional status of households. In understanding the linkage between agriculture and nutrition, specific issues, such as to what extent the increase in food production and productivity lead to better diets and how the production of certain foods influences consumption in the household, need to be addressed.

Recent literature has explored the nature of the linkage between households' agricultural production and nutrition (Carletto *et al*, 2015). There are major pathways through which agriculture influences nutrition (Ruel and Alderman as cited in Carletto *et al*, 2015; Wiggins and Keats, 2013; Hoddinott, 2012; Gillespie and Kadiyala, 2012; Hawkes and Ruel, 2008). The main pathways identified in this literature are through production for own consumption, income derived from the sale of agricultural products, food prices, and women's participation in agriculture with respect to empowerment, time, and health and nutritional status. Whether agriculture, in each of the pathways or in combination, sufficiently impacts on nutrition may depend on local conditions (Carletto *et al*, 2015). To effectively translate agriculture's potential impact into nutritional outcomes, further understanding of the impact and pathways is important (Gillespie and Kadiyala, 2012; Arimond *et al*, 2011; Masset *et al*, 2011).

Food consumption is influenced by many factors (MoARD, 2013; Bogale, 2012; Teshome, 2006). In addition to the performance of the smallholder agriculture-based livelihood system, food consumption of rural households in the study area is influenced by feeding habits. The feeding practices in the study area and rural Tigray in general have been cereal or energy-based. There is a general belief among the majority of rural households that "if *a child or a person feels his/her belly, that is enough and that is it*". This statement suggests that for the households in the study area, and in the Tigray region in general, the nutritive value of the food consumed is not the priority. It is obvious that the concern has been about quantity of food, implying low attention given to the quality and nutritional adequacy of the food. This has been so for generations.

1.3. Aim, objectives and research questions

The aim of the present study is to examine the link between household livelihoods, agricultural practices, and food and nutrition security in rural areas of south-eastern Tigray.

As noted above, the mainstay of the economy of Tigray is agriculture. Households in the study districts of Enderta and Hintalo-Wajerat, located in the food insecure south-eastern zone, rely on agriculture as their main means of livelihood. They grow mainly cereal crops and rear animals for both household consumption and sales to fulfil other basic needs. The production conditions impose restrictions on food availability obtained from own sources, and most households have some dependence on markets to obtain certain foods, as well as on other sources such as payments (in cash or kind) from the Productive Safety Nets programme (PSNP)[1]. Under these production conditions it is appropriate to investigate both the variety of what can be grown and owned by households and what they can get from other sources and the translation of these into household nutrition. Therefore, food availability, consumption and diet diversity, and relationships between agricultural production and food and nutrition security need to be studied.

The specific objectives of the research therefore are:

(1) To understand the agricultural production and disposal system, in the context of the overall household livelihood system, within which rural households in south-eastern Tigray operate;
(2) To explore the extent and nature of food consumption of rural households and the resultant food security status, including a focus on seasonal variations;
(3) To understand and analyse the pathways between the livelihood system and households' food and nutrition security;
(4) To identify households which are particularly vulnerable to food and nutrition insecurity and factors associated with such vulnerability.

To address the first objective, analysis was conducted of the types of crops grown and quantities produced, livestock reared, land issues, production and marketing decisions, alternative sources of employment and income, in order to understand food availability and disposal.

The second objective addresses the food consumption of households, seasonal variations in consumption, and how these households respond to lack or shortage of food over a given

[1] The PSNP is a social protection programme, whereby beneficiaries get cash or food (in kind) in return for their participation in productive activities (e.g. soil and water conservation and rural road construction) and direct support for those who are unable to work.

period. This part of the analysis focusses on the types of food groups consumed by rural households and their different sources, the diversity of the diet they consume, frequency of consumption, and the coping mechanisms they employ, at the high food availability and the pre-harvest seasons as well as across locations and by gender. Different indicators of food security status are calculated from the food consumption data.

The third objective brings the livelihoods and consumption data together with an aim to understand and analyse the livelihoods- and agriculture-related factors that influence food consumption and nutrition.

The fourth objective analyses whether there are differences in food security status between households in the study area; identifies vulnerable households and the factors that may contribute to such differences in food security. This may help to further the understanding of possible mitigating measures to improve the food security status of vulnerable households.

In light of the above specific objectives, this study aims to address the following research questions:

(1) How do farm resources, production choices and decisions, and agricultural income of rural households influence agricultural production and disposal?
(2) What do rural households consume, how does food consumption and food security status change over the year and what are households' responses to shortage of food?
(3) What is the relationship between agriculture, underlying socio-economic characteristics and the food and nutrition security status of households?
(4) What factors are associated with the higher levels of vulnerability of particular households?

The study is based on a sample survey of 400 households in four villages, located in two food-insecure *woredas* (districts), Enderta and Hintalo-Wajerat. Relevant primary data were collected from the households on demography and assets; household economy (production, input use and production decisions); off/non-farm employment and other sources of income; household consumption; food frequency, food security and coping mechanisms; and household health status and facilities. Qualitative data were also collected through focus group discussions and key informant interviews. The data were collected in two rounds in

2014: the pre- and post-harvest seasons. The study employs both quantitative and qualitative data analysis methods to address the objectives of the study.

1.4. Contribution of the thesis

By addressing these research questions, the study seeks to understand and identify the implications of agricultural practices and livelihood systems for rural households' nutrition under prevailing social and economic settings. An important feature of this thesis is that it addresses the agriculture-nutrition linkage in rural areas with a focus on seasonality, asset possession, location (agroecology) and gender.

Studies of this type are recent and there have been very few such studies conducted in Tigray region, despite the high levels of food insecurity and undernutrition in the area. The present study combines a focus on livelihoods systems (including agricultural production and off/non-farm income), seasonality, gender and agroecology to develop a broad understanding of agriculture-nutrition linkages and the influence of livelihoods on nutrition, whereas most previous studies addressed a few specific issues. This study also analyses differences between households according to income and wealth impacts of such differences on food security status.

Tigray region in general and the study area in particular are typically drought prone with high levels of food insecurity and undernutrition. Understanding the extent and causes of food insecurity and undernutrition are both relevant and timely. The study findings can help inform policy makers on the relationship between the livelihood/agriculture system and food security status and identify key issues that need attention.

1.5. Layout of the thesis

The Thesis comprises eight chapters. Chapter one introduces the aims and objectives of the study.

Chapter two presents an overview of the contemporary literature related to smallholder livelihoods and food and nutrition security of rural households. It discusses agriculture, livelihoods, food and nutrition and their relationship; how the understanding on the concepts of food and nutrition security have evolved over time; agriculture-nutrition linkages and

pathways linking them and the seasonality of production. Chapter two also lays out the conceptual framework for the study, which is based on insights provided by the literature on sustainable livelihoods and agriculture-nutrition pathways.

Chapter three briefly presents the food security and poverty situation in Ethiopia and Tigray region and the relevant policies in the country.

Chapter four describes the detailed methodology used in the study. The study area, sampling design, survey setting and the villages selected for the study are covered in this chapter. It discusses the data types and sources and how these data were collected, the methods of analysis and how the results are presented. The quantitative and qualitative means of data analysis used in the study are outlined.

Chapter five considers food availability: it presents results in relation to agricultural production, income and expenditure. These are analysed and presented in terms of agroecology (location), season and gender of the household head. Household characteristics, demography, land issues, livestock and other productive assets that influence the link between agriculture, food security and nutrition are analysed. Access to and use of institutional services is also analysed by village. Income from farm and off-farm activities is also analysed. Households are then disaggregated by income and wealth to provide a more differentiated household-level analysis. Factors influencing yields and food consumption are identified and discussed.

Chapter six considers food access: it assesses and analyses the consumption and food security status of households, including disaggregated analysis by gender, season and by wealth group and income quartiles. Food consumed by food group and by source is discussed to understand the contribution of agriculture and household income to food security. The food security status of households is analysed using well-recognised food security indicators: HDDS, FCS, HFIAS and CSI. The factors influencing food consumption and dietary diversity are identified using OLS regression analysis by season to identify seasonal differences.

Chapter seven integrates the analysis of availability and access through an exploration of the linkages between agricultural production and food security status. The chapter addresses the comparison between the proportion of households producing and consuming food by income

quartiles to understand the extent of the sources of foods consumed: own-produce or from purchases. It also addresses the agriculture-nutrition linkage through analysis of the relationship between single agricultural practices and dietary diversity as well as evenness of consumption. The chapter captures the role of agriculture on food security and nutrition by identifying factors associated with food security by categorizing households into poor, borderline and acceptable and by season based on the FCS scores, one indicator of food security.

Finally, chapter eight summarizes the main conclusions based on the major findings of the study that centre on the link between agricultural practices, livelihoods and food and nutrition security and makes recommendations as implications for policy and practice; its contribution to the scientific literature; and limitations and the gap to be filled by future research are also discussed.

CHAPTER TWO

SMALLHOLDER LIVELIHOODS AND FOOD AND NUTRITION SECURITY OF RURAL HOUSEHOLDS: A LITERATURE REVIEW

2.1. Introduction

This literature review discusses contemporary literature related to agriculture, livelihoods, food and nutrition security of rural households and the pathways that link them. Within the context of the agriculture-nutrition linkage, the specific aspects of seasonality, gender and agroecology are addressed. Differentiation between rural households in terms of wealth and income, and the implications for food security status, are also reviewed. Food security trends globally are discussed. The conceptual framework for the study, derived in part from the literature review, is presented.

In most of the developing world, food insecurity and undernutrition is a major problem, and smallholder farmers and their families account for the largest proportion of the undernourished (Wiggins and Keats, 2013; Salami *et al*., 2010; Savy *et al.*, 2006).

The understandings of food and nutrition security and the role of agriculture have evolved over time. During the late 1970s and early 1980s achievement of food self-sufficiency was the main strategy of food security in many African countries, including Ethiopia. The main focus was on the availability of food through production of mainly staple crops (FAO, 2015). As the understanding of food and nutrition security evolved, however, the additional components of access, utilization, stability and quality of food consumed also received attention (FAO, 2015; Rajkumar *et al*., 2012).

Agriculture and related activities are the major sources of food that can have the potential to sustain rural livelihoods. Both availability of and access to food is particularly important in order to sustain households (Thompson and Meerman, 2014; Collier and Dercon, 2009). Agriculture plays a key role in improving food and nutrition security through the supply of food to producer households or via the market for net-buyers (Dorp *et al*., 2011; Collier and Dercon, 2009; Smith and Haddad, 2000 cited in Benson, 2004). Eastern Africa however is characterized by both a poor agricultural sector and low purchasing power (Benson, 2004). Ethiopia, and the Tigray region in particular, are no exception to this. It is argued that in such

circumstances agriculture alone cannot bring food and nutrition security unless rural households also participate in off/non-farm activities to stabilize and improve their livelihoods (Haddad, 2013; Benson, 2004).

Many agree that agriculture has the potential to influence the nutritional status of households through the pathways connecting the two (du Vachat, 2013; Ruel and Alderman, 2013; Haddad, 2013; Bhagowalia *et al*., 2012; Dorp *et al*., 2011; Arimond *et al*., 2010; Ruel, 2010; Hawkes and Ruel, 2006 and 2008; World Bank, 2007). Recently there has been an increase in research which investigates the influence of agriculture on nutrition (Romeo *et al*., 2016; Carletto *et al.*, 2015; Hoddinott *et al*., 2015; Kumar *et al*., 2015) and there has been an expansion in the evidence base although it is still not adequate. . This thesis therefore aims to add to the somewhat limited evidence in this regard.

This chapter reviews key literature relevant to the thesis. Section 2.2 presents the evolution of the concept of food and nutrition security; followed by sustainable livelihoods and the livelihoods framework (section 2.3); agriculture, food security and poverty reduction (section 2.4); agriculture-nutrition linkages and pathways (section 2.5); seasonality of agricultural production (section 2.6); food production, food consumption and dietary diversity (section 2.7);; conceptual framework of the study (section 2.8); and, finally a summary.

2.2. The evolution of the concept of food and nutrition security

The concept and definition of food security has evolved considerably over the last four decades. The concept of "*secure, adequate and suitable supply of food for everyone*" was accepted by bilateral agencies as early as 1943 (Gross *et al*., 2000) and later became an important agenda after the food crisis of the mid-1970s. The United Nations General Assembly made its first World Food Conference in 1974 that concluded with the Universal Declaration on the Eradication of Hunger and Malnutrition stating "*Every man, woman and child has the inalienable right to be free from hunger and malnutrition in order to develop fully and maintain their physical and mental faculties*" (UN, 1975). The definition of food security which emerged from the World Food Conference focussed primarily on availability of supply: "*availability at all times of adequate world food supplies of basic foodstuffs to sustain a steady expansion of food consumption and to offset fluctuations in production and prices"* (FAO, 2016). This definition, based on the quantity of food supply and food prices,

was a response to the global food concerns in the mid-1970s, with agriculture assigned the task of meeting the requirements through increased food production and lower prices (World Bank, 2007).

In 1981, the concept of food security was further refined and developed as the goals of improvement in food security through food availability failed. Both the works of Pinstrup-Andersen (1981) on the inclusion of nutrition in agricultural production decisions and that of Sen (1981) on food entitlements (access) became strong influences in improving the concept of food security. This contributed to the thinking that economic access to food is equally important as maximization of agricultural production (World Bank, 2007). Definitions of food security broadened beyond satisfying energy needs of households to encompass "*availability and access of nutritious food in sufficient quantities and quality in order for people to lead a healthy and productive life*" (FAO, 1996; World Bank, 2007).

In 1986, another definition for food security was produced by the World Bank (cited in FAO, 2016): "*access of all people at all times to enough food for an active, healthy life"*. The important addition is the ability to secure sufficient food and it addresses both the supply of and effective demand for food. It also introduced time-based transitory and chronic food insecurity levels. These food insecurity levels are also associated with vulnerability to shocks and risks as well as low income and prolonged poverty (FAO, 2016).

There are various factors that affect households' access to food. These affect different households differently in different times and circumstances depending on ownership of agricultural resources, natural and physical conditions, agricultural and related policies, seasonality and gender. The understanding of these factors helps to design and implement effective policies, strategies and programmes that benefit rural farm households with respect to the availability, access and utilization of food (Pinstrup-Andersen, 2014; Thompson and Meerman, 2014; Vaitla *et al*., 2012;).

In 1992, an International Conference on Nutrition held in Rome defined food security as: "*access by all people at all times to the food needed for a healthy life*" (FAO and WHO, 1992a as cited in FAO, 2015). At the household level, food security implies access to adequate food which is sufficient in quantity, quality and safety. Food security is a prerequisite to nutrition security. Nutrition security is much more than just availability of food

or even food security. The improvement in household food security alone may not qualify to be a good nutrition indicator. Many studies indicate that the availability of different types of food groups alone does not guarantee good nutrition (Kumar *et al*., 2015; Gibson, 2014; Greiner, 2014). Equally important is both the ability to access diverse food, either from own production or from the market and other sources, and its adequate utilization (Gibson, 2014; Greiner, 2014). There is also a growing body of evidence which indicates that access to food (or food security) has to be accompanied by safe drinking water, good sanitation, good health and other factors related to nutrition (FAO, 2015; Rajkumar *et al*., 2012).

In 1996, the World Food Summit produced a food security definition as "*Food security, at the individual, household, national, regional and global levels [is achieved] when all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life"*. This embodies useful concepts of food and nutrition security up to the individual level, temporal and spatial dimensions and important policy inputs to reduce poverty (FAO, 2016; World Bank, 2007; Bouis, 2000).

In 2001, food security was again defined as "*Food security [is] a situation that exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life"*. Another important addition in this definition is the social dimension of food security, emphasizing the vulnerability and entitlements to food of households (FAO, 2016).

The food price crisis in 2008, repeated in 2011, played a major role in renewing and enhancing the global focus on food security and on nutrition. Hundreds of millions of people suffered from soaring food prices in 2008 and again in 2011. Among the hardest hit were FHH in many parts of Africa and Asia: these were the most vulnerable to undernutrition and most of them are net food buyers, with lower real incomes as a result of higher food prices. The higher and sudden increases in food prices and the volatility of these prices affected food security and nutrition of particularly poor households (World Bank, 2012). Higher prices of food increase undernourishment, and limit poor households from buying the minimum nutrient requirements to carry out daily activities. These higher food prices affect purchasing power and force these households to shift to less nutritious food. Households responded to the food price hikes by reducing the quantity, quality and number of meals consumed as well as

sale of assets and borrowings. The soaring food prices brought the issue of food and nutrition security to the forefront of governments, policy makers and international agencies and contributed to the further evolution of the concept of food security (Meerman and Alphane, 2012; World Bank, 2012). A study by D'Souza and Jolliffe (2013) on Afghan households also contributed to further understanding food security and its decline as a result of the food price hikes.

A number of important policies and strategies evolved to address the food price crisis, as reported by the Global Monitoring Report of the World Bank (2012) and Meerman and Alphane (2012). These included revision of agricultural policies to increase production; revitalizing social safety net programmes; improving nutritional policies and strategies; improving access to markets and reducing volatility of prices.

In 2012, the Committee on World Food Security formulated the definition of food and nutrition security as "*Food and nutrition security exists when all people at all times have physical, social and economic access to food, which is safe and consumed in sufficient quantity and quality to meet their dietary needs and food preferences, and is supported by an environment of adequate sanitation, health services and care, allowing for a healthy and active life.*" This is a more complete definition; it includes nutrition security and it also emphasises the importance of sanitation and health to food and nutrition security.

Food security: paradigm shifts

There have been paradigm shifts in the concept and operationalizing of food security since the first declaration of eradicating hunger and malnutrition in the mid-1970s: the shift from food availability to access; and the shift from a narrow food security (food-first) focus to a broader livelihood focus. These paradigm shifts have improved the way food and nutrition security is understood (Siyoum, 2012; Devereux, 2009; Maxwell, 2001).

The primary implication for policy from early understandings of food security was to make countries food self-sufficient through maximization of production and productivity. This was a focus on the availability of food, based on the thinking that an adequate supply of food alone would be sufficient. But the problem of food insecurity continued unabated in many developing countries. Widespread undernourishment, hunger and food crises became the subjects of concern, necessitating a first paradigm shift from food availability to access.

The second paradigm shift was from a narrow 'food-first' perspective to a broader 'livelihood approach'. Studies by Devereux and Maxwell (2001), Davies (1996, cited in Siyoum, 2012), Maxwell (1988, 1991), Frankenberger and Goldstein (1990) and Chambers (1988) argued that food insecure households make decisions based on the long-term objectives of sustaining livelihoods and not merely based on solving short-term food shortages.

The livelihoods approach focuses on sustaining the household as one productive unit through various long-term perspectives, including maintaining assets even during the hunger period, and investing in agriculture to fulfil future livelihood needs. Table 2.1 compares the differences between food-first and livelihood approaches. The livelihoods approach is concerned with the long-term effects of ensuring and sustaining livelihoods of households, by ensuring food and nutrition security. The "food first approach", which is still followed by a number of developing countries, is more limited in that it does not look into dimensions other than food such as economic, cultural, social and environmental criteria.

Table 2.1: Comparison of food-first versus sustainable livelihood approaches to household food security

Description	Food-first approach	Sustainable livelihood approach
Objective	Access to food	Sustainable livelihood
Priorities	Meeting food needs first	Food one part of livelihood needs
Time preference	Food needs met before and in preference to all others	Food needs met conditional to immediate and future livelihood needs
Entitlements	Narrow entitlement base (current and past consumption)	Broad entitlement base (includes future claims, etc.)
Vulnerability	Lack or want of food	Insecurity, exposure to risk, shocks and stress
Security	Opposite of vulnerability is enough food	Opposite of vulnerability is security
Vulnerable groups	Based on social, medical criteria	Based on social, economic and cultural criteria
Coping strategies	Designed to maximize immediate consumption	Designed to preserve livelihoods
Measuring and monitoring	Present and past consumption	Livelihood security and sustainability
Relationship to food security and environment	Degrade environment to meet immediate food needs	Preserve environment to secure future

Source: Davies (1996 cited in Siyoum, 2012)

The livelihoods approach supports analysis of differentiation between and within households, for example with respect to gender dimensions. In many developing countries female-headed

households (FHH) own less productive resources than male-headed households (MHH). This leads to reduced efficiency and increased food insecurity (Thompson and Meerman, 2014; Doss *et al*., 2013; Ahmad *et al*., 2012; Meinzen-Dick *et al*., 2011; Arimond *et al*., 2010). However, women play a key role in linking agriculture and nutrition. The income they control is more likely to be spent on food, health care and educating their children (Ahmad *et al*., 2012; Fan and Pandya-Lorch, 2012; Arimond *et al*., 2010). Gender dimensions are therefore critical to an understanding of the linkages between agriculture and food and nutrition security.

2.3. Sustainable livelihoods and the livelihoods framework

There are many definitions of sustainable livelihoods. Carney (1998, pg. 4) defines livelihood as "*A livelihood comprises the capabilities, assets (including both material and social resources) and activities required for a means of living. A livelihood is sustainable when it can cope with and recover from stresses and shocks and maintain or enhance its capabilities and assets both now and in the future, while not undermining the natural resource base*". Ellis (2000) understands livelihood as one that "*comprises the assets, the activities and the access to these (mediated by institutions and social capital) that together determine the living gained by the individual or the household*". The common features of most of the definitions are that the livelihoods approach is people-centred, focuses on the resources (assets) they have and the activities they engage in with these resources. The approach also focuses on micro-macro linkages and external influencing factors. One important benefit of the livelihoods approach is that it recognizes the efforts of households to meet livelihood needs through a diverse range of strategies.

The sustainable livelihoods framework (SLF) was developed in the 1990s (DFID, 1999; Chambers and Conway, 1991). It provides a conceptual basis to identify and understand the complex nature of the livelihoods of rural households (Maxwell *et al.*, 2013; Pain and Launtze, 2002 cited in Levine, 2014; Siyoum, 2012; Scoones, 2009; DFID, 1999). The livelihoods framework developed by DFID (1999) is the most widely used framework.

The DFID sustainable livelihoods framework contains three main interconnected elements, which influence livelihood outcomes: the vulnerability context, assets, and policies, institutions and processes (Levine, 2014; DFID, 1999). The livelihoods framework posits

rural households as having access to various assets while working in a context of vulnerability (expressed in shocks, trends and seasonality). Households use assets within the influence of prevailing policies, institutions and processes (PIP). The interaction of assets, the vulnerability context, and broader PIP influences the livelihood strategies that are available to households in their pursuit of achieving livelihood outcomes (Kollmair and Gamper, 2002). The various economic, demographic and institutional aspects influence different people differently (Scoones, 2009). According to Maxwell *et al.* (2013), in rural areas of Tigray Region, vulnerability relates to access to natural resources, access to credit, input and output prices, availability of productive safety net programs (PSNP), rainfall, drought, illness of household members and family size. The next step is analysing the influence of such factors on assets, changes in production and consumption. All these influence livelihood outcomes (Vaitla, *et al.*, 2012).

The livelihoods framework presented in Figure 2.1 is adopted to provide a clear understanding of the important actors and their interactions within the rural livelihood system. Central to this is household agricultural production and other livelihood activities that can lead to household food and nutrition security. Understanding the framework helps to analyse rural livelihoods and the interplay between agricultural production, off/non-farm activities and the livelihood strategy they practice (Dorward *et al*., 2009). This, in turn, helps to understand the link between agricultural production, food security and livelihoods at the household level (Maxwell *et al*., 2013; Siyoum, 2012).

Livelihood outcomes are the key in sustaining rural households (Levine, 2014). As indicated in Figure 2.1, increased income, reduced vulnerability, improvements in welfare and food security are the main positive livelihood outcomes common to many households. Understanding what shapes livelihood outcomes helps in choosing and designing strategies that can improve a livelihood (Levine, 2014; Barrett *et al*., 2001). Whatever choices households make, food security still remains an integral part of the livelihood goals of households (Levine, 2014).

The sustainable livelihoods framework can be applied from household to global levels (Fan and Pandya-Lorch, 2012). It needs to be modified, adapted and made appropriate to local circumstances and priorities. Maxwell *et al.* (2013), for instance, used a modified livelihood framework to analyse resilience and livelihood change over time adjusted to the context of

Tigray Region, northern Ethiopia. This framework aims to capture the major components of rural households and the factors that influence households' choice of livelihood strategies.

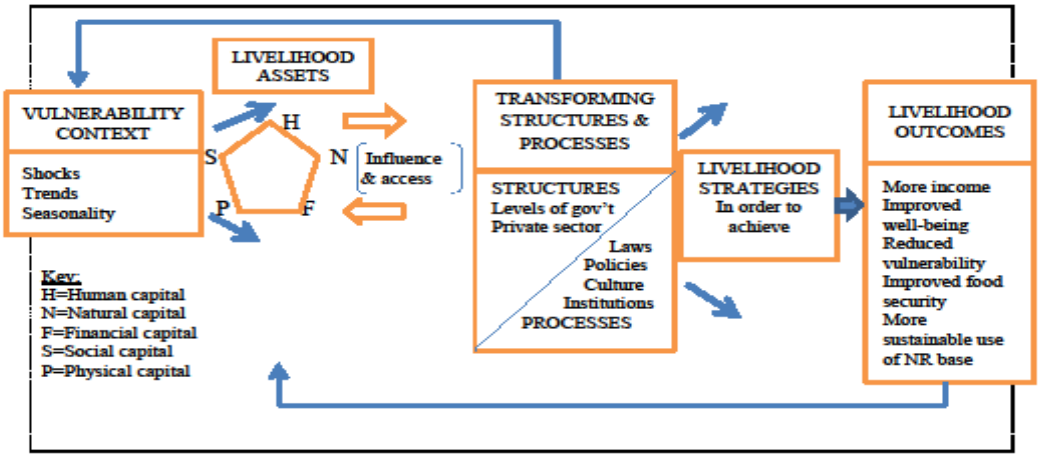


Figure 2.1: Sustainable Livelihoods Framework (DFID, 1999)

The livelihoods framework is not free from criticism. For example, Kaag *et al.* (2004, cited in Van Dijkhorst, 2011) argue that the livelihoods framework takes mainly economic variables as its locus and ignores opportunities, constraints and risks associated with the livelihood system. Scoones (2009), one of the early originators of the livelihoods approach, reviewed debates on the concept and identified four important limitations (while still asserting the overall utility of the approach). First, the livelihoods perspective concentrates on local contexts and does not consider the important dimension of economic globalisation, which has

an important bearing on livelihoods. Second, the livelihoods approach has a limited focus on politics, governance and power, which influence the macro-level development agenda. Third, the livelihoods approach failed to consider the wider picture of environmental issues, including climate change, as it deals with the narrower local perspective of sustainability. Fourth, the livelihoods approach considers households and their- particularly short-term-aspirations but has a more limited focus on possible long-term socio-economic transformations in livelihoods. It also generally considers livelihood outcomes to be positive whereas outcomes could also be negative (Siyoum, 2012).

Despite these criticisms, the livelihoods framework provides a useful conceptual foundation for this study as it draws attention to some of the key factors influencing the livelihoods of rural households and their efforts to ensure household food and nutrition security. Scoones (2009, pp. 176) reiterates that, with some modifications, the livelihoods perspective still provides a unique starting point *"...for an integrated analysis of complex, highly dynamic rural contexts."*

Household livelihood strategies:

A household livelihood strategy is composed of a group of various choices and activities that generate the means of a household's survival (Ellis, 2000). A number of factors influence the way in which these choices and activities are operated. The factors include natural, social, cultural, economic, political and psychological aspects. The choices and behaviours include resource allocation as well as utilization of income and expenditure, accessing food, response to shocks and coping mechanisms. Households employ various strategies in response to asset possession, quantity of own produce, the ability to purchase and the level of associated risks and uncertainties. Livelihood strategies vary with changes in season, space and circumstances and the strategies adopted determine food security status (CSA, 2014; Ellis, 2000). The level of vulnerability of households is determined by the assets, the risks and shocks and the coping mechanisms adopted (CSA, 2014). In the study area, the livelihoods of a good proportion of the households are characterized by vulnerability as measured by food security indicators (CSA, 2014; Maxwell *et al.*, 2013; Siyoum, 2012).

The implementation of livelihood strategies may lead to sustainable or unsustainable livelihoods. Sustainable rural livelihoods are characterized as providing long term food security. These are households who have fulfilled their food and non-food requirements

through own production, income from agriculture and off/non-farm income as well as other sources, using the assets and the opportunities in their surroundings. For households with unsustainable livelihoods, food insecurity looms (Maxwell *et al.*, 2013; Siyoum, 2012; DFID, 1999).

At the smallholder household level, the link between agriculture and nutrition becomes complex. Due to a shortage of resources, the households do not produce sufficient own-food. Thus, the livelihood strategies used by smallholder rural households may focus mainly on off/non-farm income to sustain livelihoods. In such situations, the bases of household livelihoods may come substantially from sources other than agriculture. The livelihoods framework can also be applied to resource-poor households as the change in food and income sources affects nutrition through the variety and quality of foods available as well as through changes in price.

Livelihood strategies of the poor:

Households' livelihoods are determined by the interaction between assets and activities, given the external environment they live in (Dorward *et al.*, 2009). Based on the asset-activity interaction, three livelihood strategies that the poor adopt are identified by Dorward *et al.* (2009). The first livelihood strategy of the poor is 'hanging in' whereby activities are carried out with no change in household assets maintaining the same livelihood levels in the short-term. The poor usually perform this strategy under the influence of unconducive social and economic circumstances. The second livelihood strategy is 'stepping up'. In this case, households increase assets (for instance, acquisition of dairy cows) and activities to increase production and income with the expectation of improved livelihoods in the medium-term. The third livelihood strategy is 'stepping out', whereby households use accumulated assets (for instance, accumulated livestock and buildings to earn higher income) and accomplish diversified activities to realise higher and more steady income in the long-term (Dorward *et al.*, 2009).

Dorward *et al*. (2009) highlight the influence of access to local markets and agroecology in selecting a particular livelihood strategy by poor households. The availability of both better market access and resources enable agriculture to play a key role in implementing the strategies to improve livelihoods (Dorp *et al*., 2011; Dorward *et al*., 2009; Benson, 2004). But low market access to dispose of and buy agricultural products, goods and services coupled

with poor agroecological conditions are likely to negatively influence livelihoods of the poor (Hirvonen and Hoddinott, 2015; Dorward *et al*., 2009). Access to market plays an important role in improving livelihood and food security (Babu *et al*., 2014; Dorward *et al*., 2009). Poor households are likely to follow different activities due to differences in market opportunities, agro-ecologies and asset possession (Dorward *et al*., 2009).

Wealth categorization of rural households

The livelihoods approach draws attention to differential ownership of and access to assets between households. It is important to analyse these differences to gain a better understanding of vulnerability of households to food and nutrition insecurity. Maxwell *et al.* (2013) categorized vulnerable households in Tigray into groups based on wealth. The wealth groups were determined by the per-capita productive asset values. The wealth group categories were: very poor (asset value of <2500 ETB), poor (asset value of 2500-4999 ETB), middle (asset value of 5000-7499 ETB) and better-off (asset value of >7500 ETB) during 2011 to 2013. Maxwell *et al.* (2013) used similar work done by Vaitla *et al.* (2012) to define the wealth groups, based on the work by the Disaster Preparation and Preparedness Agency (DPPA) of the Government of Ethiopia for livelihood description in 2008.

Households can also be categorized into wealth groups based on basic productive assets they own. For example, the Government of Ethiopia (2007), in its study on the Enderta Dry Midland Livelihood Zone, used land ownership and livestock holding as wealth indicators to develop wealth characteristics and to group households into poor, middle and better-off. In this thesis the latter approach was adapted by adding household condition as an additional indicator of wealth. The four study villages also belong to this livelihood zone.

The wealth status of rural households is decided more importantly by the size of farm land, the number of ploughing oxen and other livestock the households own. Land is used for the cultivation of cereals, pulses, oilseeds, vegetables, fruit and trees. These are major sources of food, income and livestock feed to the households. Livestock are important sources of food, income, and draught power. Housing conditions that the household members live in were also considered as indicators of wealth.

The wealth groups represent groups of households that have similar abilities to exploit various food and income choices. Among the wealth characteristics, land holding was considered as

the basis for categorization, and it followed local quantification practices. Households owning less than 0.75ha fall into the poor wealth group, whereas those between 0.75 and 1.5ha, and more than 1.5ha make up the medium and better-off wealth groups, respectively. The number of ploughing oxen and housing conditions were also fitted into each wealth group as indicated in Table 2.2.

Table 2.2: Wealth categorization of rural households

Indicators	Wealth characteristics by wealth group		
	Poor	Middle	Better-off
Land holding (ha)	0.00-0.75	0.75-1.50	>1.50
Livestock holding	0-10 chicken	2-10 chicken	5-13 chicken or more
	0-2 cattle	2-6 cattle	3-9 cattle or more
	0-1 ox	2 ox	2-4 ox or more
	0-10 sheep and goat	4-10 sheep and goat	7-15 sheep/goat or more
	0-2 donkey	0-2 donkey	0-4 donkey or more
	-	-	0-2 beehives or more
Housing condition	Poor (Mud wall and thatched or soil roof)	Medium (Stone or block wall and iron roof)	Good (Tile floor, brick and plastered wall and iron roof)

Source: Adapted from Enderta Dry Midland Livelihood Zone (GoE, 2007)

The vulnerability to food insecurity differs with wealth status of rural households. There is a strong association found in various studies between vulnerability and family size, land holding size and soil fertility, livestock ownership, rainfall and seasonality of production, prices, hazards, risks (Maxwell *et al*., 2013; Bogale, 2012; Vaitla *et al*., 2012).

2.4. Agriculture, food security and poverty reduction

Agriculture is understood as an important primary activity carried out to grow crops, rear animals and supply raw materials. It also has the important goal of producing nutritious agricultural products necessary for a healthy and productive life (World Bank, 2007; Fan and Pandya-Lorch, 2012). But the main paradigm until the 1970s was maximization of the production of cereals only, and it is still the main paradigm in many countries. This cereal-based agricultural production system employed a majority (60-80%) of the population in the working age group and was the main source of calories (Hazell, 2009 cited in Fan and Pandya-Lorch, 2012). In many developing countries, particularly in Asia, agricultural growth has contributed to economic growth and improved livelihoods of millions of people (World Bank, 2007; Fan and Pandya-Lorch, 2012).

In the developing world, most people derive their food requirements from agriculture. But agricultural production is governed and influenced by physical, socio-economic, cultural and political settings. All these determine the type, quantity and quality of crops grown and livestock reared and the availability of food (Fan and Pandya-Lorch, 2012).

Smallholder agriculture is dominant in most of the countries in Sub-Saharan Africa. Agricultural growth in Africa therefore requires development of the smallholder agricultural sector that most rural households rely on (Collier and Dercon, 2009). Ethiopia is no exception to this and developing smallholder agriculture has been identified as the most likely scenario to get out of poverty and ensure food security (Collier and Dercon, 2009).

Agricultural growth is recognized as one major macroeconomic tool that reduces poverty (de Janvry and Sadoulet, 2010). It plays a significant role in reducing poverty at the household level. The reduction in rural poverty over the past few decades has been linked to increases in agricultural labour productivity and increases in agricultural yield (de Janvry and Sadoulet, 2010). De Janvry and Sadoulet (2010) emphasize that the association between agricultural growth and poverty reduction varies across countries. The impact of agricultural growth also comes through its indirect influence and effectiveness on other sectors of the economy. The success story of Vietnam is good evidence in that rapid agricultural growth has been responsible for millions of farm households coming out of poverty (de Janvry and Sadoulet, 2010).

Rural farming households benefit from agricultural growth in various ways (de Janvry and Sadoulet, 2010). The major ones are: sale of agricultural products to earn income; livelihood improvement through farming as well as other sources of income; and, transforming subsistence farmers to participate in the market. Through these pathways agricultural growth has the ability to lift farm households out of poverty.

Food security: levels and global trends

The world has seen tremendous economic and social progress since the second half of the past century. But under-nutrition is still very high affecting 794.6 million people in the world in 2014-2016[2] (FAO, 2015). The prevalence of undernourished people has gone from 18.6% in

[2] Figures for 2014-2016 are provisional estimates

1990-92 to 10.9% in 2014-2016. In the developing world, 779.9 million people are undernourished, accounting for more than 98% of the world's undernourished people. The proportion of undernourished people has gone from 23.3% in 1990-92 to 12.9% in 2014-2016 (FAO, 2015) (Table 2.3). In absolute terms, however, the number of people who are unable to consume enough food to lead a normal and productive life in the developing regions is still distressingly high.

FAO (2015) points out that the 1990s has generally seen a steady decline in the proportion of prevalence of undernourishment as well as the number of undernourished people in the developing world. This was due to the rapid economic progress achieved in parts of the developing world, notably China and India. A slowdown in the reduction of undernutrition prevalence occurred in the early 2000s although it accelerated somewhat towards the end of the 2000s. The prevalence rate of undernourishment fell from 17.3% in 2005-07 to 12.9% by 2014-16 indicating this slower progress (Table 2.3).

In Africa, at present, 232.5 million people are suffering from undernutrition. The proportion of undernourished people is 20.0% of the total population in 2014-16. In sub-Saharan Africa, at present, 220.0 million people are suffering from undernutrition. The proportion of undernourished people has fallen from 33.2% in 1990/92 to 23.2% in 2014-16, but the number of undernourished people has increased by 44.3 million in 2014-16, reflecting the high annual population growth rate (2.7%) in the region (FAO, 2015). Compared to the other regions, undernutrition is most prevalent in sub-Saharan Africa. In Eastern Africa, where Ethiopia, the most populous country in this region is located, 124.2 million people are undernourished or food insecure in 2014-16, falling from 47.2% in 1990-92 to 31.5% (Table 2.3).

The causes of food insecurity in Sub-Saharan Africa are diverse and complex. The major factors that hamper the efforts to achieve food security include low productivity, environmental degradation, high population pressure, inappropriate government policies, poor social and economic infrastructure, continuous increases in food prices and civil war (FAO, 2015). With regard to policy, in the 1970s many African countries recognized rural poverty as a bottleneck to development. In response, various food security policies and strategies were

designed. However the main emphasis of the food security strategies has been to achieve food self-sufficiency through maximizing the production of staple crops (FAO, 2015).

Table 2.3: Undernutrition rates by major region for selected years

Region	**1990-1992**		**2005-2007**		**2014-2016**	
	No.[a]	%	No.	%	No.	%
World	1010.6	18.6	942.3	14.3	794.6	10.9
Developed regions	20.0	<5.0	15.4	<5.0	14.7	<5.0
Developing regions	990.7	23.3	926.9	17.3	779.9	12.9
Africa	181.7	27.6	213.0	22.7	232.5	20.0
Sub-Saharan Africa	175.7	33.2	206.0	26.5	220.0	23.2
Eastern Africa	103.9	47.2	122.5	37.8	124.2	31.5
Asia	741.9	23.6	665.5	17.3	511.7	12.1
Latin America & the Caribbean	66.1	14.7	47.1	8.4	34.3	5.5
Oceania	1.0	15.7	1.3	15.4	1.4	14.2

Source: FAO (2015)
(a) Number of undernourished people in millions

2.5. Agriculture-nutrition linkages and pathways

There has been an increased focus in recent years on the linkage between agriculture and nutritional outcomes. The agriculture-nutrition linkage started to emerge as an issue in the early 1980s following publications mainly from the World Bank and IFPRI (Dorp *et al*., 2011). Since then a number of studies have attempted to identify the impact of agricultural production on nutritional status, examining different potential pathways through which this linkage might occur (Girard *et al*., 2012; Masset *et al*., 2011). However, until recently, there has been little strong evidence to show the impact of agriculture on nutrition (Romeo *et al*., 2016; Carletto *et al*., 2015; Hoddinott *et al*., 2015; Kumar *et al*., 2015; Haddad, 2013).

The World Bank (2007) identifies five pathways that link agriculture and nutrition. The pathways overlap one another. A number of other authors have also identified pathways similar to those developed by the World Bank, including Carletto *et al*. (2015); Ruel and Alderman (2013); Wiggins and Keats (2013); Gillespie and Kadiyala (2012); Hoddinott (2012); Arimond *et al.* (2011); Masset *et al*. (2011); Kennedy and Bouis (1993). The World Bank perspective is considered in this review in conjunction with other authors. The present study focuses mainly on the first three pathways: these pathways can be analysed using data at the household level whereas the other pathways require data above the household level,

including macro-level data at the national level and prices and market data beyond the data collected for the present study. The pathways are briefly discussed as follows:

Pathway 1: production for own consumption

This is the most direct pathway that links agriculture to improved food availability and food security. The level of impact may, however, depend on the type of crops grown and livestock reared. The agricultural practices followed by farmers also have some level of influence. Whereas households producing cereal crops may enjoy better access to energy, the production of pulses, vegetables, fruit, and livestock and livestock products may lead to better access to nutritious diets containing vitamins, minerals, proteins, fats and energy (Ruel and Alderman, 2013; Gillespie and Kadiyala, 2012; Hoddinott, 2012; Arimond *et al.*, 2011; World Bank, 2007).

Dillon *et al*. (2015), in their study in Nigeria, found a statistically significant increase in dietary diversity due to an increase in crop diversity, suggesting consumption from own-production. The same study suggests that relevant policies and strategies should look for interventions beyond increases in agricultural income to improve household nutrition. In Afghanistan, Flores-Martinez *et al*. (2016) found ownership of sheep increasing the likelihood of mutton consumption from own-production and protection against reduction in anaemia, in areas with limited markets.

Pathway 2: production for income

Not all agricultural produce goes to own consumption. Households also get some income through sale of products. The sale of own produce may be induced by the purpose for which the income from agriculture is going to be used (World Bank, 2007). Households use the income for the purchase of food and other socio-economic obligations such as clothing, child education, religious functions, marriage, fuel and house construction. Most poor households sell part of the harvested produce to fulfil some basic needs. However, better-off households may go for income-oriented production. The income from agriculture may influence household food consumption. For example, higher quality foods may be purchased and health related services may be acquired with the income from agriculture (Ruel and Alderman, 2013; Gillespie and Kadiyala, 2012; Hoddinott, 2012; Arimond *et al.*, 2011; World Bank, 2007; Kennedy and Bouis, 1993).

Pathway 3: empowerment of women

This pathway is particularly important for the nutrition outcome of a household and its members, especially children. Household resources and income that women have control over as well as the time spent on care and feeding have a direct and important impact on health and nutrition outcomes (Ruel and Alderman, 2013; Gillespie and Kadiyala, 2012; Hoddinott, 2012; Arimond *et al.*, 2011; World Bank, 2007; Kennedy and Bouis, 1993).

Nutrition is strongly related to gender in Sub-Saharan Africa (SSA). Women are the most active household members responsible for a wide range of productive activities including food production, food preparation, feeding and care practices as well as fetching water and fuel. All of these demands create challenging conditions for women to secure adequate food and nutrition (Doss *et al*., 2013; Ahmad *et al*., 2012; Ecker and Breisinger, 2012; Benson, 2004). The evidence from a number of studies however confirms that empowering women with decision-making abilities and control over resources improves food and nutrition security; however the gender domain differs due to differences in culture, location and other circumstances (Meinzen-Dick *et al*., 2011).

Pathway 4: lowering food prices as a result of increased food production

This pathway links agriculture and nutrition through the supply of more agricultural products to the market. This helps lower the food demand-supply gap thereby lowering food prices (World Bank, 2007). This leads to better access to food and nutritious diets by net-buyer households. Lower food price also has an impact to switch household resources from food to other productive purposes (Ruel and Alderman, 2013; Gillespie and Kadiyala, 2012; Hoddinott, 2012; Arimond *et al.*, 2011; World Bank, 2007; Kennedy and Bouis, 1993).

Pathway 5: agricultural growth contributing to economic growth

This pathway links agriculture and nutrition through its indirect effect on nutrition by way of the contribution it makes to economic growth. The growth in the macro economy, in turn, has the potential to support improvements in reducing poverty (World Bank, 2007). For example, a 1% increase in agricultural productivity lowers the percent of population in absolute poverty by up to 0.91% (Thirtle *et al.*, 2002 cited in World Bank, 2007).

Review of studies on the agriculture-nutrition linkage

Gillespie and Kadiyala (2012) stress that the pathways that link agriculture and nutrition are themselves influenced by a number of factors, including agricultural systems practiced in the area (crop production versus animal husbandry, cereal production versus non-cereal production, etc.), socio-economic characteristics and culture.

Recent studies by Romeo *et al*. (2016) and Carletto *et al.* (2015) in Africa and South Asia examine some of the evidence on the links between household agricultural production and household nutrition. Romeo *et al* found a positive relationship between livestock production and improved nutrition which operated particularly through an income effect rather than production for own consumption. In certain local circumstances, links to household crop production and diversity of production may be particularly important. For example, Kumar *et al*. (2015) found a positive relationship between crop production and household dietary diversity and improved nutrition.

Reviews of various studies related to the links between agriculture and nutrition show a positive relationship between improved household production and higher consumption, the consumption coming from own production and income from agriculture through improved purchasing power (Girard *et al*., 2012).

Agricultural production influences households' own consumption. The influence becomes more apparent especially when there are market imperfections (Villa *et al.*, 2010 cited in Carletto *et al.*, 2015). However, even with the existence of market imperfections own production and consumption become non-separable (Singh *et al.*, 1986 cited in Carletto *et al.*, 2015). Seasonality of production is also identified as one important aspect influencing consumption from own production. As the pre-harvest season progresses, and harvest stocks are depleted, undernutrition becomes more serious (Vaitla *et al.*, 2009).

Azzari *et al*. (2015), Hoddinott *et al*. (2015), Slavchevska (2015) and Hoddinott (2012) found a positive association between livestock ownership and children's increased consumption of animal source food, but this relationship was not found for adults. Hoddinott *et al*. (2015), in their study in Ethiopia, found a strong association between household cow ownership and young children's higher consumption of milk. This relationship is significant in households far away from markets whereas there is no statistically significant association for households

closer to markets, indicating the influence of market access on dairy consumption. Related studies by Azzarri *et al*. (2015) in Uganda also found similar results: a positive association between ownership of livestock and the consumption of livestock products.

Agricultural interventions improved the dietary diversity and consumption of Vitamin A of women and children, indicating the benefits of own food production. For instance, a dairy goat intervention improved the nutrition of beneficiaries in Ethiopia (Girard *et al*., 2012). However, issues arise related to the above results: (1) households may tend to sell their good quality products which fetch better prices, and might end up buying poorer quality food; (2) it is evident that not all income from agriculture is spent on nutrition-related needs; and (3) cultural aspects - such as that pregnant women shall not eat pulses because it hurts the baby; women shall not eat large meals (it makes them fat which influences marriage chances); children shall not eat honey (it can make them stammer) and meat (may contract parasites) - may prevent women and children from consuming good quality food (Girard *et al*., 2012; Masset *et al*., 2011; World Bank, 2007).

The results of the impact on nutrition of agricultural interventions are mixed: some of the interventions brought positive changes while others did not (Girard *et al*., 2012; Masset *et al*., 2011; Berti *et al*., 2003). The meta-analysis conducted by Masset *et al*. (2011) indicates improvements in consumption of products promoted by the intervention and changes in diets among households participating in the interventions. For instance, there are increases in the consumption of vegetables, fish and milk. But the increases in consumption might have resulted in a decrease in other substitute food items. There is a positive impact on Vitamin A intake among programme participants, but little evidence on other micronutrients. The impact of agricultural interventions therefore requires further study to obtain strong evidence.

Income from the sale of household agricultural products is another pathway that links agriculture and nutrition. Carletto *et al.* (2015) and Ecker *et al.* (2011) note the importance of household income from the sale of agricultural products but argue that more income does not guarantee improved nutrition. Poor households also earn considerable income by selling mainly unskilled labour to support, maintain and improve livelihoods where there is a vibrant local economy. Such income is less influenced by seasonality and natural conditions compared to agricultural production (Dorward *et al*., 2009).

Gender is a key dimension that links agriculture to improved nutrition. Many studies show that women control household resources better, resulting in increased agricultural productivity, improved nutrition and increased spending on education, which can reduce poverty and undernutrition (Meinzen-Dick *et al*, 2011; World Bank, 2007). For households particularly engaged in subsistence farming women play a key part in agricultural production, earning income from off/non-farm activities, food preparation, and food allocation as well as choosing the quantity and diversity of food to be served to members (Pinstrup-Andersen, 2014). Some studies estimate the contribution of women in agricultural production to be over 80% in rural households (World Bank, 2007). This includes active participation in decisions over selection of crops, seeds, animals and storage of food. In female-headed households, every decision from allocation of land to food consumption is being taken by the woman (Lewis, 2014).

There is strong support from the growing evidence of the links between agriculture and nutrition that, in the face of shrinking farmlands, land degradation, climate change and sustainability concerns, more diversified farming practices are viable options: such practices could include production of poultry and small ruminants, fruit, vegetables and pulses (Romeo *et al*., 2016).

There is general consensus that growth is a necessary condition to poverty reduction but the association between economic growth and nutrition is yet to be fully explored. There is evidence that agriculture-driven growth is inadequate to address undernutrition - although it is key at the early stages of a country's development - unless it combines the contribution from the complementary sectors: education, health, water and sanitation (Ecker *et al*., 2011).

Food security and nutrition can be improved with policy support (Wiggins and Keats, 2013; Ecker *et al*., 2011): (1) the development of smallholder agriculture through land rights, increased investment in socio-economic and physical infrastructure, agricultural research and extension; (2) production of more diversified food through promotion of home garden vegetable and livestock production; (3) support through programmes that enhance health, water and sanitation, nutrition-sensitive interventions and empowering women; and (4) government (political) support.

Challenges and constraints around the agriculture-nutrition linkage

The relatively limited evidence on the link between agriculture and nutrition was discussed above. In principle, food produced in the required quantity and quality, if consumed as required, would lead to better nutritional status. However, there are great variations in production and consumption across countries. There could be situations where the link might not be realized or might be very weak (Blackie, 2014; Fan and Pandya-Lorch, 2012; World Bank, 2007). The major reasons for the non-realization of the link between agriculture and nutrition are: (1) the agriculture sector is dominated by smallholders with very small and fragmented plots of land, leading to low production and productivity. Most rural households produce for subsistence and poor nutrition is caused by low agricultural productivity that results in low production and income affecting the access to adequate food. This is common among poor rural households. In most of Sub-Saharan Africa (SSA), agricultural growth is slow and could not match the ever increasing demand for food and ensuring sufficient income. (2) Women, who make up a significant proportion of the agricultural labour force, are more vulnerable as they have responsibilities of food and nutrition security as well as family care. (3) The degraded environment and climate change force farmers to adopt unsustainable agricultural practices that, in turn, become less productive and put additional pressure on natural resources. Many households do not have the ability to adequately invest in farming systems, denying them the opportunity to improve production efficiency and to earn better income. (4) Population pressure in SSA is a major challenge which can use up additional resources and limit improvements in nutritional status.

There is therefore growing knowledge on the link between agriculture and nutrition but the evidence gap still persists (Fan and Pandya-Lorch, 2012). In many contexts the interaction between agricultural/broader livelihood systems and nutritional status is not clearly known. This study attempts to address this evidence gap for the Tigray Region, an area well known for high levels of food insecurity and undernutrition.

2.6. Seasonality of agricultural production

Seasonality has long been recognised as an important influencing factor in rural livelihoods, but the linkage between seasonal variations in agriculture and in nutritional (and food security) status has not received much attention in recent research.

In sub Saharan Africa, rain-fed agriculture dominates and most of the crops are produced in the main rainy season: this results in higher levels of available food-mainly staple crops-during the postharvest season. Seasonality of production thus influences the food consumption and dietary patterns of rural households (CFS, 2012; Hillbruner and Egan, 2008): many households face seasonal food shortages some months after the main harvest (Hillbruner and Egan, 2008; Savy *et al.*, 2006; Benson, 2004).

Seasonality can significantly influence the food security and nutritional status of rural households (Hirvonen *et al*., 2015; Hillbruner *et al*., 2008; Savy *et al*., 2006). Households are more food insecure and have lower nutritional status during the pre-harvest season. The seasonal impact is likely to be more serious among poorer households (CFS, 2012; Hillbruner and Egan, 2008). Seasonality is linked to food security of households through the pathway of dietary diversity (Hillbruner and Egan, 2008). Three pathways are identified that link seasonality and nutritional status: food availability decline during the pre-harvest season; productive activities competing for female labour; and high levels of morbidity during the pre-harvest season (Panter-Brick, 1997; Branca *et al*., 1993; Hassan *et al*., 1985; Brown *et al*., 1982 cited in Hillbruner and Egan, 2008).

Given the seasonality in production, food access is influenced by some important features, including market imperfections, irrigation use and food storage and preservation. Inefficient markets negatively affect access to food, particularly by poor rural households, through fluctuating prices and higher prices in the pre-harvest months (Benson, 2004).

2.7. Food production, food consumption and dietary diversity

The increased production of staple crops and increases in income are not sufficient to reduce undernutrition at the required pace. For instance, a study conducted by Haddad *et al*. (2002) reported high rates of undernutrition in households although there was high staple crop production and good food availability. This suggests that higher production does not necessarily bring about improvements in nutrition.

The diversity and quality of food consumed is a pressing issue for food and nutrition security in Sub Saharan Africa (SSA): the diet of households in many SSA countries is characterized by low diversity. Diet diversity may be low even in situations of good food availability and

affordability (Romeo *et al*., 2016; Kumar *et al*., 2015; Sibhatu *et al*., 2015; Thompson and Meerman, 2014; Benson, 2004). A number of recent studies indicate that smallholder farm production diversity can be an important means of improving dietary diversity (Kumar *et al*., 2015; Sibhatu *et al*., 2015; Kennedy *et al*., 2013). Sibhatu *et al*. (2015) found an average increase in the number of food groups consumed for each additional crop type or livestock produced in Ethiopia, Indonesia, Kenya and Malawi: farm production diversity was larger in Ethiopia than the other three countries but dietary diversity was higher in Indonesia and Kenya than in Ethiopia. This suggests that limited farm production diversity is not necessarily associated with lower dietary diversity since different food varieties can be bought. Kumar *et al*. (2015) found a significant positive association in a survey in Zambia between farm production diversity and dietary diversity in young children under the age of 24 months as well as nutritional status of children above the age of 24 months for subsistence households. Many smallholders in Africa diversify their production primarily to minimize risk but such diversification also contributes to improved dietary diversity (Sibhatu *et al*., 2015).

Some studies suggest an association between improved crop diversity, dietary diversity and improved nutrition but the link between production diversity and improved dietary diversity needs further study (Kumar *et al*., 2015; Gibson, 2014; Kennedy *et al.*, 2013; Bhagowalia *et al*., 2012; Remans *et al*., 2011; Hoddinott and Yohannes, 2002). For smallholder farmers, dietary diversity is expected to be positively associated with production diversity as they consume a large proportion of what they produce (FAO, 2015; Sibhatu *et al.*, 2015; IFPRI, 2014; Godfray *et al.*, 2010; World Bank, 2007) whereas households with higher income also have the potential to buy and consume diverse food (Sibhatu *et al.*, 2015).

Access to market influences the dietary diversity of households apart from and may even have a bigger positive influence on dietary diversity than farm production diversity. Households living closer to markets have higher dietary diversity than those far away from markets (Romeo *et al*., 2016; Sibhatu *et al*., 2015). This suggests an increased importance of farm production diversity in remote areas. Off/non-farm income is also associated with higher dietary diversity and its contribution is higher than increased production diversity in some areas (Romeo *et al*., 2016; Savy *et al*., 2006). Educational status of the household head positively and significantly influences dietary diversity at the peak of the cereal shortage period, suggesting the positive role of education during the pre-harvest season. But there is no

association between education and dietary diversity during the post-harvest season (Savy *et al.*, 2006).

Markets facilitate the transaction of goods and services and give signals about resources. In the developing world, there is less integration of agricultural markets due to lack or shortage of infrastructure and market institutions. This is true for majority of the rural local agricultural markets in Ethiopia (Jaleta and Gebremedhin, 2009). Improvements in access to market can improve the food security of rural households. Market reforms can have a positive improved effect on producer prices and market integration through reduced government food prices and relaxing private trade restrictions (Babu *et al*., 2014, World Bank, 2007).

In Ethiopia, the majority of household budget is spent on food, cereals taking the lion's share. Food market price inflation, therefore, is mainly due to staple crop price rises (CSA, 2014). Rises in food price inflation affect poor households, worsening their food security situation. The price inflation that occurred between 2008 and 2012 in Ethiopia (and elsewhere in the world) had influenced the food market and food security situation in the country (CSA, 2014).

Farming households, consumers and marketing agents participate in the production, consumption and marketing of agricultural produce. The major agricultural market in Ethiopia is grain marketing, with many output market outlets: direct sales to rural and urban consumers; to rural farmer-traders; to retailers; to Government; and to private flour mills (CSA, 2014). The local rural markets in Ethiopia are not developed (Dorward *et al*., 2009)

In rural Ethiopia the typical mode of transport of agricultural goods to and from the market is characterised by the use of pack animals and/or one's back or shoulder/head, as the amount of agricultural goods marketed at a time is small (CSA, 2014). Domestic agricultural commodity markets have grown in the past few decades. However, the market functioning is far from efficient despite considerable improvements in physical infrastructure such as roads, electricity, telecommunication and the launching of the Ethiopian Commodity Exchange (ECX), mainly working on coffee (Dorosh and Rashid, 2013). In order to promote agricultural marketing the National Regional State of Tigray also established the Tigray Agricultural Marketing Promotion Agency (TAMPA) (Jaleta and Gebremedhin, 2009).

The participation of households in the market depends on the distance the households are situated. Households have to travel more than 10kms, on average, to reach to a road and public transport (CSA, 2014). Market failures are common in developing countries including Ethiopia. In the presence of market failures agriculture may have more implication on nutrition through its effect of consumption from own production (Slavchevska, 2015). For example, in rural Ethiopia, households far away from local markets and owning cows consume milk produced (Hoddinott *et al*., 2015).

Food markets are one of the important factors that influence the agriculture-nutrition pathways. Markets play important roles in rural income and food prices and improvements in domestic/local food markets increase the link between agriculture and nutrition (World Bank, 2007).

2.8. Conceptual framework

The conceptual framework for the thesis was developed based on the foregoing literature review. It aims to capture the key relationships between agriculture and other income generating activities and the food security/nutritional security of rural households.

Figure 2.2 provides an overview of the major relationships between agricultural practices, production, off/non-farm activities and other sources of income, household consumption and food and nutrition security at rural household level. The main objective of this thesis is to analyse the relationships between elements of the conceptual framework in order to gain a greater understanding of the influence of agricultural practices and livelihoods systems on the food security and nutritional status of households, and to analyse the specific pathways that link agriculture and nutrition.

Haddad (2000) identifies both specific and generic effects of the link between agriculture and nutrition. The specific effects are related to the impact on food consumption from own production, impact on food prices and post-harvest activities and nutrient availability. The generic effects are the income influence of increased agricultural productivity, changes in household decision-making and impacts on nutrition requirements. Both the specific and generic effects are important to develop the understanding of the agriculture-nutrition linkage. A key focus of the present study revolves around measuring the extent, sources and types of

food consumption, relating consumption with the household agricultural and livelihood system.

The conceptual framework (Figure 2.2) links meso-level variables (agricultural systems and practices, agricultural services and infrastructure, and interventions) with the household economy and household demography. It also depicts the specific pathways linking the livelihoods system with food consumption and ultimately food and nutrition security of households. These pathways are agricultural own production, agricultural income, and off/non-farm income. Gender of household head and seasonality of production are cross-cutting dimensions that may influence food consumption and food and nutrition security of households and, therefore, they appear in the framework connected to household food consumption.

The pathways linking agriculture and household livelihoods to food consumption are depicted by arrows 1-3. Arrows 4 and 5 represent the influences of key variables on food consumption. Arrow 6 relates food consumption to household nutrition security (see Carletto *et al*., 2015; Levine, 2014; AgriDiet Project, 2013; Bhagowalia *et al*., 2012; Devereux, 2009; Hawkes and Ruel, 2008; Haddad, 2000; Kennedy and Bouis, 1993).

Arrow 1 represents the causal relationship between own agricultural production and food consumption. For smallholder households, own production is a key contributor to food consumption as these households consume most of what they produce, although it is not enough for the whole year, implying a strong link between own agricultural produce and nutrition. The agricultural practices farmers follow and the livelihood assets (human, social, natural, physical and financial capital) they own/have access to influence the amount of own production.

Arrow 2 indicates the relationship between income from agriculture and food consumption. This includes the income from sale of agricultural products and income from the sale of agricultural labour. Households purchase food and non-food items from the income earned through the above sources. In the study area and in other similar drought prone areas of Ethiopia, households sell a portion of their produce to buy other food and non-food products.

Arrow 3 relates off/non-farm income and food consumption. The sources of this income are food-for-work (FFW), cash-for-work (CFF), daily labour on non-farm activities, transfers either from government and/or from relatives and neighbours and self-employment of households (such as selling natural resources, petty trading, pottery/weaver, etc.). Income from off/non-farm activities accounts for a considerable proportion of total household income and households sustain their livelihoods through the purchase of food and non-food items using this income. In the study area most households own small and fragmented land that cannot sustain their livelihood throughout the year and they take opportunities to maintain their overall livelihoods through participation in off/non-farm activities.

Arrow 4 shows the influence of gender on household food consumption, which in turn influences nutrition security. In SSA, in particular, adult women participate highly in agricultural production and marketing of agricultural products. They also take greater responsibility in making decisions on what to consume as well as feeding and care practices especially for young children and elderly people.

Arrow 5 connects seasonality of agricultural production with seasonality of food consumption. There are differences in food consumption between the post- and pre-harvest seasons, with higher (and possibly more diverse) consumption coming immediately after the harvest period.

Arrow 6 shows the causal relationship between household food consumption and nutrition security. The missing components that have a major bearing on household nutrition security, but which are not included in the framework, are health, clean water, sanitation, and feeding as well as care practices.

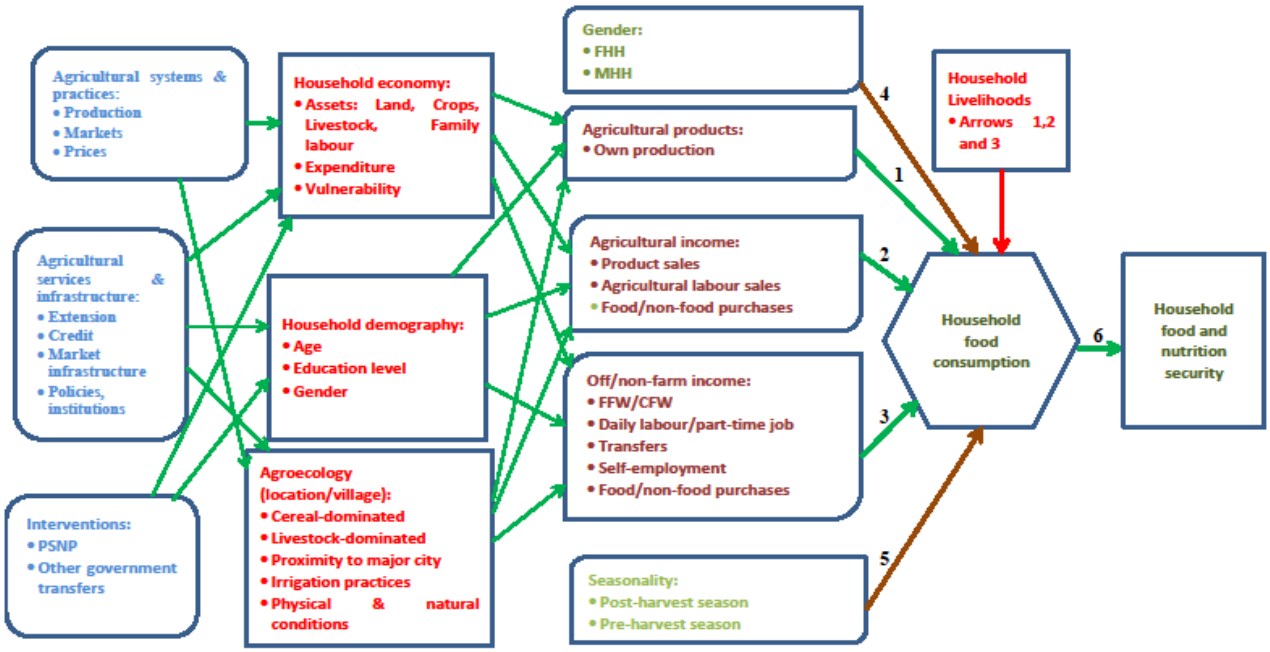


Figure 2.2: Household agriculture-livelihoods-nutrition linkages and pathways framework

The conceptual framework depicts clear pathways through which each of the objectives is addressed. The first objective is concerned with understanding the agricultural production and disposal system of rural households in the context of the overall household livelihood system. This is addressed through the focus on the pathway from household demography, household economy and agroecology to agricultural production/income. This also enables investigation of two pathways linking agriculture and food security/nutrition, food consumption from own production and from agricultural income.

The second objective aims to provide a detailed understanding of food consumption and food security status disaggregated by season, gender and agroecology. The third objective aims to analyse pathways linking the household livelihood system and food and nutrition security. This is addressed by considering the three major sources of livelihood (own-production, agricultural income and off-farm income) in the framework, and identifying the important pathways influencing household food security. Gender dimensions are also analysed to capture the pathway linking men's and women's decision-making and control over resources to food consumption. The seasonal dimension is also considered in analysis. The fourth objective aims to explore differences in vulnerability of households to food and nutrition

security through undertaking more disaggregated analyses of consumption and food security by wealth and income differences. All the objectives taken together contribute to a broad understanding of rural households' food and nutrition security status.

2.9. Summary

This chapter reviewed the evolution of the concept of food security towards the present concern with the linkages between agriculture and nutrition. Given that smallholder farming households account for the largest proportion of the undernourished in many developing countries including Ethiopia, it is important to situate an analysis of agriculture-nutrition linkages in the context of households' livelihood systems. Therefore the chapter discussed the sustainable livelihoods framework and some of the key issues therein including the importance of assets (wealth) in agricultural production, and the role of seasonality of production in influencing consumption from own production. The association between production and dietary diversity was also discussed.

Based on the literature review the conceptual framework for the study was developed: this shows the specific pathways linking the livelihoods system with food consumption and ultimately the food and nutrition security of households. The conceptual framework is the basis for the analysis in the following chapters.

CHAPTER THREE

POVERTY, FOOD SECURITY, AND POLICIES IN ETHIOPIA

3.1. Introduction

The chapter gives country and regional overviews focusing on food security and poverty situations and the relevant policies and strategies that govern such situations. It first highlights agriculture's role in the country's economy and the food poverty that exists in a view to shed light on smallholder agriculture's contribution to nutrition and the linkage between them. It then reviews policy reforms of the country in chronological order and the nutrition strategy of Ethiopia in some details. This helps to understand the policy premises and their possible influence on food and nutrition security.

Poverty in Ethiopia has reduced significantly since the mid-1990s, from 45.5% in 1995/96 to 29.6% in 2010/2011 (CSA, 2014). In rural areas poverty reduced from 47.5% in 1995/96 to 30.4% in 2010/2011. The extent of poverty is higher in rural areas (CSA, 2014).

Food poverty (measured by the proportion of the population unable to afford the minimum food basket in a given year) declined from 49.5% in 1995/96 to 33.6% in 2010/11. The corresponding figures for rural areas were 51.6% and 34.7%, respectively (CSA, 2014). The poorest households are more likely to opt for consumption of inferior quality food, less diverse diets and insufficient energy than relatively richer households (CSA, 2014).

CSA (2014) found that at the national level, 40% of households were food energy deficient: Tigray had one of the highest prevalence rates (42%) in the country. According to the food consumption score, 26% of households in Ethiopia consumed diets less than the acceptable level. About 29% of rural households had poor and borderline food consumption. About 34% of Ethiopian rural households consumed three or fewer food groups based on 7-day recall (CSA, 2014). A strong association was found between a wealth index and dietary indicators: households with lower wealth consumed less diverse diets and more starchy cereals than households with higher wealth. About 49% of the expenditure by rural households in Ethiopia was on food (CSA, 2014).

In Ethiopia the main stay of the economy is agriculture and agricultural production is constrained by various natural, demographic and socio-economic factors. The agricultural sector is predominantly rain-fed and dominated by smallholder farming. Agricultural productivity is one of the lowest in the world and the country is not able to adequately feed its people (Seyoum, 2012; MoFED, 2010; Devereux and Sharp, 2006). This low productivity has contributed to food insecurity and undernutrition. Consequent upon this, food and nutrition security is recognized as a major goal of Government policy. To achieve this, the country has adopted a number of policies and programmes which are briefly reviewed below.

3.2. Ethiopia: policies and strategies related to food security and poverty

The Government of Ethiopia embarked on policy reforms in 1993, starting with the 1993-96 structural adjustment programmes (SAP), in an effort to achieve a faster and stable economic growth (Engida *et al*., 2011). The country adopted the Agriculture-Development-Led Industrialization (ADLI) strategy in 1994 to address the long-term objective of developing the sector to ensure food security and push the other sectors of the economy to a stable growth path. The main goals of the ADLI strategy are agricultural development, poverty reduction, food security and leading the way for industrial development (Woldehanna, 2004; MoFED, 2002). Meanwhile, the Sustainable Development and Poverty Reduction Programme (SDPRP) had agriculture, water, roads, education and health as key components for implementation. The main gains from the SDPRP are improvements in food security and strong and stable growth in GDP (MoFED, 2007).

Under the auspices of the Poverty Reduction Strategy Paper (PRSP), the Plan for Accelerated and Sustainable Development to End Poverty (PASDEP) was formulated with the aim of achieving sustainable economic development (Teshome, 2006). Also the first five-year Growth and Transformation Plan (GTP 1) was implemented from 2005/6-2009/10 to meet the Millennium Development Goals (MDGs) by 2015 (MoFED, 2010). The PASDEP identified eight major pillars and the ones related to agriculture and nutrition are: building implementation capacity in the sectors, accelerating growth, enhancing women's participation in decision making and development and creation of employment opportunities (MoFED, 2007).

The main gains from the PASDEP during the first GTP were establishment of a strong broad-based economic growth and improvements in food security and poverty reduction (MoFED, 2010). An annual average economic growth rate of 11% was registered-above the required rate to halve poverty by 2015-with the population growing at 2.6% per annum (ADBG, 2011). The relative importance of agriculture and allied activities reduced from 47.4% in 2005 to 41.0% in 2010 while services went up from 39.0% in 2005 to 46.0% in 2010 and industry from 13.0% to 13.6% (MoFED, 2010).

The second GTP was implemented between 2010/11 and 2014/15 aiming to achieve the MDGs. The country envisages being a middle-income country by 2025 while ensuring a broad-based, sustainable, rapid and equitable economic growth (ADBG, 2011). The important pillars of the second GTP are faster growth with the agriculture sector still continuing as the engine of growth, greater role of the industry sector, improved social and economic infrastructure as well as human resources development. It focuses on areas with agricultural potential, encourages private investment and enables agriculture to contribute to industrial development. For the Tigray region, being a food insecure area and generally dry weather, with relatively less agricultural potential and less extensive land for commercialization compared to some regions in Ethiopia, only few (9) *woredas* were selected for the intervention. Until recently nutrition received little attention and as a result there was weak agriculture-nutrition linkage (MoFED, 2010). More recently agriculture has been mandated to mainstream nutrition in its activities (MoFED, 2013).

The Agriculture Growth Program (AGP) is one major component of the GTP designed to bring agricultural growth and ensure long-term food and nutrition security of households. The AGP is aligned with ADLI and PASDEP while focusing on agricultural growth in areas with promising potential. The AGP focuses on agricultural production, commercialization and infrastructure development that supports the growth (IFPRI, 2013; MoARD, 2013). It is planned to increase agricultural productivity and the access to market for selected crop and livestock products in the AGP *woredas* (districts) of Tigray, Amhara, Oromia and SNNPR regional states. In the programme, the main beneficiaries of the AGP are small- and medium-holder farming households with land holdings between 0.25 and 2.3ha. The programme also supports increased participation of women and youth (Berhane *et al*., 2013; MoARD, 2013).

As indicated above, one major pillar of the GTP and AGP is commercialization of agriculture, which, apart from modernizing smallholder agriculture, focuses on providing large areas of agricultural lands to commercial companies whose major objective is primarily profit maximization. The implementation of leasing large areas of land has already begun and its influence on smallholder agriculture is yet to be seen. An important question arises whether the policy genuinely prioritizes the needs of smallholder farmers in continuing to be the major force in agricultural development of the country or whether there will be reduced focus on smallholder agriculture. In the study area, however, commercialization is not a major issue of note due to physical and natural conditions that are not suitable for extensive commercial agriculture.

3.2.1. Productive safety net programme (PSNP)

Safety net programmes are responses to food shortages particularly during emergencies to support asset-poor households. In Ethiopia, the Productive Safety Net Programme (PSNP) was introduced as a major component of the food security programme in 2005 to replace the then-annual distribution of emergency food aid. It is part of the PASDEP and the biggest programme the country implements (Siyoum, 2012; Teshome, 2006). As a key social protection programme, it addresses food insecurity through the transfer of food and/or cash. The PSNP aims to bridge food shortages through smoothing consumption; helping households maintain their assets while enhancing the assets of the community; and reducing vulnerability to food insecurity (Siyoum, 2012; Devereux and Guenther, 2009; De Gramont *et al.*, 2007). The able-bodied members of households participate in productive activities such as soil and water conservation, construction of roads, schools, irrigation facilities and drinking water points. Direct support is also another component for those who cannot work (Dorosh and Rashid, 2013; Andersson *et al*., 2011). Households graduate from the safety net programme when they are able to access food all year round and endure shocks on their own (MoARD, 2009; De Gramont *et al*., 2007; Devereux and Sharp, 2006).

The PSNP in Ethiopia is the largest programme in Sub-Saharan Africa (SSA) excluding South Africa and is designed to reach more than 7 million people (Andersson *et al*., 2011); it covers about 10% of the total population (Ruel and Alderman, 2013). The PSNP was expected to take millions of beneficiary households out of poverty. It is considered to be an effective response to the enormous food insecurity problem; however studies by Devereux (2010) and

MoARD (2009) show that the rate of graduation from the safety nets is relatively low: only about 9% of total beneficiary households had graduated up to the end of 2009.

In addition to participation in the PSNP, households also participate in Other Food Security Programmes (OFSP) and benefit from agricultural extension packages and credit services for agricultural and non-agricultural activities. This helps consolidate improvements in food security (Andersson *et al*., 2011; Teshome, 2006).

3.2.2. Nutrition strategy of Ethiopia

The National Nutrition Strategy of Ethiopia came into being in 2008. The strategy paper identified challenges negatively influencing coordination of actors in the effort to solve problems of undernutrition (FDRE, 2008). The main challenges were: lack of a comprehensive national nutrition strategy, lack of transparent mandate for and coordination of sectors involved in nutrition, lack of proper programs that address nutrition and shortage of nutrition experts (FDRE, 2008). In the agriculture sector there was no mandate to address nutrition, and the main focus of agricultural policies has been improvements in agricultural production and yield to induce economic growth without much regard to the nutritional quality of the food and access to it (Woldehanna, 2014). This is reflected in the Agriculture Sector Policy and Investment Framework (PIF), a 10-year development plan (Woldehanna, 2014).

Nutrition was also neglected in the first GTP whose main focus was poverty reduction through improved economic growth: the emphasis was increase in agricultural production and productivity and calorie supply, indicating poor linkage between agriculture and nutrition even at policy and strategy levels (Woldehanna, 2014). More recently the Government has adopted an approach which integrates agriculture, education, health and poverty reduction policies. The National Nutrition Strategy (NNS) was revised in 2013 to reflect this integrated approach and it now recognises agriculture as a key component to reduce undernutrition (Woldehanna, 2014).

The increasing focus on nutrition in Ethiopia is elevated by the ‘Seqota declaration’, launched in July 2015 by the government of Ethiopia (GoE). The declaration commits Ethiopia to end

child undernutrition by 2030. The implementation framework of the declaration considers the involvement of up to 11 relevant ministries (GoE, 2015).

3.2.3. Tigray: policies and strategies related to food security and poverty

The Tigray region has adopted the national policies and strategies and these were adjusted to suit regional circumstances. Within the framework of the ADLI strategy, a natural resources conservation-based agricultural development strategy emerged. The strategy addresses the prime concern of food insecurity at the household level in the region, with the first plan put into action in 1996 and later revised in 2002 to accommodate improvements in agricultural productivity and income (MoFED, 2002). As a result, at the regional level, food self-sufficiency improved to a considerable extent and a 32% decline in food deficit was registered between 2002 and 2008, indicating the effectiveness of the policies (Van der Veen and Gebrehiwot, 2011).

For the Tigray region, the second GTP identified four key directions to achieve the objectives: enabling the work force that supports agriculture and other sectors of the economy; adapting the national-level GTP to regional circumstances; enhancing participation of all able-bodied people in developmental activities; and skill upgrading of the leadership at all levels (BoFED, 2010). An annual average economic growth rate for the region of 10% was set during the first PASDEP period (GTP 1) and an 11% growth was achieved (BoFED, 2010).

In the Tigray region, 9 *woredas* were selected for AGP implementation based mainly on agricultural potential of the area as per the second GTP guidelines discussed under the Ethiopian policies and strategies sub-section above (Berhane *et al.*, 2013). The selected *woredas* for the present study are not among the AGP woredas.

In conclusion, smallholder agriculture dominates the economy. There have been notable reductions in poverty in Ethiopia since the introduction of policy reforms on poverty and food security. However, poverty is still high in rural areas. Large proportions of households fail to fulfill the minimum food requirements. Tigray has the highest food energy deficiency prevalence rate.

Ethiopia undertook many policy reforms related to food security and poverty: ADLI, SDPRP, PASDEP, GTP, AGP, PSNP and NNS. These policies and strategies have brought improvements in food security and poverty reductions as well as a stable economic growth. Initially nutrition was neglected and had little attention in the policy and practice as recent as 2013 though the NNS was launched quite earlier. Agriculture had no mandate to deliver nutrition, with the main focus on increases in production and productivity. These resulted in weak link between agriculture and nutrition. Meanwhile, the conservation-based agricultural development in Tigray region resulted in notable improvements in food self-sufficiency.

CHAPTER FOUR

DATA AND METHODS

4.1. Introduction

This chapter outlines the research methodology used in the study. Initially it provides information on the study area. It then discusses issues relating to sampling and data collection. Approaches to data analysis are then discussed, including discussion of the various methods used to measure household food security status.

Stratified sampling was used in selecting sample households. Of the six zones in Tigray region, the south-eastern zone was selected based on vulnerability to food insecurity; two *woredas* out of four in the zone and four villages-Mahbere Genet and Meseret from Enderta and Andi Woyane and Tsehafti from Hintalo-Wajerat *woredas*-were selected. 400 households were randomly selected for the household survey, proportionate to the number of households living in each village. Household survey questionnaires, Focus Group Discussions (FGD) and Key Informant Interviews (KII) were conducted in each of the four villages, including personal (researcher) observation as a supplement to the primary data. Secondary data were also used from various sources. For the analysis, both quantitative and qualitative methods were employed.

4.2. Study area description

4.2.1. Tigray regional overview

Tigray National Regional State is located in northern Ethiopia extending from $12^{o}12'$ to $14^{o}57'$ North latitude and $36^{o}27'$ to $39^{o}59'$ East longitude. The region, with a geographical area of about 53 thousand km^2, has a population of over 4 million, which is predominantly rural and engaged in subsistence rain-fed agriculture. Agro-ecologically[3], Tigray region is mainly classified into lowland (53%), midland (39%) and highland (8%) (Solomon, 2005; Hagos *et al*., 1999; Hurni, 1998). The average temperature ranges from 4^0 to 40^0c. Rainfall is erratic

[3] There are 3 main agroecological zones: Highland (*dega*) = altitude in excess of 2300 metres above sea level (m.a.s.l); Midland (*woina-dega*) =altitude between 1500 and 2300 m.a.s.l; and lowland (*kolla*) =altitude below 1500 m.a.s.l (Hagos *et al*., 1999; Hurni, 1998).

and is highly variable both temporally and spatially. Annual rainfall is about 450 to 900 mm at an average (TBoFED, 2013). The region has six administrative zones namely, Western, North-western, Central, Eastern, South-eastern and Southern, which are further divided administratively into 34 rural *woredas*, 12 urban *woredas* and 660 villages.

Tigray Region generally displays high levels of food insecurity and undernutrition. Juhar (2012), in his study on vulnerability of households in rural areas of Tigray region, found that about 50% of the households were vulnerable to inadequate food stock, and about 29% were in a transitory state moving in and out of food insecurity. About 23% were food insecure while also vulnerable. According to CSA (2014) the child stunting rate in Tigray is 44%, above the national average of 40%.

Agriculture in the Tigray region and the study area in particular is dominated by smallholder agriculture, mainly practising mixed farming. Almost all rural households are market participants both in selling and buying food and non-food products. However, as subsistence farmers, the majority of production is intended for own consumption, while most households actively participate in off/non-farm activities to maintain and/or improve their livelihoods. Food insecurity and undernutrition are prevalent in the study area.

4.2.2. The study area, sampling design and survey setting

South-eastern Tigray is the most drought-prone, food insecure and vulnerable zone. Its agriculture, which is based on plough cultivation of predominantly cereal crops, faces various problems and constraints, including: erratic and unreliable rainfall; serious environmental degradation and depletion of natural resources; low capital; land fragmentation; poor soil fertility; low crop and livestock productivity; and, vulnerability to plant and livestock diseases. The sector is excessively dependent on seasonal rainfall.

The south-eastern zone was selected for the study on the basis of the high levels of food insecurity. Dry climatic conditions dominate the zone and the annual rainfall ranges from 450 to 600mm. The zone is generally categorized as a midland agro-ecology and characterized by undulated terrain, with bush scrub vegetation as the main land cover. This is a moderately populated zone; crop and livestock production are the main economic activities. The main rainy season, which the agriculture of the zone depends on, is from June to mid-September.

The main crops grown are *teff (Eragrostis tef)*, wheat, barley, sorghum and maize, and pulses like vetch and lentil are grown to a limited extent. The South-eastern zone has four districts (*woredas*), namely, Dogua Tembien, Enderta, Hintalo-Wajerat and Seharti-Samre, of which two districts, Enderta and Hintalo-Wajerat (Figure 3.1) were selected for the study. This selection was based on the level of drought and food insecurity, the proportion of vulnerable households, water availability for crop production, and distance from major markets. The information used for selection of districts was collected from the south-eastern zone administration office (SEZAO, 2013).

Enderta district:

Enderta district surrounds Mekelle city and comprises 17 villages (*tabias*). The total population was estimated at 104,410 in 2013, of which 51% were female and 49% male (EWOARD, 2013). The total land area of the district is 23,587 ha. The average land holding per household in the district is about 1 ha. The farming practice in the district is mainly rain-fed cereal production. The major crops grown are *teff*, wheat barley and maize. Irrigation is practiced to a small extent. The total number of cattle stands at 72,564, with an average of 3 per household, and the total number of sheep and goats is 43,964 (average 1.9 units per household) (*Ibid*). This is a district where the most food insecure households and those most vulnerable to food insecurity live: this is the main criterion for its selection. One of the two villages is close to the major market in the Tigray region (Mekelle city) while the other is dominated by cereal crop production.

Hintalo-Wajerat district:

Hintalo-Wajerat district has 22 villages with a total population of 129,601 in 2013: females account for 49.9% of the population, males 50.1% (HWWOARD, 2013). The total geographical area of the district is 36,055 ha and the average land holding per household is 0.81ha. In this district, farm households rely mainly on rainfall to grow their crops. The major crops grown are *teff*, wheat, barley and sorghum. Irrigation is practiced to a certain extent but the majority of it is practiced at Andi Woyane village (one of the two selected sites). Livestock production is an important sub-sector here. The number of cattle in the district was 127,760 (average 2.9 per household) and the number of sheep and goats was 116,313 (average 2.6 per household) (*Ibid*). This is also a district where high numbers of food insecure and vulnerable households live. One of the selected villages has relatively more irrigation facilities whereas in the other village livestock rearing is dominant.

Selection of villages:

For the purpose of the study two villages each from Enderta and Hintalo-Wajerat districts were selected based on proximity to markets, the farming practices followed (cereal-based or livestock-dominated) and irrigation practices (Figure 3.1). In selecting the study villages data pertaining to particular farming system(s) followed, land holding of households, major crops grown, number of large and small ruminants, irrigation facilities and distance of each village from Mekelle city and *woreda* capital were gathered from Administration Offices, Agriculture and Rural Development Offices, Health and Water Offices of the two districts. The villages selected for the study represent mainly a midland agroecological zone and households generally practice a mixed crop-livestock type of farming. The selected villages for the study are the following:

Mahbere Genet *tabia* (Enderta): A village very close to Mekelle city, with many off/non-farm activities;

Meseret *tabia* (Enderta): A village dominated by cereal-based farming system;

Andi Woyane *tabia* (Hintalo-Wajerat): A village with relatively higher numbers of irrigation users that are expected to have higher cash income through cash crops; and,

Tsehafti *tabia* (Hintalo-Wajerat): A village with a dominant livestock activity, with mixed type of farming.

Figure 4.1 shows the map of Tigray as well as the districts and villages selected for the study.

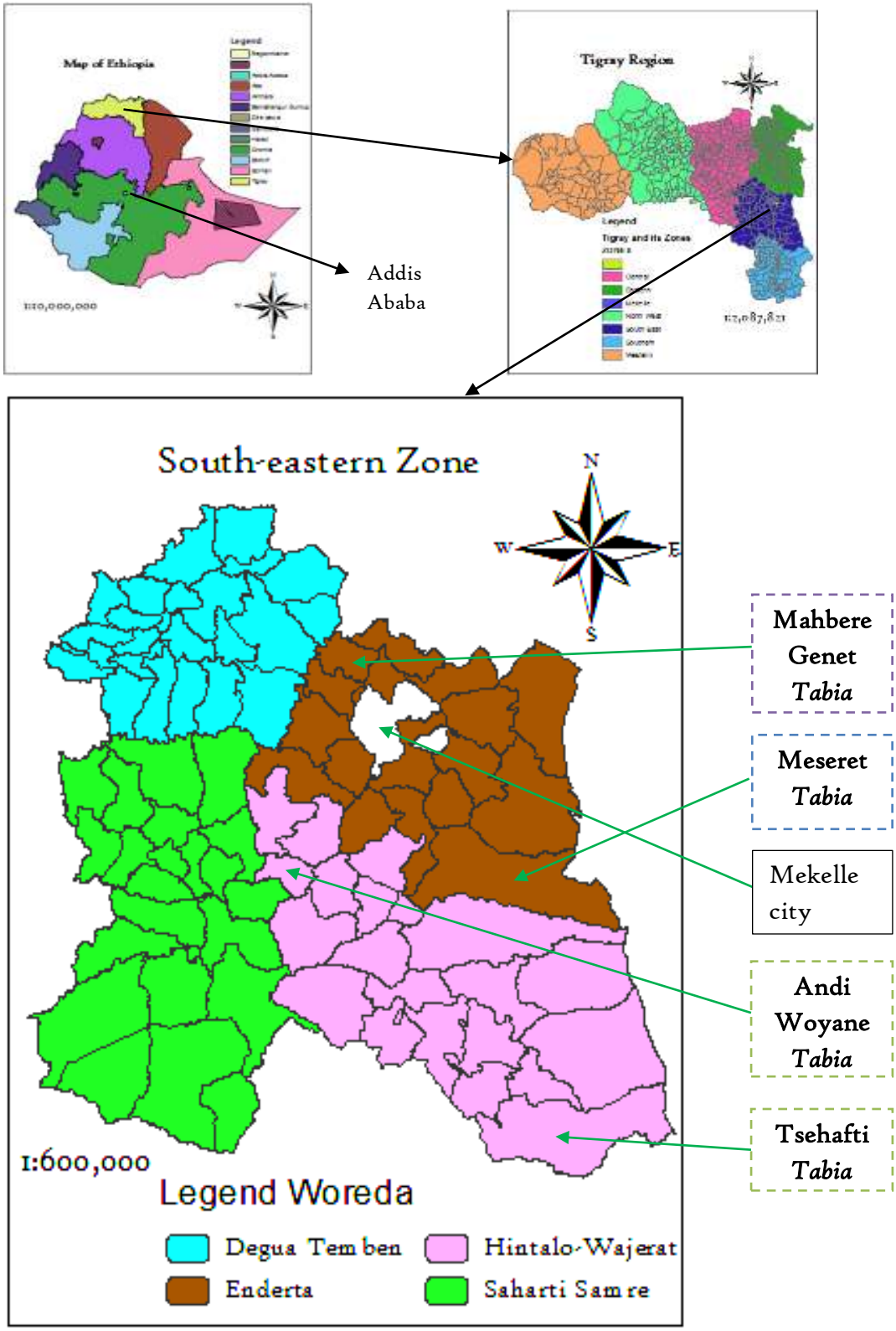


Figure 4.1: Location map of the study *tabias*

Selection of sample households

Complete enumeration of rural households living in each of the 4 villages was taken from the household registry of the respective village administration office to select sample respondents. Before final selection of households, the authenticity of the list was checked by the researcher against residence change, migration, deaths, divorce and separation.

The sample size for the study was determined using power calculations. The calculation took the complete list of all households in the selected villages, confidence intervals and sampling error into account. Finally, 400 sample households were randomly selected for the study, proportionately taken from each village (Figure 4.2 and Table 4.1).

Five enumerators from Mekelle University (the home base of the researcher) participated in the two rounds of household data collection that took, on average, about 26 working days each. All the enumerators were MSc holders in the areas of agriculture, economics and natural resources with adequate experience in household data collection using a questionnaire. The researcher gave training on household data collection for two days followed by pilot testing at a nearby village, with each enumerator as well as the researcher filling-in 3 survey questionnaires. Based on the testing the researcher clarified the questionnaire point by point before the primary data collection. After starting the actual data collection, there were daily discussions with the enumerators on the questionnaire and data collection process, until the researcher felt that the process was going well. The researcher himself participated in primary household data collection on some occasions in all the four villages for better understanding. The researcher had also the additional task of checking each filled-in questionnaire every collection day for validity.

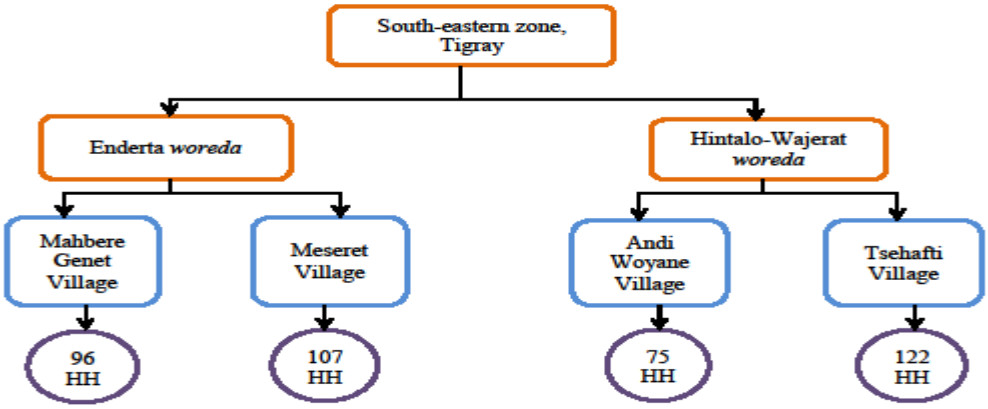


Figure 3.2: Sampling procedure of the household survey

Table 4.1 depicts the proportionate sample size in each of the four selected villages:

Table 4.1: Village and gender-wise sample size

S. N.	Name of village	No. of households in the village			Sample households (Round 1)			Sample households (Round 2)		
		Total	FHH	MHH	Total	FHH	MHH	Total	FHH	MHH
	Enderta district:									
1	Mahbere Genet	1435	1181	254	96	20	76	96	20	76
2	Meseret	1599	1314	285	107	10	97	101	10	91
	Hintalo-Wajerat district:									
3	Andi Woyane	1121	936	185	75	11	64	72	11	61
4	Tsehafti	1823	1517	306	122	23	99	121	23	98
	Total	5978	4948	1030	400	64	336	390	64	326

4.3. Description of the data and methods of data collection

4.3.1. Data type and sources

Primary data

The primary data collected were on demography and assets, household economy, off-farm employment and other sources of income, household food consumption, food frequency and coping mechanisms as well as household health status and facilities. The other important sources of primary data were group discussions and interviews with selected farmers as well as village-level managers, development and health extension workers.

Secondary data type and sources

Secondary data pertaining to agricultural production and yields, growth, natural and physical conditions in the study area, level of food insecurity, nutritional status, prices of agricultural products and other statistical data were collected from various sources.

4.3.2. Methods of data collection

In order to capture seasonal differences in food availability, access and utilization data were collected in two rounds, one immediately after harvest in January and February 2014 (Round 1, post-harvest season) and the other before harvest in September 2014 (Round 2, pre-harvest season). These periods were selected for data collection as they are typical high and low food availability periods of the year (Maxwell *et al*, 2013). Relevant information was also gathered through Focus Group Discussions (FGDs) and Key Informant Interviews (KIIs). In the second round, data were collected from 390 households, with 10 (2.5%) of them missing for various reasons. The missing households were randomly distributed and do not influence the validity of the results. The data collection techniques used for the study are briefly discussed below.

Household survey questionnaire

The primary data were systematically collected from sampled rural households in the study area using a structured questionnaire for both the pre- and post-harvest rounds, for the agriculture year 2013/14. The household survey questionnaire, divided into six modules, is the main component of the data collection process (See Appendix I).

The household survey questionnaire was prepared based on the Sustainable Livelihoods Approach developed by Maxwell and Caldwell (2008), the Household Economy Approach developed by Save the Children (Save the Children, 2008), Coates *et al*. (2007), Swindale and Bilinsky (2006), Doocy *et al*. (2005) as well as DFID (DFID, 2000). The modules include demography and assets; household economy (particularly agricultural production); off-farm employment and other sources of income; household consumption; food frequency, food security and coping mechanisms; and health status and facilities. It contains both closed and open-ended questions. The former enables to get factual data relevant to the study objectives and the latter to accommodate for diverse opinions from respondents. In most cases, both the head and the spouse were interviewed in the sampled male-headed households while the mother was the respondent in case of the sampled female-headed households. All the data collected answer the four research questions of the study. The contents of the sections are briefly described as follows:

In module 1, data pertaining to the household demography (age, sex, relationship with the household head, religion, marital and educational status, major occupation and migration of members) were collected using a roster. The module also captured houses and housing conditions, assets (mainly agricultural) used for agricultural and off/non-farm activities and durable goods; access to and ownership of land as well as use right. These are particularly important to understand household composition and the variables that influence availability of productive activities, livelihoods and nutrition.

Module 2 is about household economy and decisions made on crop and livestock production activities. During the post-harvest season size of farm land, detailed crop and livestock input/output data, own produce for home consumption as well as seed and disposal of agricultural products, extension services and marketing were collected. The data on input use mainly include labour (mainly family), amount of seed, fertilizer and pesticides. The questionnaire for the pre-harvest (lean) season is similar to that of the post-harvest season as comparisons are made on selected variables between the two seasons, except that it is less detailed on crop production and input use.

Module 3, Off/non-farm employment and other sources of income, captures details of the activities and income earned over the past 12 months from employment, transfers and self-employment. The income from employment includes food-for-work (FFW), cash-for-work

(CFW) and other daily labour. The income from transfers is mainly from remittance, government transfer (pension and compensation), participation in PSNP, assistance from relatives and neighbours. The self-employment income sources include sale of handicrafts and natural resources, sale of beverages and other petty trading. The module also captures the household member(s) controlling income and the barriers to greater participation in off/non-farm activities.

In module 4, data pertaining to household food consumption and the sources over a 30-day period, disaggregated into cereals, pulses, vegetables and fruits, livestock and livestock products, and other food items such as oil and sugar and food consumption decision were collected.

Module 5, on food frequency, food security and coping mechanisms captures the frequency of food consumption of 16 possible food groups over a period of one month prior to the interview day to analyse dietary diversity; data for HFIAS food consumption frequency levels based on 9 relevant questions; household coping strategies that include frequency-based responses on 7 questions. Data were also collected on food shortage that households faced during the past 12 months; food shortage months and responses to shocks experienced by households. Dietary diversity score is often computed based on 7-day or 24 hour recall. However, in this study, a 30-day recall was used. Generally using the 30-day recall has some limitations: food groups are much more likely to have been consumed over a longer than a shorter period. This may make dietary diversity comparisons with other studies difficult. However, in the study area most households eat the same type and composition of food items almost every day and recall for a relatively longer period is not thought to be a problem. Almost all households consume cereals and pulses on a daily basis and very little vegetables and fruits occasionally. Exceptions are religious (Christian) holidays, which take place four times a year, where meat, eggs and dairy products are consumed for 1-2 days. Thus, it is expected that in the Tigray context using a 7-day recall or a 30-day recall period will result in similar estimates of dietary diversity. In addition, there is some advantage in using a longer recall period in estimating the Food Consumption Score, which measures frequency as well as diversity of consumption.

Module 6, on health status and facilities captures the health status of members of the household; the source of and access to water and sanitation, food preparation and cooking

place, feeding and caring practices, fuel and water fetching and frequency of visits and support from health extension workers. This module was used to a lesser extent in analysis.

Focus Group Discussions

Selected questions from the household survey were used for the FGDs to understand, triangulate and validate the findings, by selecting 8-10 farmers in each of the four villages. The participants were selected randomly but at least one-third of them were arranged to be women (and, on average, 31% were women farmers). The discussion was arranged in cooperation with the village officials, in which the date of discussion was fixed together by selecting a convenient day. In each village, discussions were chaired by village managers (deputies to the village administrators who are responsible for technical aspects related to land administration, agriculture, water resources, soil and water conservation and environmental rehabilitation), with the researcher asking questions, giving explanations and taking notes as rapporteur. The major points were related to agriculture-nutrition linkages and decision making; issues related to off/non-farm activities and income; and consumption and nutrition security and coping mechanisms used in periods of food shortage and shocks (See Appendix-II). The discussions were interactive to the satisfaction of the researcher in light of the objectives of the study. The discussions took 2.0-2.5 hours. The summary of the results from the discussions indicate that most of the responses are generally similar in all the four villages, with few differences (some of these are discussed in their respective chapters).

Key Informant Interviews

Relevant agriculture and nutrition issues and selected questions from the household survey were also used for the KIIs for better understanding of agriculture, food and nutrition security situations in the study area. Information was gathered from all the four villages by selecting 3 key personnel from each of the four villages: village manager, extension development agent and health extension worker. Information pertaining to the impact of agriculture on nutrition, the understanding of good nutrition, the trend of food availability during the months of the year, farmers' problems related to production, consumption and marketing of crops and livestock and land security and use right were collected (See Appendix III). The interviews with each person in each of the four villages were conducted by the researcher. The interview results show that the understandings of the key informants on the issues raised in the four villages were generally similar.

The administration and agriculture and rural development offices at *woreda* and village levels played an important role in the arranging and conduct of the household survey as well as FGDs and KIIs. All data collection was successfully completed according to plan. To compensate for the time spent during the household survey, a quarter kilo of coffee was given to each respondent. Similarly, participants in the group discussions and informant interviews were compensated for the hours they spent with the researcher.

Researcher observation

The researcher's observation was helpful in understanding the livelihoods of the rural households and the sources of their livelihood and in triangulating the findings. Observation of living conditions of households in general and agricultural fields, housing, livestock rearing and management, housing conditions, cooking place and cooking materials, food consumption habits, physical appearance and clothing of household members, sources of water, sanitation, informal discussions with some members including coping mechanisms practised after food shortage and other shocks were all important. Selected photos are presented showing part of the study villages and respondent interviews (See Appendix IV).

Ethical considerations

Ethical approval was sought and obtained prior to data collection from respondents. The necessary ethical procedure was followed and detailed discussions took place with appropriate University authorities, the selected woreda and village administration personnel, and with respondent households. The discussions included the objectives of the study, the means of data collection, the data and information designed to be collected, and the use of the data: specifically that they are only to be used for academic purposes, that names of individual households are not to be mentioned and that the corresponding data collected are not individually reported. These discussions were followed by issuance of approval letters from Mekelle University - the home base of the researcher - and then the woreda office of administration. The researcher is from the local area and this helped in facilitating the data collection process. The letters produced before the data collection- in the local language - are provided in Appendix V. Further discussions were made with village administration authorities to smooth the data collection process, which resulted in full clearance from all the authorities at all levels. Before the interviews the enumerators obtained the informed consent of the households for the interviews. Village administration authorities were cooperative and helpful in the smooth completion of the survey in all the four villages in the stipulated time.

The researcher has the advantage of being from the study area, speaks the local language Tigrigna (mother tongue) and has an in-depth knowledge of the culture, which helped to get the trust and ease the understanding with the local authorities and households. This helped to carry out the household surveys, FGDs and KIIs successfully.

Description of the data (set)

Quantitative and qualitative data were collected on household characteristics, household economy, food consumption, nutritional outcomes as well as variables influencing the outcomes in two rounds on the same selected sample households.

The household survey questionnaire provides quantitative information on important variables in relation to demography and assets; household economy (particularly agricultural production); off-farm employment and other sources of income; household consumption; food frequency, food security and coping mechanisms; and health status and facilities. Local units of area and weight were converted to standard units in the data set. The area of farmlands is given in hectares, locally measured in *tsimdi* (1 *tsimdi*=0.25ha); local measures of weight (*cuanculu, birchikho, shember, mishe, khefer*) are converted to kilograms; and monetary values are given in Ethiopian Birr (ETB), one USD equivalent to 19.09 ETB (January 10, 2014) at one point during the post-harvest season and 19.76 ETB (August 25, 2014) during the pre-harvest season.

The information from FGDs, KIIs and the open-ended opinions of respondents in the household survey were also categorized under appropriate groups by village, using Excel. Relevant anecdotes were noted and in some cases are quoted directly in the thesis.

Data entry

Responses to the closed-ended questions in the two-round household survey questionnaires were entered into a computer using SPSS version 16.0 and outputs were generated. Data cleaning was carried out especially on standardizing the units of measurement used. The information collected using the open-ended questions as well as information from the FGDs and KIIs were transcribed, categorized, tabulated and analysed.

4.4. Methods of data analysis

Households are the entry point and focus of food and nutrition security, as the variables at the household level are major drivers of nutritional outcomes (Christiaensen and Alderman, 2001 cited in Thompson and Amoroso, 2014). Quantitative and qualitative methods of data analysis were used in combination to better understand the livelihoods of households, the agriculture-nutrition linkage and factors influencing food and nutrition security in answering the objectives of the study. Household food security is measured using various indicators. The various indicators used are discussed further below. Some important challenges arise when attempting to measure the agriculture-nutrition linkage at household level. In relation to consumption from own production, it is important to develop a production diversity index. On the income side, disaggregating agricultural income and how this has been spent can be important (Carletto *et al.*, 2015).

Carletto *et al*. (2015), and Masset *et al*. (2011) identified important challenges in building the link between agriculture and nutrition at the household level: (1) identification of the set of accurate variables to run rigorous analysis, for instance, a production diversity index might be the most appropriate measure to see the link between own produce and consumption. (2) Selection of appropriate methods to measure nutritional status is another challenge: whether to use proxy measures such as dietary diversity or outcome measures such as biomarkers or anthropometric indicators is subject to the objective which the measure serves.

Table 4.2 briefly summarizes the data that were required to analyse each of the research objectives; the sources for both the quantitative and qualitative data; and the means of data analysis. Approaches to data analysis are discussed further below.

Table 4.2: Summary of required data, data sources, and tools for analysis

Research questions	Required data	Data source	Tools of Analysis
How do farm resources, production choices and decisions, and agricultural income of rural households influence agricultural production and disposal?	Households characteristics Farm size, All factors of production (land, labour, inputs, implements) Production (cereals, pulses, oil seeds, vegetables, fruits, others) Livestock ownership Land size Agroecology Household income (farm and off/non-farm income)	Secondary sources Household survey data FGD KII	Quantitative: Descriptive (%, significance tests) Qualitative: FGD summary, KII summary
What do rural households consume; how does food consumption and food security status change over the year and what are households' responses to shortage of food?	Food consumption data by item 30-day food frequency Food shortage months Data from HFIAS scale Data on major shocks faced by HHs Data on coping mechanisms	Household survey data FGD KII Personal observation	Quantitative: Descriptive HDDS FCS HFIAS CSI Qualitative: FGD summary, KII summary
What is the relationship between agriculture, underlying socio-economic characteristics and the food and nutrition security status of households?	Variables that influence household consumption Variables that influence household nutrition security Agricultural production and income Selected institutional aspects	Household survey data FGD KII Personal observations	Quantitative: Descriptive statistics Regression analysis, Correlation Probit model Qualitative: FGD summary, KII summary
What factors are associated with the higher levels of vulnerability of particular households?	Wealth group, income quartile data and households categorized based on FCS scores, households categorized based on HFIAS, households disaggregated into FHH and MHH	Household survey data FGD KII Personal observations	Quantitative: Regression analysis Qualitative: FGD summary, KII summary

Quantitative methods of data analysis:

Descriptive statistics

Descriptive statistics were used for data analysis. These include percentages, averages, ratios and frequencies to understand the socioeconomic characteristics of households and their influence on household economy and livelihoods, food consumption, seasonality of consumption and food and nutrition security. Descriptive statistics were also used to understand the correlations and differences among rural households for selected variables and for factors influencing nutrition security. Tests of significance-chi square, F and t-tests-were used to examine the existence of statistical significance of influencing variables. The results are presented in the form of tables, bar graphs and pie charts.

Econometric tools used in the study

The nature of the data and the dependent variables limit the choice and use of econometric tools used; specific approaches are elaborated in their respective chapters. Ordinary Least Squares (OLS) multivariate regression model is used to estimate the influence of variables on food consumption, dietary diversity and access to food as well as to analyse the association between farm practices and dietary diversity. Dependent variables in the analysis included the food security indicators which serve as proxies for food and nutrition security.

The Probit model is used for a dependent variable with dichotomous choices (Jackman, 2000); it is used in the analysis to see the association between individual crop and livestock farming practices by incidence of HDDS food groups.

Qualitative methods of data analysis:

As explained above qualitative data were collected through open-ended questions from the household survey, FGDs and KIIs. The information from the group discussions and key informants analysed focused mainly on: contribution of agriculture and other livelihood sources to nutrition; production and consumption decisions by FHH and MHH; food consumption and taboos; foods consumed and feeding practices; individual household members versus food priority; level of food consumption between seasons; community understanding of nutrition and coping strategies; local markets and food availability; and land issues, production, consumption and marketing problems. The collected information was transcribed, categorized, summarized and discussed. The results were important in deepening

the understanding on agriculture, livelihoods, nutrition and the link between them as well as seasonality of consumption, and what needs to be done to achieve food and nutrition security.

Direct quotes from the FGDs were used wherever possible to reflect the voice of households and the existing situations in production, household food consumption, nutrition and other socio-economic and cultural aspects in the area.

4.4.1. Comparison: FHH and MHH

Valid gender comparisons are possible when selected sample households (FHH and MHH) adequately represent the population. Comparisons on selected variables were made to understand important differences between FHHs and MHHs in selected variables. The ratios between FHHs and MHHs at both levels were tested for equality and were found to be equal: MHHs account for 82.8% and 84.0% of the sample households and the population, respectively whereas the corresponding figures for FHH are 17.2% and 16% (See Table 3.1). Thus, the comparison between FHH and MHH on selected variables is valid and this is applied in the subsequent chapters.

4.4.2. Measurement of food security and agriculture-nutrition linkages

Amartya Sen's conceptual contribution to food and nutrition security helped to redefine the way it is understood: food insecurity is not mainly due to the problem of availability of food in an area but the lack or shortage of access to food (Webb *et al*., 2006). Food and nutrition security is influenced by location, wealth, farm size, agricultural input use, access to markets, access to safe water and mother's education (CFS, 2012; Feleke *et al.*, 2005 cited in Hillbruner and Egan, 2008; Iram and Butt, 2004; Garrett and Ruel, 1999). Households are said to be food and nutrition-secure when food security is attained and combined with adequate feeding and care practices, health services, water and sanitation (Rajkumar *et al*., 2012). There is no single method that adequately measures food security. Therefore, a bundle of indicators are used to determine whether households are food and nutrition secure (Hirvonen *et al*., 2015; Maxwell *et al*., 2014; Carletto *et al*., 2013; Coates, 2013; FAO/WFP/IFAD, 2013; Kennedy *et al.*, 2013). In this study the indicators used are primarily relating to food intake, as opposed to broader measures which take into account health status, care practices and so on.

Four major food security indicators are commonly used in the measurement of food security at the rural household level.

Household Dietary Diversity Score:

Dietary diversity is the number of food groups consumed over a given period of time (Ruel, 2003 cited in Thompson and Amoroso, 2014). Dietary diversity is a measure of access to food by households.

The household dietary diversity score (HDDS) was first developed by the Food and Nutrition Technical Assistance (FANTA) Project (Swindale and Bilinsky, 2006). HDDS is a proxy measure for household's access to food. It measures dietary diversity at household level in a 12-scale score. Later, FAO standardized the guideline and it became a standard tool for diet diversity measurement. The foods consumed by households are first recorded into 16 standardized food groups, before regrouping them into 12 food groups. Simple counting of the food groups consumed over a given reference period gives the dietary diversity score of households for the reference period, usually a 24-hour or 7-day recall. Mean scores are derived to analyse consumption patterns of households and differences in consumption between them (Thompson and Amoroso, 2014).

Dietary diversity indicators are believed to be good indicators of food and nutrition security (Headey and Ecker, 2012). This is because the measure of diversity of diets captures the consumption of nutritious food, which fulfils one requisite of the standard definition of food and nutrition security (FAO, 1996). Another reason is related to the theory of demand, which explains that as households become richer they tend to shift consumption to a more diverse and balanced diet and, thus, increasing utility (Headey and Ecker, 2012). Studies in Mozambique and Tanzania show the use of mean dietary diversity in differentiating households with high and low dietary diversity: the differences in dietary diversity between households may provide a basis for developing policy interventions (Thompson and Meerman, 2014). Recent studies suggest that the application of dietary diversity indicators to measure food security is growing (Maxwell *et al*., 2014; Carletto *et al*., 2013; Headey and Ecker, 2012).

Dietary diversity indicators can be used to capture seasonal variations in household food consumption. Comparisons between the dietary diversity in the main harvest season and the

pre-harvest seasons are one indication of the impact of agriculture on food security (Headey and Ecker, 2012).

Dietary diversity scores are not free from limitations: one particular limitation of the HDDS is that there is no cut-off point to show the adequacy of diet diversity for a household. It does not consider food consumption frequency (Maxwell *et al*., 2014; Maxwell *et al*., 2013). It also does not consider food consumed by members of a household outside of their home (Swindale and Bilinsky, 2006). This underestimates the dietary diversity in urban areas (Thompson and Amoroso, 2014). However, this is not a problem for rural households as food is mostly consumed at home.

Results of dietary diversity scores can be used to address the issues of gender equality as well as to improve diet quality. But many agree that they should be used along with other measures and triangulated against important dimensions of food and nutrition security (Maxwell *et al*., 2014; Thompson and Amoroso, 2014).

Food Consumption Score:

The food consumption score (FCS) was first developed by the World Food Programme (Maxwell *et al.*, 2013; WFP, 2009; Wiesmann *et al.*, 2006). The FCS combines diet diversity and the frequency with which this diet is consumed by households. Therefore, it is a measure of both household dietary diversity and food consumption. Data can be collected based on a seven-day recall. However, many studies also analyse the FCS based on data collected for 30 days preceding the interview (Maxwell *et al*., 2013; Vaitla *et al*., 2012).

FCS is a composite score based on dietary diversity, food frequency, and relative nutritional importance of different food groups. FCS captures the quality, quantity and diversity of food consumed. It gives more weight to food groups that are deemed more nutritious (WFP, 2008). FCS assigns a weight of 4 to the meat, fish and milk food group; a weight of 3 to pulses; a weight of 2 to cereals; a weight of 1 to vegetables and fruits, and 0.5 to sugar and oil. It is an acceptable proxy indicator to measure diet quality at household level. Combined with other indicators of access to food it can be a good indicator of the food security status of households (Headey and Ecker, 2012). The score for FCS ranges between 0 and 64. Households scoring below 21 are considered to be experiencing poor food consumption, 21.5 to 35 are

experiencing borderline food consumption whereas those higher than 35 are considered to have acceptable food consumption (Maxwell *et al*., 2013).

The joint statement by FAO and WFP (2012) maintains that HDDS and FCS are proxy indicators of access to food. Both indicators are used to compare access to food at different locations and over time (FAO and WFP, 2012). The FCS combines a longer reference period and consumption frequency and differentiates food groups and provides a complete and in-depth assessment of access to food (FAO and WFP, 2012; Vaitla *et al*., 2012; WFP, 2009).

Household Food Insecurity Access Scale:

The household food insecurity access scale (HFIAS) was first developed by Coates *et al.* (2007). It measures food insecurity by combining three dimensions of food access: quantity, quality and anxiety related to adequacy of food. The HFIAS captures behaviours of households with respect to inadequate quantity and quality of food consumed. It also considers the anxiety and uncertainty over household's insecure access to food. Inadequate quality includes variety and preferences for the type of food households consume. HFIAS captures a mix of sufficiency and psychological factors. The score ranges between 0 and 27, depending on responses to nine questions covering the above dimensions of food access. Higher scores of HFIAS suggest greater food insecurity and vice versa (Maxwell *et al.*, 2013).

HFIAS is an easy and simple method which captures multidimensional concepts of household food security. HFIAS addresses perceived risks of food insecurity unlike dietary diversity recall or anthropometric measures (Kabunga *et al.*, 2014). HFIAS, as a qualitative measure of food insecurity, is a robust and applicable tool, and can be applied in other wider settings (Kabunga *et al.*, 2014).

Coping Strategies Index:

The coping strategies index (CSI) was developed by Maxwell in 1996, with a view to measuring how households respond when they cannot access adequate food. CSI measures the adjustments households make in food consumption and livelihoods. Coping can be related to consumption changes; expenditure reduction; and, income expansion. CSI captures the element of sufficiency or quantity. Households are asked multiple behavioural frequency-weighted questions ranging from the changes they made in the diet to their responses to coping mechanisms of getting food (Maxwell *et al.*, 2013).

There are no standards to make comparisons between the commonly used food insecurity indicators thus it is difficult to choose from the indicators (Maxwell *et al.*, 2014). This implies the use of a combination of suitable indicators depending on objectives, as suggested by Maxwell *et al.* (2014), Coates (2013) and FAO (2013).

Maxwell *et al.* (2014) attempted to compare the major indicators of food security viz., HDDS, FCS, HFIAS and CSI for rural households in two woredas of Tigray region, and found that the measures showed differences in estimating food insecurity prevalence. However, the same study also reveals moderate correlations and overlap between the indicators and similarity in household food security trends over time. The differences in the food insecurity prevalence measures are due to differences in dimension of the indicators, differences in the measure of severity of food insecurity, and differences in the method of classification of food insecurity of households. CSI and HFIAS as well as FCS and HDDS are correlated and clustered together. Although CSI and HFIAS are clustered together as measures of food insecurity, the indicators measure food insecurity prevalence differently: the prevalence estimates for HFIAS are higher than the CSI scores (Maxwell *et al.*, 2014). One possible explanation for the difference is that HFIAS includes a wider range of behaviours and experiences of households (Maxwell *et al.*, 2014).

All the food security indicators measure various dimensions of food security and are proven measures (Coates *et al.*, 2006 cited in Maxwell *et al.*, 2014; and Maxwell *et al.*, 2008). The applicability and validity of the indicators depends on the objectives and circumstances, making universal application of household categorization based on results non-plausible (WFP, 2012; Coates *et al.*, 2007). For instance, in categorizing households based on CSI results, local criteria should be considered as these indices widely vary from one location to another (Maxwell and Caldwell, 2008).

Various studies suggest that dietary diversity indicators are applicable across households within countries and can be used in policy analysis. For example, household dietary analysis is studied by Wiesmann *et al*. (2009) in three developing countries; and Hoddinott and Yohannes (2002) for 10 countries. But Headey and Ecker (2012), Deaton (2011) and Deitchler *et al.* (2010) argue that there is no study thus far that validates dietary diversity indicators for cross-country comparisons. This is mainly because there are significant differences in diets across countries.

4.5. Summary and conclusion

In the face of the widespread problems constraining agricultural production and productivity, the task to get rural households out of poverty and food insecurity is huge. Thus, policies, strategies and programmes related to the food system need to be designed better to contribute to poverty reduction and improve food and nutrition security. For this, it is important to improve understanding of the livelihood systems, the agriculture-nutrition linkage, the pathways of the link as well as seasonality, gender and other influencing factors.

For this study, data collection was carried out in four villages from two *woredas* of the south-eastern zone of Tigray, selected based on the level of vulnerability to food insecurity. The data were collected using household survey questionnaire, FGDs and KIIs. Descriptive statistics, multiple regression techniques, Ordinary Least Squares (OLS) regression and probit analysis were used for the quantitative analysis. The following chapters discuss the analysis of these data.

CHAPTER FIVE

AGRICULTURAL PRODUCTION, PRODUCT DISPOSAL, AND EXPENDITURE

5.1. Introduction

Agriculture is the back bone of the economy of rural households in many developing countries. The World Bank (2007) report strongly states that growth in agriculture can induce growth in other sectors of the economy in Africa and that smallholder rural farming communities are the major contributors to growth in agriculture (de Janvry and Sadoulet, 2010).

As discussed in section 2.5 of Chapter 2, there are distinct pathways that link agriculture and nutrition. These pathways are direct but multifaceted. Agriculture is linked to nutrition through production for household's own consumption, income from sale of agricultural products, reduced food prices and women's participation in agriculture by way of empowering them to decision making, income, nutritional status and health (Wiggins and Keats, 2013; Gillespie and Kadiyala, 2012; Hoddinott, 2012; Hawkes and Ruel, 2008). There is potential for smallholder agriculture to improve food security and the nutritional status of households mainly through these pathways. Despite all these direct and indirect contributions, rural households, who are predominantly smallholders, are food insecure and suffer from malnutrition (Wiggins and Keats, 2013). Increased food production should have an effect on a household's food availability, access and utilization. This chapter mainly analyses two of the pathways viz., agricultural production for own food consumption and income through the sale of produce.

The chapter is structured with reference to the main guiding conceptual frameworks, i.e. the livelihoods framework and the agriculture-nutrition pathways literature. Thus there is an initial focus on household demographics and household assets. Land is the key productive asset and a number of issues are discussed in relation to land ownership and use. This is followed by analysis of agricultural production and the disposal of agricultural products, household income from various sources (on-farm, off-farm and non-farm), farm expenditure and factors influencing food security, based on data collected for the 2013/14 agriculture year. Differences in production and disposal in terms of seasonality, location (agro-ecology) and gender are analysed. Further differentiated analysis is conducted by disaggregating

households into wealth groups (based on assets) and income quartiles, in order to analyse potential differences between households.

5.2. Household demography and assets

Table 5.1 presents basic demographic data for the 400 sample households by village and in total. Overall 16% (64) are female-headed households and 84% (336) are male-headed households. The average age of the household head is about 46 years but this differs slightly from site to site. The average family size for all the sites is 5.9 with significant differences across the four sites. The highest family size is observed at Meseret *Tabia* (6.3) and the lowest is at Mahbere Genet *Tabia* (5.4). The average adult equivalent is 4.9 and varies significantly between 4.5 at Mahbere Genet and 5.2 at Meseret *Tabias*.

Another important household characteristic is level of education. As shown in Table 5.1, 59% (236) of the household heads are illiterate and the remaining 41% (164) can read and write, with the highest grade achieved being grade 10. The general education levels of mothers are very low, with an average literacy rate of only 18.2%.

Migration was also analysed. Of the total household members, 3.2% (74) migrated during the 2013 agriculture year for various reasons. Migration for education accounts for 50% of the cases followed by employment outside of their permanent residence (32.4%), searching for job (14.9%) and staying with relatives (2.7%).

The results show that there is no significant difference in the key households' characteristics among sample households across the study villages except for family size (Table 5.1). Adult equivalent is also significantly different between villages: this is an important variable which can influence differences in food consumption among households across villages in the study area.

Table 5.1: Household characteristics

Description	Total (All sites)	Village (*Tabia*)				χ^2 and F- and t-tests[4] (p-values)
		Andi Woyane	Mahbere Genet	Meseret	Tsehafti	
Sex of Household head (%)						
Female	16.0	14.7	20.8	9.3	18.9	0.110
Male	84.0	85.3	79.2	90.7	81.1	
Age of Household head						
Mean (years)	46.1 (0.69)[a]	47.2 (1.44)	48.2 (1.56)	45.1 (1.35)	44.5 (1.20)	0.184
Family size						
Mean (no./household)	5.9 (0.11)	5.8 (0.19)	5.4 (0.23)	6.3 (0.22)	5.9 (0.20)	0.032**
Adult equivalent[5]	4.9 (0.09)	4.9 (0.17)	4.5 (0.19)	5.2 (0.18)	4.9 (0.17)	0.071*
Education of HH head (%)						
Illiterate	59.0	54.7	61.5	61.7	57.4	0.736
Read & write	41.0	45.3	38.5	38.3	42.6	
Education of mother (%)						
Illiterate	81.8	80.0	80.2	78.5	86.9	0.281
Read & write	18.2	20.0	19.8	21.5	13.1	
HH members migrated (%)	3.2	4.6	2.7	2.7	3.1	0.211
Observation (n)	400	75	96	107	122	
Adult equivalent-FHH[b]	3.2 (0.16)	3.6 (0.34)	3.2 (0.28)	3.3 (0.38)	3.1 (0.33)	0.763
Observation (n)	64	11	20	10	23	
Adult equivalent-MHH[c]	5.2 (0.09)	5.1 (0.18)	4.8 (0.23)	5.4 (0.19)	5.3 (0.18)	0.156
Observation (n)	336	64	76	97	99	

**, * at 5% and 10% levels of significance; (a) Figures in brackets indicate Standard Errors; (b, c) FHH=Female-Headed Households; MHH=Male-Headed Households

The chi-squared test of the null hypothesis tests the relationship between categories of gender of sample households, education level of household heads and mothers, whereas the F-test of the null hypothesis tests differences in average mean values of age of household head, family size and adult equivalent of households between the study villages.

[4] t-test tests the difference between the means of two groups on some continuous variable; chi-square test tests whether there is relationship between categorical variables; and F-test is used to compare more than two means, based on the ratio of two variables

[5] Adult equivalent is calculated using nutrition (calorie) based scales developed by Dercon and Krishnan (1998)

5.3. Rural households and productive assets
5.3.1. House and housing conditions

Table 5.2 reports indicators of rural households' living conditions, consisting of number of rooms and housing conditions, storage for agricultural products and sheds for livestock. The average family size is 5.9 and the average number of rooms is 1.42: this is inadequate for such a family size, indicating one consequence of persistent food insecurity problems in the area. The housing conditions are better at Mahbere Genet *Tabia*: this *Tabia* is closer to markets and opportunities for off-farm employment since it is close to Mekelle, the capital of Tigray national state. Availability of good quality stone, sand, and masons in the village could also contribute to better housing conditions. The housing conditions are lowest at Tsehafti *Tabia*. This might be linked to repeated crop failures and drought in the *Tabia*; this is also verified by the results of the FGDs in the *Tabia*.

The quality of storage for agricultural products and sheds for livestock has a bearing on availability of agricultural produce. Of all the households, 30% do not have storage and/or livestock shed; instead they use sacks for storage, while 63.7% use traditional buildings made from mud wall and thatched roofing as livestock shed. Across sites there are differences in storage/livestock shed quality. Households that do not have storage are highest in Mahbere Genet *tabia* (52.1%) and lowest in Andi Woyane (18.7%) and Meseret (20.6%) *tabias.* Use of traditional storage is highest at Meseret *Tabia* (74.7% of households) and lowest at Mahbere Genet *Tabia* (41.7%), where households use sacks to store their products. As stated by households, sacks are believed to be prone to insects and rodents that significantly reduce the quantity and quality of harvested and/or purchased produce.

About 8.8% of the households do not have separate kitchens to cook food, while 88.2% use traditional buildings made of mud wall and thatched roofing. Only about 3% of households use improved buildings for kitchen made of stone and iron roofing.

Table 5.2: House and housing conditions

Description	Total (All sites)	Village (*Tabia*)				F and χ^2-tests (p-value)
		Andi Woyane	Mahbere Genet	Meseret	Tsehafti	
Number of rooms						
Mean (rooms/household)	1.42 (0.03)[a]	1.37 (0.08)	1.66 (0.08)	1.47 (0.07)	1.22 (0.05)	0.000***
Residence quality[6] (%)						
Poor	42.00	50.70	12.50	31.80	68.90	0.000***
Medium	57.50	48.00	87.50	67.30	31.10	
Good	0.50	1.30	0.00	0.90	0.00	
Storage/livestock shed quality (%)						
No storage house	30.00	18.70	52.10	20.60	27.90	0.000***
Poor	63.70	73.30	41.70	74.70	65.50	
Medium	5.50	8.00	6.20	4.70	4.10	
Good	0.80	0.00	0.00	0.00	2.50	
Kitchen building quality (%)						
No separate kitchen	8.80	2.70	19.80	2.80	9.00	0.000***
Poor	88.20	90.70	74.00	96.30	91.00	
Medium	2.80	5.30	6.20	0.90	0.00	
Good	0.20	1.30	0.00	0.00	0.00	
Observation (n)	400	75	96	107	122	

***at 1% level of significance; (a) Figures in brackets indicate Standard Errors
The F-test of the null hypothesis tests differences in average mean values of number of rooms of households between villages, whereas the chi-squared test of the null hypothesis tests the relationship between categories of residence, storage and kitchen quality.

5.3.2. Livestock

Livestock rearing is an important agricultural activity in the area. Households raise cattle, small ruminants, chicken, equines and some also keep beehives. The average Tropical Livestock Unit (TLU) for the four sites is 4.04 per household. TLU is higher in Meseret and Tsehafti *Tabias*. In terms of ploughing, average oxen ownership is 1.29 (Table 5.3), however ploughing needs a pair of oxen. The shortage of oxen is bridged by shared/borrowed oxen by households (38.1%), swapping oxen for labour (3.1%) and paying a donkey load of straw for oxen (1.7%). Significant differences were observed in the TLU owned by FHH and MHH (Table 5.3): MHH own more TLU and oxen and the differences are statistically significant.

[6] Description of building quality: (i) Poor quality: Mud wall and thatched/soil roof; (ii) Medium quality: Stone/block wall and iron roof; and, (iii) Good quality: Tile floor, brick and plastered wall and iron roof

Table 5.3: Livestock resources (2013/14 agriculture year)

Description	Total (All sites)	Village (*Tabia*)				F-test (p-value)
		Andi Woyane	Mahbere Genet	Meseret	Tsehafti	
TLU (Tropical Livestock Unit)[7] (mean)	4.04 (0.16)[a]	3.22 (0.26)	2.79 (0.27)	5.34 (0.37)	4.41 (0.30)	0.000***
Ploughing oxen (mean)	1.29 (0.05)	1.13 (0.10)	0.95 (0.09)	1.80 (0.11)	1.20 (0.08)	0.000***
Observation (n)	400	75	96	107	122	
TLU (mean)						
FHH[b] (TLU/HH)	1.61	2.03	0.71	2.41	1.86	0.124
MHH[c] (TLU/HH)	4.51	3.42	3.33	5.64	5.00	0.000***
Oxen (mean)						
FHH (No./FHH)	0.39	0.64	0.20	0.80	0.26	0.152
MHH (No./MHH)	1.46	1.22	1.14	1.91	1.41	0.000***
Observation (n)-FHH	64	11	20	10	23	
Observation (n)-MHH	336	64	76	97	99	

***at 1% level of significance; (a) Figures in brackets indicate Standard Errors; (b, c) FHH=Female-Headed Households; MHH=Male-Headed Households;
The F-test of the null hypothesis tests differences in average mean values of the indicated variables between the study villages.

5.4. Land: area, ownership and management

5.4.1. Land holding

Table 5.4 shows the average land holding of households in the four sites: the overall average holding for the sample households is 0.80ha (or 0.16ha per adult). There are significant differences among the four villages in terms of land holding size. The highest holding per household is 1.20ha at Meseret *Tabia* and the lowest is 0.46ha at Tsehafti *Tabia*.

For female-headed households the average land size is 0.67ha, the smallest (0.36ha) being observed in Tsehafti *Tabia* while male-headed households own 0.82ha on average and the smallest is 0.48ha: this difference is statistically significant.

[7] TLU (Tropical Livestock Unit): Ox/Bull=1 TLU; Cow=0.8 TLU; Heifer=0.5 TLU; Calf=0.2 TLU; Sheep/Goat=0.1TLU; Horse=0.8 TLU; Donkey/Mule=0.5 TLU; Camel=1.1 TLU; and, Poultry=0.01 TLU (Njuki *et al*., 2011)

Table 5.4: Land holding by *Tabia* and gender (in ha)

Description	Total (All sites)	Village (*Tabia*)				F-test (p-value)
		Andi Woyane	Mahbere Genet	Meseret	Tsehafti	
Land holding						
Total land holding [8]	326.20	85.30	53.20	130.60	57.10	
Average land holding (all HH)	0.80	0.69	0.87	1.20	0.46	0.000***
Observation (n)	400	75	96	107	122	
Average land holding (FHH)	0.67	0.78	0.68	1.24	0.36	0.000***
Average land holding (MHH)	0.82	0.68	0.93	1.19	0.48	0.000***
Observation (n)-FHH	64	11	20	10	23	
Observation (n)-MHH	336	64	76	97	99	

***at 1% level of significance

The F-test of the null hypothesis tests differences in average mean values of the indicated variables between households in the study villages.

The farmland holding distribution summarized in Table 5.5 indicates that 69% of all the households own 1ha or less (38% up to 0.5ha and 31% of them between 0.5 and 1ha). Landless households account for 3% of sample households. Of all the 4 *tabias*, households at Tsehafti have the smallest land holding (74.6% of them own up to 0.5ha only) while households at Meseret *tabia* possess larger land holdings (about 58% have more than 1ha). It can be expected that production is higher in households with larger plot sizes and vice versa, with important implications for food security status. Production levels are discussed in section 5.5.

[8] Total land holding is land owned by a household. Total land holding is the sum total of own-cultivated land and rented-out land during the 2013/14 agriculture year

Table 5.5: Land ownership of households by land size (in ha)

Land size (ha)	Total (All sites)		Andi Woyane		Mahbere Genet		Meseret		Tsehafti	
	No. of HHs	%	No. of HHs	%	No. of HHs	%	No. of HHs	%	No. of HHs	%
No land	12	3.0	0	0.0	8	8.3	2	1.9	2	1.6
0.01-0.5	152	38.0	24	32.0	22	22.9	15	14.0	91	74.6
0.51-1.0	124	31.0	40	53.4	33	34.4	28	26.2	23	18.9
1.01-1.5	70	17.5	10	13.3	20	20.8	34	31.8	6	4.9
1.51-2.0	31	7.8	1	1.3	9	9.4	21	19.6	0	0.0
>2.0	11	2.7	0	0.0	4	4.2	7	6.5	0	0.0
Observation (n)	400		75		96		107		122	

5.4.2. Farmland ownership

The biggest share of the farmland (43.4%) in all 4 villages is owned jointly by both males and females as compared to plots owned or contributed to by females only (22.8%) or males only (33.8%) in the household. The figures are broadly similar for each village. As indicated in Table 5.7, 83.6% of the farmlands come from land distribution while transfer accounts for 15.5% of the means of ownership. The transfer has been mainly from parents and from spouses upon separation. Of the total 400 households, 97% (388 households) have their own land and the remaining 3% are dependent on either rented-out land and/or on livestock and off/non-farm income for their livelihood (Table 5.6).

The study results from 6 countries in Africa by Doss *et al*. (2013) show that women are underprivileged in terms of land ownership and land rights, implying lower food availability (from own-production) and low access to food. According to Ahmad *et al*. (2012) inadequate access to land also affects women's role in agricultural production. Amongst the sample households, while there is no clear gender bias in terms of rights to land, average land owned by FHH is less than that owned by MHH: this again indicates lower food availability for FHH, even before renting patterns are taken into consideration.

Table 5.6: Land ownership

Description	Total (All sites)	Village (*Tabia*)				χ^2-test (p-value)
		Andi Woyane	Mahbere Genet	Meseret	Tsehafti	
Ownership of land (%)						
Female	22.8	31.9	21.3	20.6	19.8	0.002***
Male	33.8	29.2	32.0	33.3	38.7	
Both female and male	43.4	38.9	46.7	46.1	41.5	
Means of ownership (%)						
Transfer	15.5	16.9	14.7	13.7	17.0	0.017**
Distribution	83.6	81.7	84.0	85.3	83.0	
Other (gift, etc.)	0.9	1.4	1.3	1.0	0.0	
Observation (n)	400	75	96	107	122	

***, ** at 1% and 5% levels of significance

The chi-squared test of the null hypothesis tests the relationship between the values of categories of the indicated variables for households in the study villages.

5.4.3. Land rent and rental arrangements

Table 5.7 provides data on land rental arrangements. The biggest single source of land rented-in was from female relatives (43.7%), followed by renting-in from a male relative (22.6%) and other males (20.5%). This is in line with the practice in the study area that female-headed households, if they decide to rent-out their plots, are persuaded to rent it to a male relative. This is also supported by the fact that the majority of the land was rented-out to male relatives (66.1%). The results from the FGDs in all the four villages also reveal that women are likely to rent-out their farm land due to shortage of agricultural labour, lack of ploughing oxen (see also Table 5.3) and, above all, the prevailing cultural farming practice does not allow women to plough on their own; it is even considered as a taboo for a woman to hold a plough. Households in the area see it as "*bi akebabina kab qhedem litsenhena meches sebeyti kitihars newri mikhuanu iyu"* (the culture and tradition in the area does not allow women to plough their own land). Instead, women are expected to give their land to someone to plough. This is still a common belief in the study area though there are changes since very recently. The dominant tenancy arrangement in the area is a 50:50 share of the product, with additional arrangements in which the tenant covers the cost of inputs and takes all the by-products. This accounts for 60.5% of all arrangements. About 99% of the tenancy arrangement is made by the land owner and the tenant privately and only 1% of the same were registered with the *Tabia* office.

Table 5.7: Land rent and rental arrangement

Description	Total (All sites)	Village (*Tabia*)				χ^2-test (p-value)
		Andi Woyane	Mahbere Genet	Meseret	Tsehafti	
Land rented-in from (%)						
Female relatives	43.7	45.4	46.1	41.8	42.3	0.193
Other female	13.2	11.4	20.5	7.3	15.4	
Male relatives	22.6	27.3	23.1	23.6	17.3	
Other male	20.5	15.9	10.3	27.3	25.0	
Observation (n)	190	44	39	55	52	
Rented-in land tenancy arrangement (%)						
50:50 share of harvest	17.9	13.6	15.4	18.2	23.1	0.025**
50:50 share of harvest & tenant covers inputs	13.7	25.0	7.7	5.5	17.3	
50:50 share of harvest, tenant covers inputs, takes by- products	60.5	56.8	59.0	65.4	59.6	
Cash rental	3.7	4.6	7.7	3.6	0.0	
Others	4.2	0.0	10.2	7.3	0.0	
Observation (n)	190	44	39	55	52	
Land rented-out to (%):						
Female relatives	3.1	0.0	4.0	0.0	5.9	0.038**
Other female	0.0	0.0	0.0	0.0	0.0	
Male relatives	66.1	91.7	52.0	72.7	64.7	
Other male	30.8	8.3	44.0	27.3	29.4	
Observation (n)	65	12	25	11	17	

**at 5% level of significance

The chi-squared test of the null hypothesis tests the relationship between the values of categories of the indicated variables for households in the study villages.

5.4.4. Decisions on land, land security and arrangement

Land tenure security is an important issue influencing land productivity and investment. Out of the sample households, 68.7% (275) of them have a blue land certificate as explained below while 19.5% (78) said that they have no land certificate at all though they use the land (Table 5.8).

Tigray National Regional State is one of the regions in Ethiopia that started land registration and certification in 1998/99 with the aim of providing tenure security for households. The certificate holders are entitled to limited land tenure rights that include using the land for agriculture, transferring it to offspring(s), renting it out to others for a limited period, and compensation in case of loss of plots (Dokken, 2013; FAO, 2013). According to Holden *et al.* (2011) the objective of certification is to enhance tenure security and ensure that rural households have the confidence to invest in and be beneficiaries from the land they are

provided with. Land tenure security is believed to encourage long-term improvements on land and the proclamation (FDRE Rural Land Administration and Land Use Proclamation No. 456/2005) states that there will be no further land redistribution.

A provisional certificate is issued to rural households entitling them to use the land until a formal certificate is issued. These temporary certificates are issued in white, green and red until the issuance of permanent certificates (currently blue cards, with yellow cards under preparation). Most rural households in the study area already have a blue certificate showing ownership of plot(s). The blue land certificate contains the name of the title holder (head of the household), location, plot size in local units, land use type, plot soil fertility status, and borders (Adgo *et al*, 2014). The yellow certificate currently under preparation, has, in addition to the details featured on the blue certificate, the name of the spouse and names of offspring(s), and map of the plot(s) developed from an aerial photo, which is more accurate than all other certificates issued so far. Upon completion, this will be issued to eligible households. This is believed to solve problems should border disputes among households arise.

In order to administer issues related to rural land, Tigray region has brought into being an agency, namely, the Tigray Environmental Protection Land Use and Administration Authority in 2004 (Adgo *et al*, 2014).

The majority of decisions on issues related to land such as the use of land, dealing with land registration officials, renting-in and renting-out of land, were made mutually by both men and women (60.8% of sample households). Respondents were also asked about their feeling of security on the land they owned: 75.8% (303) said that they feel secure while the remaining 24.2% (97) fear that, in the future, the government may take their plots to use for other purposes. This indicates that there are households who do not feel secure about their land, even having certificates.

Another issue of potential importance is the occurrence of disputes over farmland. 91.2% (365) of households have not had disputes over land holding. However, 22 respondents (5.5%) reported disputes over borders with neighbours, followed by 9 (2.3%), and 4 (1%) in which respondents had disputes with local officials and landlords/tenants, respectively over their plot(s). Thus, generally disputes over land are not a serious problem (Table 5.8).

Table 5.8: Land ownership and security

Description	Total (All sites)	Village (*Tabia*)				χ^2 test (p-value)
		Andi Woyane	Mahbere Genet	Meseret	Tsehafti	
Land certification (%)						
No land certificate	19.5	28.0	18.7	14.0	19.7	0.000***
Temporary (white, green, red)	7.0	8.0	5.2	3.7	10.6	
Blue	68.7	56.0	74.0	82.3	60.7	
Yellow	4.8	8.0	2.1	0.0	9.0	
Decision maker about land (%)						
Male	22.8	14.7	26.7	23.8	24.2	0.068*
Female	16.4	14.7	21.1	12.4	17.5	
Both male & female	60.8	70.6	52.2	63.8	58.3	
Land security feeling (%)						
No	24.2	25.3	29.2	16.8	26.2	0.188
Yes	75.8	74.7	70.8	83.2	73.8	
Dispute over the farm land (%)						
No dispute	91.2	89.3	89.6	92.5	92.6	0.593
Dispute with local officials	2.3	4.0	2.1	2.8	0.8	
Dispute with neighbours	5.5	4.0	7.3	3.8	6.6	
Dispute with landowners/ tenants	1.0	2.7	1.0	0.9	0.0	
Observation (n)	400	75	96	107	122	

***, * at 1% and 10% levels of significance

The chi-squared test of the null hypothesis tests the relationship between the values of categories of the indicated variables for households in the study villages.

5.5. Agricultural production

5.5.1. Area cultivated

The total cultivated land during the 2013/14 agriculture year was 453.9 ha, an average of 1.13 ha per household. Across the sites, there are differences in the average size of land cultivated. The average farmland areas for Andi Woyane, Mahbere Genet, Meseret and Tsehafti *Tabias* were 0.96, 0.99, 1.78 and 0.79 ha, respectively. Of the total average cultivated land of 1.13 ha, households cultivated an average of 0.80 ha from their own land (70.9% of the total cultivated land). Production on own-cultivated land is the highest at Meseret *Tabia* (1.27 ha) and the lowest at Tsehafti *Tabia* (0.49 ha) (Table 5.9).

The total rented-in land was 132.2 ha (an average of 0.33 ha per household). Average rented-in land was the highest at Meseret *Tabia* (0.5 ha). The *tabia* also has the highest average own-cultivated land. This is because the total cultivated area is larger in Enderta district than Hintalo-Wajerat district (see section 4.2.1.2); the highest average land holding per household is also in this *tabia* (See Table 5.4); FHH have higher average land holdings in the village, and likely rent-out; and a significant proportion of MHH in the *tabia* also rent-out land due to

resource (labour and oxen) limitations. This is also verified by the results of the discussion with the focus group in the village. Total rented-out land was 30.0 ha, an average of 0.08 ha per household during the 2013/14 agriculture year. The average rented-out land was the highest at Mahbere Genet *Tabia* (0.13 ha). Of the total rented-out land, 62.5% (18.9 ha) was rented out by female-headed households; and 57.8% (37) of the female-headed households did so. Female-headed households at Mahbere Genet *Tabia* (7.3 ha) had the highest amount of land rented-out, while it was the lowest at Andi Woyane *Tabia* (1.8 ha) (Table 5.9).

Table 5.9: Area cultivated at main season, 2013/14 agriculture year (in ha[9])

Description	Total (all sites)	Village (*Tabia*)				F-test (p-value)
		Andi Woyane	Mahbere Genet	Meseret	Tsehafti	
Total cultivated land [10]						
Total land cultivated	453.90	71.70	95.50	190.10	96.60	
Mean (ha/household)	1.13 (0.11)[a]	0.96 (0.14)	0.99 (0.25)	1.78 (0.23)	0.79 (0.10)	0.000***
Own-cultivated land						
Total own-cultivated land	321.70	52.40	72.70	136.30	60.30	
Mean (ha/household)	0.80 (0.12)	0.70 (0.16)	0.76 (0.27)	1.27 (0.25)	0.49 (0.11)	0.000***
Rented-in land						
Total land rented-in	132.20	19.30	22.80	53.80	36.30	
Mean (ha/household)	0.33 (0.16)	0.26 (0.15)	0.24 (0.14)	0.50 (0.25)	0.30 (0.43)	0.065*
Rented-out land						
Total land rented-out	30.00	4.00	12.20	8.10	5.70	
Mean (ha/household)	0.08 (0.04)	0.05 (0.07)	0.13 (0.10)	0.08 (0.10)	0.05 (0.05)	0.029**
Observation (n)	400	75	96	107	122	
Rented-out land by FHH						
Total rented-out area	18.90	1.80	7.30	5.40	4.40	0.024**
Mean rented-out land (ha/HH)	0.30	0.16	0.37	0.54	0.19	
Observation (n)	64	11	20	10	23	

***, **, * at 1%, 5% and 10% levels of significance; (a) Figures in brackets indicate Standard Errors

The F-test of the null hypothesis tests differences in average mean values of the indicated variables between households in the study villages.

[9] Area is locally measured in *tsmdi* but converted to hectare (ha): 1 *tsmdi* is equivalent to 0.25 ha

[10] Total cultivated land for the 2013 agriculture year is the sum total of own-cultivated land and rented-in land

5.5.2. Crop production

5.5.2.1. Cultivated area of major crops by village (in ha)

Table 5.10 summarizes the total and average cultivated area of cereals, pulses, oilseeds and vegetables. During the 2013/14 agriculture year the average area cultivated for cereal production was 0.99ha per household, and there were significant differences between the four villages. The highest were at Meseret *Tabia* (1.49ha) and the lowest were at Tsehafti *Tabia* (0.75ha). Of all the crops, the average area share of cereals was 87.1%. This indicates the dominance, in terms of area coverage, of cereals in the study villages. Pulses and oil seeds were the second largest, covering 11.7% of the total area, while vegetables covered only 1.2%. The allocation of the major proportion of the area to cereal crops suggests farmers' inclination to prioritise production of energy-source foods.

Table 5.10: Cultivated area of major crops by village

Description	Total (All sites)	Village (*Tabia*)				F-test (p-value)
		Andi Woyane	Mahbere Genet	Meseret	Tsehafti	
Cereals						
Total cultivated area	395.50	57.60	87.20	159.20	91.50	0.000***
Mean area (ha/HH)	0.99	0.77	0.91	1.49	0.75	
	(0.05)	(0.05)	(0.06)	(0.08)	(0.11)	
% area share of all crops	87.10	80.40	91.30	83.70	94.80	
Pulses and oilseeds						
Total cultivated area	52.90	11.90	7.10	30.50	3.40	0.000***
Mean area (ha/HH)	0.13	0.16	0.07	0.29	0.03	
	(0.01)	(0.02)	(0.01)	(0.02)	(0.01)	
% area share of all crops	11.70	16.60	7.40	16.10	3.50	
Vegetables						
Total cultivated area	5.50	2.20	1.20	0.40	1.70	0.108
Mean area (ha/household)	0.01	0.03	0.02	0.004	0.01	
	(0.001)	(0.01)	(0.01)	(0.001)	(0.01)	
% are share of all crops	1.20	3.00	1.30	0.20	1.70	
Fruit and trees[a]	-	-	-	-	-	
Observation (n)	400	75	96	107	122	

*** at 1% level of significance; (a) Fruit and trees are mostly intercropped with vegetables and, areas are accounted for vegetables only

The F-test of the null hypothesis tests differences in average mean values of the indicated variables between households in the study villages.

Results of the FGDs from all the four *tabias* indicate heavy reliance on cereals as staple foods. *Injera*[11] is a major food item in the area (and in Ethiopia in general) with no generally accepted substitute. The local rural households go as far as saying "*Kab injera litsibiqhy littiemy neger yeley; bi amlak zitebarekhe iyu*" (there is nothing sweeter and more beneficial than *injera* and it is even blessed by god). This indicates how the community is obsessed with eating *injera*, whose sources are cereals, and this is reflected in households allocating the majority of their land to the production of cereals. This cultural practice will likely continue for some time, although the focus group participants realize that good nutrition involves going beyond just consuming cereals and there are, at present, signs of better awareness of food consumption diversity.

5.5.2.2. Cultivated area of major crops by gender

As indicated in Table 5.11, there were significant differences in the average area cultivated between FHH (0.57ha) and MHH (1.07ha) for cereals and pulses and oil seeds (Table 5.11). This partly reflects the high proportion of land rented out by FHH (Table 4.9).

Table 5.11: Average cultivated area of major crops by gender (ha/HH)

Description	Average (all HHs)	FHH	MHH	F-test (p-value)
Total average cultivated area[a]	1.134	0.635	1.240	
Cereals	0.990 (0.05)[b]	0.570 (0.06)	1.070 (0.05)	0.000***
Pulses and oil seeds	0.130 (0.01)	0.060 (0.02)	0.150 (0.01)	0.002***
Vegetables	0.014 (0.001)	0.005 (0.002)	0.020 (0.005)	0.171
Observation	400	64	336	

*** at 1% level of significance; (a) The average cultivated area includes own cultivated area and rented-in land; (b) Figures in brackets indicate Standard Errors
The F-test of the null hypothesis tests differences in average mean values of the indicated variables between households in the study villages.

5.5.2.3. Average production of major crops by gender (ha/HH)

The average production per household of cereals, pulses and oilseeds was significantly lower for FHH as compared to MHH. There was no significant difference in the production of

[11] *Injera* is a large, round thin pan cake made mainly from a small seed growing in Ethiopia, called *teff* (*Eragrostis tef*) as well as barley and maize

vegetables between the two, as indicated by the F-value (Table 5.12a). Table 5.12a indicates the average household production by gender, and Table 4.12b shows the differences in average yield (Kg/ha) between FHH and MHH: significant yield differences were found for cereals and pulses and oilseeds. In the study villages, women are not allowed to engage in ploughing activities and many of them do not have oxen. FHH depend on male relatives or hire labour to plough the land, or rent-out the land. As a result, FHH receive a small amount of produce, as the tenancy arrangement for product share allows them to take only 50% of the produce from the land they rent. With respect to vegetable production, however, the plot is very small in size and it mostly requires hand tools, which are easily managed by women.

Table 5.12a: Average production of major crops by gender (Kg/HH)

Description	Total	FHH	MHH	F-test
Cereals	803.5 (56.01)	396.0 (56.40)	881.0 (64.97)	10.337***
Pulses and oil seeds	70.1 (5.91)	33.0 (12.44)	77.0 (6.56)	7.553***
Vegetables	83.7 (23.89)	20.0 (10.98)	96.0 (28.33)	1.351
Observation (n)	400	64	336	-

***at 1% level of significance; (a) Figures in brackets indicate Standard Errors
The F-test of the null hypothesis tests differences in average mean values of the indicated variables between households in the study villages.

Table 4.12b: Average yield of major crop groups by gender (Kg/ha)

Description	Total	FHH	MHH	F-test
Cereals	937.4 (31.78)	717.3 (81.82)	979.3 (34.05)	9.320***
Pulses and oil seeds	282.1 (26.00)	113.9 (37.34)	314.1 (29.83)	8.106***
Vegetables	1,390.0 (45.90)	709.9 (49.10)	1,519.7 (53.83)	0.418
Observation (n)	400	64	336	-

***at 1% level of significance; (a) Figures in brackets indicate Standard Errors
The F-test of the null hypothesis tests differences in average mean values of the indicated variables between households in the study villages.

5.5.2.4. Cereal production

Production:

Cereals, mainly wheat (*Triticum eastivum*), barley (*Hordeum vulgare*), teff (*Eragrostis tef*), maize (*Zea mays*), sorghum (*Sorghum bicolor*) and *hanfets* (a mix of wheat and barley

commonly cultivated in the study area), were the dominant crops grown in the area in 2013/14 agriculture year. Although there are altitudinal differences, all the 4 study villages are in the midland agro-ecology zone, where these crops grow suitably. The total combined amount of cereals produced by households during the main harvest in 2013/14 agricultural year was 321,398Kgs: the average quantity of cereals produced per household was 803.5Kgs and the per capita (based on adult equivalent) production was 165.3Kgs (Table 5.13).

Significant differences in total and per capita production were observed across sites. The highest per capita production was registered at Meseret (259.8Kgs) and the lowest was at Mahbere Genet (93.8Kgs) (Table 5.13).

Yield:

The average yield of the major cereals combined in the study area during the 2013/14 agriculture year was 813kgs/ha. As compared to the regional average, the yield reported from the four sites is very low. The highest average yield was 1,101kg at Andi Woyane: this might be partly due to better rainfall and supplementary irrigation facilities. The lowest yield was at Mahbere Genet *Tabia* (462Kgs), where there were reports of crop failure due to shortage of rainfall and hail damage (Table 5.13).

Table 5.13: Cereal production

Description	Total (All sites)	Village (*Tabia*)				F-test (p-value)
		Andi Woyane	Mahbere Genet	Meseret	Tsehafti	
Total cereals produced (Kg)	321,398.0	63,475.0	40,267.0	143,430.0	74,226.0	
Average production (Kg/HH)	803.5	846.3	419.4	1,340.5	608.4	0.000***
Per capita production (Kg)	165.3	173.8	93.8	259.8	123.9	0.000***
Average yield (Kg/ha)	813.0	1,101.0	462.0	901.0	811.0	0.000***
Observation (n)	400	75	96	107	122	

***at 1% level of significance

The F-test of the null hypothesis tests differences in average mean values of the indicated variables between households in the study villages.

5.5.2.5. Pulse production

Production:

The major pulses grown in the area were vetch (*Lathyrus sativus*), lentil (*Lens culinaris*), linseed (*Linum usitatissimum*) and chickpea (*Cicer arietinum*). Pulses were the second largest crops grown in the area, next to cereals. As indicated in Table 5.14, the total amount of major

pulses and oilseeds produced from the four villages during the year amounted to 28,049Kg. The per capita production of all pulses in the study area is 14.4Kg. The dominant pulse crop in terms of area coverage in the villages was vetch, which covered 72.5% of total pulses produced. Vetch is the main source of staple pulse flour commonly used for consumption in the area. It is largely grown at Meseret *Tabia*, covering 68.7% of the total vetch produced in the study villages. Vetch is mainly a midland crop and the soil type and climate of the *Tabia* is more suitable for vetch production as compared to the other *Tabias*.

Yield:

The average yield of the major pulses and oilseeds combined in the area during 2013 agriculture year was 530kgs/ha. The highest average yield reported by households was 632kg at Meseret *Tabia*. The lowest was 228kgs from Mahbere Genet *Tabia* (Table 5.14). Low yields were reported as compared to the regional average.

Table 5.14: Pulses and oilseeds production

Description	Total (All sites)	Village (*Tabia*)				F-test (p-value)
		Andi Woyane	Mahbere Genet	Meseret	Tsehafti	
Total production (Kg)	28,049.0	5,265.0	1,622.0	19,271.0	1,891.0	
Average production (Kg/HH)	70.1	70.2	16.9	180.1	15.5	0.000***
Per capita production (Kg)	14.4	14.4	3.8	34.9	3.2	
Average yield (Kg/ha)	530.0	442.0	228.0	632.0	556.0	0.000***
Observation (n)	400	75	96	107	122	

***at 1% level of significance

The F-test of the null hypothesis tests differences in average mean values of the indicated variables between households in the study villages.

5.5.2.6. Vegetable production

Production:

The major vegetables grown were tomato (*Solanum lycopersicum*), onion (*Allium cepa*) and pepper (*Piper nigrum*). The total quantity of the major vegetable crops produced was 33,504kgs and per capita vegetable production was 17.2kg. Of the four villages, the largest proportion of vegetables (65.1%) was produced at Andi Woyane *Tabia*. This higher proportion is due to more extensive use of irrigation in the *Tabia*. Of all the households in the *Tabia*, about 85% own one or more of the different sources of irrigation water in the area (earth dam, shallow well, ponds and diversion structures). The highest per capita vegetable

production was at Andi Woyane *Tabia* (59.7kg) and the lowest was at both Meseret and Tsehafti *Tabias* (7.3kg) (Table 5.15).

Yield:

The average yield of the major vegetables combined was 6,092kgs per ha during the 2013/14 agriculture year. The average yield produced was the highest at Meseret and Andi Woyane *Tabias.*

Table 5.15: Vegetables production at post-harvest season

Description	Total (All sites)	Village (*Tabia*)				F-test (p-value)
		Andi Woyane	Mahbere Genet	Meseret	Tsehafti	
Total production (Kg)	33,504.0	21,795.0	3,341.0	4,013.0	4,355.0	
Average production (Kg/HH)	83.8	290.6	34.8	37.5	35.7	0.001***
Per capita production (Kg)	17.2	59.7	7.8	7.3	7.3	
Average yield (Kg/ha)	6,092.0	9,907.0	2,784.0	10,033.0	2,562.0	0.000***
Observation (n)	400	75	96	107	122	

***at 1% level of significance

The F-test of the null hypothesis tests differences in average mean values of the indicated variables between households in the study villages.

5.5.2.7. Fruit and trees production

The major fruits grown in the study area are cactus, hops (*Humulus lupulus*), guava (*Psidium guajava*) and banana (*Musa acuminata*). The total combined produce during the 2013/14 agriculture year was 23,294kgs. The per capita production was 12.0kgs (Table 5.16).

Table 5.16: Major fruits and trees production (Kg)

Description	Total (All sites)	Village (*Tabia*)				F-test (p-value)
		Andi Woyane	Mahbere Genet	Meseret	Tsehafti	
Total production	23,294.0	6,362.0	4,986.0	8,364.0	3,582.0	
Average production (Kg/HH)	58.2	84.8	51.9	78.2	29.4	0.192
Per capita production (Kg)	12.0	17.4	11.6	15.2	6.0	
Observation (n)	400	75	96	107	122	

The F-test of the null hypothesis tests differences in average mean values of the indicated variables between households in the study villages.

As indicated in Table 5.17a, the village level average yield is lower than that of the regional level for the selected crops during the 2013/14 agriculture year, except for onion. Likewise, the regional average yield is lower than the national average for most of the selected major

crops grown, for the indicated year. This could be due to various reasons including differences in agroecology, labour availability, water availability, fertility of soils and seed quality.

Table 5.17a: Average yield (Kg/ha) for selected crops (2013/14 agriculture year)

Crop	National-level yield (1)	Regional-level yield (2)	Village-level yield (3)	(3) as % of (2)
Teff	1,465	1,369	526	38.4
Barley	1,872	1,665	949	57.0
Wheat	2,445	1,852	1,758	94.9
Maize	3,254	2,407	1,361	56.5
Sorghum	2,283	2,573	1,156	44.9
Field peas	1,379	1,325	814	61.4
Chickpeas	1,845	1,341	501	37.4
Lentils	1,265	1,097	729	66.5
Linseed	920	1,073	356	33.2
Onion	9,015	5,733	7,355	128.3
Hops	1,237	3,277	2,039	62.2

Source: Yield data from own survey, 2014 and CSA, 2015

As summarized in Table 5.17b, significant differences were observed in average yield (Kg/ha) of major crop groups across villages. The differences between villages are apparent for cereals and vegetables, with the highest average yield reported from Andi Woyane village; the highest for pulses and oil seeds is from Meseret village. The differences in average yield between villages likely lead to differences in food availability and disposal of agricultural products for various purposes including food consumption. Yields in Andi Woyane are boosted by the presence of irrigation: the influence of irrigation is clear in relation to yields of vegetables in that village.

Table 5.17b: Average yield of major crop groups by village (Kg/ha)

Description	Total (All sites)	Village (*Tabia*)				F-test (p-value)
		Andi Woyane	Mahbere Genet	Meseret	Tsehafti	
Cereals	937.4 (31.78)	1,293.3 (71.40)	634 (50.93)	1,098.0 (46.81)	816.4 (64.54)	21.844***
Pulses and oil seeds	282.1 (26.00)	363.1 (53.21)	108.0 (27.74)	562.5 (62.60)	123.3 (41.84)	21.133***
Vegetables	1390.0 (45.90)	5,987.1 (234.42)	386.0 (24.03)	548.6 (22.96)	92.2 (15.07)	8.184***
Observation (n)	400	75	96	107	122	

***at 1% level of significance; (a) Figures in brackets indicate Standard Errors
The F-test of the null hypothesis tests differences in average mean values of the indicated variables between households in the study villages.

5.6. Disposal of agricultural products

Most of the cereals and pulses produced by the smallholder farmers are meant for household consumption, while the majority of the vegetables and fruits produced by the households are supplied to the market.

Cereals disposal:

The major cereals disposed of during the 2013/14 agriculture year were wheat, barley, *teff*, maize, sorghum and *hanfets*. 74.8% of the total cereals produced were meant for home consumption. The amount of produce sold accounted for 9.7% (Table 5.18). The retained amount for seed (12.2%) seems high: in focus group discussions farmers stated that the average seed rate (kg/ha) in the area is 100 for wheat, 150 for barley and 30-35 for *teff*. As these are the major sources of their food, farmers always tend to retain seed for the next production season in excess of the seed rate required as a contingency.

Wheat is one of the staple cereals used for making '*ambasha*' (a thick rounded pan cake), a food item common in the study area and in Tigray region. Wheat is considered as one of the superior food items by households: for them, "*himbasha bifiluy ina niri'a: bittaemi ttenkara nkhon, mulu'e ttienay newih idmey tihibena"* (eating *ambasha* makes a person very strong, healthy and can live longer). Such is the belief on single cereal crops.

Pulses and oilseeds disposal

The main pulses and oilseeds disposed of were vetch, lentil, linseed and chickpea. On average, 53.4% of pulses and oilseeds were allocated for consumption by households. The

amount sold at local and Mekelle markets stood at 23.5%. The amount retained for seed was 19.6% of the total product (Table 5.18). Again, as was the case in cereals disposal, seed retained for the next production season seems high.

Vegetable disposal

In the four study villages, the major vegetables grown were tomato, onion and pepper. Only 6.0% of the vegetables produced were consumed at home by households. Vegetables are perishable with a shelf life of a few days. As much as 94.0% of the produce was sold at nearby towns and Mekelle city (Table 5.18). The consumption of vegetables is very low in all the villages.

Fruit and trees disposal

The major fruits and trees grown in the area are cactus, hops, guava and banana. Most of the produce (65.2%) was marketed while the remaining 34.8% were for household consumption.

Livestock

As indicated in Table 5.18, the average number of cattle, sheep and goats as well as chickens consumed at home and sold in the main harvest season is insignificant. Meat consumption in the villages is very low and livestock are mainly raised to support crop production, for sale during periods of crop failure, to meet other social and local cultural obligations such as marriage, *tezkar* (a function in memory of a dead spouse, offspring or relative), religious holidays, and for the consumption of eggs and milk.

Table 5.18: Average disposal of major crops and livestock from own production at post-harvest season

Description	Total (All)	Village (*Tabia*)				F-test (p-value)
		Andi Woyane	Mahbere Genet	Meseret	Tsehafti	
Major cereals (Kg/HH)						
Amount consumed	600.9 (74.8%)[a]	658.2	339.2	1,049.3	378.2	0.000***
Amount sold	77.7 (9.7%)	56.1	1.0	54.1	172.1	0.523
Amount retained for seed	98.4 (12.2%)	111.0	78.2	181.1	34.1	0.000***
In-kind payment and gift given	26.5 (3.3%)	21.0	1.0	56.0	24.0	0.003***
Major pulses and oilseeds (Kg/HH)						
Amount consumed	37.5 (53.4%)	39.2	10.1	96.8	5.9	0.000***
Amount sold	16.5 (23.5%)	22.0	1.0	38.4	6.2	0.000***
Amount retained for seed	13.7 (19.6%)	7.6	5.8	36.7	3.4	0.000***
In-kind payment and gift given	2.5 (3.5%)	1.4	0.0	8.2	0.0	0.001***
Major vegetables (Kg/HH)						
Amount consumed	5.0 (6.0%)	12.6	1.2	6.6	1.9	0.020**
Amount sold	78.7 (94.0%)	278.0	33.6	30.9	33.8	0.000***
Major fruits (Kg/HH)						
Amount consumed	20.3 (34.8%)	34.7	24.2	18.2	10.2	0.049**
Amount sold	38.0 (65.2%)	50.1	27.8	60	19.2	0.504
Livestock (Number/HH)						
Cattle consumed	0.03	0.00	0.02	0.00	0.07	0.506
Cattle sold	0.38	0.49	0.25	0.31	0.48	0.046**
Sheep and goat consumed	0.53	0.40	0.04	0.59	0.94	0.000***
Sheep and goat sold	0.99	0.84	0.22	1.21	1.50	0.000***
Chicken consumed	2.18	1.11	1.88	3.30	2.08	0.000***
Chicken sold	1.49	2.83	1.15	1.16	1.21	0.046**
Observation (n)	400	75	96	107	122	

***, ** at 1% and 5% level of significance; (a) Percent in brackets show proportions within each crop group

The F-test of the null hypothesis tests differences in average mean values of the indicated variables between households in the study villages.

The proportion of food consumption from own production for major crop groups is 65.3% for the main harvest season, of which about 90.0% is cereals. This is higher than the results reported by Hirvonen and Hoddinott (2015) based on a survey in five Regions of rural

Ethiopia, which found that of the total food consumption 50% is from own-production, 44% from purchases and the remaining 6% from other sources.

5.7. Farm production decisions

Table 5.19 shows data on who makes farm-level decisions on what type of crops and livestock to produce, inputs to be used in the production process and their marketing. 62.2% of crop choices are mutually decided by both men and women followed by only men (19.2%), and only women (9.8%), most of whom were from female-headed households. The decision on the choice of other inputs follows a quite similar pattern to that of crop choice, as would be expected, although regarding the marketing of crops, 68.7% of decisions were made jointly by males and females, followed by women only (15%). The majority of the decisions on crop production and marketing are decided by both men and women in all the sites, though this is the lowest at Mahbere Genet *Tabia* (where, conversely, a higher proportion of decisions are made by women only, perhaps partly due to the higher proportion of female-headed households in that *Tabia*).

Both men and women decide on choice of livestock type and inputs used in rearing livestock in 68.7% and 68.4% of households respectively. 65% of livestock marketing decisions are made by both men and women, while women only make 16.1% of decisions, and men only make 15% (Table 5.19).

Table 5.19: Crop and livestock production decision making

Description	Total (All sites)	Village (*Tabia*)				χ^2 test (p-value)
		Andi Woyane	Mahbere Genet	Meseret	Tsehafti	
A. Crop Production:						
Decision on crop choice (%)						
Tenant decides (rented-out land)	8.8	4.0	18.8	3.7	8.2	0.001***
Male	19.2	18.7	24.0	20.6	14.8	
Female	9.8	9.3	13.5	7.5	9.0	
Both male and female	62.2	68.0	43.7	68.2	68.0	
Decision on input choice (%)						
Tenant decides	8.8	4.0	18.8	3.7	8.2	0.001***
Male	18.2	17.3	24.0	18.7	13.9	
Female	9.5	9.3	13.5	6.5	9.0	
Both male & female	63.5	69.4	43.7	71.1	68.9	
Decision on crop marketing (%)						
Tenant decides	4.8	2.7	10.4	1.9	4.1	0.006***
Male	11.5	10.7	12.5	15.0	8.2	
Female	15.0	13.3	24.0	10.3	13.1	
Both male & female	68.7	73.3	53.1	72.8	74.6	
B.Livestock production						
Decision on livestock choice (%)						
Male	16.6	8.3	20.5	17.3	18.3	0.000***
Female	15.0	12.5	19.3	7.7	20.0	
Both male & female	68.4	79.2	60.2	75.0	61.7	
Decision on livestock marketing (%)						
Male	15.5	9.7	19.0	16.4	15.8	0.001***
Female	16.1	13.9	20.2	9.6	20.0	
Both male & female	65.0	76.4	54.8	72.1	59.2	
Separate decision by type	3.4	0.0	6.0	1.9	5.0	
Observation (n)	400	75	96	107	122	

***at 1% level of significance

The chi-squared test of the null hypothesis tests the relationship between the values of categories of the indicated variables for households in the study villages.

5.8. Access to and use of institutional services

5.8.1. Household participation in extension and related activities

Table 5.20 summarizes the participation of households in extension and other related activities. About 75% (299) of the households reported that they participated in various extension training programmes and demonstrations on new varieties of crops, soil and water conservation, diseases and pests, irrigation, and agricultural marketing. 46.5% of the households are members of cooperatives; of these households, 50% have men only as members, 39.2% have both men and women, and 10.8% have women only. Most of the farmers in the study area, and elsewhere in Tigray region, are members of farmers'

associations but not all are members of cooperatives: households do not depend much on cooperatives as fertilizer, the major input required by farmers, is supplied by the Office of Agriculture and Rural Development and other merchandise is available at nearby markets. In terms of participation in public meetings, 56.5% reported that they have participated in general meetings that help them in improving agricultural production and productivity. In these meetings, participation of women is low: women participating by themselves accounted for only 11.9%, compared to men by themselves (75.8%), and both men and women (12.3%).

Table 5.20: Participation in extension and related activities

Description	Total (All sites)	Village (*Tabia*)				χ^2 test (p-value)
		Andi Woyane	Mahbere Genet	Meseret	Tsehafti	
Extension contact (%)						
No	25.2	26.7	34.4	17.8	23.8	0.049**
Yes	74.8	73.3	65.6	82.2	76.2	
Cooperative membership (%)						
No	53.5	42.7	61.5	58.9	49.2	0.043**
Yes	46.5	57.3	38.5	41.1	50.8	
Cooperative members (%)						
Female	10.8	20.9	13.5	6.8	4.8	0.000***
Male	50.0	46.5	70.3	50.0	40.3	
Both male and female	39.2	32.6	16.2	43.2	54.9	
Observation	400	75	96	107	122	

***, ** at 1% and 5% levels of significance

The chi-squared test of the null hypothesis tests the relationship between the values of categories of the indicated variables for households in the study villages.

5.8.2. Credit and saving

Discussions with various groups of the farming households indicated that every rural household now has access to credit from various sources, mainly from micro finance institutions, cooperatives, banks, government offices through agriculture packages and private lenders. During the 2013/14 agriculture year, 253 (63.3%) borrowed money for financing various agricultural activities. About 80 % of those who got loans are men and 18.2% are women (Table 5.21). The loans were mainly meant for the purchase of fertilizer, pesticide, insecticide, improved seeds, poultry, oxen and sheep and goat. By source of loan, the major provider is the regional government (50.6%) through its Agriculture Office at *woreda* and village levels, followed by microfinance institutions (35.0%) and farmers' cooperatives (14.4%).

In relation to savings, during 2013, 24% of the households had savings in various institutions: banks (11.5%), cooperatives (26.0%), microfinance institution (33.3%) and '*Equb*', a traditional mechanism of saving money (29.2%). The majority of the saving account holders are men (68.7%); women are 25% and joint account holders 6.3%.

Table 5.21: Credit and saving by rural households

Description	Total (All sites)	Village (*Tabia*)				χ^2 test (p-value)
		Andi Woyane	Mahbere Genet	Meseret	Tsehafti	
Household members taking loan (%)						
Female	18.2	21.2	31.4	9.1	16.4	0.000***
Male	79.8	73.0	64.7	90.9	83.6	
Both male and female	2.0	5.8	3.9	0.0	0.0	
Observation (n)	253	52	51	77	73	
Saving place (%)						
Bank	11.5	3.7	0.0	22.7	17.9	0.000***
Cooperatives	26.0	37.0	0.0	54.6	10.7	
Microfinance institute	33.3	48.2	22.7	18.2	46.4	
'*Equb*'	29.2	11.1	77.3	4.5	25.0	
Saving account holder (%)						
Female	25.0	24.0	36.4	23.8	17.9	0.465
Male	68.7	72.0	54.5	66.7	78.5	
Both male & female	6.3	4.0	9.1	9.5	3.6	
Observation (n)	96	25	22	21	28	

***at 1% level of significance

The chi-squared test of the null hypothesis tests the relationship between the values of categories of the indicated variables for households in the study villages.

Ahmad *et al*. (2012) identified inadequate access to extension services, land, plant protection chemicals and credit as important factors among many that negatively affect the role of women in agricultural production, although women contribute significantly in terms of production of food, cash and other in-house productive activities. The data above provide some evidence to support the view that men have greater access to support services – or are the direct contact with such services to a greater extent- than women.

5.9. Income earned by households

The total household income is the aggregate income from various sources: crops, livestock and livestock products, off/non-farm activities and other sources including remittance and transfer. Income data, by source, were collected for the post- and pre-seasons. Since most of

the households share the same local markets, the unit prices of sales and purchases were used to calculate imputed income for households who have not participated in market activities. The household income is computed using equation 5.1.

$$IHHj = \sum_{i=1}^{n}(PCij + PLkj + PVmj + PFqj + PLSrj + POtj + ONv) \qquad (5.1)$$

Where IHH is the income of the jth household; P is the price of a crop or livestock; C_i is the amount of cereals sold; L_k is pulses and/or oilseeds (legumes) sold; V_m is vegetables sold; F_q is fruit and/or trees sold; LS_r is livestock and/or livestock products sold; O_t is other food items sold; and ON_v is off/Non-farm income.

Income from various sources is computed with the purpose of understanding the livelihood differences between households and suggesting possible ways to improve rural livelihoods. Using per capita income and income quartiles, comparisons were made between season, location (agroecology) and gender among rural households, also including the sources of income influencing livelihoods. To make valid comparisons between households, incomes were adjusted to an adult equivalent basis.

5.9.1. Farm income

5.9.1.1. Crop income

Crop income at post-harvest season

Rural households follow a mixed type of farming, producing crops and raising animals. The average crop income for the post-harvest season was 2,031 ETB per household and there were significant differences across the four villages. The highest income was at Andi Woyane *Tabia*, mainly due to higher sales from vegetable production. The major sources of crop income are the sales income from cereals and vegetables. Significant differences were observed in incomes among the four villages in pulses and oilseeds, vegetables and fruit and trees sales. Households in Andi Woyane *Tabia* had the highest income from vegetable sales probably due to more use of irrigation in the *Tabia* (Table 5.22). Farm households are expected to have higher income from crop sales at the immediate post-harvest period; however, the income, particularly from cereals, was less than 10% of the value of own produce. The amount of cereals consumed from own production was high (see Table 5.18).

Table 5.22: Average crop sales income at post-harvest season

Description	Average (All sites)	Village (*Tabia*)				F-test (p-value)
		Andi Woyane	Mahbere Genet	Meseret	Tsehafti	
Average crop income[a]:	2,031	3,689	622	2,391	1,806	0.078*
Cereals	676	620	10	784	1,143	0.317
Pulses and oilseeds	249	449	13	468	118	0.000***
Vegetables	652	2,366	410	110	264	0.014**
Fruits and trees	444	254	189	1,029	281	0.004***
Observation (n)	400	75	96	107	122	

***, **, * at 1%, 5% and 10% levels of significance
(a) Average crop income: ETB per adult equivalent. During the time of survey, 1 USD was equivalent to 19.09 ETB at the post-harvest season (as of January 10, 2014) and 19.76 ETB at the pre-harvest season (as of August 25, 2014)
The F-test of the null hypothesis tests differences in average mean values of the indicated variables between households in the study villages.

Crop income at pre-harvest season

At the pre-harvest season, the majority of crop income was from vegetable sales (90.6%). Households used irrigation water to produce vegetables in the dry season between February and May/June. Significant differences were observed in crop income between the four villages, mainly due to differences in vegetable income. Households at Andi Woyane *Tabia* had significantly higher income from vegetable sales (Table 5.23).

Table 5.23: Average crop sales income at pre-harvest season

Description	Average (All sites)	Village (*Tabia*)				F-test (p-value)
		Andi Woyane	Mahbere Genet	Meseret	Tsehafti	
Average crop income[a]:	915	2,630	704	429	468	0.010**
Vegetables	829	2,509	701	288	381	0.010**
Fruits and trees	86	121	3	141	87	0.521
Observation (n)	390	72	96	101	121	

**at 5% level of significance; (a) Average crop income: ETB per adult equivalent
The F-test of the null hypothesis tests differences in average mean values of the indicated variables between households in the study villages.

There were differences in crop income between the high and pre-harvest seasons. All the major cereals, pulses and oilseeds are produced following the main rainy season between June and mid-September, and farmers sell their produce in the months immediately after harvest to cover food and non-food expenditure. Perennial fruit and tree crops such as mango, avocado and hops are other sources of income.

5.9.1.2. Livestock income

Livestock income at post-harvest season

The average household income from sales of livestock and livestock products was ETB 2,790. Livestock income includes sale of milking cows, oxen, sheep, goat and poultry. Milk, butter, and eggs were also other sources of income for the households. The majority of income was from sale of livestock (87.8%) while livestock products covered only 12.2%. There were significant differences in income between the four villages. The main differences in income were due to sale of livestock but no significant differences were observed in income from milk, butter, and eggs (Table 5.24).

Table 5.24: Average livestock income at post-harvest season

Description	Average (All sites)	Village (*Tabia*)				F-test (p-value)
		Andi Woyane	Mahbere Genet	Meseret	Tsehafti	
Average livestock income[a]	2,790	3,697	1,345	2,952	3,227	0.018**
Livestock sales	2,449 (87.8%)[b]	3,230	1,186	2,494	2,922	0.032**
Livestock products sales	341 (12.2%)	467	159	458	305	0.251
Observation (n)	400	75	96	107	122	

**at 5% level of significance; (a) Average livestock income: ETB per adult equivalent; (b) Figures in brackets are proportions of income from livestock and livestock products sales
The F-test of the null hypothesis tests differences in average mean values of the indicated variables between households in the study villages.

Livestock income at pre-harvest season

The average household income from sales of livestock and livestock products in the pre-harvest season was ETB 1,517. The highest share of income was from sales of livestock (89.6%), while livestock products covered only 10.4%. There were significant differences in income between the four villages, mainly due to differences in live animal sales (Table 5.25).

Table 5.25: Average livestock income at pre-harvest season

Description	Average (All sites)	Village (*Tabia*)				F-test (p-value)
		Andi Woyane	Mahbere Genet	Meseret	Tsehafti	
Average livestock income[a]	1,517	1,881	671	1,167	2,263	0.000***
Livestock sales	1,359 (89.6%)[b]	1,705	557	1,045	2,050	0.000***
Livestock products	158 (10.4%)	176	114	122	213	0.122
Observation (n)	390	72	96	101	121	

***at 1% level of significance; (a) Average livestock income: ETB per adult equivalent; (b) Figures in brackets are proportions of income from livestock and livestock products sales
The F-test of the null hypothesis tests differences in average mean values of the indicated variables between households in the study villages.

The average income from the sale of livestock and livestock products was higher than income from crop sales at both the high and pre-harvest seasons: livestock income accounted for 57.9% of average farm income at the post-harvest season and 62.4% at the pre-harvest season (calculated from Tables 5.22-5.25). One reason for this is that the majority of cereals, pulses and oilseeds produced were consumed at home, retained as seed and disposed of as in-kind payments for borrowings and to the church. Households sell more livestock products when the crop harvest from the preceding season starts to wane, to cover food consumption and other non-food expenses. The income from crops, livestock and livestock products is one component of the linkage between agriculture and the consumption and nutrition of rural households.

According to focus group discussions with farmers in the four villages, farmers indicated that, despite the good potential for livestock rearing, the income from livestock and livestock products is low. The major constraints raised were shortage of livestock feed, inadequate veterinary services, shortage of capital and labour, lack of storage and preservation of perishable products and inadequate market and marketing facilities for livestock and livestock products.

The farm income-both crop and livestock -was ETB 4,821 during the post-harvest season, which accounted for 50.7% of the total household income. The total farm income was ETB 2,432 during the pre-harvest season, covering 39% of the total income. Significant differences were observed across villages in both seasons, the highest farm income was at Andi Woyane village and the lowest was at Mahbere Genet village in both seasons (Table 5.29).

5.9.2. Off/non-farm income[12]

In the study area, 80.5% of households participated in off/non-farm activities; only 19.5% did not participate due to lack of such activities in their locality, old age and/or illness (Table 5.26).

An important aspect in relation to income from off/non-farm activities is the control over such income. In 71.1% of the households, such incomes are controlled jointly by both men and women, and in 20.3% of the households, it is women who control the income.

Across the four villages, participation in off/non-farm activities is the highest (89.6%) at Mahbere Genet *Tabia*, which is very close to Mekelle, the capital for Tigray region. This is followed by Tsehafti *Tabia* (88.5%).

Table 5.26: Participation in and control over income from off/non-farm activities, by location

Description	Total (All sites)	Village (*Tabia*)				χ^2 test (p-value)
		Andi Woyane	Mahbere Genet	Meseret	Tsehafti	
Participation (%)						
No	19.5	25.3	10.4	32.7	11.5	0.000***
Yes	80.5	74.7	89.6	67.3	88.5	
Observation (n)	400	75	96	107	122	
Control over income by (%):						
Female	20.3	15.8	28.8	12.3	21.3	0.000***
Male	8.6	12.3	12.6	11.0	1.9	
Both male and female	71.1	71.9	58.6	76.7	76.8	
Observation (n)	325	57	87	73	108	

***at 1% level of significance

The chi-squared test of the null hypothesis tests the relationship between the values of categories of the indicated variables for households in the study villages.

[12] Activities or income outside of one's farm are treated as off-farm or non-farm. Both are usually used interchangeably in many studies. Of the two, off-farm activity is broader and it is non-farm activity plus labour employed in agricultural activities in other farms (e.g., Berjan *et al*, 2013; Ellis and Freeman, 2004; Woldehanna, 2000). Off farm income, for instance, includes income from rented-out farmland, agricultural wage on other farms, employment in the industry and service sectors, pensions, transfers, remittance, income from self-employment other than agriculture.

About 92% of the FHH reported that they participated in off/non-farm activities as against about 78% by MHH. There were significant differences between the two groups (Table 5.27). The higher participation by FHH in off/non-farm activities was driven by small farm land ownership and renting out of farm land to tenants. A considerable number of FHH participated in food for work (FFW) and cash for work (CFW), which include soil and water conservation, local rural road and school construction as well as selling labour for weeding and harvesting as daily labourers. FHH were also engaged in self-employment that included making and selling of handicrafts, local beverage making and selling, running a small merchandise shop and female hair dressing.

Table 5.27: Participation in off/non-farm activities, by gender

Description	Average (all HHs)	Households		F-test (p-value)
		FHH	MHH	
Participation (%)				
No	78	7.8	21.7	0.009***
Yes	322	92.2	78.3	
Observation (n)	400	64	336	

***at 1% level of significance
The F-test of the null hypothesis tests differences in average mean values of the indicated variables between households in the study villages.

Table 5.28 summarizes income earned from off/non-farm activities by type of source across the four villages in both the high and pre-harvest seasons. Significant differences were observed between the villages in total off-farm income and in all the three sources of income except for income from self-employment at the pre-harvest season. The three sources are income from the employment of one or more members of the household engaged mainly in daily labour and part-time jobs; transfers in the form of mainly PSNP through food-for-work and cash-for-work as well as direct transfers especially to FHH, remittance from relatives and pension; and, self-employment in the sale of handicrafts, sale of natural resources and petty trading. In the study area the major available resources contributing to rural livelihoods are land and labour. Land, however, is mainly rain-fed, small and fragmented and therefore inadequate to support a significant proportion of rural households. Hence, rural households engage in off/non-farm activities to improve their livelihood (Dorward *et al*., 2009).

Table 5.28: Off/Non-farm average income[a] at post- and pre-harvest seasons, by location

Amount: ETB

Description	Total (All sites)	Village (*Tabia*)				F-test (p-value)
		Andi Woyane	Mahbere Genet	Meseret	Tsehafti	
Post-harvest season:						
Employment	2,462	3,183	3,943	1,880	1,364	0.018**
Transfers	728	494	544	389	1,316	0.025**
Self-employment	1,493	2,017	2,079	1,904	345	0.064*
Total off-farm income	4,683	5,694	6,566	4,173	3,025	0.014**
Observation (n)	400	75	96	107	122	
Pre-harvest season:						
Employment	1,863	1,989	3,137	665	1,777	0.000***
Transfers	613	254	634	260	1,101	0.000***
Self-employment	1,328	1,670	2,328	1,256	394	0.416
Total off-farm income	3,804	3,913	6,099	2,181	3,272	0.000***
Observation (n)	390	72	96	101	121	

***, **, * at 1%, 5% and 10% levels of significance; (a) Average monthly income: ETB per adult equivalent; average monthly income was calculated based on income from 12 months at the post-harvest season, and income from 6 months at the pre-harvest season

The F-test of the null hypothesis tests differences in average mean values of the indicated variables between households in the study villages.

5.9.3. Rural household income

5.9.3.1. Total household income by location

Figure 5.1 shows household income by location and by season. The sources of household income are farm and off/non-farm income. The average household income at the post-harvest season was ETB 9,504. For the post-harvest season, the average farm income covered 50.7% of the total household income. Significant differences in household income ($p<0.05$) were observed across the four *tabias*. Farm income was the highest at Andi Woyane *tabia* and lowest at Mahbere Genet *tabia*. As expected, the highest off/non-farm income *(*ETB 6,566) was registered at Mahbere genet *tabia,* a village close to Mekelle city. The lowest off/non-farm income was at Tsehafti *tabia* (ETB 3,025).

At the pre-harvest season, farm income covered 39.0% while off/non-farm income accounted for 61.0%. Significant differences were found among the 4 *Tabias* in farm income, off/non-farm income and household income ($p<0.001$). Total household income was the highest at Andi Woyane *Tabia* (ETB 8,424) (Figure 5.1). During the pre-harvest season, the majority of income (ETB 6,099) for households at Mahbere Genet *Tabia* was from off/non-farm

activities, mainly from stone and sand mining for Mekelle city market and jobs created due to its proximity to the regional capital. Such differences in household income among the four villages could be attributed to their differences in farming activities related to farm land size, water availability, livestock ownership, and to off/non-farm job opportunities which are influenced by proximity to urban centres (Mekelle).

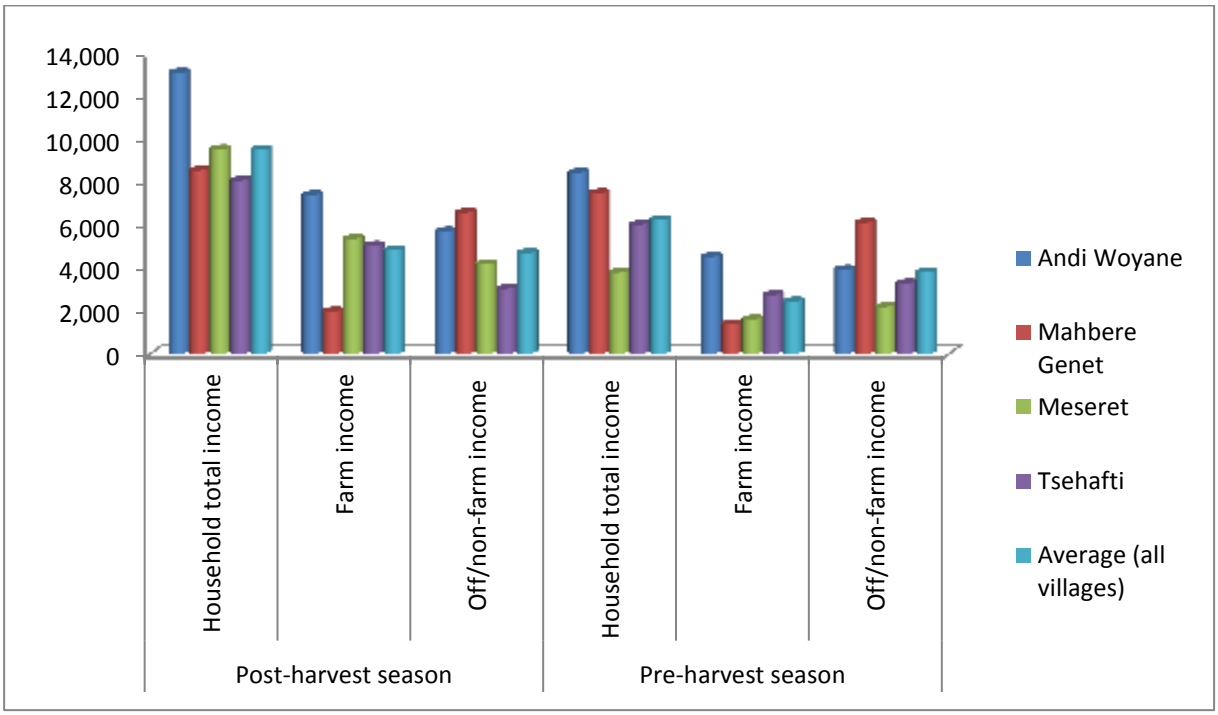


Figure 5.1: Average total income by source, season and village

5.9.3.2. Total household income by gender

The average household income at the post-harvest season for FHH and MHH was ETB 5,396 and ETB 10,286 respectively. The household income for MHH was significantly ($p<0.05$) higher than that of FHH, but there were no significant differences in off/non-farm income between FHH and MHH (Figure 5.2a). The difference in farm incomes reflects differences in average land cultivation between FHH and MHH (See Table 5.4) and differences in average yield of cereals, pulses and oil seeds between the two categories (See table 5.12b), which in turn reflects the high proportion of land rented-out by FHH.

At the pre-harvest season, the average household income was significantly ($p<0.05$) higher for MHH than for FHH due to considerable differences in the sales income from livestock and

livestock products between the two. There were no significant differences between FHH and MHH in crop and off/non-farm income (Figure 5.2b).

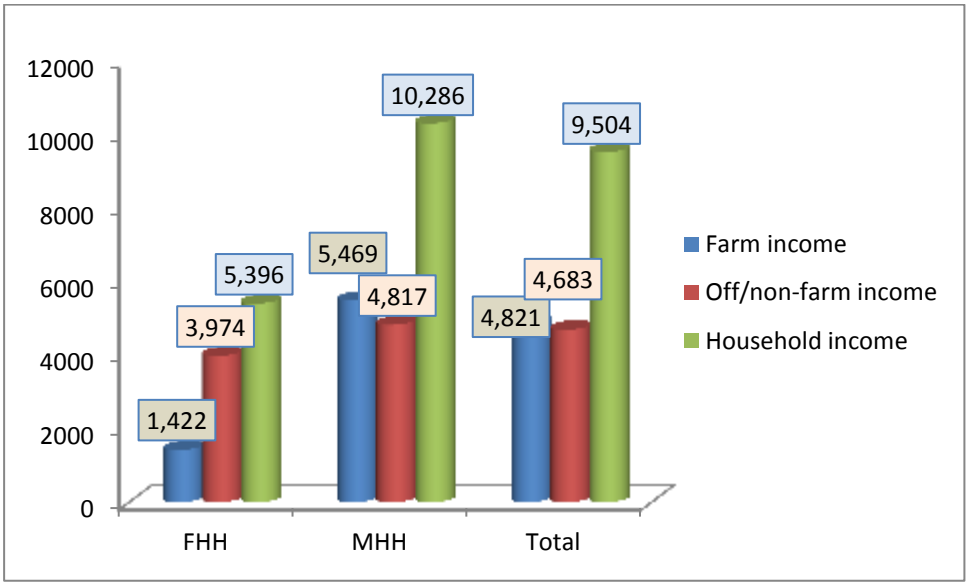


Figure 5.2a: Average income of households at post-harvest season, by gender

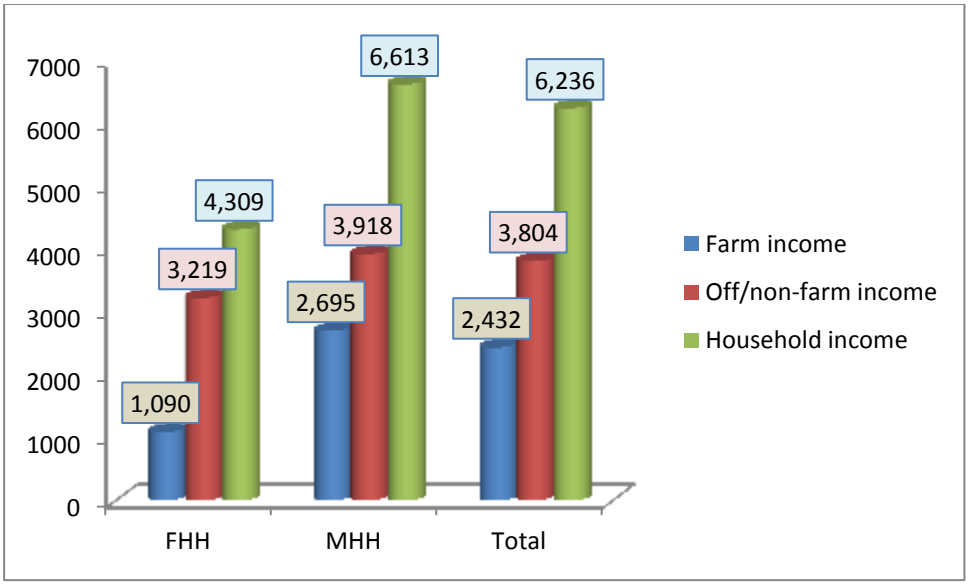


Figure 5.2b: Average income of households at pre-harvest season, by gender

5.10. Household expenditure

5.10.1. Agricultural input expenditure

At the farm household level, the average farm expenditure per household amounted to ETB 1,378 for the main harvest season: this mainly includes labour, seed, fertilizer and pesticide. There were significant differences in farm expenditure between villages. Farmers at Tsehafti *Tabia* spent the lowest (ETB 710) while input expenditure at Meseret *Tabia* was as high as

ETB 2,120 per household. The farm input cost per hectare was also significantly different between the four villages (Table 5.29).

Table 5.29: Average farm input expenditure at the post-harvest season, by location

Description	Average (All sites)	Village (*Tabia*)				F-test (p-value)
		Andi Woyane	Mahbere Genet	Meseret	Tsehafti	
All crops (ETB/HH)	1,378.0	1,753.0	1,107.0	2,120.0	710.0	0.000***
Cereals	1,261.0	1,461.0	988.0	2,035.0	673.0	0.000***
Pulses and oilseeds	42.0	105.0	14.0	44.0	25.0	0.001***
Vegetables	70.0	187.0	98.0	32.0	9.0	0.002***
Fruit and trees	4.6	0.4	6.5	8.5	2.7	0.568
All crops (ETB/ha)	1,219.0	1,826.0	1,118.0	1,191.0	899.0	0.000***
Observation (n)	400	75	96	107	122	

***at 1% level of significance

The F-test of the null hypothesis tests differences in average mean values of the indicated variables between households in the study villages.

5.10.2. Food consumption and expenditure

5.10.2.1. Food consumption

Monthly food consumption, all villages

Food consumption was measured using the 30-day recall of the standard food groups recommended by FAO (2013) and developed and utilized by a number of studies (Romeo *et al*., 2016; Swindale and Bilinsky, 2006). Food consumption data pertaining to cereals, legumes (pulses), vegetables, fruits, livestock and livestock products and other food items were collected by quantity consumed and by source (consumption from own production, purchases, gift/borrowing and transfers/aid), then were converted to the standard food grouping for analysis. The data were collected using the consumption section of the household survey (Module 4) and computed using equation 5.2.

$$HHCj = \sum_{i=1}^{n}(QCij + QLkj + QVmj + QFqj + QLSrj + QOFtj) \qquad (5.2)$$

Where HHC is the monthly food consumption of the jth household; Q is the quantity in kilogrammes (Kg) of a crop or livestock or other food items consumed; C_i is cereal consumed; L_k is pulse and/or oilseeds; V_m is a vegetable; F_q is a fruit and/or tree; LS_r is livestock and/or livestock product; and OF_t is other food items.

The average monthly proportion of food consumption, by quantity (Kg), of different food groups by households is presented in Figure 5.3a. At the main harvest season, the consumption of cereals accounts for 76.4% of the quantity consumed followed by pulses and oil seeds (9%). Households reported very low consumption of fruit and beef. As indicated in Figure 5.3b, the patterns of consumption are similar at the low food availability season except for very slight differences in the average quantities consumed. There is a tendency for rural households to shift to consumption of even more cereals at the pre-harvest season (Figure 5.3a and Figure 5.3b) where most rural households get food from the market, with prices influencing food consumption. Analysis of the monthly retail price data of the major crops in the study area from October 2013 to September 2014, which includes the two-round data collection period, shows that prices are generally lower between December and April -during and after the few months of the main harvest - while prices are higher during the pre-harvest season (Figure 5.3c). The food prices of these major staple cereals and pulses in the study area generally increase as the food stocks from own production reduce, at which point food purchases increase, pushing food prices up due to the increased demand for the agricultural products.

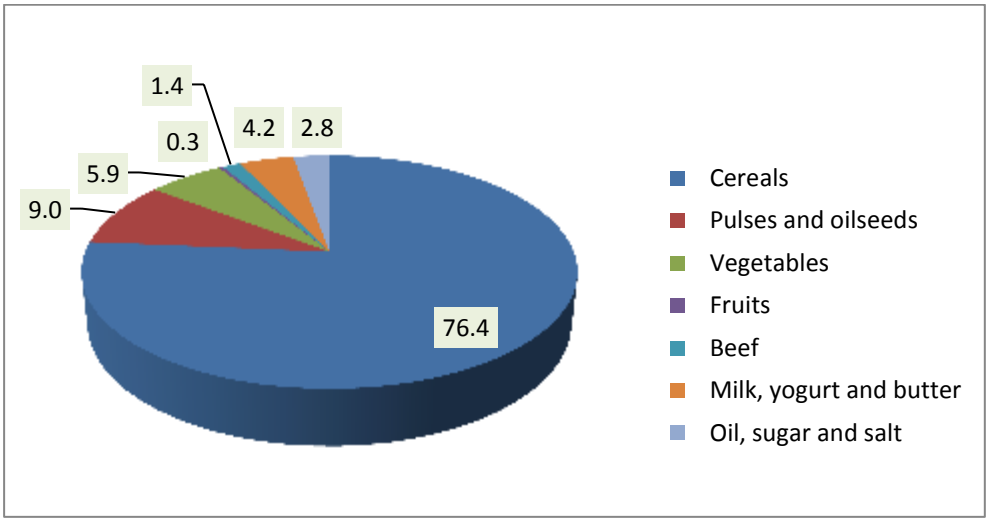


Figure 5.3a: Monthly proportions of food consumption at the post-harvest season (%)

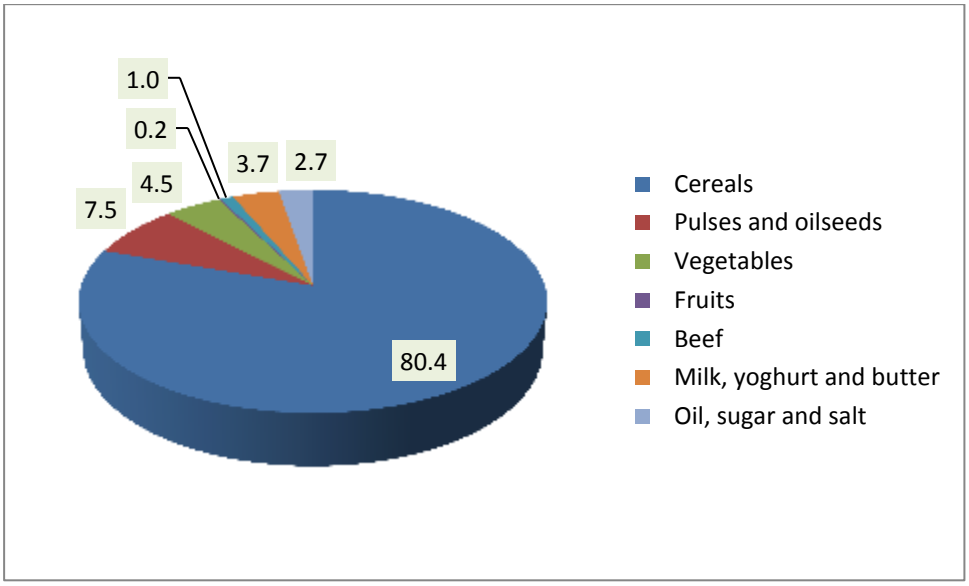


Figure 5.3b: Monthly proportions of food consumption at the pre-harvest season (%)

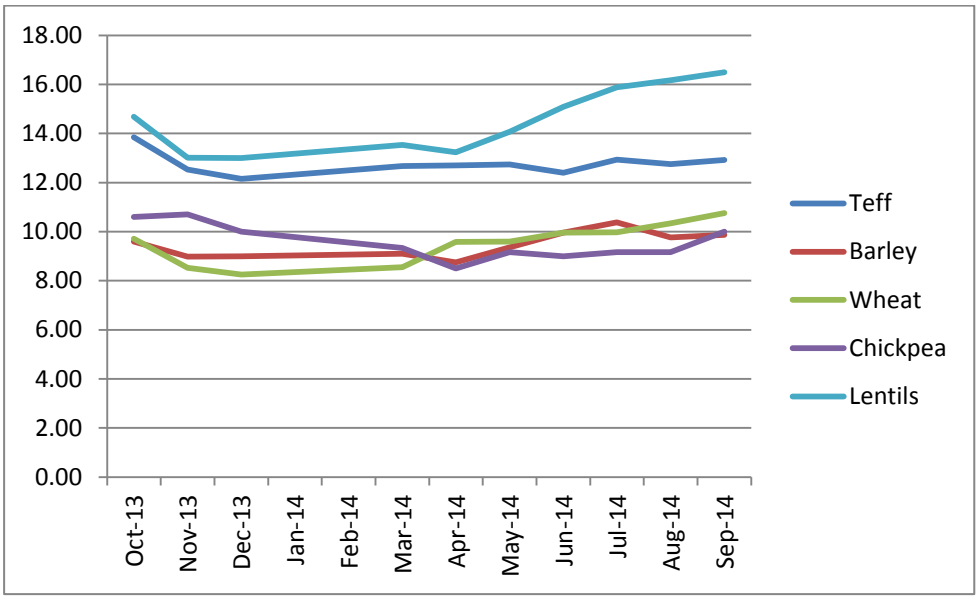


Figure 5.3c: Average monthly retail price (ETB/Kg) of major crops at Mekelle market

Source: Monthly price data from TAMPA, 2014

On the quality of produce and food consumption, households said that "*bizuh gize libaelna kab mibilae tsiryetu tsibuqh likohne mhrti lab edagatat Mekelley khalioty ina nwesd. Izuy nigebro lihashe atawi agninas mienti khalie ttatta gujji kinimelie iyu.Gin izuy kiliwett hamlelewo ni'amn"* (we usually sell good quality agricultural produce in the local and Mekelle markets to get better prices). In exchange, they buy food items and commodities including sugar, spices, coffee, kerosene, clothes, utensils and furniture.

5.10.2.2. Food expenditure

The food consumption data collected from the households for the 30-day period was converted to expenditure using prevailing local market prices in the period when selling and buying of the food items took place in the market; this includes the imputed value of own consumption of products obtained from own-production, gift/borrowing and transfers/aid.

Monthly food expenditure, all villages

Households spent 26.3% of their monthly food expenditure on cereals during the main harvest season. The proportion seems low relative to the high percentage consumption of cereals by weight because the relative prices of the other food expenditure items are high. The corresponding figure for cereals at the pre-harvest season was 46.6%. Whereas the monthly consumption of cereals and pulses by quantity is similar between the two periods, the higher proportion of cereals in total expenditure in the pre-harvest season suggests that households make up for the shortage of cereals through purchase during the low food availability season (Figure 5.4a and Figure 5.4b). The proportion of expenditure on livestock and livestock products appears to be relatively high, as the unit cost of meat, milk and butter is higher compared to the other food items. Published sources are not available for unit prices of these livestock products for the study area but the discussion with the focus groups in the four villages revealed that, on average, the price of meat varies between ETB 120/kg in the post-harvest season and ETB 140/kg in the pre-harvest season as oxen-the major sources of meat in rural areas-participate in agricultural activities and thus fewer are sold in the market; the average prices of milk and butter vary from ETB 15/lt and ETB 180/kg during the post-harvest season to ETB 18/lt and ETB 220/kg during the pre-harvest season, respectively. The main reason for the lower unit prices during the post-harvest season is higher yield due to better availability of livestock feed.

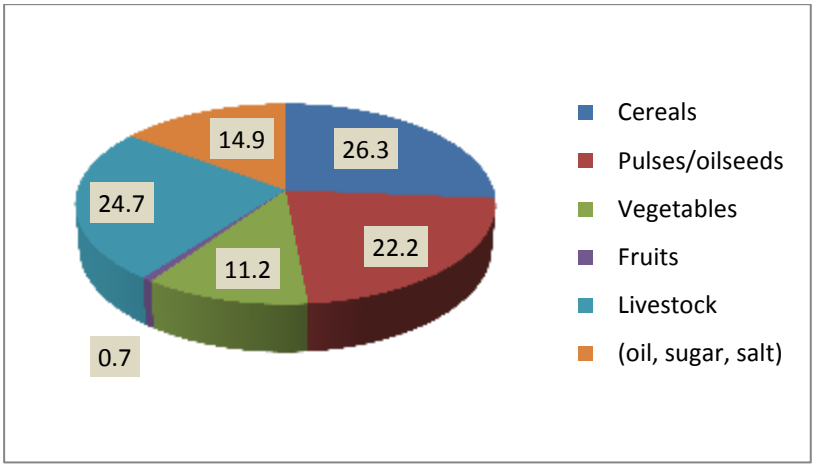


Figure 5.4a: Proportion of monthly food expenditure by households at the post-harvest season (%)

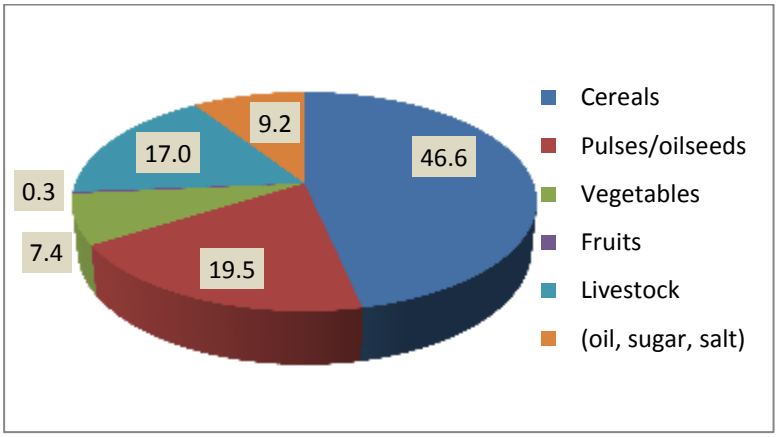


Figure 5.4b: Proportion of monthly food expenditure by households at the pre-harvest season (%)

Food expenditure, by village

The average monthly major food expenditure for the post-harvest season was ETB 563 per household. Purchased food items included cereals, pulses, vegetables, fruit, meat, egg, milk and edible oil. There were significant differences in food expenditure among the villages. The lowest monthly food expenditure was at Meseret *Tabia*; the highest was at Mahbere Genet *Tabia* (Table 5.30). At the pre-harvest season, the monthly food expenditure was ETB 660, and significant differences were observed between the study villages. Monthly food expenditure at Mahbere Genet *tabia* was again the highest at the pre-harvest season, as the production of cereals-the major food item-was lowest (see Table 5.13) at the *Tabia* (Table 5.30).

Table 5.30: Average food expenditure per household, by village

Amount: ETB

Description	Average (All sites)	Village (*Tabia*)				F-test (p-value)
		Andi Woyane	Mahbere Genet	Meseret	Tsehafti	
Monthly food expenditure[a] (main harvest season)	563	723	786	405	427	0.000***
Observation (n)	400	75	96	107	122	
Monthly food expenditure (pre-harvest season)	660	750	1032	510	436	0.000***
Observation (n)	390	72	96	101	121	

***at 1% level of significance; (a) Value of expenditure given in ETB

The F-test of the null hypothesis tests differences in average mean values of the indicated variables between households in the study villages.

5.10.3. Non-food expenditure

The non-food expenditure includes fixed assets and consumables: this data was collected for the previous 12 months during the second round (pre-harvest season), so it also covers expenditure in the main harvest season. The major fixed assets include buildings, stores, farm implements, household furniture and kitchen utensils. The consumables include mainly clothes, detergent soap, kerosene, school fees, medical expenses, and expenses for major social and religious ceremonies such as wedding, *teskar*, *christina* and *tsebel*. The ceremonies do not take place on a regular basis but rural households in the study area spend relatively large amounts of money to finance them.

Non-food expenditure, by location

The average annual non-food expenditure was ETB 5,035 and there were no significant differences across the four villages. The proportion of expenditure on consumable items was higher as compared to expenditure on fixed assets. Consumable items included clothing, sanitary items, school fees for children, fuel, and religious and cultural ceremonies. Fixed assets included improvement on buildings, and household and kitchen equipment (Table 5.31).

Table 5.31: Average annual non-food expenditure of rural households, by location

Amount: ETB

Description	Average (All sites)	Village (*Tabia*)				F-test (p-value)
		Andi Woyane	Mahbere Genet	Meseret	Tsehafti	
Average annual non-food expenditure	5,035	5,995	4,212	4,683	5,413	0.221
Consumable items expenditure	4,375	4,520	3,802	4,286	4,819	0.088*
Fixed assets expenditure	660	1,475	410	397	594	0.108
Observation (n)	390	72	96	101	121	

*at 10% level of significance

The F-test of the null hypothesis tests differences in average mean values of the indicated variables between households in the study villages.

Non-food expenditure, by gender

There were significant differences in the non-food expenditure between FHH and MHH, and on the amounts spent on consumable items. The investments in fixed assets between FHH and MHH were significantly different from each other (Table 5.32). This reflects the fact that MHH earned more income from farm and non-farm activities and spent more on non-food items.

Table 5.32: Average annual non-food expenditure of rural households, by gender

Amount: ETB

Description	Households		F-test (p-value)
	FHH[a]	MHH[b]	
Average annual non-food expenditure	3,369	5,363	0.005***
Consumable items expenditure	3,012	4,643	0.001***
Fixed assets expenditure	357	720	0.388
Observation (n)	64	326	

*** 1% level of significance; (a, b) FHH=Female-Headed Household; MHH=Male-Headed Household

The F-test of the null hypothesis tests differences in average mean values of the indicated variables between households in the study villages.

5.11. Income and expenditure by wealth group

To understand the differences in asset possession and the influence of household wealth on food availability, the rural households were categorized into three wealth groups- poor, middle and better-off according to their land holding size, livestock ownership and housing conditions (See Table 2.2). The characteristics for wealth categorization were adapted from a study for the Enderta Dry Mid Livelihood Zone (GoE, 2007). Livelihood zones are geographical areas demarcated based on some common patterns broadly shared by households

living in the area. These patterns include access to food, markets and income. The four villages of this study are located in this livelihood zone.

The results presented in Table 5.33 reveal that rural households differ significantly in family size, land holding, and Tropical Livestock Unit (TLU) depending on their wealth status. Households in the poor wealth group have the smallest family size, land holding and livestock ownership. The majority of the rural households (52.8%) fall under the poor wealth category. The middle and better-off wealth groups comprise 35.7% and 11.5% of the households, respectively. The majority of the female-headed households (FHH) are in the poor wealth group (65.5%); only 4.7% of the FHH are in the better-off group. About half of the male-headed households (MHH) are in the poor wealth category and 12.8% in the better-off group (Table 5.33).

Table 5.33 also shows significant differences in wealth among the four villages. In terms of wealth, the lowest is Tsehafti *tabia*, where 84% of the households are in the poor wealth category. This village has the lowest average land holding of all the villages. The highest proportion of households in the better-off category is at Meseret *tabia*, where the average land holding is higher as compared to the other villages.

Table 5.33: Mean results of selected household characteristics by wealth group

Description	Household Wealth group			χ^2 and F-tests (p-value)
	Poor	Middle	Better-off	
Family size	5.33 (0.14)[a]	6.34 (0.18)	6.83 (0.30)	0.000***
Land holding (ha)	0.39 (0.01)	1.07 (0.02)	1.85 (0.05)	0.000***
TLU	3.16 (0.18)	4.46 (0.27)	6.80 (0.62)	0.000***
% by wealth group, by gender				0.044**
FHH	65.60	29.70	4.70	
MHH	50.30	36.90	12.80	
% by wealth group, by location				0.000***
Andi Woyane	60.00	38.70	1.30	
Mahbere Genet	41.70	46.80	11.50	
Meseret	21.50	46.70	31.80	
Tsehafti	84.40	15.60	0.00	
Observation (n)	211 (52.8%)	143 (35.70%)	46 (11.50%)	

***, ** at 1% and 5% levels of significance; (a) Figures in brackets indicate Standard Errors
The chi-squared test of the null hypothesis tests the relationship between categories of proportion of gender of headship and location by wealth group; the F-test of the null hypothesis tests differences in average mean values of family size, land holding and TLU by wealth group.

Table 5.34 summarizes yield, income and disposal of own farm produce in terms of wealth groups. Yield of cereals and pulses show significant differences between the three wealth groups. The lowest yields of cereals and pulses are reported by households in the poor wealth group. Average farm incomes increased with wealth; however average income from off/non-farm activities was slightly higher from households in the poor wealth group although the difference was not significant. The average consumption of cereals and pulses from own produce was significantly different between the wealth groups. In both cases, consumption was highest by households in the better-off wealth group. The sales income from pulses was significantly higher for the better-off wealth group. These differences provide indications of differences in food availability and access among rural households in the area. One of the most interesting differences is the fact that poor households sold a significant proportion of their cereals, even though they consumed less. This may indicate the necessity to generate cash income for essential non-food expenditures, but possibly at the expense of basic food security. Although not statistically significant, the average total income of households in the poor wealth group is higher than that of the middle group, due to differences in off/non-farm income; the majority of such income comes from participation in the PSNP except in

Mahbere Genet tabia (close to the regional capital Mekelle) where most of the off/non-farm income comes from mining of natural resources (See Table 5.28). In general the data showing the importance of the PSNP to incomes of the poor wealth group provide an indication that it is effectively targeted.

Table 5.34: Mean yield, income and product disposal of own produce at post-harvest season, by wealth group

Description	Household Wealth group			F-test
	Poor	Middle	Better-off	
Average yield of cereals (Kg/ha)	871 (46.25)[a]	1,035 (52.48)	936 (62.91)	2.730*
Average yield of pulses (Kg/ha)	163 (23.65)	351 (45.51)	613 (125.08)	16.654***
Average farm income (ETB)	4,259 (897.82)	4,584 (448.77)	8,140 (1154.30)	2.711*
Average off/non-farm income (ETB)	5,039 (660.92)	4,242 (577.84)	4,417 (1289.20)	0.387
Average total income	9,298 (1189.3)	8,826 (725.59)	12,557 (1617.20)	1.268
Disposal of own produce at post-harvest season (Kg)				
Cereals consumed	365	765	1,172	59.147***
Cereals sold	100	46	71	0.161
Pulses consumed	18	48	108	41.227***
Pulses sold	6	20	33	8.610***
Observation (n)	211	143	46	

***, * at 1% and 10% levels of significance; (a) Figures in brackets indicate Standard Errors
The F-test of the null hypothesis tests differences in average mean values of the indicated variables between households in the study villages.

Table 5.35 summarizes food, non-food and farm expenditure by wealth group. No significant differences were observed on the monthly average food consumption expenditure and annual non-food expenditure between the poor, middle and better-off wealth groups. Households in the poor wealth group earned considerable income from off/non-farm activities (see Table 5.34) and might have spent a high proportion of it on both food and non-food items. Households in the middle and better-off wealth groups consumed a higher amount of cereals and pulses from own produce as compared to households under the poor wealth group. As such, it is expected that food purchases might not show significant difference between wealth groups as one might expect higher food expenditure by poor households since they produce less food; but they are constrained by lower income. Significant differences were observed in

farm expenditure during the main agricultural season, in which households in the middle and better-off wealth groups used more inputs like fertilizer, pesticides and seeds.

Table 5.35: Mean results of selected expenditure types by wealth group

Amount: ETB

Description	Household wealth group			F-test
	Poor	Middle	Better-off	
Food consumption expenditure (monthly average)	556.00 (35.01)[a]	592.00 (41.43)	505.00 (63.66)	0.579
Non-food expenditure (annual average)	4,782.00 (369.35)	5,146.00 (437.44)	5,855.00 (660.23)	0.850
Farm expenditure (post-harvest season average)	937.00 (163.96)	1,704.00 (103.51)	2,385.00 (228.92)	13.460***
Observation (n)	211	143	46	

***at 1% level of significance; (a) Figures in brackets indicate Standard Errors
The F-test of the null hypothesis tests differences in average mean values of the indicated variables between households in the study villages.

5.12. Disaggregation by household income quartiles

To analyse differences among the rural households regarding food access, households were divided into four quartiles. The quartiles are based on household income from farm and off/non-farm activities. As indicated in Table 5.36, the average family size, land holding, and TLU were significantly higher at the higher household income quartiles (Q3 and Q4). Significant differences were also observed in off/non-farm participation: 63% for quartile 1 and 87% for quartile 4. These results imply increased household income through available labour for both farm and off-farm activities, higher production, and income from sale of livestock and livestock products. The expectation is that the participation in off/non-farm activities may be higher for poor households at the lowest income quartile (as most of them also have poor wealth) so that they can get cash to purchase food and non-food items; however this is not the case: only 63% of the bottom quartile participated in off/non-farm activities, indicating the presence of various factors which limit such participation and contribute to low-income status. One such factor is likely to be gender status of the household: however the results do not provide clear evidence: although 34% of FHH (who comprise 16% of the total sample) are in the lowest quartile, about 92% of all FHH participated in off/non-farm activities (see Table 5.27). Evidently there are low-income MHH who also do not participate in such activities.

The majority of the female-headed households (73.5%) were in the two lower household income quartiles and only 7.8% were in income quartile 4. About 55% of the MHH were in the higher income quartiles (Q3 and Q4) (Table 5.36). A number of factors could contribute to lower incomes of FHH. FHH were short of ploughing oxen (only 0.39 as compared to 1.46 for MHH) and had only 1.61 TLU as compared to 4.51 for MHH) (see Table 5.3). The farm practice in the study villages considers women's participation in ploughing activities as a taboo. FHH rely on relatives, neighbours and tenants for land cultivation. For example, as indicated in Table 4.9, about 63% of the total land rented-out in the 2013/14 agriculture year was from FHH, and they shared only 50% of the produce with the tenant.

Table 5.36: Means of selected household characteristics by household income quartile (n=400)

Description	Household income quartiles[a]				F- and χ^2 - tests
	Q1	Q2	Q3	Q4	
Family size	5.14 (0.24)[b]	5.51 (0.20)	6.27 (0.20)	6.54 (0.19)	9.920***
Age of household head	49.30 (1.60)	44.50 (1.41)	45.60 (1.19)	44.80 (1.25)	2.618*
Land holding (ha)	0.69 (0.05)	0.75 (0.06)	0.78 (0.04)	0.98 (0.06)	5.519***
Tropical Livestock Unit (TLU)	3.19 (0.25)	3.47 (0.25)	3.99 (0.33)	5.52 (0.41)	10.713***
% within HH income quartile					12.004***
FHH	34.40	39.10	18.80	7.80	
MHH	23.20	22.30	26.20	28.30	
% of households' extension contact	73.00	70.00	73.00	84.00	1.587
% off/non-farm participation by households	63.00	82.00	90.00	87.00	28.094***
% of households' access to credit within quartile	55.00	64.00	71.00	63.00	1.215

***, * at 1% and 10% levels of significance; (a) Household income quartiles are given in ascending order from left to right, Q1 being the lowest; (b) Figures in brackets indicate Standard Errors

The F-test of the null hypothesis tests differences in average mean values of family size, age of household head, land holding and TLU of households between the study villages by income quartile; the chi-squared test of the null hypothesis tests the relationship between categories of gender of head of household, extension contact, off/non-farm participation and access to credit of households by income quartile.

As shown in Table 5.37, there were significant differences in farm expenditure among the household income quartiles. Farm expenditure for the post-harvest season was significantly higher at the higher household income quartiles. The monthly average food consumption expenditure was also significantly higher at higher quartiles and vice versa.

Table 5.37: Means of farm expenditure and food consumption by household income quartile (n=400)

Description	Household income quartiles[a]				F-test (p-value)
	Q1	Q2	Q3	Q4	
Farm expenditure (Post-harvest season)	984.00 (92.14)[b]	1,042.00 (111.66)	1,232.00 (104.82)	2,254.00 (347.90)	0.000***
Food consumption expenditure (monthly average)	435.00 (48.11)	549.00 (53.93)	571.00 (37.52)	696.00 (53.91)	0.003***

*** at 1% level of significance; (a) Household income quartiles are given in ascending order from left to right, Q1 being the lowest; (b) Figures in brackets indicate Standard Errors

The F-test of the null hypothesis tests differences in average mean values of the indicated variables between households in the study villages, by income quartile.

5.13. Analysis of factors influencing yield and consumption from own produce

The following sections analyse factors influencing agricultural yield and food consumption from own farms of rural households. The variables included in the analysis were selected based on empirical research works by CSA (2014), Berhane *et al*. (2011), Salami *et al*. (2010), Gebrehiwot (2008), Adenew (2004) and Callens and Seiffert (2000).

5.13.1. Factors influencing cereal yields

One factor affecting food security at household level is the availability of cereals for consumption, and this is partly influenced by cereal yields, which are generally low in the study area. Therefore the relationship between cereal yield and selected household and socio-economic variables was analysed using OLS multiple regressions. Regression results show the association between and change in the value of a dependent variable caused by a change in the coefficient value of an independent variable, isolating a relationship by adjusting for other variables that may confound the relationship. This feature distinguishes regression analysis from cross-tabulations and correlations, which do not control for the possible influence of other variables. The summary statistics of the variables are reported in Table 5.38. The coefficients of the regression, standard errors and model goodness-of-fit are shown in Table 5.39.

Table 5.38: Summary statistics of variables used in regression for cereal yield

Variables	Mean	Std.dev	Min	Max
Location (4 villages dummy)				
Sex of the household head (1=Male; 0=Female)	0.84	0.37	0	1
Age of the household head (years)	46.06	13.79	21	92
Adult equivalent	4.86	1.87	0.74	9.78
Education level of the HH head (Read and write=2; Illiterate=1)	1.41	0.49	1	2
Land holding (ha)	0.80	0.55	0	3.3
TLU (Tropical Livestock Unit) (number)	4.04	3.29	0	20.4
Extension contact (1=Yes; 0=No)	0.75	0.43	0	1
Household access to credit (1=Yes; 0=No)	0.63	0.48	0	1
Cooperative membership (1=Yes; 0=No)	0.46	0.50	0	1
Participation in Off/Non-farm activities (1=Yes; 0=No)	0.80	0.40	0	1
Farm input expenditure on cereals (ETB)	1261	192. 62	0	32485

The results of the regression analysis presented in Table 5.39 indicate that an increase in cereal yield was positively and significantly associated with location, Tropical Livestock Unit ownership (TLU) and household access to credit. Cereal yield was higher for households at Andi Woyane and Meseret *Tabias* as compared to households in Tsehafti *Tabia*- a reference category in the regression analysis. There were no significant differences in cereal yield between Mahbere Genet and Tsehafti *Tabias*. This suggests that cereal yield varies with location of households, controlling for other factors. Larger ownership of livestock also contributed to higher cereal yield mainly through draught power. Households' access to credit was also related to higher yield through credit purchases of fertilizer, improved seeds and pesticides. Adult equivalent was negatively and significantly associated with cereal production. This could be due to low availability of family labour, resulting from more dependents in the household and less time available for mothers with young children. Age, education and sex of household head, land holding size, extension contact and farm expenditure were not significantly associated with cereal yield.

Table 5.39: Multiple regression analysis results for variables associated with cereal yield

Independent variables	Standardized coefficients Beta	t-value
Tsehafti *Tabia* (reference dummy)		
Andi Woyane *Tabia*	0.320***	5.846
Mahbere Genet *Tabia*	-0.051	-0.866
Meseret *Tabia*	0.182***	2.760
Age of the household head	-0.022	-0.436
Sex of household head	0.063	0.227
Adult equivalent	-0.109**	-1.976
Education level of the HH head	-0.022	-0.460
Land holding size	-0.056	-0.868
Tropical Livestock Unit (TLU)	0.221***	4.000
Household access to credit	0.093**	1.978
Extension contact	0.063	1.275
Cooperative membership	0.047	0.944
Participation in Off/Non-farm activities	0.014	0.282
Farm input expenditure on cereals	0.039	0.797
Constant	***	3.463
Adjusted R^2	0.190***	
Observation (n=400)		

***, **, * at 1%, 5% and 10% levels of significance

5.13.2. Factors influencing consumption from own production

OLS multiple regressions were used to analyse the relationship between the proportion of quantity of consumption from own produce and selected household and socio-economic variables. As shown in Table 5.40, age and sex of household head, land holding, TLU, cereal yields and extension contact were significantly and positively associated with consumption from own produce while household income was significantly and negatively associated with the same. This suggests that larger holding size, larger livestock ownership, higher yields of the major staple food in the area and lower household income induced more consumption through higher food supply from own farm. Proportion of consumption from own produce was not significantly associated with education of the household head, pulses and vegetable yields. Overall this result suggests that households with more productive resources are better able to attain higher food consumption levels, from own production.

Table 5.40: Multiple regression analysis results for variables associated with proportion of quantity of consumption from own produce

Independent variables	Standardized coefficients Beta	t-value
Tsehafti *Tabia* (reference dummy)		
Andi Woyane *Tabia*	0.056	1.031
Mahbere Genet *Tabia*	-0.095*	-1.753
Meseret *Tabia*	0.138**	2.247
Sex of the household head	0.096**	2.012
Age of household head (years)	0.149***	3.168
Education of household head	-0.071	-1.603
Adult equivalent	0.004	0.073
Land holding	0.236***	4.030
Tropical Livestock Unit (TLU)	0.159***	3.012
Log household income	-0.112**	-2.484
Yield of cereals	0.168***	3.581
Yield of pulses	0.018	0.374
Yield of vegetables	-0.020	-0.463
Extension contact	0.093**	2.097
Constant		4.812
Adjusted R^2	0.321***	
Observation (n=400)		

***, **, * at 1%, 5% and 10% levels of significance

5.14. Comparison: Selected local, national and international socio-economic characteristics

Comparisons were made on selected socio-economic characteristics between smallholder farm households of the study villages and Ethiopia, Indonesia, Kenya, Malawi and Tanzania (Table 5.41). The average land size (larger than Kenya and Malawi), production diversity (higher than Indonesia) and household dietary diversity (higher than Ethiopia) for the study villages were found to be lower than the pooled average values. TLU is also smaller than that in Tanzania. The production diversity in the study villages is significantly lower than the national average. The HDDS score for the study villages at the post-harvest season is lower than that of Indonesia, Kenya and Malawi.

Table 5.41: Comparisons of selected household socio-economic characteristics of smallholder farm households in various countries

Variables[13]	Tigray (study villages)[a]	Pooled	Ethiopia	Indonesia	Kenya	Malawi	Tanzania
Land size (ha)	0.80	1.26	1.63	4.50	0.71	0.74	-
Production diversity	3.73	6.13	10.19	1.74	7.82	4.80	-
HDDS	5.90	7.99	5.42	10.02	11.40	8.48	-
TLU	4.04	-	-	-	-	-	5.00[b]

Source: National and international data from Sibhatu *et al*. (2015) and Slavchevska (2015)
[a]The results pertain to the post-harvest season taken from various tables; [b]computed from Slavchevska (2015) data collected in 2011.

5.15. Conclusions

The main aim of this chapter is to describe and analyse the agricultural-based livelihood system in order to develop an understanding of the interactions between household livelihoods and food and nutrition security. The chapter therefore focusses on households' demographic characteristics, land and other asset ownership, agricultural production activities, off/non-farm activities and other aspects of the livelihood system, disaggregating where appropriate by season, location, gender, wealth and income.

Generally levels of human capital and asset ownership are poor in the study areas. The majority of household heads in the study area are illiterate; in the case of FHH more than 80% are illiterate. The housing conditions, storage and livestock sheds in the study area are generally poor although there are significant differences across villages.

The average household land holding is 0.80ha, with significant differences across villages and gender of household head: FHH own less land than MHH although there is no clear gender bias on rights to land. Most FHH rent out their land to male relatives: the culture hampers them from doing otherwise, coupled with labour shortage. With the product share

[13] The national and international data were collected at a closer time (2011 and 2012) the primary data for this thesis were collected. The data for Ethiopia is reported to be nationally representative (Sibhatu *et al*., 2015). The dietary diversity score for the four study villages is based on a 30-day recall against the others (7-day recall). But as discussed in section 6.4.1, in the rural Tigray context, using a 7- or 30-day recall would give similar results.

arrangement of 50:50, most FHH receive only half of what is produced from their rented-out land.

Farm resources and production decisions:

There were significant differences in average cultivated land during the 2013/14 agriculture year across villages. Cereals dominate in area coverage: this reflects the local feeding habit which prioritises energy-based food consumption. Although households understand what good nutrition is, they still equate consuming cereals - by making *injera* - to a blessing from god.

Land size is small and fragmented and cultivation is mainly rain-fed: this is inadequate to support the livelihoods of a significant proportion of rural households. The per capita production of cereals, pulses and oil seeds, vegetables and fruit is low compared to regional and national averages and it negatively influences food availability. The average production per household of cereals, pulses and oilseeds was significantly lower for FHH as compared to MHH, presumably due to renting out land and dependence on male relatives. The highest yield for cereals and highest production for vegetables was in Andi Woyane tabia due to better rainfall and supplementary irrigation facilities. Fruit production is very low in the study area.

There are significant differences in livestock ownership across villages. The average TLU is about 4 per household and the average ploughing oxen ownership is less than the minimum required for ploughing; while oxen ownership for MHH is significantly higher than for FHH.

In terms of disposal of agricultural products, most of the cereals and pulses and oilseeds produced were for own consumption whereas the majority of vegetables and fruit produced were for the market. The proportion of cereals consumed was higher than the results reported by Hirvonen and Hoddinott (2015) for five regions of rural Ethiopia including Tigray. Livestock are mainly raised to support crop production, for sale during periods of crop failure, to meet other social and local cultural obligations, religious holidays, and for the consumption of eggs and milk.

There has been considerable expansion of agricultural institutions providing support services in Tigray in recent years. The majority of households participated in extension training

programmes and demonstrations on new crop varieties, SWC, diseases and pests, irrigation, and agricultural marketing. There appear to be no problems in access to credit in the study area: borrowing is common with the majority of households receiving loans from microfinance institutions and BoARD. Men have greater access to support services – or are the direct contact with such services –than women, as also found by Ahmad *et al*. (2012).

There are significant seasonal variations in the amount and sources of household income. At high season the major sources of crop income are cereals and vegetables. Significant differences were observed in incomes among the four villages in pulses and oilseeds, vegetables and fruit and trees sales.

At the low season, the majority of crop income was from vegetable sales, where irrigation water was used. Significant differences were observed in crop income across the villages mainly due to differences in vegetable income.

In both seasons the majority of income was from sale of livestock while livestock products covered only about one-tenth of the total livestock income. There were significant differences in income between the four villages. Pre-harvest, households sell more livestock products when the crop harvest from the preceding season starts to wane, to bridge the gap in food consumption and other non-food expenses. This is one aspect of the link between agriculture, consumption and nutrition. Farm income accounted for about half of total household income post-harvest and considerably less pre-harvest. Significant differences in income were observed across villages in both seasons.

The majority of households participated in off/non-farm activities: FHH had higher participation rates, driven by limited land availability: FHH participated in the PSNP and in self- employment such as handicrafts, local beverage making and selling, running small merchandise shops and female hair dressing.

For the high season, the average farm income covered about half of total household income. At the low season, off/non-farm income was higher than farm income. Significant differences were observed across the four *tabias* in both seasons due to differences in farming activities related to farm land size, water availability, livestock ownership, and off/non-farm job

opportunities, which are influenced by proximity to urban centres. In both seasons, the household income of MHH was significantly higher than that of FHH.

In terms of consumption, at the main harvest season cereal consumption accounted for the majority of food consumed (by weight), followed by pulses and oilseeds. The consumption of fruits and beef was low. Households tend to consume even more cereals in the lean season where most rural households get part of their food from the market, with prices influencing food consumption. Prices are generally higher during the lean season, influencing quantity and quality of food consumed. The proportion of expenditure on livestock and livestock products appears to be relatively high despite low consumption of these items, as the unit cost of meat, milk and butter is relatively high.

More disaggregated analysis was conducted by categorising households, first by wealth group, then by income quartile. The purpose was to examine differentiation between households in relation to assets, production, income, expenditure and basic food consumption. There were significant differences between the wealth groups in the yield and consumption of cereals and pulses: average farm income was lowest for the poor wealth category; however average income from off/non-farm activities was slightly higher for the households in the poor wealth group. It is interesting to note that poor households sold a significant proportion of their cereals, even though they consumed less. This may indicate the necessity to generate cash income for essential non-food expenditures, but possibly at the expense of basic food security.

No significant differences were found in the monthly average food consumption expenditure and annual non-food expenditure between the poor, middle and better-off wealth groups. Households in the poor wealth group earned considerable income from off/non-farm activities and particularly from the PSNP and might have spent a high proportion of it on both food and non-food items. This may suggest that the PSNP has been effectively targeted towards those households most in need of support.

The average family size, land holding, and TLU were significantly higher at the higher household income quartiles. These results imply increased household income through available labour for both farm and off-farm activities, higher production, and income from sale of livestock and livestock products.

OLS multiple regression estimates showed that age of household head, adult equivalent, land holding, TLU, cereal and pulses yields were significantly and positively associated with consumption from own produce. Overall this result, along with other findings in the chapter, suggests that households with more productive resources are better able to attain higher food consumption levels.

In conclusion, rural households do not produce enough to maintain and improve their livelihoods due mainly to inadequate productive agricultural resources. As a way out, the households also depend on off/non-farm income from various activities, including self-employment in petty activities, PSNP and borrowing.

Rural households rely on cereals for food consumption, constituting the largest proportion of the food basket of the rural households. The consumption of fruit and vegetables (crops rich in micronutrients) from own production and from purchases, on the other hand, is very low denying households access to more nutritive, healthy and diverse food.

Seasonality of production, gender of the household head and location of rural households influence production as well as food access and stability. These, in turn, influence the food security and livelihoods of rural households.

Food consumption (from own production and purchases) and dietary diversity of rural households are influenced by wealth and income, which in turn result from differences in agricultural asset possession, yield, income and average consumption expenditure. The factors that influence consumption from own production (the first agriculture-nutrition pathway) differ in importance: the most important ones with positive influences are age of household head, land holding, TLU and yield of cereals.

CHAPTER SIX

CONSUMPTION AND FOOD SECURITY STATUS OF RURAL HOUSEHOLDS

6.1. Introduction

The major objective of the present study is to understand how and to what extent agricultural practices and broader livelihood activities influence the food and nutritional security of households.

Household nutritional outcomes are determined by many factors that are complex (Babu *et al.*, 2014). For countries like Ethiopia, where agriculture plays an important role in the economy, increases in agricultural production and productivity have the potential to improve food and nutrition security.

In this chapter, the main focus is on households' access to food, one dimension of food security. Analysis was conducted using descriptive statistics to identify and compare consumption of various food groups by season, location and gender, proportions of major food groups consumed in a given period, and sources of food consumed. The four indicators discussed in Chapter 4 (i.e. HDDS, FCS, HFIAS and CSI) were used to measure food security across location, gender and season, and disaggregated by wealth and household income. Multiple regression models were also used to understand the relationship between food security and factors influencing food consumption and dietary diversity of households.

Section 6.2 deals with household food consumption based on a 30-day recall. It examines whether there are significant differences in food consumption among households between the post- and pre-harvest seasons, different locations (villages) and between FHH and MHH. Section 6.3 identifies the major sources of food consumed by households and assesses the extent of contribution and influence of the major sources of the food consumed: own production, and purchases from agricultural and other income. This provides more insights on the contribution of farming practices to household food consumption.

Section 6.4 derives the four major indicators of food security (HDDS, FCS, HFIAS and CSI) to enable a greater understanding of the food security status of households. Significance tests were conducted for differences between households with respect to seasonal variations,

location and household headship (gender). In section 6.5 comparisons are made to see the correlation between the food security indicators using Spearman's rho.

Sections 6.6 and 6.7 analyse differences in household food security by wealth group and income quartile and compares their food security status between post- and pre-harvest seasons. In section 6.8, OLS multiple regression estimates of factors influencing food consumption and dietary diversity are analysed. Appropriate significance tests (F and χ^2-tests) were carried out to see food security differences between households and seasonal differences, location, gender, wealth and income.

6.2. Household food consumption

At the post-harvest season, cereals make up 76.4% (by weight) of the major foods consumed by rural households. This is followed by pulses (9.0%) and vegetables (5.9%). The consumption of fruit is very low (0.3%) while livestock and livestock products - mainly milk and milk products - account for 5.5% of the total food consumed. The pattern is generally similar at the pre-harvest season (Table 6.1), except that cereal consumption makes up an even higher proportion (80.4%) of total consumption in the pre-harvest season. There is a small reduction in quantities consumed of all food types except cereals during the pre-harvest period.

Table 6.1: 30-day average food consumption[a], by season

Description	Post-harvest season	Pre-harvest season
Cereals consumed (Kg)	106.40 (76.4%)[b]	106.30 (80.4%)
Pulses consumed (Kg)	12.50 (9.0%)	9.90 (7.5%)
Vegetables consumed (Kg)	8.20 (5.9%)	5.90 (4.5%)
Fruit consumed (Kg)	0.36 (0.3%)	0.24 (0.2%)
Livestock & livestock products (Kg/lt)	7.70 (5.5%)	6.20 (4.7%)
Others (oil and sugar)	4.00 (2.9%)	3.60 (2.7%)
Observation (n)	400	390

(a) Consumption: Kg/Lt per household/month; (b) Figures in brackets are proportions of food groups consumed for each season

Table 6.2 summarizes the average monthly food consumption in terms of adult equivalent by season and location. Significant differences were found between *tabias*. The average monthly food consumption per adult equivalent-all food groups summed up- varied between 31.6Kg (Meseret *tabia*) and 22.4Kg (Tsehafti *tabia*) at the post-harvest season, whereas the

corresponding quantities for the pre-harvest season were between 29.7Kg (Mahbere Genet *tabia*) and 23.5Kg (Tsehafti *tabia*). In terms of quantity food consumption was the lowest at Tsehafti *tabia* in both seasons probably due to low crop yield and low farm and off/non-farm income.

Table 6.2: Average monthly adult-equivalent food consumption[a], by season and location (Kg)

Description	Village (*Tabia*)				F-test (p-value)
	Andi Woyane	Mahbere Genet	Meseret	Tsehafti	
Post-harvest season (Round 1):					
Average food consumption	31.6	31.0	31.6	22.4	0.000***
Cereals	22.9	23.8	24.4	17.6	0.000***
Pulses and oilseeds	3.6	2.6	2.5	2.1	0.000***
Vegetables	2.3	1.9	1.9	0.9	0.000***
Fruit	0.2	0.1	0.0	0.0	0.002***
Livestock and livestock products[b]	1.7	1.5	2.0	1.2	0.198
Others (oil and sugar)	0.9	1.1	0.8	0.6	0.000***
Observation (n)	75	96	107	122	
Pre-harvest season (Round 2):					
Average food consumption	29.7	28.1	28.9	23.5	0.009***
Cereals	22.8	21.8	24.4	19.1	0.01**
Pulses and oilseeds	2.3	2.1	1.8	2.1	0.132
Vegetables	1.6	1.4	1.3	0.8	0.000***
Fruit	0.0	0.1	0.0	0.0	0.024**
Livestock and livestock products	2.2	1.7	0.8	0.8	0.001***
Others (oil and sugar)	0.8	1.0	0.6	0.7	0.000***
Observation (n)	72	96	101	121	

***, ** at 1% and 5% levels of significance; (a) Consumption: Kg or Lt per adult per month; (b) Livestock and livestock products include meat, milk, yogurt, and butter
The F-test of the null hypothesis tests differences in average mean values of the indicated variables between households in the study villages.

The proportions of average monthly food consumption of the major food groups are reported in Table 6.3. In both seasons the consumption of cereals accounted for the highest proportion of the food consumed. In all the four *tabias* and for both seasons, cereals comprised more than 70% of the total quantity consumed, followed by pulses. At the post-harvest season, significant differences were observed between the *tabias* in the consumption of all food groups except livestock and livestock products. The results indicate that in all the *tabias* consumption of energy-rich crops predominates.

These empirical results correspond to the study by Hirvonen and Hoddinott (2015) who compared the % food group consumption of young children in rural Ethiopia by region. They found that the food groups predominantly consumed by young children were grains and roots and legumes, while the lowest food groups consumed were meat, eggs, vegetables and fruit. The proportion of food group consumption by young children can reflect the proportion of consumption for the household as in most cases children eat what the other members of the household eat. This is also verified by the FGD participants. The same study also reports lower consumption of Vitamin A-rich vegetables and fruit and dairy products in Tigray compared to the national average.

Table 6.3: Proportion of average monthly food consumption by season and location (%)

Description	Village (*Tabia*)				$\chi 2$-test (p-value)
	Andi Woyane	Mahbere Genet	Meseret	Tsehafti	
Post-harvest season (Round 1):					
Cereals	72.4	77.1	77.1	78.5	0.000***
Pulses and oilseeds	11.3	8.2	7.9	9.2	0.000***
Vegetables	7.4	6.2	6.1	4.0	0.000***
Fruit	0.6	0.2	0.1	0.2	0.002***
Livestock and livestock products	5.3	4.8	6.4	5.3	0.198
Others (oil and sugar)	3.0	3.5	2.4	2.8	0.000***
Observation (n)	75	96	107	122	
Pre-harvest season (Round 2):					
Cereals	76.5	77.6	84.5	81.5	0.01**
Pulses and oilseeds	7.7	7.4	6.1	8.9	0.132
Vegetables	5.4	5.1	4.5	3.3	0.000***
Fruit	0.1	0.4	0.1	0.1	0.024**
Livestock and livestock products[1]	7.5	6.1	2.7	3.4	0.001***
Others (oil and sugar)	2.8	3.4	2.1	2.8	0.000***
Observation (n)	72	96	101	121	

***, ** at 1% and 5% levels of significance

The chi-squared test of the null hypothesis tests the relationship between the values of categories of the indicated variables for households in the study villages.

On the basis of adult-equivalent per capita monthly food consumption female-headed households (FHH) consumed a higher amount of food (30.3Kg) in the post-harvest season as compared to male-headed households (MHH) (28.3Kg). The pattern was similar for the pre-harvest season. But when food consumption per household is considered the monthly average

during the post-harvest season was higher for MHH (147.3Kg) compared to 97Kg for FHH. This is because MHH have larger family size (more adults) than FHH (Table 6.4).

Table 6.4: Average monthly food consumption[a], by season and gender

Description	Kg/Lt per HH		Kg/Lt per adult-equivalent		F-test (p-value)
	FHH	MHH	FHH	MHH	
Post-harvest season (Round 1):					
Average food consumption	97.0	147.3	30.3	28.3	0.000***
Cereals	74.5	112.5	23.3	21.6	0.000***
Pulses and oilseeds	9.6	13.1	3.0	2.5	0.003***
Vegetables	7.0	8.4	2.2	1.6	0.132
Fruit	0.38	0.35	0.1	0.1	0.869
Livestock and livestock products	2.3	8.8	0.7	1.7	0.004***
Others (oil and sugar)	3.3	4.1	1.0	0.8	0.005***
Observation (n)	64	336	64	336	
Pre-harvest season (Round 2):					
Average monthly food consumption	96.0	139.1	30.0	26.8	0.000***
Cereals	76.0	112.2	23.8	21.6	0.001***
Pulses and oilseeds	7.6	10.3	2.4	2.0	0.002***
Vegetables	4.7	6.2	1.5	1.2	0.072*
Fruit	0.23	0.24	0.1	0.0	0.956
Livestock and livestock products	4.0	6.6	1.3	1.3	0.154
Others (oil and sugar)	3.4	3.6	1.1	0.7	0.452
Observation (n)	64	326	64	326	

***, * at 1% and 10% levels of significance; (a) Consumption: Kg/Lt per household per month and Kg or Lt per adult per month

The F-test of the null hypothesis tests differences in average mean values of the indicated variables between households in the study villages.

The proportions of food consumption by food groups shown in Table 6.5 are similar to those reported in Table 6.3. During the post-harvest season, there were no differences between FHH and MHH in the consumption of vegetables and fruit whereas significant differences were observed in the consumption of livestock and livestock products. This difference might be due to the differences in livestock holding, household income and wealth between the two groups.

Table 6.5: Proportion of average monthly food consumption by season and gender (%)

Description	Households		χ2-test (p-value)
	FHH	MHH	
Post-harvest season (Round 1):			
Cereals	76.7	76.4	0.000***
Pulses and oilseeds	9.9	8.9	0.003***
Vegetables	7.2	5.7	0.132
Fruit	0.4	0.2	0.869
Livestock and livestock products	2.4	6.0	0.004***
Others (oil and sugar)	3.4	2.8	0.005***
Observation (n)	64	336	
Pre-harvest season (Round 2):			
Cereals	79.3	80.7	0.001***
Pulses and oilseeds	7.9	7.4	0.002***
Vegetables	4.9	4.5	0.072*
Fruit	0.2	0.2	0.956
Livestock and livestock products	4.2	4.7	0.154
Others (oil and sugar)	3.5	2.5	0.452
Observation (n)	64	326	

***, **, * at 1%, 5% and 10% levels of significance

The chi-squared test of the null hypothesis tests the relationship between the values of categories of the indicated variables for households in the study villages.

6.3. Sources of food for consumption

The sources of food consumed by the households are from own production, purchases, gift and transfer/aid. As indicated in Table 6.6, the main sources of food for the households were from own production and purchases from the market.

6.3.1. Cereal consumption

Consumption levels disaggregated by crop categories and source are reported in Table 6.6. The average cereal consumption at the post-harvest season was 106.40Kg per household over a period of 30 days. At the post-harvest season, 82.4% (88.11Kg) of this consumption was fulfilled through production while 15.6% (16.67Kg) was purchased from the local markets. The remaining 2% was from gifts and transfers. At the pre-harvest season, 31.9% of cereals consumed came from the market, own production accounted for 51.6% while the remaining 16.5% was accounted for by transfers and gifts (Table 6.6).

The results of F-tests showed that there were no significant differences in cereal consumption among the two seasons. The food consumption of households in the area is largely cereal-

based and this is consistent year round. In terms of source, the proportion of consumption of cereals consumed from own produce was significantly higher in the post-harvest season (82.4%) compared to 51.6% in the pre-harvest season. Consumption of cereals from purchase increased significantly in the pre-harvest season (31.9%) as against the post-harvest season (15.6%) (Table 6.6).

6.3.2. Pulse consumption

The average consumption of pulses per household for a period of 30 days was 12.50Kg during the high and 9.9Kg during the pre-harvest seasons. At both the high and pre-harvest seasons, pulses consumed from purchases were more than 60% of total consumption. The average monthly consumption of pulses was significantly higher at the post-harvest season as compared to the pre-harvest season. Both pulses consumed from own source and from purchases were also significantly higher at the post-harvest season (Table 6.6).

6.3.3. Vegetable consumption

The average consumption per household of vegetables at the villages was 8.20kg at the high and 5.90kg at the pre-harvest seasons. Most of the vegetables consumed (92.3% at the high and 94.2% at the pre-harvest seasons) were purchased from local markets. The remaining very small proportion came from the households' plots, which were either owned and/or rented-in. The consumption of vegetables from both own source and purchase were significantly higher at the post-harvest season compared to the pre-harvest season.

6.3.4. Fruit consumption

The average consumption per household of major fruit was 0.36kg at the post-harvest season and 0.24kg at the pre-harvest season. The amounts consumed show that fruit consumption is very low in the area. Most of this consumption was from purchases (77.0% at the high and 58.3% at the pre-harvest seasons). Only fruit consumed from purchases were significantly higher at the post-harvest season.

There are taboos related to food consumption especially on children and women. According to the households, few of these are: *"li qholi'a mear ayihibwoy limntaysi keykhultf; siga li qholi'a ayihibwoy-mienti hasakhu keygodiewo; li ttinisti sebeyti ttiremre ayhibwoy limntaysi*

tu ab khebdi lello hitsan keygudae" (giving honey to children creates speech problems (stammering); eating meat makes children contract parasites; and giving pulses to a pregnant woman hurts the baby inside). All these negatively influence the consumption of important food items. These notions are changing since the last 4-5 years.

6.3.5. Milk and milk products consumption

Most households consume livestock products from their own produce. The average monthly consumption of milk and milk products in the area amounted to 5.94lt at the post-harvest season. The corresponding amount consumed at the pre-harvest season was 4.87lt: the average monthly per adult equivalent consumption is between 0.99lt and 1.21lt, a very low amount. The monthly consumption of fruit is almost negligible. This indicates a very low level of consumption of micronutrient-rich foods in the study area (Table 6.6).

Table 6.6: Monthly consumption of major food items by season and source

Description	Post-harvest season Mean	Pre-harvest season Mean	F-test (p-value)
Cereals consumed[a]	106.40	106.27	0.886
Cereals consumed from own produce	88.11 (82.4%)[b]	54.94 (51.6%)	0.000***
Cereals consumed from purchase	16.67 (15.6%)	33.88 (31.9%)	0.000***
Pulses consumed	12.50	9.90	0.000***
Pulses consumed from own produce	4.04 (32.0%)	3.01 (30.4%)	0.003
Pulses consumed from purchase	8.22 (65.2%)	6.02 (60.8%)	0.000***
Vegetables consumed	8.20	5.90	0.000***
Vegetables consumed from own produce	0.46 (5.6%)	0.23 (3.9%)	0.043
Vegetables consumed from purchase	7.60 (92.3%)	5.57 (94.2%)	0.000***
Fruit consumed	0.36	0.24	0.135
Fruit consumed from own produce	0.07 (20.0%)	0.06 (25.0%)	0.810
Fruit consumed from purchase	0.27 (77.0%)	0.14 (58.3%)	0.038
Milk & milk products consumed	5.94	4.87	0.276
Milk & milk products consumed from own produce	5.56 (93.6%)	4.41 (90.6%)	0.238
Milk & milk products consumed from purchase	0.32 (5.4%)	0.36 (7.4%)	0.801
Observation (n)	400	390	

***at 1% level of significance; (a) Consumption: Kg or Lt per household; (b) Figures in brackets are proportions of consumption from own produce and purchase. The percentages do not add up to 100% as there was consumption from gift

The F-test of the null hypothesis tests differences in average mean values of the indicated variables between households in the study villages.

The results above indicate the continued high dependence on cereal consumption. Focus group discussion participants claim they now know what nutritious food is due to the nutrition awareness creation and demonstration programmes but their capability is limited. In their own words they say "*khebdina kinimelie ina nitsier; shiro equa biaqhma siga khoyna; shiro ina nitinfs"* (Our aim is to make our belly full partly because we do not afford to eat nutritious food; even *shiro* has become expensive and is like 'meat' nowadays; we even breathe *shiro*[14]). Respondents use emphatic language to explain the extent of cereal consumption and the food

[14] *shiro* is flour prepared from pulses to make a local spiced sauce

insecurity and undernutrition in the villages. The possibility of consuming other foods is made more difficult in the pre-harvest season when the price of food items increases.

The food gap

One measure of food security status is the food gap experienced by households. Among the 400 respondents, 50.5% said that they faced food shortage in the previous 12 months preceding the end of the harvest for the 2013/14 agriculture year. The highest proportion of households facing food shortage was at Tsehafti *tabia* (76.2%); the lowest was at Andi Woyane *tabia* (30.7%). In terms of months of food shortage in the previous 12 months, households, on average, had shortages for 1.54 months (Table 6.7).

At the pre-harvest season, 72.1% of households reported that they faced food shortages during the period between the end of the harvest season (Round 1) and the peak of the pre-harvest season (Round 2). There were significant differences among the four villages. The highest experience of food shortages was at Mahbere Genet *tabia* (81.2% of households); the lowest was at Tsehafti *tabia* (56.2%). The latter result is somewhat surprising given that most other indicators show that Tsehafti is a food insecure area: it may indicate effective provision of food assistance for example through the PSNP.

The food shortage situation of households was significantly different between the post- and pre-harvest seasons, according to the opinions of household heads. 51.5% of households said that the food situation is the same between the two seasons, but 44.1% said that food shortage was higher (food availability was worse) during the pre-harvest season. Only 4.4% said that food access was higher in the pre-harvest season. Significant differences were observed across the four villages (Table 6.7).

Table 6.7: Responses of households to selected food security issues

Description	Total (All sites)	Villages (*Kebele/Tabia*)				χ^2 test (p-value)
		Andi Woyane	Mahbere Genet	Meseret	Tsehafti	
Post-harvest season (Round 1):						
% food shortage faced						
No	49.5	69.3	54.2	60.7	23.8	0.000***
Yes	50.5	30.7	45.8	39.3	76.2	
Average food shortage (months)[a]	1.54	0.84	1.10	1.12	2.68	
Observation (n)	400	75	96	107	122	
Major changes in diet in past 3 years (%):						
No	70.0	45.3	75.0	69.2	82.0	0.000***
Yes	30.0	54.7	25.0	30.8	18.0	
Pre-harvest season (Round 2):						
% food shortage faced						0.000***
No	27.9	20.8	18.8	22.8	43.8	
Yes	72.1	79.2	81.2	77.2	56.2	
Average food shortage (months)[b]	0.69	0.31	0.49	0.47	1.27	
Observation (n)	390	72	96	101	121	
Food shortage comparison: Pre-against post-harvest season (%)						0.012**
Better	4.4	4.2	4.2	5.9	3.3	
Worse	44.1	31.9	34.4	48.5	55.4	
Same	51.5	63.9	61.4	45.6	41.3	
Observation (n)	390	72	96	101	121	

***, ** at 1% and 5% levels of significance; (a) Food shortage during the 12 months prior to round 1; (b) Food shortage during the 6 months prior to round 2

The chi-squared test of the null hypothesis tests the relationship between the values of categories of the indicated variables for households in the study villages.

During and for a few months after the main harvest the majority of food consumed by a majority of households comes from own-production, with food purchase covering a small proportion during this period. Many households then start to participate in the market as sellers of agricultural produce and buyers of food as well as non-food items and this generally increases until the next harvest. Apart from agricultural income, households use part of the income from PSNP and other non-farm activities for consumption smoothing by way of food purchases and use of the in-kind benefit especially during the pre-harvest season. Households also use labour sales, borrowing and gifts for consumption smoothing purposes to bridge the consumption gap mainly during the lean period when their food stocks wane. Consumption smoothing differs from household to household: the focus group discussions confirm that, generally, households with better resources, better production and higher yields start

consumption smoothing later than poorer households. Such consumption smoothing is found in many parts of Sub-Saharan Africa. For example in rural Burkina Faso, households experience severe income shocks particularly during drought periods. In such situations, stocks of grains are used as the main consumption smoothing mechanism (Kazianga and Udry, 2005) in which rural households make adjustments to grain stocks to smooth out consumption.

6.4. Food security status of rural households

Various food security indicators were employed to compare food security status between the period after the main harvest (post-harvest) and the pre-harvest season (pre-harvest).

6.4.1. Household dietary diversity score

This section presents findings from the analysis of household dietary diversity: this analysis is based on households' responses to questions about the number of food groups consumed within the preceding period. In this study, the recall period used was the previous 30 days: this period was chosen to capture consumption patterns representative of "normal" consumption during the high and pre-harvest seasons. A 30-day recall period is quite long for the measurement of dietary diversity, but care was taken to exclude consumption during "feast" days or other holidays in the survey. Generally dietary diversity is taken to be a good indicator of the nutritional quality of the diet; it does not fully measure nutritional status, since an indicator of quantity is also needed for that purpose, which is provided in the alternative FCS measure (discussed later).

6.4.1.1. Overall DDS by season

The household dietary diversity scores (HDDS) in high and pre-harvest seasons are on average 5.9 and 5.8, respectively (Table 6.8); there was no statistically significant difference in dietary diversity between the seasons and across locations. This is against the expectation that dietary diversity will be higher in the post-harvest when there is more food available, and is indicative of a monotonous diet amongst rural households in the area. A study by Maxwell *et al*. (2013) in Seharti-Samre district (adjacent to one of the districts covered by the present study) reported higher mean values of HDDS for the post-harvest season compared to pre-harvest.

6.4.1.2. Village level dietary diversity score (DDS)

Statistically significant differences were observed in household dietary diversity across villages. The mean value of HDDS is the highest at Andi Woyane *tabia* (6.28) and the lowest at Tsehafti *tabia* (5.34) during the post-harvest season. Most households at Andi Woyane *tabia* own irrigation facilities and engaged mainly in supplementary irrigation activities during the 2012/13 agriculture year. This suggests that practicing irrigation can increase household dietary diversity. At the pre-harvest season, Andi Woyane *tabia* again had the highest DDS (6.18) and Tsehafti *tabia* had the lowest DDS (5.33) (Table 6.8).

6.4.1.3. HDDS by gender

The mean value of HDDS at the post-harvest season is higher for MHH (5.92) and lower for FHH (5.81). At the pre-harvest season the mean HDDS is higher for MHH (5.80) and lower for FHH (5.78) (Table 6.8). These differences were not statistically significant (F-test results not shown), indicating generally similar dietary diversity between FHH and MHH. However, the dietary diversity difference was statistically significant between MHH at the post- and pre-harvest seasons and statistically significant for FHH at the pre-harvest season only.

Table 6.8: Village level DDS by season

Description	Total (All sites)	Villages (*Kebele/Tabia*)				F-test
		Andi Woyane	Mahbere Genet	Meseret	Tsehafti	
HDDS (Post-harvest season)						
Mean (Per household)	**5.90** (0.06)	6.28 (0.12)	6.17 (0.10)	6.04 (0.09)	5.34 (0.12)	16.871***
Observation (n)	400	75	96	107	122	
HDDS-FHH	5.81(0.15)	5.82	5.85	5.82	5.75	0.939
HDDS-MHH	5.92 (0.06)	6.28	6.15	6.04	5.42	16.451***
HDDS (Pre-harvest season)						
Mean (Per household)	**5.80** (0.06)	6.18 (0.13)	6.13 (0.09)	5.77 (0.12)	5.33 (0.09)	14.413***
Observation (n)	390	72	96	101	121	
HDDS-FHH	5.78 (0.16)	5.90	5.88	5.68	5.72	3.876***
HDDS-MHH	5.80 (0.06)	6.07	6.04	5.88	5.40	12.141***

Note: Figures in brackets indicate Standard Errors
The F-test of the null hypothesis tests differences in average mean values of the indicated variables between households in the study villages.

On dietary diversity households said that "*hadar leyblen deqkhi anstiyo libeletse binetsanet silelinqhesaqhesa li deqhen tebaetay kab limerho sidra bilihashe melki'u kab lelewen zitefelaleye aynet migbi yimgba*; *wala ahmltiy fremrey kab edaga hizen yimetsa"* (apart from consuming own produce FHH heads are more mobile and participate in the market as petty traders more often than the MHH and purchase more vegetables and fruits for the household, indicating better dietary diversity).

Figure 6.1 graphs the frequency distribution of dietary diversity scores. A HDDS score of 6 was the highest dietary diversity score: 142 households (35.5%) had a DDS score of 6 during the post-harvest season and 138 households (35.4%) had a DDS of 6 during the pre-harvest season. This suggests that households had relatively good dietary diversity. However this measure has limitations in that it does not measure the frequency/quantity of consumption of different food groups.

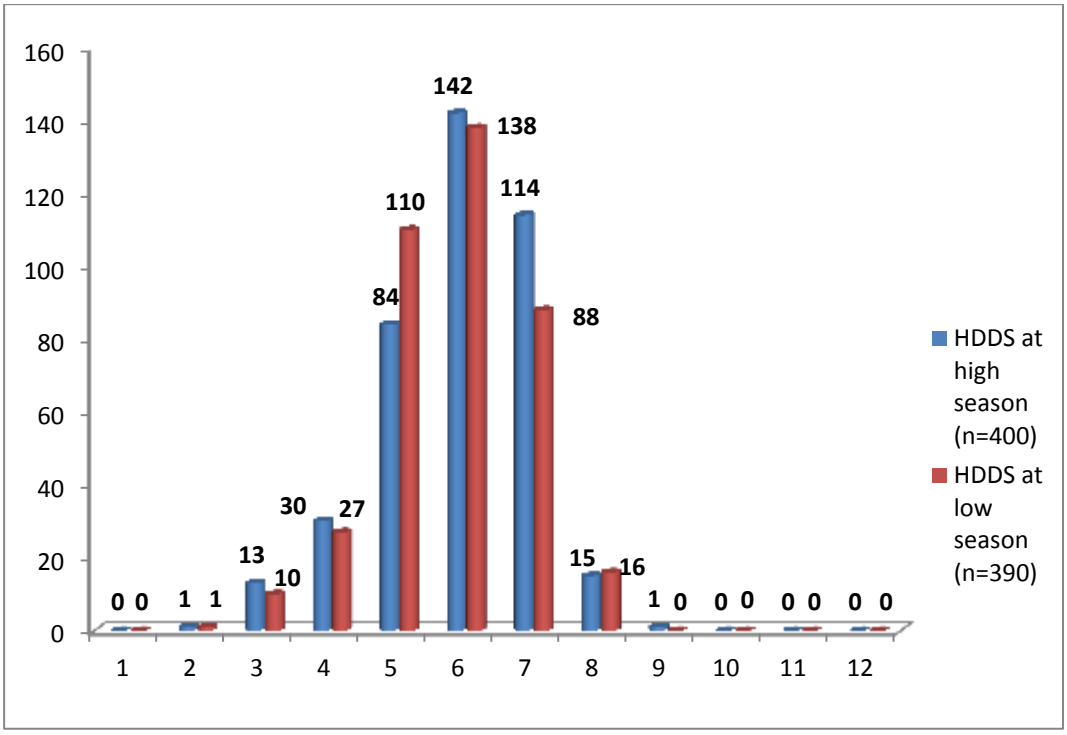


Figure 6.1: HDDS score by season

6.4.2. Food consumption score (FCS)

6.4.2.1. Overall and village level FCS by season

FCS is a composite score that considers both the diversity/type and frequency of food consumed by households over a period of one month and the relative importance of various food groups consumed by assigning weights to the designated food groups. The construction of the FCS measure is discussed in more detail in section 3.4.2. The mean FCS score for the post-harvest season is 31.38 and the score for the pre-harvest season is 30.44 (Table 6.9). There was a significant difference in food consumption between the two seasons, showing better access to food in the post-harvest season where food availability is better. Vaitla *et al*. (2012) also found significant differences in FCS between the two seasons for rural households in eastern and south eastern Tigray, the FCS score being higher in the post-harvest season. Maxwell *et al*. (2013) also reported higher FCS scores in the post-harvest season. Therefore there is substantial evidence to confirm that access to food is relatively higher at the main harvest season.

Based on the mean FCS significant differences were observed among the four study villages. At the post-harvest season, mean FCS was the lowest at Tsehafti *tabia* (27.69) and the highest at Andi Woyane *tabia* (33.39) from a maximum score of 64. For the pre-harvest season mean FCS was again the lowest at Tsehafti *tabia* (29.18) but the highest FCS was observed at Mahbere Genet *tabia* (32.83) (Table 6.9). Higher mean FCS at Mahbere Genet-the village very close to Mekelle city-might be due to higher incomes that households earn from off/non-farm activities during the pre-harvest season, which are partly spent on the purchase of food items.

The FCS at both the high and pre-harvest seasons shows significant differences among FHH at the four villages. Higher FCS values of 31.15 and 32.05 were observed at Mahbere Genet *tabia* at high and pre-harvest seasons respectively. FCS scores were the least (25.25 and 23.40) at Meseret *tabia* at high and pre-harvest seasons respectively (Table 6.9). The FCS values were the highest at Mahbere Genet *tabia* due to higher incomes received from off/non-farm job opportunities that would have led to higher consumption. On the other hand, low scores of FCS at Meseret *tabia* could be explained by the lack or shortage of off/non-farm job opportunities in the village and its surroundings. While the FCS score for MHH is higher than for FHH across both seasons and in all villages, the difference is particularly noticeable in Meseret. This may be partly linked to the domination of cereal production in Meseret allied with high renting-out of land by FHH (See Table 5.9) and the difference in TLU between the FHH and MHH: MHH have the ploughing capacity to plough more land which they can only obtain by renting-in.

For MHH, FCS scores at the high and pre-harvest seasons show significant differences across the four villages. At the post-harvest season, FCS values were the highest at Andi Woyane *tabia* (34.26) and the lowest at Tsehafti *tabia* (27.94). At the pre-harvest season, FCS scores were the highest at Mahbere Genet *tabia* (33.03) and the lowest at Tsehafti *tabia* (29.70).

Table 6.9: Village level FCS by season and gender

Description	Total (All sites)	Villages (*Kebele/Tabia*)				F-test (p-value)
		Andi Woyane	Mahbere Genet	Meseret	Tsehafti	
FCS (Post-harvest season)						
Mean (per household)	31.38 (0.41)[a]	33.39 (0.91)	33.26 (0.72)	32.51 (0.79)	27.69 (0.76)	0.016**
Observation (n)	400	75	96	107	122	
FCS- FHH	28.32	29.64	31.15	25.25	26.58	0.044**
FCS- MHH	32.00	34.26	33.82	33.26	27.94	0.000***
FCS (Pre-harvest season)						
Mean (per household)	30.44 (0.43)	30.72 (0.99)	32.83 (0.78)	29.47 (0.82)	29.18 (0.83)	0.016**
Observation (n)	390	72	96	101	121	
FCS- FHH	28.64	30.68	32.05	23.40	26.98	0.039**
FCS- MHH	30.79	30.72	33.03	30.13	29.70	0.056*

***, **, * at 1%, 5% and 10% levels of significance; (a) Figures in brackets indicate Standard Errors

The F-test of the null hypothesis tests differences in average mean values of the indicated variables between households in the study villages.

6.4.2.2. Household level FCS by season

Based on the FCS score the food consumption of households is categorized under 3 groups, following WFP practice (also see Maxwell *et al*, 2014): poor food consumption with a score of 0.0-21.0, borderline food consumption ranging between scores of 21.0 and 35.0, and adequate food consumption with a score greater than 35.0. Based on the data collected from sample households in the four villages the FCS score ranges between 0.0 and 64.0. As revealed in Table 5.10, during the post-harvest season the majority of households (58.7%) are within the border line food consumption. The corresponding figure for the pre-harvest season is 59.0%. The proportion of households with poor food consumption increases from 9.8% in the post-harvest season to 13.8% in the pre-harvest season. The FCS score for some households is as low as 8 for both seasons. This indicates that there are households who lack adequate access to food during both the high and pre-harvest seasons.

Table 6.10: Household level FCS at high and pre-harvest seasons

FCS score[15]	FCS at post-harvest season		FCS at pre-harvest season	
	No. of households	%	No. of households	%
0.0-21.0	39	9.8	54	13.8
21.5-35.0	235	58.7	230	59.0
>35.0	126	31.5	106	27.2
Observation (n)	400		390	

6.4.3. Household food insecurity access scale

Overall and village level HFIAS by season

The household food insecurity access scale (HFIAS) has a psychometric property. HFIAS shows the level of food security households experience based on what they have. HFIAS is a continuous index which measures the extent of food access or food insecurity during 30 days before the survey. A higher mean HFIAS score indicates higher food insecurity. The mean HFIAS scores for the high and pre-harvest seasons are 3.33 and 4.21 respectively (Figure 6.2), and this difference was statistically significant. This result is consistent with the study by Maxwell *et al*. (2013) and Vaitla *et al*. (2012) for rural households in southern and south-eastern Tigray.

The village level HFIAS scores are reported in Figure 6.2 and Table 6.11 and the results show significant differences in food security levels across the 4 *tabias*. At the post-harvest season, HFIAS scores are highest at Tsehafti *tabia* (5.25) and lowest at Andi Woyane *tabia* (1.43). This indicates households at Tsehafti *tabia* are more food insecure compared to households in the other three *tabias*. At the pre-harvest season Tsehafti *tabia* has the highest HFIAS score (5.96) indicating least food insecurity among the study *tabias* followed by Mahbere Genet *tabia* (3.57). Higher levels of food insecurity at Tsehafti are partly explained by the small average land sizes in that *tabia*.

[15] FCS score: 0-21 (Poor food consumption), 21.5-35.0 (Borderline food consumption) and >35 (Adequate food consumption). Eight major food groups are considered along with their assigned weights. The FCS score ranges between 0-6.

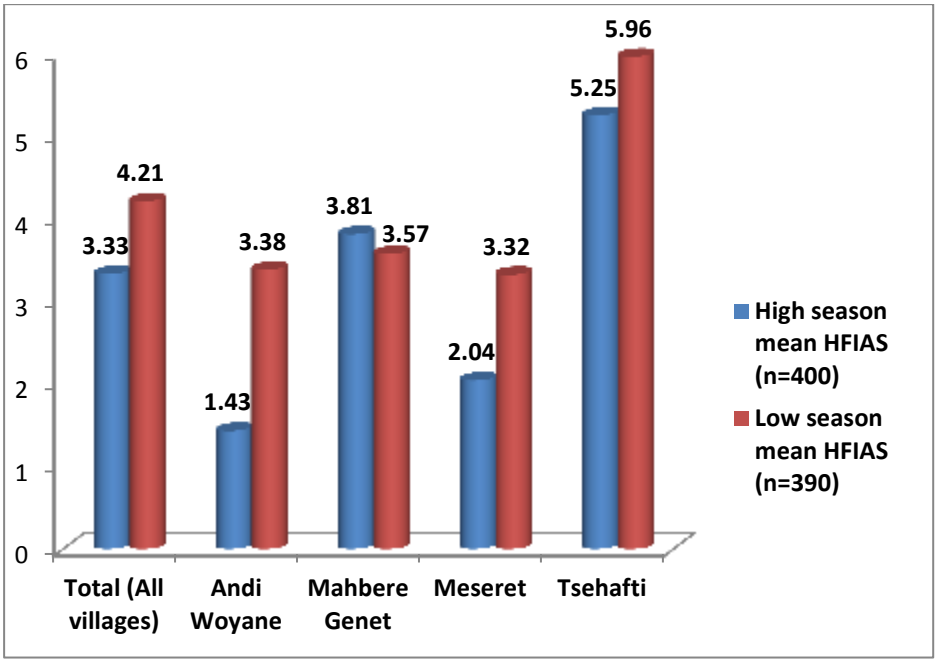


Figure 6.2: Mean HFIAS scores by village and season

In terms of gender of the household head, HFIAS scores show significant differences between MHH and FHH across all *tabias*. At the post-harvest season, the mean HFIAS score for MHH was 3.17 and for FHH it was 4.16; female-headed households are more food insecure than male-headed households in all *tabias* except Tsehafti. At the pre-harvest season, MHH appear to be more food insecure (as measured by HFIAS) in three of the four tabias: this may be partly due to the larger family size and higher consumption demand in MHH, allied with reduced food availability at the pre-harvest season.

Table 6.11: Village level HFIAS by season and gender

Description	Total (All sites)	Villages (*Kebele/Tabia*)				F-test (p-value)
		Andi Woyane	Mahbere Genet	Meseret	Tsehafti	
HFIAS (Post-harvest season)	n=400	n=75	n=96	n=107	n=122	
Mean	3.33 (0.20)[a]	1.43 (0.24)	3.81 (0.43)	2.04 (0.24)	5.25 (0.44)	0.001***
HFIAS-FHH	4.16	1.73	5.55	2.40	4.87	0.048**
HFIAS-MHH	3.17	1.38	3.36	2.00	5.33	0.000***
HFIAS (Pre-harvest season)	n=390	n=72	n=96	n=101	n=121	
Mean	4.21 (0.24)	3.38 (0.53)	3.57 (0.41)	3.32 (0.35)	5.96 (0.48)	0.001***
HFIAS-FHH	4.20	4.82	3.35	3.20	5.09	0.567
HFIAS-MHH	4.21	3.11	3.63	3.33	6.16	0.000***

***, ** at 1% and 5% levels of significance; (a) Figures in brackets indicate Standard Errors
The F-test of the null hypothesis tests differences in average mean values of the indicated variables between households in the study villages.

The HFIAS can be used to divide the households into four categories based on their level of food insecurity: food secure, mildly food insecure, moderately food insecure and severely food insecure. As indicated in Table 6.12, at the post-harvest season 45.5% of the households in the four villages are food secure. The remaining 54.5% are mildly to severely food insecure. During the pre-harvest season, 41% of rural households are food secure while the remaining 59% are mildly to severely food insecure: as expected more households experience food insecurity during the pre-harvest season than the post-harvest season. This is in agreement with the findings from southern Ethiopia for the pre-harvest season (Regassa and Stoecker, 2011), although the level of food insecure rural households was higher in their study (82.3%).

Mean HFIAS measures show differences in food security status across the four villages. In all the study villages except Mahbere Genet, the proportion of food secure households was higher during the post-harvest season. The proportion of food secure households was the lowest at Tsehafti *tabia* in both seasons. Households at Andi Woyane *tabia* were more food secure (66.7%) during the post-harvest season and 50% were food secure during the pre-harvest season (Table 6.12). For Mahbere Genet *tabia* the proportion of food insecure households was higher during the post-harvest season compared to the other three villages: this was mainly due to crop failure in most parts of the village during the 2013/14 agriculture year due to hail.

Table 6.12: Distribution of households by level of food insecurity as measured by HFIAS

Description	Food secure (%)[16]	Mildly food insecure (%)	Moderately food insecure (%)	Severely food insecure (%)
All sites				
Post-harvest season (n=400)	45.5	11.5	42.0	1.0
Pre-harvest season (n=390)	41.0	13.1	44.6	1.3
Andi Woyane *tabia*				
Post-harvest season (n=75)	66.7	12.0	21.3	0.0
Pre-harvest season (n=72)	50.0	8.3	37.5	4.2
Mahbere Genet *tabia*				
Post-harvest season (n=96)	39.6	7.3	52.1	1.0
Pre-harvest season (n=96)	53.1	9.4	36.5	1.0
Meseret *tabia*				
Post-harvest season (n=107)	51.4	20.6	28.0	0.0
Pre-harvest season (n=101)	40.6	18.8	40.6	0.0
Tsehafti *tabia*				
Post-harvest season (n=122)	32.0	6.6	59.0	2.5
Pre-harvest season (n=121)	26.4	14.0	58.7	0.8

6.4.4. Coping strategies index (CSI)

6.4.4.1. Overall and village level CSI by season

The CSI measures behaviour of households when they are confronted with the problems of access to sufficient food and related items. The CSI captures food shortage management of households via their behavioural responses. Seven coping strategies questions were asked to households in the high and pre-harvest season. The CSI results range between 0 and 72: the higher the score, the higher the degree of food insecurity. The mean CSI scores for the high and pre-harvest seasons are 20.10 and 21.25, respectively (Table 6.13), and this difference is statistically significant. Maxwell *et al*. (2013) and Vaitla *et al*. (2012) also found similar CSI scores.

At both the high and pre-harvest seasons, there were no significant differences among households in the four villages regarding coping strategies they employ for food shortage mitigation (Table 6.13). There were also no significant differences in the coping strategies used by FHH across all the villages in both the high and pre-harvest seasons. For MHH however there were significant differences in CSI values across all four villages in both the

[16] The four categories of food insecurity (access) are adapted from Coates *et al.* (2007). HFIAS for Measurement of Household Food Access: Indicator Guide (v.3). FANTA Project

high and pre-harvest seasons: this indicates that the decisions made by MHH on managing food shortages in the four villages are different. In the post-harvest season, CSI values are the highest at Tsehafti *tabia* (22.37) and the lowest at Meseret *tabia* (18.62). During the pre-harvest season, CSI scores are again the highest at Tsehafti *tabia* (22.70) and the lowest at Meseret *tabia* (20.13). Higher CSI values at Tsehafti *tabia* indicate higher food insecurity than in other villages, consistent with the other food security indicators.

Table 6.13: Village level CSI by season

Description	Total (All sites)	Villages (*Kebele/Tabia*)				F-test (p-value)
		Andi Woyane	Mahbere Genet	Meseret	Tsehafti	
CSI (Post-harvest season)						
Mean (per household)	20.10 (0.24)[a]	19.47 (0.41)	20.02 (0.43)	18.60 (0.22)	21.88 (0.61)	0.000***
Observation (n)	400	75	96	107	122	
CSI-FHH	19.63	20.45	19.65	18.40	19.74	0.685
CSI- MHH	20.19	19.30	20.12	18.62	22.37	0.000***
CSI (Pre-harvest season)						
Mean (Per household)	21.25 (0.30)	21.49 (0.74)	20.48 (0.54)	20.34 (0.49)	22.50 (0.62)	0.024**
Observation (n)	390	72	96	101	121	
CSI-FHH	21.77	22.81	21.15	22.20	21.61	0.935
CSI- MHH	21.15	21.25	20.30	20.13	22.70	0.008***

***at 1% level of significance; (a) Figures in brackets indicate Standard Errors
The F-test of the null hypothesis tests differences in average mean values of the indicated variables between households in the study villages.

As revealed in Table 6.14, the most common coping strategies that households applied during both the high and pre-harvest seasons were borrowing food or getting help from relatives, purchase of food on credit, consuming seed stock intended for use in the next farming season and reducing meals for adults so that small children could eat normal meals. The degree of severity of the first three measures taken by households is low to mild. Reduction of meals, however, is considered a tougher decision. During the post-harvest season 61 households (15.3%) restricted consumption by adults; at the pre-harvest season the corresponding figure was 79 (20.3%). Overall, households used a lot more coping strategies in the pre-harvest season (286) compared to post-harvest season (166), indicating the wider problems associated with access to food for a large number of households in the pre-harvest season.

Table 6.14: Village-wise coping strategies practiced by households

Coping Strategy	Total (All sites)	Villages (*Kebele/Tabia*)			
		Andi Woyane	Mahbere Genet	Meseret	Tsehafti
Post-harvest season (Round 1):					
Borrow food or get help from relatives	16 (4.0%)[a]	7	3	1	5
Purchase food on credit	21 (5.3%)	8	2	0	11
Gather wild foods	0 (0.0%)	0	0	0	0
Consume seed stock for next season	65 (16.3%)	18	11	9	27
Send a member to eat elsewhere	3 (0.8%)	0	2	0	1
Send a member to beg	0 (0.0%)	0	0	0	0
Restrict consumption by adults	61 (15.3%)	14	8	6	33
Pre-harvest season (Round 2):					
Borrow food or get help from relatives	56 (14.4%)	12	15	10	19
Purchase food on credit	82 (21.0%)	17	15	18	32
Gather wild foods	2 (0.5%)	0	0	0	2
Consume seed stock for next season	60 (15.4%)	12	11	10	27
Send a member to eat elsewhere	7 (1.8%)	0	4	1	2
Send a member to beg	0 (0.0%)	0	0	0	0
Restrict consumption by adults	79 (20.3%)	19	10	14	36

(a) Figures in brackets are proportions of coping strategies practised by households

The results of the FGDs also show that households with larger land size and livestock ownership give priority to serving food to adolescent boys rather than adolescent girls and children particularly during the agricultural activity peak period as boys carry out physical activities that include ploughing, threshing, bagging, transporting produce, looking after livestock, participating in off-farm activities and other activities outside home. The households use such prioritising as one mechanism of rationing the already scarce food during the pre-harvest season. The people in the study area customarily say "*wedi tebaetay iyu harisu ikhli zemtsie, imo ab iwan mahres zibezhen zihashen migbi ni'eu yigbae"* (it is the male who is responsible for bringing food to the household and, therefore, needs to be better fed especially during farming activities: both in quantity and quality).

6.4.4.2. Household level CSI by season

In both seasons, almost all households fall into the 'moderately food insecure' category as measured by the CSI index (Table 6.15). There is no significant seasonal change in the movement of households from one category to another. This reflects similar concerns of households regarding food access and they are compelled to follow similar coping mechanisms in both seasons.

Table 6.15: Household level CSI by season

CSI score[17]	Category description	CSI at post-harvest season		CSI at pre-harvest season	
		Frequency	%	Frequency	%
0.0-2.0	Food secure	0	0.0	0	0.0
3.0-12.0	Mildly food secure	0	0.0	0	0.0
13.0-40.0	Moderately food insecure	397	99.2	383	98.2
>40.0	Severely food insecure	3	0.8	7	1.8
	F-test	113.126***		172.203***	
	Observation (n)	400		390	

The differences among the households in the four categories of food insecurity within each season are statistically significant at 1% level of significance

The F-test of the null hypothesis tests differences in average mean values of the indicated variables between households in the study villages.

6.5. Household food security indicators: comparisons

In order to understand the validity and consistency of the various food security indicators, comparisons were made between the four household food security indicators: HDDS, FCS, HFIAS and CSI. Food security indicators measure different phenomena and a group of indicators have to be used in combination to capture the various elements of food security (Hirvonen *et al*., 2015; Maxwell and Coates, 2014; Carletto *et al*., 2013). A number of studies show different food security distributions among households as measured by different indicators (Maxwell and Coates, 2014; Kennedy *et al*., 2010).

Spearman's rho correlation analysis was used to analyse the association between food security indicators: it is a stronger measure than Pearson's correlation (Maxwell and Coates, 2014). Table 6.16 and Table 6.17 show significant correlations between the indicators at the post- and pre-harvest seasons. Kennedy *et al*. (2010) compared the food security-measuring abilities of HDDS and FCS and also found strong correlation between the two indicators.

[17] The CSI score categorization is based on that of Maxwell and Coates (2014).

Table 6.16: Spearman's rho correlations between food security indicators, at post-harvest season

Variables	HDDS	FCS	HFIAS	CSI
HDDS	1.000			
FCS	0.446***	1.000		
HFIAS	-0.312***	-0.402***	1.000	
CSI	-0.251***	-0.302***	0.546***	1.000
No. of observations (N)	400			

*** at 1% level of significance (2-tailed test)
This is a symmetric matrix

Table 6.17: Spearman's rho correlations between food security indicators, at pre-harvest season

Variables	HDDS	FCS	HFIAS	CSI
HDDS	1.000			
FCS	0.554***	1.000		
HFIAS	-0.218***	-0.267***	1.000	
CSI	-0.175***	-0.307***	0.610***	1.000
No. of observations (N)	390			

***at 1% level of significance (2-tailed test)
This is a symmetric matrix

The relationship between the three major food security indicators and factors associated with food access was analysed using data for the post-harvest season: results are presented in Table 6.18. Most of the factors significantly influencing food access are similar to all the indicators, but differ in their magnitude of influence as explained by the coefficients. Location, Tropical Livestock Unit (TLU) and household income are common and significant in the three measures. Age of household head and land holding size significantly influence HDDS and HFIAS but not FCS. Farm expenditure on crops significantly influences FCS but not HDDS and HFIAS.

Table 6.18: Results of multivariate regression models, post-harvest season

Independent variables	HDDS	FCS	HFIAS
Tsehafti *Tabia* (reference)			
Andi Woyane *Tabia*	0.286***	0.277***	-0.335***
Mahbere Genet *Tabia*	0.310***	0.356***	-0.143**
Meseret *Tabia*	0.209***	0.192***	-0.257***
Age of the household head	-0.191***	-0.048	0.095*
Sex of household head	-0.025	0.021	-0.024
Adult equivalent	-0.027	-0.011	0.104*
Education level of mother	0.066	0.086*	-0.040
Land holding size	0.112*	0.042	-0.122*
Tropical Livestock Unit (TLU)	0.138**	0.411***	-0.208***
Household access to credit	0.087*	0.054	-0.056
Extension contact	-0.039	-0.072	0.102**
Irrigation use	0.081	0.054	-0.055
Participation in Off/Non-farm activities	0.074	-0.036	0.040
Farm expenditure on crops	-0.071	-0.141**	0.068
Household income	0.145**	0.202***	-0.132**
Constant	***	***	***
Adjusted R^2	0.189***	0.282***	0.202***
Observation (n)	400	400	400

***, **, * at 1%, 5% and 10% levels of significance

6.6. Food security status and household wealth

The food security indicators were next analysed to assess the food security status of households disaggregated by wealth. As indicated in Table 6.19, significant differences were observed in all indicators except for CSI in the pre-harvest season. The direction of differences was consistent with wealth status, indicating improved food security with higher levels of wealth. This suggests that significant differences in the size of cultivated land and livestock ownership-the variables which determine the extent of household wealth-contribute to differences in food security among rural households. Vaitla *et al*. (2012) similarly disaggregated rural households using wealth groups and compared their differences using FCS, HFIAS and CSI between the two seasons: all were associated with better food security status for the wealthiest group in the post-harvest season.

Table 6.19: Food security indicators by wealth group, at post- and pre harvest seasons

Food security indicators	Post-harvest season (mean)				Pre-harvest season (mean)			
	WG 1[a]	WG 2	WG 3	F-test	WG 1	WG 2	WG 3	F-test
HDDS	5.73	6.06	6.20	0.005***	5.66	5.96	5.98	0.021**
FCS	29.52	33.19	34.40	0.000***	29.45	31.27	32.37	0.041**
HFIAS	4.07	2.71	1.87	0.000***	4.64	4.15	2.42	0.017**
CSI	20.79	19.48	18.91	0.009***	21.59	21.27	19.67	0.148
Observation (n)	211	143	46		206	139	45	

***, ** at 1% and 5% levels of significance; (a) WG1-WG3: wealth groups from the lowest to the highest household wealth, WG1 the lowest

The F-test of the null hypothesis tests differences in average mean values of the indicated variables between households in the study villages, by wealth group.

6.7. Food security status and household income

Food security indicators by farm income quartile

Households were divided into quartiles based on their income from agricultural activities to analyse whether differences in farm income are associated with differences in the food security status of households. Significant differences were observed among households disaggregated by farm income as measured by the four indicators. All four indicators were also consistent. The patterns of the four indicators were similar at both the post- and pre-harvest seasons, except for CSI at the pre-harvest season (Tables 6.20 and 6.21). These findings generally suggest that differences in farm income can contribute to differences in food security status.

Table 6.20: Food security indicators by farm income quartile, at the post-harvest season

Description	Farm income quartiles[a]				F-test (p-value)
	Q1	Q2	Q3	Q4	
HDDS	5.64 (0.01)[b]	5.75 (0.003)	5.92 (0.002)	6.16 (0.001)	0.000***
FCS	31.32 (0.10)	30.52 (0.02)	32.00 (0.01)	35.59 (0.01)	0.000***
HFIAS	4.65 (0.06)	3.48 (0.01)	2.94 (0.01)	1.87 (0.002)	0.000***
CSI	20.91 (0.07)	20.39 (0.01)	19.69 (0.01)	18.82 (0.003)	0.000***

***at 1% level of significance; (a) Q1-Q4: household income quartiles from the lowest to the highest income, Q1 the lowest; (b) Figures in brackets indicate Standard Errors

The F-test of the null hypothesis tests differences in average mean values of the indicated variables between households in the study villages, by income quartile.

Table 6.21: Food security indicators by farm income quartile, at the pre-harvest season

Description	Farm income quartiles[a]				F-test (p-value)
	Q1	Q2	Q3	Q4	
HDDS	5.79 (0.01)[b]	5.61 (0.003)	5.91 (0.002)	5.96 (0.001)	0.000***
FCS	28.28 (0.09)	29.68 (0.03)	30.34 (0.01)	34.35 (0.01)	0.000***
HFIAS	5.60 (0.07)	4.66 (0.01)	4.38 (0.01)	2.79 (0.003)	0.000***
CSI	21.05 (0.06)	21.92 (0.02)	21.20 (0.006)	21.23 (0.01)	0.000***

***at 1% level of significance; (a) Q1-Q4: household income quartiles from the lowest to the highest income, Q1 the lowest; (b) Figures in brackets indicate Standard Errors
The F-test of the null hypothesis tests differences in average mean values of the indicated variables between households in the study villages, by income quartile.

Food security indicators by household income quartile

Significant differences were observed in the dietary diversity of households based on total household income at the post-harvest season, as measured by HDDS and FCS. The HFIAS and CSI measures also showed significant differences but the patterns between the quartiles were not consistent. HFIAS and CSI scores between Q2 and Q3 were not as expected in both seasons (Tables 6.22 and 6.23): Q3 households appear to be more concerned about food security status and to adopt more coping strategies than Q2 households; the reasons for this are not obvious.

Table 6.22: Food security indicators by household income quartile, at post-harvest season

Description	Household income quartiles[a]				F-test (p-value)
	Q1	Q2	Q3	Q4	
HDDS	5.57 (0.12)[b]	5.86 (0.11)	5.85 (0.11)	6.32 (0.10)	0.000***
FCS	28.58 (0.89)	30.55 (0.73)	31.45 (0.83)	35.00 (0.72)	0.000***
HFIAS	4.77 (0.45)	3.26 (0.41)	3.42 (0.41)	1.86 (0.26)	0.000***
CSI	22.00 (0.66)	19.50 (0.40)	20.10 (0.44)	18.81 (0.31)	0.000***

***at 1% level of significance; (a) Q1-Q4: household income quartiles from the lowest to the highest income, Q1 the lowest; (b) Figures in brackets indicate Standard Errors
The F-test of the null hypothesis tests differences in average mean values of the indicated variables between households in the study villages, by income quartile.

Table 6.23: Food security indicators by household income quartile, at the pre-harvest season

Description	Household income quartiles[a]				F-test (p-value)
	Q1	Q2	Q3	Q4	
HDDS	5.39 (0.11)[b]	5.88 (0.11)	6.04 (0.10)	5.89 (0.11)	0.000***
FCS	27.21 (0.85)	30.78 (0.83)	31.51 (0.82)	32.20 (0.87)	0.000***
HFIAS	5.75 (0.54)	3.98 (0.44)	4.22 (0.51)	2.92 (0.39)	0.000***
CSI	21.82 (0.64)	20.63 (0.53)	22.04 (0.69)	20.55 (0.003)	0.171

***at 1% level of significance; (a) Q1-Q4: household income quartiles from the lowest to the highest income, Q1 the lowest (b) Figures in brackets indicate Standard Errors
The F-test of the null hypothesis tests differences in average mean values of the indicated variables between households in the study villages, by income quartile.

6.8. Regression analysis: OLS estimation of factors influencing food consumption and dietary diversity

Food consumption, dietary diversity and food security of rural households are influenced by a number of factors that are internal as well as external to the farming practices followed. In this section, regression analysis was conducted to identify factors influencing the food security indicators HDDS, FCS and HFIAS in both post- and pre-harvest seasons (whereas Table 6.18 above reports on analysis for the post-harvest season only).

Household dietary diversity score

Multivariate linear regression analysis was used to analyse the association between dietary diversity and various socio-economic factors on HDDS for both the post- and pre-harvest seasons; these results are reported in Table 6.24. At the post-harvest season, location of households, age of household head, total cultivated land, TLU, access to credit and household income were significantly associated with dietary diversity. Hoddinott *et al*. (2015) also found significant relationship between livestock ownership (milking cows) and dietary diversity. With the exception of the age of the household head, which was negatively associated, all others were positively associated with dietary diversity. At the pre-harvest season, location, age of household head, TLU, education level of mother and access to credit were significantly associated with diet diversity: land size and household income were not strongly related in this season. There is little crop cultivation in the pre-harvest season (except very small amounts of irrigated land), therefore it is likely that land size might not cause significant changes in dietary diversity. The significant positive association between HDDS and the

educational level of mothers at the pre-harvest season (but not at the post-harvest season), suggests the role mothers' education plays to protect dietary diversity of households from declining in the food scarce season. Savy *et al*. (2006) also found literacy of mothers to significantly and positively influence dietary diversity only in the pre-harvest season in rural Burkina Faso. Education of mothers is part of women's empowerment that can play an important role in linking agriculture and nutrition and this finding indicates it is relevant in the study area.

Table 6.24: Multiple regression analysis results for variables associated with HDDS at post- and pre-harvest seasons

Independent variables	HDDS post-harvest season		HDDS pre-harvest season	
	Standardized coefficients Beta	t-value	Standardized coefficients Beta	t-value
Tsehafti *Tabia* (reference dummy)				
Andi Woyane *Tabia*	0.286***	4.479	0.305***	4.649
Mahbere Genet *Tabia*	0.310***	5.128	0.324***	5.169
Meseret *Tabia*	0.209***	3.169	0.088	1.285
Age of the household head	-0.191***	-3.593	-0.108**	-1.969
Sex of household head	-0.025	-0.488	-0.054	-0.997
Adult equivalent	-0.027	-0.484	-0.008	-0.142
Education level of mother	0.066	1.288	0.184***	3.485
Land holding size	0.112*	1.733	0.076	1.130
Tropical Livestock Unit (TLU)	0.138**	2.485	0.103*	1.788
Household access to credit	0.087*	1.814	0.096*	1.937
Extension contact	-0.039	-0.801	0.034	0.673
Irrigation use	0.081	1.425	-0.032	-0.542
Participation in Off/Non-farm activities	0.074	1.507	-0.070	-1.372
Farm expenditure on crops	-0.071	-1.208	-0.040	-0.655
Household income	0.145**	2.569	0.065	1.114
Constant	***	13.796	***	13.103
Adjusted R^2	0.189***		0.154***	
Observation (n)	400		390	

***, **, * at 1%, 5% and 10% levels of significance

Food consumption score

At the post-harvest season, location of households, education level of mother, TLU, and household income were significantly related to changes in dietary diversity and consumption of households as measured by FCS. Sex of household head, adult equivalent, land holding size, irrigation use and participation in off/non-farm activities were not significantly related to FCS (Table 6.25). The FCS for Tsehafti *tabia* was lower as compared to the other three *tabias*.

At the pre-harvest season, location of households (Mahbere Genet *tabia*), age of household head, education of mother, land holding, and TLU were strongly associated with FCS scores. Only Mahbere Genet *tabia* was significantly different from the other *tabias* in FCS (Table 6.25). Age of household head negatively and significantly influences food consumption in the pre-harvest season, suggesting the advantage of younger household heads in protecting households through higher mobility, better access to health and nutrition media, household-level nutrition demonstrations and relevant training; these explanations were supported by the FGD participants. The positive, significant influence of land holding on food consumption in the pre-harvest season might be due to intensive agricultural works (land preparation, sowing, fertilizing, weeding, etc.) that cause increased food consumption for the peak farming activity period; higher food production on such land may be another explanation.

Table 6.25: Multiple regression analysis results for variables associated with FCS at post- and pre-harvest seasons

Independent variables	FCS post-harvest season		FCS pre-harvest season	
	Standardized coefficients Beta	t-value	Standardized coefficients Beta	t-value
Tsehafti *Tabia* (reference dummy)				
Andi Woyane *Tabia*	0.277***	4.608	0.098	1.461
Mahbere Genet *Tabia*	0.356***	6.255	0.206***	3.209
Meseret *Tabia*	0.192***	3.092	-0.105	-1.503
Age of the household head	-0.048	-0.964	-0.106*	-1.883
Sex of household head	0.021	0.430	0.030	0.549
Adult equivalent	-0.011	-0.201	-0.056	-0.943
Education level of mother	0.086*	1.796	0.106*	1.959
Land holding size	0.042	0.686	0.122*	1.782
Tropical Livestock Unit (TLU)	0.411***	7.856	0.248***	4.218
Household access to credit	0.054	1.205	-0.018	-0.350
Extension contact	-0.072	-1.566	0.036	0.691
Irrigation use	0.054	1.015	-0.045	-0.748
Participation in Off/Non-farm activities	-0.036	-0.788	-0.012	-0.231
Farm expenditure on crops	-0.141**	-2.547	0.001	0.013
Household income	0.202***	3.816	0.099	1.649
Constant	***	8.484	***	8.466
Adjusted R^2	0.282***		0.116***	
Observation (n)	400		390	

***, **, * at 1%, 5% and 10% levels of significance

Food Consumption Score and dietary diversity by FCS category

This section further analyses the relationship between production, consumption and food security using FCS as the indicator of food security status. Households were categorized by food security status using the FCS categories of Poor, Borderline and Acceptable.

To examine the link between aspects of the production system and nutrition, a crop diversity index needs to be developed (Carletto *et al.*, 2015). The Crop Diversity Index (CDI) was constructed to represent production diversity and analyse whether this can contribute to diet/consumption diversity. CDI was determined using the methods developed by Vaitla *et al.* (2012). The CDI measures the diversity of crops grown by indicating the number of crops grown by farming households in the past year (Lopus, 2012). The calculation of CDI starts by taking the percentage of the total land area planted to a single crop; the resultant value for the single crop is squared and all the squared values are summed to get a CDI value between 0 and 1. A value of 1 indicates growing a single crop (a monoculture cropping system) while crop diversity increases as the value of CDI moves from 1 to 0 (Vaitla *et al.*, 2012). One limitation of the crop diversity index is that it usually considers main crops only. If so, this has the potential to understate actual production diversity (Covarrubias, 2015).

Table 6.26 summarizes the relationship between FCS in the post-harvest season, and socio-economic as well as production variables. At the post-harvest season, Poor (food insecure), Borderline and Acceptable (food secure) households were significantly different in cereals and pulses production, Crop Diversity Index (CDI), TLU, per capita household income, crop and livestock products consumed from own produce and livestock products' consumption from purchases. This suggests that agricultural production and production diversity are important factors that contribute significantly to the food security status of households. 68.8% of the households were in the food insecure and borderline categories, which signals vulnerability of the majority of households to food insecurity.

Table 6.26: FCS versus selected variables at post-harvest season, by category of FCS

Description	FCS at post-harvest season			F-test
	Poor	Borderline	Acceptable	
Age of household head (Years)	47.26	45.90	46.02	0.863
Per capita cereal production (Kg)	122.22	162.44	223.77	0.035**
Per capita pulses & oilseeds production (Kg)	9.58	12.46	22.51	0.006***
Per capita vegetables production (Kg)	0.23	14.45	33.91	0.323
Per capita fruits production (Kg)	0.80	6.58	14.73	0.164
Crop Diversity Index (CDI)	0.51	0.45	0.37	0.000***
Tropical Livestock Unit	2.44	3.50	5.53	0.000***
Per capita household income (ETB)	955.62	2,064.00	2,744.20	0.036**
Adult equivalent	4.56	4.77	5.12	0.152
Per capita crops consumed from own produce (Kg)[a]	18.58	18.55	22.58	0.017**
Per capita crops consumed from purchase (Kg)	6.60	7.71	8.23	0.692
Per capita livestock products consumed from own stock (Lt)	0.00	0.42	2.92	0.000***
Per capita livestock products consumed from purchase (Lt)	0.00	0.05	0.16	0.045**
Observations (n)	35 (8.8%)	240 (60.0%)	125 (31.2%)	

***, ** at 1% and 5% levels of significance; (a) Consumption: Based on 30-day household consumption

The F-test of the null hypothesis tests differences in average mean values of the indicated variables between households in the study villages, by FCS category.

Household food insecurity access scale

At the post-harvest season, the household food insecurity access scale (HFIAS) was strongly and significantly associated with location of households, age of the household head, adult equivalent, land holding size, TLU and household income. Sex of head of household, education of mother, irrigation use and participation in off/non-farm activities did not have a significant association with the score (Table 6.27). In the pre-harvest season, education of mother was significantly related to HFIAS, in addition to location, TLU and household income.

Table 6.27: Multiple regression analysis results for variables associated with HFIAS at post- and pre-harvest seasons

Independent variables	HFIAS post-harvest season		HFIAS pre-harvest season	
	Standardized coefficients Beta	t-value	Standardized coefficients Beta	t-value
Tsehafti *Tabia* (reference dummy)				
Andi Woyane *Tabia*	-0.335***	-5.280	-0.188***	-2.759
Mahbere Genet *Tabia*	-0.143**	-2.381	-0.216***	-3.336
Meseret *Tabia*	-0.257***	-3.927	-0.184***	-2.612
Age of the household head	0.095*	1.797	0.068	1.200
Sex of household head	-0.024	-0.474	0.057	1.025
Adult equivalent	0.104*	1.855	0.054	0.902
Education level of mother	-0.040	-0.793	-0.108**	-1.987
Land holding size	-0.122*	-1.900	-0.049	-0.705
Tropical Livestock Unit (TLU)	-0.208***	-3.773	-0.142**	-2.379
Household access to credit	-0.056	-1.177	-0.036	-0.705
Extension contact	0.102**	2.110	0.045	0.871
Irrigation use	-0.055	-0.986	-0.024	-0.388
Participation in Off/Non-farm activities	0.040	0.817	0.015	0.294
Farm expenditure on crops	0.068	1.172	0.009	0.146
Household income	-0.132**	-2.367	-0.136**	-2.251
Constant	***	3.423	***	3.634
Adjusted R^2	0.202***		0.093***	
Observation (n)	400		390	

***, **, * at 1%, 5% and 10% levels of significance

Results of these regression analyses generally indicate the importance of location, age of household head, wealth (particularly TLU, but also land holding), income and mothers' education level in influencing food security status. The study conducted by Regassa and Stoecker (2011) also found that education of mother, agro-climatic zone and livestock ownership significantly predicted food insecurity in southern Ethiopia in the pre-harvest season.

6.9. Conclusions

The main focus of the chapter was on households' access to food. Descriptive statistics were used to identify and compare consumption of various food groups by season, location and gender. Food security indicators (HDDS, FCS, HFIAS and CSI) were used to measure food security across location, gender and season, and disaggregated by wealth and household income. Multiple regression models were also used to understand the relationship between food security and factors influencing food consumption and dietary diversity of households.

In all the study villages, cereals are the dominant staple foods consumed by rural households. The consumption of vegetables, fruits and milk and milk products is low.

There were significant differences in monthly average per capita food consumption across villages. In both seasons per capita food consumption was the lowest at Tsehafti *tabia*, due to relatively low crop yield, lack of adequate off/non-farm activities and shortage of livestock feed in the village for consecutive years.

The major sources of food consumed were own production and purchases, with own-production during the post-harvest season higher than the pre-harvest season; in the latter season households tried to make up the food shortage from own production through purchases and participation in PSNP.

Food insecurity is a general problem in the study area. The average number of months which households experienced food shortages during the year was 1.54: food shortage was higher in the lean season, with significant differences across villages.

In terms of food security indicators, there were no significant differences in HDDS between seasons and across locations although dietary diversity is expected to be higher during the post-harvest season. This indicates a monotonous diet amongst rural households in the area. The present study used a combination of indicators to better estimate the level of food and nutrition security in the study area. The Spearman's rho correlation results among the different indicators were significant during both seasons, supporting the use of a combination of these indicators.

Location, TLU and per capita household income were common significant influencing factors in the three measures: HDDS, FCS and HFIAS. Age of household head and land holding size significantly influence HDDS and HFIAS but not FCS. Farm expenditure on crops significantly influences FCS but not HDDS and HFIAS.

When households were disaggregated by wealth group, all food security indicators were significant, indicating food security levels increase with increase in wealth. There were significant differences in the indicators when households were disaggregated by farm income:

in general food security status improved as farm income increased. A similar pattern was observed for overall household income, with one exception:

Households in the third highest income quartile appear to be more concerned about their food security status (measured by HFIAS) and to adopt more coping strategies than households categorized below them; the reasons for this are not obvious.

There were no significant differences in HDDS between FHH and MHH, suggesting similar type of dietary diversity patterns followed by households. However, there were significant differences in food consumption measured by FCS between the post- and pre-harvest seasons, between FHH and MHH and across villages, indicating better access to food in the post-harvest season. Significant differences were observed in gender-disaggregated FCS scores across the four villages in both seasons.

The FCS-disaggregated score shows that the majority of households are in the 'borderline' category: the proportion of households falling into this category was similar in both seasons while the proportion of households falling into 'poor' category was higher during the lean season. The FCS score for MHH is higher than for FHH across both seasons and in all villages.

The HFIAS scores show higher access to food during the post-harvest season. Significant differences were also observed in food security levels across villages. Tsehafti *tabia* is the most food insecure village; this can be partly explained by the small average land sizes in that *tabia.*

The HFIAS results show that FHH are more food insecure than MHH across villages except at Tsehafti *tabia* where MHH are more food insecure. MHH appear to be more food insecure at the lean season in three of the four *tabias*: this may be partly due to the larger family size and higher consumption demand in MHH, allied with reduced food availability at the low season.

The CSI index shows almost households fall into the 'moderately food insecure' category. There were no significant differences between the seasons and between FHH and MHH in terms of the pattern of coping strategies followed to mitigate food shortage. Higher CSI

values at Tsehafti *tabia* indicate higher food insecurity than in other villages, consistent with the other food security indicators.

The OLS regression estimates captured the relationship between selected variables and food consumption, dietary diversity and food security of rural households through HDDS, FCS and HFIAS: location, TLU, household income (for post-harvest season only) and education of mother (for pre-harvest season only) were the most important and statistically significant variables. The role of mothers' education appears to be important in maintenance of food security particularly in the lean season. Age of household head is negatively and significantly related to food security (measured by FCS) in the lean season, suggesting the advantage of younger household heads in protecting households due to better access to media, nutrition demonstrations and other relevant trainings.

CHAPTER SEVEN

HOUSEHOLD AGRICULTURAL PRODUCTION, FOOD SECURITY AND NUTRITION LINKAGES

7.1. Introduction

The previous two chapters have separately assessed the production and consumption status of households. This chapter explores the relationship between production and consumption by focussing on the link between agriculture and nutrition.

As previously discussed, there are several pathways that link agriculture and nutrition (Pinstrup-Andersen, 2012). Four pathways are identified in the link between agriculture and nutrition, namely, consumption of own production, income from agriculture, food prices and the household's gender aspects (Ruel and Alderman, 2013; Gillespie and Kadiyala, 2012; Hoddinott, 2012; Arimond *et al.*, 2011; World Bank, 2007). The extent to which agriculture impacts on nutrition also depends on location, local conditions and products. However, there is little evidence about this linkage at the household level (Carletto *et al.*, 2015).

The link between agricultural production and consumption/ nutrition is evident from the fact that undernutrition is more severe during the pre-harvest season when food stocks from the main harvest are reduced (Vaitla *et al.*, 2009 cited in Carletto *et al.*, 2015). This link is more commonly viewed as a problem of food security where the primary focus is on ensuring adequate supply of cereals. From a wider nutritional perspective, dietary diversity is an additional objective, and one way of improving dietary diversity would appear to be by diversifying agricultural production (Sibhatu *et al*., 2015; Muller, 2009). Therefore it is important to examine the diversity of the agricultural production system and explore whether there is a linkage with more diverse diets.

In Ethiopia, there are limiting factors that hamper production diversity. Natural and physical conditions as well as poor market access are some of the important constraints (Hirvonen & Hoddinott, 2015). Tigray region is no exception.

This chapter therefore primarily focuses on the first pathway discussed above, namely the link between own production and consumption at household level. In particular, the analysis

addresses the association between own-production diversity and dietary diversity, the strength of association between single agricultural practices and diversification of diets, and identification of the factors influencing food consumption and food and nutrition security.

7.2. Methods of analysis

The factors that lead to food and nutrition security are interconnected and influenced by social, economic, cultural and political factors (Ghattas, 2014). As already discussed in this thesis, food and nutrition security can be assessed using various indicators that include HDDS, FCS and HFIAS at the household level. These direct measures are superior to other indicators in the sense that they include quantitative, qualitative, psychological and social dimensions (Ghattas, 2014).

Dietary diversity is a good indicator of food and nutrition security and can be regarded as an indirect measure of nutritional status (Swindale and Bilinsky, 2006; Hoddinott and Yohannes, 2002). However surveys conducted in rural Ethiopia using dietary diversity indicators have come up with differing findings. Hirvonen *et al.* (2015) found high dietary diversity in the pre-harvest season as compared to the post-harvest season, but Vaitla *et al*. (2012) found improved dietary diversity and food security in the post-harvest season as compared to the pre-harvest season using FCS. This suggests the use of a combination of indicators to determine the food and nutrition security status of households. In the present study, HDDS and FCS are both used to analyse the link between agricultural production and the food security and nutritional status of households.

The extent of production and consumption of food groups is further analysed using the proportion (%) of rural households producing and consuming major food groups, by income quartile as well as by wealth group and by season. HDDS captures the number of food groups consumed but does not indicate the frequency and extent of consumption of each food group. To understand the evenness of consumption between food groups the Simpson index and Shannon index were used (Romeo *et al*., 2016).

The relationship between farm practices diversification and dietary diversification is analysed using the Ordinary Least Squares (OLS) multivariate regression model. A Probit model is used to analyse the association between single agricultural practices and dietary diversity.

7.3. Production and consumption diversity by food group

Tables 7.1 and 7.2 summarize the proportion of households producing and consuming food based on seven major food groups; households are divided into income quartiles for more differentiated analysis. Selection of the seven major food groups was conducted following a similar study by Hirvonen and Hoddinott (2015) for rural Ethiopia. For the post-harvest season, significant differences were observed in the proportion of households producing legumes, eggs and other fruit and vegetables (such as avocado, banana, onion and green pepper) between income groups (Table 7.1). There were no significant differences in the proportion of households producing grains, roots and tubers between the income groups. Most farming households in the study area give priority to the production of cereals and allocate the majority of land to the production of cereals: this is because the majority of the land is rain-fed, the production cost of cereals is relatively low as compared to the other food groups, and food consumption in the area is mostly cereal-based. Dairy products and Vitamin A-rich fruit and vegetables were produced by less than 10% of households in all the income brackets. The results for the proportion of households producing grains and legumes are similar to the findings by Hirvonen and Hoddinott (2015) for rural Ethiopia; but the proportion of households producing dairy products (6.8%) is far below their finding of 23%, suggesting that the consumption of dairy products in the study area comes mainly from purchases.

Table 7.1: Percent of households producing specific food groups at the post-harvest season, by income quartile (n=400)

Household income quartiles	Grains, roots & tubers	Legumes & nuts	Dairy products	Poultry, meat	Eggs	Vitamin A rich fruit & vegetables	Other fruit & vegetables
Overall	95.8	45.3	6.8	73.5	46.8	2.3	18.3
Q1 (Low)	94.0	40.0	4.0	68.0	37.0	1.0	8.0
Q2 (L. middle)	93.0	38.0	8.0	71.0	51.0	1.0	13.0
Q3 (U. middle)	97.0	42.0	6.0	75.0	42.0	3.0	19.0
Q4 (High)	99.0	61.0	9.0	80.0	57.0	4.0	33.0
χ^2-test (p-value)	0.134	0.003	0.507	0.246	0.021	0.383	0.000

The chi-squared test of the null hypothesis tests the relationship between the values of categories of the indicated variables for households in the study villages, by income quartile.

Significant differences were observed in the consumption of all food groups except for grains, legumes and other fruits and vegetables, based on the 30-day food group consumption (Table 7.2). In almost all the households in the four income levels, there were no differences in the

proportion of households consuming grains and legumes. The proportion of households consuming dairy products, poultry, eggs and vitamin-A rich fruit and vegetables was significantly higher for the high income households, and lowest for the poor households. This suggests that the consumption of nutrient-rich food groups increases with income and vice versa.

More than 90% of households in all income brackets produce grains, roots and tubers and all households consume this food group. It is likely that households consumed most of what they have produced, indicating the link between own production and consumption/nutrition. Although only 4-9% of households in all the income quartiles produced dairy products, 35% (low income) to 71% (high income) consumed this food group. The pattern is similar for vitamin A-rich fruits and vegetables. This suggests a high proportion of the quantities consumed of these food groups is sourced from purchases. The proportion of households consuming poultry and meat is likely exaggerated as the figure does not report the frequency of consumption.

The proportion of households consuming a particular food group generally increases with increases in income (Table 7.2). Such an increase is significant for dairy products, poultry, meat, eggs and Vitamin-A rich fruit and vegetables (carrot, red pepper, etc.) across the income quartiles. Sibhatu *et al*. (2015) also found that higher incomes of households are associated with higher consumption of more diversified food and therefore improved levels of nutrition.

Table 7.2: Percent of households consuming specific food groups at the post-harvest season, by income quartile (n=400)

Household income quartiles	Grains, roots & tubers	Legumes & nuts	Dairy products	Poultry, meat	Eggs	Vitamin A rich fruit & vegetables	Other fruit & vegetables
Overall	100.0	99.8	50.5	49.5	30.3	41.3	93.5
Q1 (Low)	100.0	99.0	35.0	39.0	21.0	19.0	91.0
Q2 (L. middle)	100.0	100.0	44.0	42.0	25.0	41.0	92.0
Q3 (U. middle)	100.0	100.0	52.0	53.0	27.0	47.0	93.0
Q4 (High)	100.0	100.0	71.0	64.0	48.0	58.0	98.0
χ^2-test (p-value)	-	0.393	0.000	0.028	0.000	0.000	0.190

The chi-squared test of the null hypothesis tests the relationship between the values of categories of the indicated variables for households in the study villages, by income quartile.

The proportions of households producing and consuming specific food groups by wealth group (see Chapter 5) are reported in Tables 7.3 and 7.4. At the post-harvest season there were statistically significant differences among wealth groups in the proportion of households producing grains, legumes, poultry and other fruit and vegetables. This suggests that the wealth situation of households significantly influences the production of the majority of the food groups (Table 7.3). The proportion of households producing dairy products and vitamin A-rich fruit and vegetables in the area is very low, and there were no significant differences between the wealth groups in production of these food groups.

Table 7.3: Percent of households producing specific food groups at the post-harvest season, by wealth group

Wealth Group	Observation (n)	Grains, roots & tubers	Legumes & nuts	Dairy products	Poultry, meat	Eggs	Vitamin A rich fruit & vegetables	Other fruit & vegetables
Overall	400	95.8	45.3	6.8	73.5	46.8	2.3	18.3
Poor	211	92.4	28.4	6.2	65.4	42.2	1.9	13.3
Middle	143	99.3	58.0	6.3	81.2	51.8	2.1	28.0
Better-off	46	100.0	82.6	10.9	87.0	52.2	4.4	10.9
χ^2-test (p-value)	-	0.002	0.000	0.498	0.000	0.154	0.592	0.001

The chi-squared test of the null hypothesis tests the relationship between the values of categories of the indicated variables for households in the study villages, by wealth group.

As indicated in Table 7.4, significant differences were observed between the proportion of poor, middle and better-off households in consuming dairy products, poultry, eggs, Vitamin A-rich fruit and vegetables and other fruit and vegetables. The proportion of households consuming these food groups is the highest for better-off households. This suggests that wealth is a significant contributor to differences in food consumption, indicating the influence of agricultural assets in food consumption. The difference in the proportion of households consuming particular food groups between wealth groups is wider as one goes from energy-rich grain consumption to more nutritious foods (dairy, poultry, eggs and vitamin A-rich fruit and vegetables). Overall, the proportion of households producing poultry and eggs is in most cases greater than the proportion of households consuming these food groups. This indicates that for some households, poultry and eggs are produced for cash rather than for consumption. For all the other food groups, the proportion of households consuming is greater than the proportion of households producing.

Table 7.4: Percent of households consuming specific food groups at the post-harvest season, by wealth group

Wealth Group	Observation (n)	Grains, roots & tubers	Legumes & nuts	Dairy products	Poultry, meat	Eggs	Vitamin A rich fruit & vegetables	Other fruit & vegetables
Overall	400	100.0	99.8	50.5	49.5	30.3	41.3	93.5
Poor	211	100.0	99.5	43.1	28.4	21.8	33.7	90.5
Middle	143	100.0	100.0	52.5	73.4	33.6	44.0	96.5
Better-off	46	100.0	100.0	78.3	71.7	58.7	67.4	97.8
χ^2-test (p-value)		-	0.640	0.000	0.000	0.000	0.000	0.036

The chi-squared test of the null hypothesis tests the relationship between the values of categories of the indicated variables for households in the study villages, by wealth group.

The proportions of rural households consuming specific food groups at the pre-harvest season by income and wealth are summarized in Tables 7.5 and 7.6. On average, only 18 to 40% of the rural households consume high-nutritional value food groups in the pre-harvest season, showing the significance of seasonality in dietary patterns. The proportions of households consuming dairy products, eggs and other fruit and vegetables over the 30-day consumption period were significantly different among households grouped under the income quartiles (Table 7.5): the higher income quartiles (Q3 and Q4) had larger proportions of households consuming these food groups. As expected, grains and legumes are consumed by almost all households across all income quartiles in the pre-harvest season, but a higher proportion of households in the higher income quartiles consume the most nutritious foods (such as dairy products, meat, eggs and Vitamin A rich fruit and vegetables).

Table 7.5: Percent of households consuming specific food groups at the pre-harvest season, by income quartile (n=390)

Household income quartiles	Grains, roots & tubers	Legumes & nuts	Dairy products	Poultry, meat	Eggs	Vitamin A rich fruit & vegetables	Other fruit & vegetables
Overall	100.0	99.5	35.6	40.8	19.2	18.2	56.2
Q1 (Low)	100.0	98.0	26.5	37.8	11.2	14.3	46.9
Q2 (L. middle)	100.0	100.0	32.7	38.8	14.3	15.3	49.0
Q3 (U. middle)	100.0	100.0	40.2	39.2	19.6	20.6	59.8
Q4 (High)	100.0	100.0	43.3	47.4	32.0	22.7	69.1
χ^2-test (p-value)		0.112	0.063	0.494	0.001	0.357	0.006

The chi-squared test of the null hypothesis tests the relationship between the values of categories of the indicated variables for households in the villages, by income quartile.

The analysis by wealth groups shows a similar pattern. As shown in Table 7.6, the poor wealth category has the lowest proportion of rural households consuming dairy products, meat, eggs, Vitamin-A rich fruit and vegetables and other fruit and vegetables. Most poor households consume more energy-rich foods and less of more micronutrient-rich foods. The food groups consumed by the lowest proportions of households in the pre-harvest season were Vitamin A-rich fruit and vegetables (18.2% of households), eggs (19.2%) and dairy products (35.6%).

Table 7.6: Percent of households consuming specific food groups at the pre-harvest season, by wealth group

Wealth Group	Observation (n)	Grains, roots & tubers	Legumes & nuts	Dairy products	Poultry, meat	Eggs	Vitamin A rich fruit & vegetables	Other fruit & vegetables
Overall	390	100.0	99.5	35.6	40.8	19.2	18.2	56.2
Poor	206	100.0	99.0	32.0	18.9	14.6	14.6	46.6
Middle	139	100.0	100.0	35.3	64.0	18.0	20.1	65.5
Better-off	45	100.0	100.0	53.3	68.9	44.4	28.9	71.1
χ^2-test (p-value)			0.409	0.026	0.000	0.000	0.060	0.000

The chi-squared test of the null hypothesis tests the relationship between the values of categories of the indicated variables for households in the study villages, by wealth group.

These results suggest the importance of interventions in agricultural production (that can partly lead to higher own-consumption) and other income generating activities to improve food consumption. Hirvonen and Hoddinott (2015) also suggest improvements in agricultural interventions that enhance production and income for improved nutrition security.

Carletto *et al*. (2015) analysed the link between agricultural production and nutrition using studies from seven developing countries (including livestock ownership and nutrition in Ethiopia) and found a link between decisions on agricultural production and consumption; crop production and agricultural income was positively associated with dietary diversity; and seasonality affected the extent of consumption from own-production. They particularly emphasized the positive livestock-nutrition linkage. Similarly, Hoddinott *et al*. (2015) found a strong association between ownership of cows and consumption of milk and milk products in rural Ethiopia; Azzari *et al*. (2015) also found a strong relationship between livestock ownership and consumption of animal source foods in Uganda.

7.4. Association between agricultural practices and dietary diversity

7.4.1. Food diversity indicators and evenness of consumption

The HDDS gives equal weights to all the 12 food groups included in the analysis. In reality however, food groups consumed in a given period might not all be consumed in equal or appropriate quantities, indicating an uneven consumption of food groups. In order to mitigate the equal weights problem of HDDS scores, two additional diversity measures are used as in Romeo *et al*. (2016): the Simpson index and Shannon index.

Both the Simpson index and Shannon index are constructed based on the expenditure share of each food group regardless of the source of the food (converted into monetary values at the prevailing prices) in per capita terms.

The Simpson index (Simpson, 1949) and Shannon index (Shannon and Weaver, 1948) values are computed based on the following (equation 7.1):

Simpson index= $1 - \sum_i wi2$ (7.1)

Where w_i is the food expenditure share of food group i. In the Simpson index the food shares are squared, reducing the weight of food groups with smaller expenditure shares relative to those with larger expenditure shares. This index takes values between 0 and 1: an index value towards zero implies consumption of only one food group while a value closer to one implies more equal distribution of expenditure on food groups.

Shannon index= $-\sum_i wi \cdot log(wi)$ (7.2)

Where w_i, as in (eq. 7.1) above, is the food expenditure share of food group i. The Shannon index takes log values thereby reducing the weight of food groups with larger expenditure shares relatively more than food groups with smaller expenditure shares. The Shannon index value ranges between zero and the log value of the highest number of food groups consumed in a period. The implications of both indices are similar. Both indices enable analysis of the association between farming activities and the number of food groups that households consume as well as the evenness and adequacy of consumption. A value of 1 for the Simpson index and 2.48 for the Shannon index indicates perfect evenness with respect to dietary

diversity (Romeo *et al*., 2016). This type of analysis adds a food adequacy dimension to the consideration of dietary diversity.

Identifying particular agricultural practices that are more strongly correlated with dietary diversity requires the disaggregation of the practices into specific crop and livestock types so as to test the contribution of individual farming practices to dietary diversity. For this purpose, an Agriculture Enterprise Score (AES) was constructed using the crops and livestock production data of the main harvest season. It was constructed by identifying and then grouping the individual farming practices under the group they generally belong to (See Table 7.8a). The AES was used to test the effect of own-production on consumption (Romeo *et al*., 2016).

Individual agricultural practices were compared against the three diversity measures-HDDS, Simpson index and Shannon index-to understand the association between production and food consumption. These dietary diversity measures were tested for correlation between them and ANOVA was used to test for differences in household characteristics and outcome indicators (Romeo *et al*., 2016).

The analysis in Table 7.7 is based on the monthly food expenditure shares of the 12 food groups used for dietary diversity analysis, with adult equivalents used to compare differences across villages. Consumption of food groups from all sources were converted into monetary values. Overall, the HDDS indicates that rural households consumed 6 out of the 12 food groups, but it does not indicate either the frequency or amount of food groups consumed. The results for mean Simpson index and Shannon index are 0.63 and 1.44, respectively (Table 7.7), indicating a lack of evenness and adequacy in the distribution of food groups consumed: specifically there is lack of balance between consumption of macro- and micro-nutrients. The AES value (3.73) reveals that households produce less than 4 food groups in the main harvest season. This is higher than the results (1.98) for rural Ethiopia reported by Hirvonen and Hoddinott (2015), although they also reported substantial variations among regions. There were significant differences in dietary diversity, evenness and adequacy of consumption across villages. Most of the indicators show Andi Woyane *tabia* to be better than the other *tabias*.

Table 7.7: Food diversity indicators at post-harvest season, by village

Indicator	All villages	Andi Woyane	Mahbere Genet	Meseret	Tsehafti	F-test
HDDS	5.90	6.28	6.17	6.04	5.34	16.87***
Simpson index	0.63	0.67	0.62	0.59	0.64	337.10***
Shannon index	1.44	1.52	1.42	1.35	1.47	467.20***
AES	3.73	4.09	3.00	4.12	3.72	14.86***
Observations (n)	400	96	75	107	122	-

***at 1% level of significance

The F-test of the null hypothesis tests differences in average mean values of the indicated variables between households in the study villages.

7.4.2. Farm practices diversification and diet diversification

Farming practices diversification, dietary diversity and evenness of consumption:

The OLS multivariate regression was used to analyse the relationship between farming activities and dietary diversity of rural households by employing the model specified below in Equation 7.3, following Romeo *et al*. (2016):

$$Y = \beta_0 + \beta_1 AES + \sum_{j=2}^{n} \beta j X + \upsilon \qquad (7.3)$$

Where Y is a dietary diversity measure using HDDS, the Simpson index or the Shannon index; the Agriculture Enterprise Score (AES) is the sum total of individual farm practices produced by the household that reflect production diversity; the β_1 coefficient indicates the strength of association between own-production diversification and diet diversity; and X represents a vector of control variables that influence dietary diversity. The selected control variables were location, family size, gender and age of household head, landholding size, TLU, income and education of mother. These variables were selected based on empirical findings by Romeo *et al*. (2016), Carletto *et al*. (2015), Sibhatu *et al*. (2015) and on the analysis in the previous chapters of the present study.

Equation 7.4 estimates the influence of individual farming practices on dietary diversity by using dummy independent variables, following Romeo et al. (2016):

$$Y = \beta_0 + \sum_{k=1}^{m} \beta \kappa IFP + \sum_{q=m+1}^{n} \beta q X + \upsilon \qquad (7.4)$$

Where Y is a dietary diversity measure using HDDS, the Simpson index or the Shannon index; the Individual Farming Practice (IFP) variable is a dummy independent variable

showing the incidence of production in the main harvest; the β_k coefficient indicates the strength of association between IFP and dietary diversity; IFP is a dummy variable (Yes/No) representing whether a household engaged in each of the farming practices.

The correlation between the three measures of dietary diversity-HDDS, Simpson index and Shannon index-was tested using Pearson Product-Moment Correlation; tests were also carried out to check for the existence of multicollinearity and the variance inflation factors (VIF) turned out to be between 1.055 and 1.135, which is well below the suggested cut-off mark of 10 given by Kutner *et al*. (2004 cited in Romeo *et al*., 2016), indicating that multicollinearity is not a problem in the model used.

Table 7.8a summarizes the association between individual production practices and the three measures to identify which individual practice influences dietary diversity and 'dietary distribution' better. Only production of pulses was statistically significant and contributed positively to the dietary diversity of households as measured by HDDS. Pulses, vegetables and poultry production practices were positively and significantly associated with Simpson and Shannon indices, suggesting that these were used mainly as sources of income for the purchase of other food and non-food items. There was also a positive and significant association between sheep/goat production and the two indices, as well as between fruit and honey production and the Shannon index. The significant differences observed and magnitude of association among the individual production practices and the indicators suggest differences in the contribution of particular farming practices to dietary diversity and the evenness of consumption between the different food groups consumed by households. Romeo *et al*. (2016) found a significant and positive association between pulses (only for HDDS) and poultry (all the 3 diversity measures) production for poor Kenyan farmers.

In terms of the average of the number of crops grown (summing individual farm practices) in the study villages for the 2013/14 agriculture year, the AES was found to be statistically significantly associated with dietary diversity of households, suggesting a direct positive relationship between production diversity and dietary diversity (Table 6.8b).

Sibhatu *et al*. (2015), using data from smallholder rural households in Ethiopia and three other developing countries, found that overall farm production diversity is positively associated with dietary diversity but claim that market access has a larger influence, indicating also that

other important factors exist. However, the association was not statistically significant in the case of Ethiopia. For smallholder farm households who already reached higher production diversification (as many smallholders diversify production to minimize risk), own-farm crop and livestock diversification might not have a significant influence and may even in some cases have a negative association with dietary diversity due to '*foregone income resulting from farm diversification beyond optimal levels*'. Sibhatu *et al*. (2015) suggest market access improvements for subsistence farmers to improve dietary diversity.

Kumar *et al*. (2015) also found a positive, significant relationship between household dietary diversity and the number of agricultural activities as well as number of food groups produced for farming households in Zambia. They attribute this association partly to the improper functioning of local and nearby markets leading many households to depend on on-farm agricultural production to achieve diversified diets; this provides evidence for the role of the first agriculture-nutrition pathway for smallholder subsistence farms.

Table 7.8a: OLS multivariate regression analysis of crop and livestock production practices on household diet diversity, at the post-harvest season

Individual production practices	HDDS	Simpson index	Shannon index
Crop production			
Cereals	0.072 (0.285)[a]	-0.006 (0.007)	-0.016 (0.015)
Pulses/Legumes	0.441*** (0.118)	0.011*** (0.003)	0.028*** (0.006)
Vegetables	0.198 (0.175)	0.016*** (0.004)	0.031*** (0.009)
Fruits	0.253 (0.189)	0.011 (0.004)	0.023** (0.010)
Livestock ownership			
Cattle	-0.239 (0.156)	0.002 (0.004)	0.006 (0.008)
Sheep and goat	-0.140 (0.119)	0.006** (0.003)	0.014** (0.006)
Poultry	0.148 (0.130)	0.011*** (0.003)	0.023*** (0.007)
Beekeeping	0.165 (0.178)	0.006 (0.004)	0.015* (0.009)
Observations (n)	400	400	400
R-squared	0.059	0.114	0.151

***, **, * at 1%, 5% and 10% levels of significance
(a) Figures in parentheses are standard errors

Table 7.8b: OLS multivariate regression analysis of AES on household dietary diversity, at the post-harvest season

Description	HDDS
AES	0.102** (0.041)[a]
Observations (n)	400
R-squared	0.015

**at 5% level of significance
[a]Figure in parenthesis is standard error

Individual farming practices by incidence of HDDS food groups:

A binary probit regression model was used (following Romeo *et al*, 2016) in an attempt to identify whether the influence of individual farm practice on dietary diversity worked primarily through an income effect or a production-for-own-consumption effect. The dependent variables are the 12 different food groups included in the HDDS (FAO, 2013). The independent variables are the incidence of household production of each food group namely, cereals, pulses, vegetables, fruits, cattle, sheep and goat, poultry and beekeeping. Wald chi-square statistics were calculated to test the significance of variables.

The Probit model is a non-parametric model used to determine the regression coefficient estimates of the independent variables on the dependent variable. For analysis it uses the maximum likelihood estimator. The model takes the probability that Y=1 assuming the cumulative standard normal distribution function, evaluated at $z = \beta_0 + \beta_1 X$, following Jackman (2000):

$$\Pr(Y = 1|X) = \Phi(\beta_0 + \beta_1 X) \qquad (7.5)$$

Where Φ is the cumulative normal distribution function; β_1 is the change in the z-value for a unit change in X; and $z = \beta_0 + \beta_1 X$ is the z-value of the Probit model.

β is estimated using the following:

The log-likelihood function for Probit i

$$\ln L = \sum w_j \ln \Phi(X_j \beta) + \sum w_j \ln(1 - \Phi(X_j \beta)) \qquad (7.6)$$

where w_j denotes optional weights

In the Probit regression model analysis, the marginal effect (ME) is a more useful measure, which reports the percentage change in the independent variable (X_i) to the percentage change in the dependent variable (Y).

The marginal effect is estimated using the following:

$$\text{MEj} = \frac{\partial P(Yi=1)}{\partial Xji} = \frac{\partial F(\beta_1+\beta_2 X_{2\text{i}}+\beta_3 X_{3\text{i}}+\beta kXk\text{i})}{\partial Xji} \quad (7.7)$$

Where F is the cdf of a standard normal random variable

$$= \text{F}'\,(\beta_1 + \beta_2 X_{2\text{i}} + \beta_3 X_{3\text{i}} + \beta\kappa X\kappa i)\ \beta j \quad (7.8)$$

Table 7.9 reports the results of this analysis. Among the individual production practices in the area pulses, sheep/goat, poultry and beekeeping are altogether significantly associated with seven of the 12 food groups by incidence of consumption. Pulses were positively and significantly associated with roots/tubers, meat and sweets but not with its corresponding own food group. This suggests the contribution to dietary diversity of pulses is primarily through an income effect. Sheep/goats were positively and significantly associated with their own consumption and with other food groups (vegetables, eggs and oils), suggesting that they contributed to dietary diversity of both through own-consumption and through income effects. Poultry were also significantly and positively related with their own consumption (meat) and with milk and milk products, also suggesting a combination of own-consumption and income effects. Beekeeping (honey production) was positively and strongly associated with the consumption of milk and milk products, more likely through an income effect.

Table 7.9: Binary probit analysis[1]: Individual crop and livestock practices by incidence of HDDS food groups, at the post-harvest season

Variable	Cereals (1)	Roots & tubers (2)	Vegetables (3)	Fruit (4)	Meat (5)	Eggs (6)	Fish (7)	Legumes (8)	Milk & products (9)	Oils & fats (10)	Sweets (11)	Condiments (12)
Cereals	-4.861 (0.005)[a]	-0.033 (0.324)	-0.257 (0.517)	0.380 (0.503)	-0.485 (0.414)	-0.516 (0.351)	-	-4.679 (0.006)	-0.822 (0.358)	-0.061 (0.526)	-0.200 (0.355)	-4.516 (0.006)
Pulses/Legumes	4.493 (0.001)	0.258* (0.135)	0.270 (0.216)	0.128 (0.173)	0.058** (0.150)	-0.078 (0.135)	-	4.068 (0.002)	-0.123 (0.135)	0.052 (0.249)	0.290** (0.137)	0.171 (0.377)
Vegetables	4.554 (0.003)	-0.096 (0.200)	-0.050 (0.315)	-0.049 (0.269)	-0.318 (0.215)	-0.108 (0.199)	-	4.287 (0.003)	-0.109 (0.199)	0.364 (0.475)	0.061 (0.204)	-0.603 (0.450)
Fruits	4.451 (0.003)	-0.365 (0.220)	0.195 (0.367)	-0.504 (0.352)	-0.064 (0.236)	0.145 (0.218)	-	4.186 (0.003)	0.132 (0.216)	-0.116 (0.394)	-0.310 (0.215)	-0.081 (0.568)
Cattle	4.702 (0.001)	0.271 (0.179)	-0.069 (0.269)	-0.065 (0.233)	0.037 (0.195)	-0.053 (0.180)	-	4.511 (0.001)	0.141 (0.179)	-0.059 (0.298)	-0.058 (0.185)	-4.976 (0.003)
Sheep & goat	4.411 (0.002)	-0.144 (0.135)	0.476** (0.229)	0.128 (0.173)	0.411** (0.159)	0.263* (0.137)	-	4.292 (0.002)	0.073 (0.136)	0.709** (0.319)	0.062 (0.139)	0.501 (0.435)
Poultry	4.657 (0.001)	0.238 (0.148)	-0.061 (0.229)	0.066 (0.195)	0.232** (0.160)	0.113 (0.148)	-	-4.475 (0.002)	0.370** (0.149)	0.257 (0.246)	-0.084 (0.153)	0.461 (0.370)
Beekeeping	-0.284 (0.003)	0.133 (0.201)	-0.116 (0.327)	-0.228 (0.282)	0.048 (0.239)	0.002 (0.205)	-	0.120 (0.003)	0.462** (0.208)	4.940 (0.004)	0.213 (0.212)	4.822 (0.004)

**, * at 5% and 10% levels of significance for the probit marginal effects

(a) Figures in parentheses are standard errors

[1] In the binary probit model analysis, each cell is the result of the association between each of the 12 food groups (as dependent variable) and individual farm practices (as independent variables) and each cell result is taken as one probit model.

7.5. Conclusions

The chapter focuses on exploring the association between agricultural production and food consumption. The primary focus is on exploring the link between agricultural production diversity and dietary diversity. The analysis uses descriptive statistics; indices measuring production diversity; and OLS multivariate regression and probit models to explore the association between agricultural practices and food and nutrition security of rural households.

For the post-harvest season, significant differences were observed in the proportion of households producing legumes, eggs, and other fruits and vegetables between the income quartiles. For the remaining food groups produced there were no significant differences between the income quartiles.

For the post-harvest season there were significant differences between the four income groups in the proportion of households consuming the food groups with higher nutritional value - dairy products, meat/poultry, eggs and 'Vitamin A rich fruits and vegetables' - with the proportion of households consuming these food groups increasing with income. For dairy products and Vitamin A-rich fruits and vegetables the proportion of households consuming was higher than those producing, suggesting consumption from purchases. Similar results were found when households were disaggregated by wealth group.

Overall, the proportion of households producing poultry and eggs is greater than the proportion of households consuming these food groups. This indicates that for some households, poultry and eggs are produced for cash rather than for consumption. For all the other food groups, the proportion of households consuming is greater than the proportion of households producing.

In the pre-harvest season, grains and legumes are consumed by almost all households across all income quartiles/wealth groups, but a higher proportion of households in the higher income quartiles consume the most nutritious foods compared to the lower income groups. The proportion of households consuming high-nutrition food groups in the pre-harvest season was low compared with the post-harvest season, indicating the significance of seasonality in influencing dietary patterns particularly for nutritious foods.

Overall, households with the lowest income or wealth are nutritionally vulnerable as a result of less consumption of highly nutritive food groups, partly due to limited diversity of production. These results suggest the importance of interventions in agricultural production and other income generating activities to improve food consumption. These findings are consistent with the findings by Azarri *et al*. (2015), Carletto *et al*. (2015), Hirvonen and Hoddinott (2015) and Hoddinott *et al*. (2015).

In order to mitigate the equal weights problem of HDDS scores, two additional diversity measures were used as in Romeo *et al*. (2016): the Simpson index and Shannon index. The results of these indices show a lack of evenness and adequacy in the distribution of food groups consumed. There were significant differences in dietary diversity, evenness and adequacy of consumption across villages: most of the indicators show Andi Woyane *tabia* to be better than the other *tabias*, probably due to greater use of irrigation.

OLS regression analysis results show that production of pulses, while correlated to the three (HDDS, Simpson and Shannon indices) dietary diversity outcome variables, strongly and positively influenced the number of food groups consumed and the evenness and adequacy of diet. Vegetables and poultry were strongly and significantly associated with diet evenness. Overall, farm production diversity was strongly associated with dietary diversity, linking agriculture and nutrition. Kumar *et al*. (2015) and Sibhatu *et al*. (2015) found similar results.

The binary probit analysis results show a significant relationship of pulses with roots/tubers, meat and sweets but not with its own group. Similarly, sheep/goat was significantly associated with its own group (meat) and with vegetables, eggs and oils. Poultry was significantly and positively associated with its own group (meat) and with milk and milk products as was beekeeping with milk and milk products. These results indicate the influence of individual farming practices linked to dietary diversity and food access via the own-production and agricultural income pathways.

CHAPTER EIGHT

CONCLUSIONS AND RECOMMENDATIONS

8.1. Introduction

This chapter draws together the key findings of the research, and discusses the policy implications arising from it. It also briefly considers the contribution of the thesis to the academic literature, the limitations of the study and the need for further research.

Food insecurity remains a policy priority in developing countries like Ethiopia, where agriculture is a major sector in the economy and is dominated by smallholder farmers. Many studies report the important role agriculture plays in improving the food and nutrition security of households through multiple pathways. There is a growing interest in understanding these agriculture-nutrition linkages, and, as a result, there is a growing body of evidence relating the two (Romeo *et al*., 2016; Carletto *et al*., 2015; Sibhatu *et al*., 2015; Maxwell *et al*., 2013; Vaitla *et al*., 2012). This thesis aims to contribute to this debate and to provide specific insights into the situation prevailing in the Tigray Regional State of Ethiopia.

Agricultural policies in Ethiopia hitherto have focused on maximizing production and productivity without much regard for nutritional dimensions. While this may address part of the challenge of food security, it cannot fulfil nutritional requirements. The local saying among people in the study area, that "*if a person feels their belly full, that is enough and that is it*", focuses only on the quantity of food consumed, but needs to be challenged.

The main objective of the thesis is to examine the link between household livelihoods, agricultural practices and food and nutrition security in rural areas of south-eastern Tigray. In addressing the research questions of the study (See section 1.3) data were collected in two rounds, at the post- and pre-harvest seasons, from 400 households living in four villages of two food insecure districts in south-eastern Tigray, north Ethiopia. Additional qualitative data were collected from FGDs and KIIs to understand the general perception of farmers on agricultural practices, livelihoods, food and nutrition security and the link between them. Descriptive statistics, analysis of qualitative interviews, multiple regression analysis and probit model analysis were employed to address the research questions.

8.2. Summary of main conclusions

This section summarizes the major findings of the study and their implications.

8.2.1. Agricultural production and livelihoods

Households in the study area rely on mixed crop-livestock farming as their main means of livelihood. Rain-fed agriculture dominates the study area and most crops are produced in the main rainy season.

Land holdings are small, with average holdings per household of 0.8ha. There are variations in landholding size across the study villages, and also between FHH and MHH: the latter have larger land sizes (0.82 ha for MHH, 0.67 ha for FHH). Land rental is a common livelihood practice in the study area, particularly for FHH in terms of renting out land. The biggest single source of land rented-in was from female relatives. Differences between male- and female-headed households are therefore larger for land operated compared with land owned: 1.24 ha for MHH, 0.64 ha for FHH. This clearly impacts on food availability by household.

Most land is allocated to producing cereals, reflecting households' reliance on cereals as their staple food. Pulses and oil seeds were the second largest category of crops, while the area allocated for the production of vegetables was very small, mainly due to less access to water for irrigation. This, in turn, leads to very low consumption of own production of vegetables and fruit. There is no significant difference between FHH and MHH in the average area allocated for vegetable and fruit production.

The average livestock holding per household is 4.04 TLU, with some variation across the study villages. There are major differences in both livestock ownership and oxen ownership (the key asset for ploughing) between MHH and FHH: MHH own 4.51 TLU and 1.46 oxen, compared with 1.61 TLU and 0.39 oxen owned by FHH. This further indicates the gender differences in asset ownership and capacity to cultivate land, and provides one explanation of why FHH rent-out significant amounts of land.

Significant differences were observed in average yield (kg/ha), in both the total and per capita production of major crop groups across villages. Compared to the national and regional average, the yield of the major crops grown in the study villages is low: average cereal yields

in the study area were only 813kg/ha, although there were notable differences between villages due to local factors. Regression analysis showed an association between cereal yields and location (village), TLU ownership, and access to credit. This difference in average yield between villages leads to differences in food availability and disposal of agricultural products, including food consumption.

The main sources of food for the households were found to be mainly from own production; purchases from the market were second and the remaining amount was covered by gifts and transfers or aid. Most of the cereals and pulses produced by the smallholder farmers are meant for household consumption, while most of the vegetables and fruit produced by the households are supplied to the market. Meat consumption of the households in the study villages is very low and livestock are mainly raised to support crop production, for sale during periods of crop failure, and to meet other social and cultural obligations. Higher levels of food availability were reported during the post-harvest season than the pre-harvest season. As the pre-harvest season progresses and harvest stocks are depleted, food consumption becomes more limited compared to the post-harvest season. Regression analysis was conducted to identify factors associated with consumption from own-production: age of household head, adult equivalents, land holding size, TLU, and cereal and pulses yields were significantly and positively associated.

There has been a growth in institutional support services for agriculture in Tigray in recent years. Amongst the sample households, 75% participated in extension-related activities; 47% of households have co-operative membership: in 50% of these households membership is by men only. About 63% of households took loans for agricultural activities: 80% of these loans were taken by men. Only 24% of households hold savings accounts: 69% are held by men only, 25% by women only and 6% by both. These findings provide some evidence that men in the study area have greater access to or involvement with support services than women.

Agriculture is the main livelihood activity in the study area but does not generate sufficient income to enable household food and non-food needs to be met. Income from off/non-farm activities is therefore very important and on average makes up 54% of total household income. There are substantial differences in total income and its composition by location, season and gender. In the post-harvest season, in all study villages except Mahbere Genet, farm income is higher than off/non-farm: Mahbere Genet is close to the regional capital,

Mekelle, which affords more options for generating such income. In the pre-harvest season, however, off/non-farm income is higher in three of the villages. Total incomes are higher post-harvest than in the pre-harvest season, and the relative contribution of farm income to total income is higher post-harvest. Income earned by FHH is only about 52% of the income earned by MHH, and the composition differs markedly: 53% of MHH income is from farm sources compared with only 26% of income earned by FHH.

8.2.2. Household food consumption and food security

The second objective of the study was to explore the extent and nature of household food consumption, including a focus on seasonality in consumption and differences by location and gender.

Food consumption is dominated by cereals: on average they make up 76% of all food consumption (by weight) in the post-harvest season and 80% in the pre-harvest season. Consumption of vegetables, fruit, and livestock and livestock products is low in both seasons, but particularly pre-harvest, whereas cereal consumption is maintained at the same level in both seasons. These consumption patterns were similar across the study villages but quantities consumed were lower in Tsehafti: this is likely related to smaller landholding sizes, lower yields and lower household incomes in Tsehafti. The low consumption of non-cereal products is likely to have adverse effects on nutritional status, and seasonal differences in non-cereal consumption suggest that nutritional status may deteriorate during the pre-harvest season. Most cereal consumption comes from own-production in the post-harvest season but over 30% is sourced from the market in the pre-harvest season.

Analysis by head of household revealed important differences in consumption: somewhat surprisingly, overall adult-equivalent food consumption was higher for FHH (particularly in respect of cereals) than for MHH in both seasons, although the opposite was the case in terms of per household consumption (since MHH have more family members). This pattern of FHH consumption may be partly influenced by Food-for-Work payments under the PSNP.

A large proportion of households face a food gap: about 50% of households said they had experienced a food gap (averaging 1.54 months) in the 12 months preceding the harvest, and 72% said they had experienced a food gap between the harvest and the pre-harvest season (i.e. between the two data collection periods). About 44% of households felt that food shortages

were worse in the pre-harvest season while 52% felt there was no difference in food availability between seasons. Tsehafti had the highest proportion of households who reported a food gap for the 12 months preceding harvest.

Different indicators were used to measure the level of household food security by location, season and gender. Average dietary diversity (HDDS) was 5.9 post-harvest and 5.8 pre-harvest, and there was no statistically significant difference between these figures. Dietary diversity was lowest in Tsehafti in both seasons. HDDS is higher for MHH than FHH in both seasons except in Tsehafti, although the difference was only significantly higher in the post-harvest season.

The mean Food Consumption Score (FCS), which measures both dietary diversity and frequency of consumption, was significantly higher in the post-harvest season than pre-harvest; furthermore there were significant differences between villages (Tsehafti again had the lowest score) and between MHH and FHH: the FCS score was higher for MHH than FHH in all villages and both seasons. Both the HDDS and FCS data provide an indication that dietary quality may be better amongst MHH rather than FHH, although, as noted above, on an adult-equivalent basis FHH consumption of cereals appears to be higher than that of MHH.

The HFIAS is a measure of a household's short-term food security status and includes subjective elements and strategies to address food shortages. Post-harvest, about 54% of households were mildly to severely food insecure, and this rose to 59% in the pre-harvest season. Post-harvest, FHH had higher HFIAS scores (indicating higher food insecurity) in all villages except Tsehafti, but in the pre-harvest season FHH had lower scores in three villages: the reasons for this are not obvious but may partly be an indication of reasonably assured availability of cereals through the PSNP, or of other local arrangements. Tsehafti was again the village with the highest level of food insecurity. Mahbere Genet was unusual in having higher food insecurity (measured by HFIAS) in the post-harvest season: this is likely to be linked to the more limited role played by agriculture in the livelihood system in this village.

Households use a variety of coping strategies to address food shortages: these were measured using the Coping Strategies Index (CSI). The mean CSI scores for the post- and pre-harvest seasons are 20.10 and 21.25, respectively and this difference was statistically significant. CSI scores were again highest in Tsehafti. There was no significant difference in coping strategies

used by FHH across villages and seasons, but there were significant differences for MHH. Households used various coping strategies: the most common were borrowing food or getting help from relatives, buying food with credit, consuming seed stock intended for the next farming season, and reducing meals for adults to protect consumption by small children. Borrowing or buying food and restricting adult consumption were much more widely used in the pre-harvest season than post-harvest when food is more generally available.

Generally the analysis of food security status according to different indicators found high levels of commonality between them: correlation analysis confirmed significant associations between the measures. Regression analysis also identified that location, TLU ownership and household income were significantly associated with the three indicators (HDDS, FCS and HFIAS). However, other factors were significantly associated with some but not all indicators, highlighting that they measure somewhat different aspects of food security: for example age of household head and landholding size significantly influence HDDS and HFIAS but not FCS; farm expenditure on crops significantly influences FCS but not HDDS and HFIAS. The education level of mothers was significantly and positively associated with better food security in the pre-harvest season according to all indicators: this provides support for the importance of the women's empowerment "pathway" to improved nutrition highlighted in agriculture-nutrition literature.

8.2.3. Pathways linking household livelihood systems and food and nutrition security

The "pathways" literature has identified a number of ways in which agriculture can influence nutrition. As noted above, women's empowerment is one such pathway. In relation to agricultural production, the main pathways are consumption from own-production and consumption using income generated from sales of agricultural produce. One of the questions arising is whether diversity in agricultural production has a positive impact on diversity in food consumption. These issues were addressed in the thesis.

Initially the extent of production diversity relative to consumption diversity was examined, including an analysis disaggregated by income quartiles and wealth groups. Almost all households produce grains and all consume them, but for other food commodities there is divergence between the proportion of households producing and consuming. For example, only about 6% of households produce dairy products, but 50% consume them in the post-harvest season and 36% in the pre-harvest season. Conversely, about 74% of households

produce poultry but 50% consume poultry post-harvest and 41% pre-harvest. Eggs are produced by 47% of households but consumed by only 30% post-harvest and 19% pre-harvest. It is evident that some food products which could be good sources of nutrition are quite likely instead to be sold as "cash crops". Although more households consume dairy products than produce them, the level of consumption is low, averaging almost 6 litres per household per month post-harvest and slightly below 5 litres pre-harvest. It is also notable that a smaller proportion of low income households consume food products with higher nutritional value (dairy products, meat, eggs, and fruit and vegetables).

A binary Probit regression model was used (following Romeo *et al*, 2016) in an attempt to identify whether the influence of individual farm practice on diet diversity worked primarily through an income effect or a production-for-own-consumption effect. The contribution to dietary diversity of pulses appeared to be primarily through an income effect. Sheep/goats and poultry appeared to contribute to dietary diversity both through own-consumption and through an income effect. Beekeeping (honey production) was positively and strongly associated with the consumption of milk and milk products, suggesting an income effect.

8.2.4. Household vulnerability to food and nutrition insecurity

Although south-eastern Tigray generally is characterised by low agricultural productivity, small land sizes and high levels of food insecurity, the study also found important differences between households, based on disaggregation into wealth groups and income quartiles, as well as between FHH and MHH. Farm and total incomes are highest in the better-off wealth group, although the poor wealth group has slightly higher total income than the middle group. A higher percentage of FHH are in the poor wealth group and lowest income quartiles than MHH.

In relation to food consumption, household wealth and income were found to have a significant influence on the food and nutrition security of households in the study: the proportion of households consuming dairy products, poultry, eggs and vitamin-A rich fruit and vegetables was significantly higher for high-income households, while poorer households consumed mainly energy-rich foods (carbohydrates).

Results of the food security indicators generally also show better food security status as wealth increases, and these results hold in both seasons. The same generally holds true (with some minor deviations for the second income quartile) when food security indicators are disaggregated by income group; the main exception is the CSI in the pre-harvest season where, although the scores between income quartiles are significantly different, there is no clear direction in these differences, suggesting that all households need to adopt coping strategies in this season. Regression analysis also indicated that the main components of household wealth (land and livestock) and household income are significantly associated with the food security indicators. It is also notable that education level of women is also significantly associated with food security in the pre-harvest season.

8.3. Recommendations and implications for policy and practice

The current agricultural production practice in Ethiopia focuses on maximization of production and productivity, particularly of cereals, with less focus on nutrition needs: this approach needs to be modified both in policy and in ground-level implementation (for example through the nature of extension advice provided). The findings of the study yield important insights that can inform policy makers interested in developing more nutrition-sensitive agriculture.

To improve the feeding culture of the households, it is necessary to incorporate nutrition education as part of the day to day agricultural and health extension packages and continuous education on appropriate feeding practices using, first, locally available foods and then introducing other nutrient-dense foods such as sweet potato and orange potato, which are proven micronutrient-rich tubers.

The achievement of food security and nutrition at household level requires a “comprehensive household-level food basket approach”, which can be effected by injecting efforts from all relevant directions; it has to involve a multi-sectoral approach and requires financial and human resources and the coordination of all stakeholders at all levels from village to the regional level, in the context of the study area. The responsibilities of actors in effecting this food basket approach could take the following shape:

Farmers could prepare land (in the homestead garden or on their main plots) in the dry season before activities of the main harvest season start, to plant diversified nutrient-dense crops,

particularly locally adaptable vegetable varieties such as quality protein maize, pumpkin, pulses and other local vegetables, which are rich in micronutrients and protein. Along with this, engaging in enhanced production of poultry and small ruminants would benefit households both for home consumption and to generate income for other food and non-food needs. These measures may partially address the seasonality of food and nutrition insecurity and contribute to offsetting the food security differences due to differences in income and gender of household head. Such measures would be facilitated if micro-irrigation or other methods of water harvesting could be extended in the study area: the potential for this needs to be further investigated.

Empowering women with control over resources and decision-making improves food and nutrition security of the household. Therefore, the Government of Tigray, the Tigray Bureau of Agriculture and Rural Development, Bureau of Water Resources Development, Office of Micro and Small Scale Enterprises, microfinance institutions and other pertinent government institutions should give attention to supporting women's empowerment activities. The measures may include promoting the production of poultry, fruits, vegetables, small ruminants and self-employment in the activities of their choice (through proper training and skill upgrading); promoting kitchen garden activities both for food and income generation with support from government and non-government organizations; capacity building training, demonstrations and field visits on improved crop and livestock husbandry, nutrition, home gardening and food preservation; and access to household-level small scale irrigation, improved seeds, access to credit and market information as well as integration.

The government and other organizations should mobilize and allocate more resources to improve and diversify crop and livestock production and livelihood sources. These include support for irrigation facilities; distribution of seeds of higher nutritive value from research institutes; providing effective extension services, encouraging cooperatives and credit to farmers; development of roads, cold storage (including identifying and improving of local practices); improvements to markets, market information and integration to facilitate food exchange; and expansion of other employment opportunities. Regular farmer-to-farmer extension activities (including demonstration and field visits) can be promoted for the exchange of knowledge, skill and practice.

The policy dimension is also important. There is a need to promote a multi-sectoral approach to improving nutrition, involving relevant sectors including agriculture. In addition to considering improved ways to design policy the government must be committed to implement the national nutrition programme and the 'Seqota Declaration'. In this regard, policy revision and effective implementation are needed to promote nutrition-sensitive production approaches, as opposed to the current focus on not production maximization of a few cereal crops. Further, consensus has to be reached that smallholder agriculture dominates and will continue to dominate. Thus, policy support to smallholders is necessary if they are to have access to a good basket of nutritious food for a productive life and development. There is a need also to coordinate line bureaus for more effective results building on and improving the existing system; but there has to be a focal body for this.

To improve the dietary culture of the households it is necessary to incorporate basic education on nutrition and appropriate feeding practices using locally available foods (as part of the day to day extension activities of the village agricultural and health extension workers). In addition the, Bureau of health and Bureau of Agriculture should design more applicable and effective training on nutrition, home gardening, food preservation, and water conservation to improve household availability and access to and utilization of locally available foods.

8.4. Contribution to the academic literature

The Thesis adds to the existing literature through an in-depth analysis of household-level agriculture, livelihood systems and nutrition linkages in a food-insecure and agriculture-dependent livelihood system in a specific rural part of Ethiopia, with an emphasis on household differentiation and seasonality. This is supported by close analysis of dimensions such as location of households, gender of household head and income. It also identifies the influence of specific individual farming practices on dietary diversity of households and it disaggregates the effects between through production for own consumption and income effects.

8.5. Limitations and future research

The study was confined to four villages in two districts of a food insecure area. It is reasonable to assume that findings can be generalised to other parts of Tigray and, to a lesser extent to similar agro-ecological and socio-economic settings elsewhere in Ethiopia and the

Horn of Africa. More comprehensive research, based on a wider range of conditions and larger sample sizes, would be required, however, for a more complete picture.

Dietary diversity of rural smallholder households may be influenced by other variables not included in the analysis. To better understand the evenness and adequacy of distribution of major food items consumed by the rural households within the framework of the selected variables, the Simpson index and Shannon index were used.

Despite the enormous data collected on various variables in two rounds there might be possible endogeneity concerns while analysing relationships between dependent and independent variables, as there could be decisions endogenously decided by individual households. While the OLS regression analyses control for confounding factors, there might be unconsidered variables affecting the degree of association between, for example, production diversity and dietary diversity.

For the purpose of the study, a 30-day recall was used, which might result in an over-estimate of dietary diversity. However, care was taken to collect the consumption data for the specified period to avoid possible distorting influences such as feast days. The use of 30-day recall may however reduce the scope to make valid comparisons between this study and studies from other areas.

The thesis tries to study the agriculture-nutrition linkage and nutrition security using proxy measures only. Nutrition outcomes of individual household members were not analysed directly as these need data on health issues and anthropometric measures.

Following from this study, future research may extend the analysis by looking in more detail at daily food consumption and probing more into other components that impact on nutrition, such as health status, drinking water, sanitation, cooking and caring practices. There is also a need to disaggregate households and focus on individuals within households, particularly differences between children and adults. Extending the research beyond production and consumption into the nutritional outcomes for individuals will require a multidisciplinary approach that combines proxy measures of food security (HDDS, FCS, HFIAS and CSI) with anthropometric and biometric measures to achieve a more complete picture of agriculture-

nutritional linkages and contribute to policies for achieving sustainable food and nutrition security for all.

To conclude, the main findings from the present study suggest that more research is required in the areas of the links between agricultural practices, livelihood systems and nutrition security of households and individuals taking account of particular socio-economic, agroecological, natural and physical settings, with particular reference to individual crop and livestock diversity versus dietary diversity, access to food, utilization and stability of consumption. This may help to better understand the main linkages between agriculture/livelihoods and nutrition.

9. REFERENCES

ADBG (African Development Bank Group) (2011). Federal Democratic Republic of Ethiopia: Country Strategy Paper 2011-2015, April 2011

Adenew, B. (2004). The Food Security Role of Agriculture in Ethiopia. e-Journal of Agricultural and Development Economics. www.fao.org/es/esa/eJADE. 1(1): 138-153

Adgo, E., Gebreselassie, Y., Tsegaye, A., Abate, S. and Ayele, A.A. (2014). Impact of Land Certification Sustainable Land Resource Management in the Amhara Region, Ethiopia. DCG Report No. 75

AgriDiet Project (2013). Conceptual Framework and Guidelines for Methodology. Version 4, July 2013 URL: http://agridiet.ucc.ie/2013/07/16/methodology-and-concept-frame-work-package-3/ [Accessed on October 20, 2013]

Ahmad, A.E., Imam, N.A. and Siddig, K.H.A. (2012). Women as a key to Agriculture and Food Security in Sudan: The Case Study of Northern Kordofan State. Journal of Agricultural Science and Technology

Andersson, C., Mekonnen, A. and Stage, J. (2011). Impacts of the Productive Safety Net Programme in Ethiopia on Livestock and Tree Holdings of Rural Households. Journal of Development Economics, 94: 119-126

Arimond, M., Hawkes, C., Ruel, M.T., Sifri, Z., Berti, P.R., Leroy, J.L. Low, J.W. Brown, L.R. and Frongillo, E.A. (2011). Agricultural interventions and nutrition: Lessons from the past and new evidence. In: Thompson, B. Amoroso, L. (Eds). Combating micronutrient deficiencies: Food-based approaches. FAO: Food and Agriculture Organization and CAB International

Arimond, M., Wiesmann, D., Becquey, E., Carriquiry, A., Daniels, M. C., Deitchler, M., and Torheim, L. E. (2010). Simple Food Group Diversity Indicators Predict Micronutrient Adequacy of Women's Diets in 5 Diverse, Resource Poor Settings. J Nutr 140 (11): 2059S-2069S. DOI: 10.3945/jn.110.123414

Azzari, C., Zezza, A., Haile, B. and Cross, E. (2015). Does livestock ownership affect animal source foods consumption and child nutritional status? Evidence from rural Uganda. The Journal of Development Studies. Routledge

Babu, S.C., Gajanan, S.N. and Sanyal, P. (2014). Food Security, Poverty, and Nutrition Policy Analysis: Statistical Methods and Applications. Second Edition. Elsevier Inc.

Barrett, C.B., Reardon, T. and Webb, P. (2001). Nonfarm income diversification and household livelihood strategies in rural Africa: Concepts, dynamics, and policy implications. Food Policy 26 (2001) 315-331

Benson, T. (2004). Africa's Food and Nutrition Security Situation: Where Are We and How Did We Get Here? IFPRI, Washington, D.C

Berhane, G., Dereje, M., Hoddinott, J., Koru, B., Nisrane, F., Tadesse, F., Taffesse, A.S., Worku, I. and Yohannes, Y. (2013). Agricultural Growth Programme (AGP) of Ethiopia: baseline Report 2011. Ethiopia Strategy Support Programme II. International Food Policy Research Institute (IFPRI)

Berjan, S., El Bilali, H., Sorajic, B., Driouech, N., Despotovic, A. and Simic, J. (2013). Off-Farm and Non-Farm Activities Development in Rural South-Eastern Bosnia. IJERD-International Journal of Environmental and Rural Development (2013) 4-1, p. 131

Berti, P.R., Krasevec, J. and FitzGerald, S. (2003). A Review of the Effectiveness of Agriculture Interventions in Improving Nutrition Outcomes. Public Health Nutrition: 7(5), 599-609. DOI: 10.1079/PHN2003595

Bhagowalia, P., Headey, D. and Kadiyala, S. (2012). Agriculture, Income, and Nutrition Linkages in India: Insights from a Nationally Representative Survey. IFPRI Discussion Paper 01195

Blackie, M. (2014). The role of agriculture in the nutrition of children. Paediatrics and International Child Health. Vol. 34, no. 4:289-294, DOI: 10.1179/2046905514Y.0000000146

BoFED (Bureau of Finance and Economic Development) of Tigray (2010). Tigray Regional State: Five Years (2010/11-2014/15) Growth and Transformation Plan. Mekelle, Ethiopia

Bogale, A. (2012). Vulnerability of Smallholder Rural Households to Food Insecurity in Eastern Ethiopia. Springer, 4: 581-591

Bouis, H.E. (2000). Improving Human Nutrition through Agriculture: The Role of Agricultural Research. Food and Nutrition Bulletin. Vol 21, Issue 4, 2000

Callens, K. and Seiffert, B. (2000). An Analysis of Constraints and Opportunities to Nutrition Security in Four Woredas in Northern Shoa and Southern Tigray. FAO, Government of Ethiopia and Belgian Survival Fund. Addis Ababa, Ethiopia

Carletto, C., Zezza, A. and Banerjee, R. (2013). Towards better measurement of household food security: Harmonizing indicators and the role of household surveys. Global food security 2 (2013): pp30-40

Carletto, G., Ruel, M., Winters, P. and Zezza, A. (2015). Farm-level pathways to Improve Nutritional Status: Introduction to the Special Issue. The Journal of Development Studies, 51:8,945-957, DOI: 10.1080/00220388.2015.1018908

Carney, D. (1998). Implementing the Sustainable Rural Livelihoods Approach. In: Carney, D. (Ed.). Sustainable Rural Livelihoods: What Contributions Can We Make? Department for International Development, London

CFS (Committee on World Food Security) (2012). Coming to Terms with Terminology: Food Security, Nutrition Security, Food Security and Nutrition and Food and Nutrition Security. CFS 2012/39/4. 39th Session. Rome, Italy, 15-20 October 2012

CFS (Committee on World Food Security) (2012). Investing in Smallholder Agriculture for Food and Nutrition Security. High Level of Panel of Experts on Food Security and Nutrition.

Chambers, R. (1988). Sustainable rural livelihoods: a key strategy for people, environment and development. In: Conroy, C. and Litvinoff, M. (Eds.). The Greening of Aid. London, Earthscan

Chambers, R. and Conway, G.R. (1991). Sustainable Rural Livelihoods: Practical Concepts for the 21st Century, Institute of Development Studies Discussion Papers, 296. Cambridge

Chung, K. (2012). An Introduction to Nutrition-Agriculture Linkages. MINAG/DE Research Report 72E. Maputo, Mozambique: Directorate of Economics, Ministry of Agriculture

Coates, J. (2013). Build It Back Better: Deconstructing Food Security for Improved Measurement and Action. Global Food Security 2 (2013): 188-194

Coates, J., Swindale, A. and Bilinsky, P. (2007). Household Food Insecurity Access Scale (HFIAS) for Measurement of Food Access: Indicator Guide (Version 3). Washington, D.C.: Food and Nutrition Technical Assistance Project, Academy for Educational Development

Collier, P. and Dercon, S. (2009). African Agriculture in 50 Years: Smallholders in a Rapidly Changing World. Expert Meeting on How to Feed the World in 2050. FAO, Economic and Social Development Department

Covarrubias, K. A. (2015). The Role of Crop Diversity in Household Production and Food Security in Uganda: A Gender-differentiated Analysis. FOODSECURE Working Paper no. 32

CSA (Central Statistical Agency) of Ethiopia (2014). Comprehensive Food Security and Vulnerability Analysis of Ethiopia. Ethiopia Central Statistical Agency and World Food Programme. **URL**: http://www.csa.gov.et and http://www.wfp.org/food-security/ [Accessed on February 23, 2016]

CSA (Central Statistical Agency) of Ethiopia (2015). Report on Area and Production of Crops. Addis Ababa

CSA (Central Statistical Agency) of Ethiopia and ICF (2016). Ethiopia Demographic and Health Survey 2016: Key Indicators Report. Addis Ababa, Ethiopia, and Rockville, Maryland, USA. CSA and ICF

CSA (Central Statistical Agency) of Ethiopia (2016). The Population of the Regions of Ethiopia: Census Results and Latest Official Projections. Addis Ababa

Deaton, A. (2011). The Financial Crisis and the Wellbeing of America. NBER Working Paper No. 17128. Cambridge

De Gramont, A. T., Gebre Egziabher, K., Dinku, S., Gebretsadik, S. and Bekele, T. (2007). Productive Safety Net Programme: PSNP Financial Agreement No 9351/ET Mid Term Evaluation: Draft Report, Addis Ababa, Ministry of Agriculture and Rural Development

Deitchler, M., Ballard, T., Swindale, A., Coates, J. (2010). Validation of a Measure of Household Hunger for Cross-cultural Use. Washington, DC: Food and Nutrition Technical Assistance II Project (FANTA-2), AED

de Janvry, A. and Sadoulet, E. (2010). Agricultural Growth and Poverty Reduction: Additional Evidence. The World Bank Research Observer. 25:1. DOI: 10.1093/wbro/lkp015

Dercon, S., Krishnan, P., 1998. Changes in Poverty in Rural Ethiopia 1989-1995: Measurement, Robustness Tests and Decomposition. CSAE Working Paper Series WPS/98.7. Centre for the Study of African Economies, Oxford

Devereux, S. (2009). Why Does Famine Persist in Africa? Food Security, Vol. 1, No. 1, pp. 25-35

Devereux, S. (2010). Dependency and Graduation: Frontiers of Social Protection. Regional Hunger and Vulnerability Programme. Brief No. 5, Johannesburg

Devereux, S. and Guenther, B. (2009). Agriculture and Social Protection in Ethiopia. Future Agricultures Consortium, Working Paper no. 08. Brighton, UK

Devereux, S. and Sharp, K. (2006). Trends in Poverty and Destitution in Wollo, Ethiopia, The Journal of Development Studies, 42:4, 592-610, DOI: 10.1080/00220380600681910

DFID (Department for International Development) (1999). Sustainable Livelihoods Guidance Sheets **URL**: http://www.livelihoodscentre.org/-/sustainable-livelihoods-guidance-sheets# [Accessed on May 18, 2013]

DFID (Department for International Development) (2000). Sustainable Livelihoods Guidance Sheets. London; DFID **URL**: http://www.livelihoods.org/info/info_guidancesheets.html [Accessed on May, 20, 2013]

Dillon, A., McGee, K. and Oseni, G. (2015). Agricultural Production, Dietary Diversity and Climate Variability. The Journal of Development Studies, 51:8, 976-995, DOI: 10.1080/00220388.2015.1018902

Dokken, T. (2013). Land Tenure in Tigray: How large is the Gender Bias? Centre for Land Tenure Studies. Norwegian University of Life Sciences. Working Paper 05/13

Doocy, S., Teferra, S., Norell, D. and Burnham, G. (2005). Credit Programme Outcomes: coping capacity and nutritional status in the food insecure context of Ethiopia. Elsevier Ltd. doi:10.1016/j.socscimed.2004.10.025. Social Science and Medicine 60 (2005), pp. 2371-2382

Dorosh, P.A. and Rashid, S. (2013). Food and Agriculture in Ethiopia. Progress and Policy Challenges. IFPRI issue brief 74

Dorp, M. van, C.H. Oenema and I.D. Verdonk (2011). Agriculture-Nutrition Linkages: Linking Agriculture and Food Security to Nutrition Improvement. Wageningen University Research Centre

Dorward, A., Anderson, S., Bernal, Y.N., Vera, S.E., Rushton, J., Pattison, J. and Paz, R. (2009). Hanging in, Stepping up and Stepping out: Livelihood Aspirations and Strategies of the Poor, Development in Practice, 19:2, 240-247, DOI: 10.1080/09614520802689535

Doss, C., Kovarik, C., Peterman, A., Quisumbing, A.R. and van den Bold, M. (2013). Gender Inequalities in Ownership and Control of Land in Africa. IFPRI Discussion Paper 01308

D'Souza, A. and Jolliffe, D. (2013). Conflict, Food Price Shocks, and Food Insecurity: The Experience of Afghan Households. Food Policy 42 (2013).pp 32-47

du Vachat, E. (2013). Showing the Seeds of Good Nutrition: Making agricultural policies deliver better nutrition. ACF. **URL:** www.actioncontrelafaim.org/en/content/seeds-of-good-nutrition [Accessed on July 2014]

Ecker, O. and Breisinger, C. (2012). The Food Security System: A New Conceptual Framework. IFPRI Discussion Paper 01166

Ecker, O., Breisinger, C. and Pauw, K. (2011). Reshaping Agriculture for Nutrition and Health: The Nexus between Agriculture and Nutrition: Growth is good but is not enough to Improve Nutrition, Chapter 6. International Food Policy Research Institute. Washington, DC

Ellis, F. (2000). Rural Livelihood and Diversity in Developing Countries. Oxford, Oxford University Press

Ellis, F. and Freeman, H.A. (2004). Rural Livelihoods and Poverty Reduction Strategies in Four African Countries. Journal of Development Studies, 40(4): 1-30

Engida, E., Tamru, S., Tsehaye, E., Debowicz, D., Dorosh, P. and Robinson, S. (2011). Ethiopia's Growth and Transformation Plan: A Computable General Equilibrium Analysis of Alternative Financing Options. Development Strategy and Governance Division, International Food Policy Research Institute (IFPRI)-Ethiopia Strategy Support Programme II. ESSP II Working Paper 30. IFPRI-EDRI. Addis Ababa, Ethiopia

EWOARD (Enderta Woreda Office of Agriculture and Rural Development) (2013). Enderta Woreda Annual Agriculture Report. Quiha, Tigray, Ethiopia

Fan, S. and Brzeska, J. (2012). Reshaping Agriculture for Nutrition and Health: The Nexus between Agriculture and Nutrition: Do Growth patterns and Conditional Factors matter, Chapter 4. International Food Policy Research Institute. Washington, DC

Fan, S. and Pandya-Lorch, R. (Eds.) (2012). Reshaping Agriculture for Nutrition and Health. International Food Policy Research Institute. Washington, DC

FAO (Food and Agriculture Organization) (1996). Agricultural and Farm Systems: Concepts and Definitions. **URL**: www.fao.org [Accessed on August 13, 2015]

FAO (Food and Agriculture Organization) (2011). Guidelines for Measuring Household and Individual Dietary Diversity. Food and Agriculture Organization of the United Nations, Rome. **URL**: http://www.fao.org/docrep/014/i1983e/i1983e00.pdf [Accessed on July 15, 2014]

FAO (Food and Agriculture Organization) and WFP (World Food Programme) (2012). Household Dietary Diversity Score and Food Consumption Score: A Joint Statement of FAO and WFP.

FAO (Food and Agriculture Organization) (2013). The State of Food and Agriculture Systems for Better Nutrition. Rome: Food and Agriculture Organization

FAO (Food and Agriculture Organization), WFP (World Food Programme) and IFAD (International Fund for Agricultural Development) (2013). The State of Food Insecurity in the World. Rome: FAO/WFP/IFAD

FAO (Food and Agriculture Organization) (2015). The State of Food Insecurity in the World 2015. Food Security and Nutrition: the Drivers of Change. Rome

FAO (Food and Agriculture Organization) (2016). Food security: concepts and measurement, Chapter 2. **URL**: http://www.fao.org/docrep/005/y4671e/y4671e06.htm# [Accessed on June 9, 2016]

FDRE (Federal Democratic Republic of Ethiopia) (2008). National Nutrition Strategy. Addis Ababa, Ethiopia

Flores-Martinez, A., Zanello, G., Shankar, B. and Poole, N. (2016). Reducing Anaemia Prevalence in Afghanistan: Socioeconomic Correlates and the Particular Role of Agricultural Assets. PLoS One, 11 (6): e0156878. DOI: 10.1371/journal.pone.0156878

Frankenberger, T. R. and. Goldstein, D. M. (1990). Food Security, Coping Strategies and Environmental Degradation. Office of Arid Land Studies, University of Arizona. Arid Lands Newsletter, Vol. 30, pp. 21-27

Garrett, J. and Ruel, M. (1999). Are determinants of rural and urban food security and nutritional status different? Some insights from Mozambique. World Development; 27:1955–75

Gebrehiwot, T. (2008). Rural Food Security in Tigray, Ethiopia: Policy Impact Evaluation. MSc Thesis. International Institute for Geo-information Science and Earth Observation, Enschede. Netherlands

Ghattas, H. (2014). Food Security and Nutrition in the Context of the Global Nutrition Transition. FAO, Rome

Gibson, R.S. (2014). Enhancing the Performance of Food-based Strategies to Improve Micronutrient Status and Associated Health Outcomes in Young Children from Poor-resource Households in Low-income Countries: Challenges and Solutions. In: Thompson, B. and Amoroso, L (Eds). Improving Diets and Nutrition: Food-based Approaches, Chapter 3. FAO: The Food and Agriculture Organization of the United Nations and CABI.

Gillespie, S. and Kadiyala, S. (2012). Reshaping Agriculture for Nutrition and Health: Exploring the Agriculture-Nutrition Disconnect in India, Chapter 20. International Food Policy Research Institute. Washington, DC

Girard, A.W., Self, J.L., McAuliffe, C. and Olude, O. (2012). The Effects of Household Food Production Strategies on the Health and Nutrition Outcomes of Women and Young Children: A Systematic Review. Paediatric and Perinatal Epidemiology, 2012, 26 Suppl. 1, 205-222

Godfray, H.C.J., Beddington, J.R., Crute, I.R., Haddad, L., Lawrence, D., Muir, J.F., Pretty, J., Robinson, S., Thomas, S.M. and Toulmin, C. (2010). Food Security: The Challenge of Feeding 9 Billion People. Science 327 (5967): 812-818, DOI: 10.1126/science.1185383

GoE (Government of Ethiopia) (2007). Livelihood Profile of Tigray Region, Ethiopia: Enderta Dry Midland Livelihood Zone. **URL**: http://www.dppc.gov.et/Livelihoods/Tigray/Tigray%20Livelihood%20Zone%20Reports/EDM.pdf [Accessed on February 20, 2016]

GoE (Government of Ethiopia) (2013). Cost of Hunger Summary Report for Ethiopia. Addis Ababa

GoE (Government of Ethiopia) (2015). S**c**aling up Nutrition: Ethiopia Commits to Ending Undernutrition by 2030 with the Seqota Declaration. **URL**: http://scalingupnutrition.org/news/ethiopia-commits-to-ending-under-nutrition-by-2030-with-the-seqota-declaration#.VrJTlrKLTIU [Accessed on July 16, 2016]

Greiner, T. (2014). Food-based Approaches for Combating Malnutrition-Lessons Lost? In: Thompson, B. and Amoroso, L (Eds). Improving Diets and Nutrition: Food-based Approaches, Chapter 4. FAO: The Food and Agriculture Organization of the United Nations and CABI.

Gross, R., Schoeneberger, H., Pfeifer, H. and Preuss, H.J.A. (2000). The Four Dimensions of Food and Nutrition Security: Definitions and Concepts. Nutrition and Food Security. FAO/EU/inwent

Haddad, L. (2000). A Conceptual Framework for Assessing Agriculture-Nutrition Linkages. Food and Nutrition Bulletin: Vol. 21, no. 4: 367-373

Haddad, L., Alderman, H., Appleton, S., Song, L. and Yohannes, Y. (2002). Reducing Child Undernutrition. FCND Discussion Papers 137, International Food Policy Research Institute, IFPRI

Haddad, L. (2013). From Nutrition Plus to Nutrition Driven: How to realize the elusive potential of agriculture for nutrition? Food and Nutrition Bulletin, Vol. 34, No. 1. The United Nations University

Hagos, F., Pender, J. and Gebreselassie, N. (1999). Land Degradation in the Highlands of Tigray and Strategies for Sustainable Land Management. Socio-economic and Policy Research Working Paper 25. ILRI (International Livestock Research Institute), Addis Ababa, Ethiopia

Hawkes, C. and Ruel, M. (2006). Understanding the Linkage between Agriculture and Health. IFPRI, Focus 13 **URL**: http://www.ifpri.org/publication/understanding-links-between-agriculture-and-health [Accessed on June 25, 2015]

Hawkes, C. and Ruel, M. (2008). From Agriculture to Nutrition: Pathways, Synergies and Outcomes. Agricultural and Rural Development. The World Bank. Issue 40. Washington, DC

Headey, D. (2012). Reshaping Agriculture for Nutrition and Health: Turning Economic Growth into Nutrition-Sensitive Growth, Chapter 5. International Food Policy Research Institute. Washington, DC

Headey, D. and Ecker, O. (2012). Improving the Measurement of Food Security. International Food Policy Research Institute. IFPRI Discussion Paper 1225

Hillbruner, C. and Egan, R. (2008). Seasonality, Household Food Security, and Nutritional Status in Dinajpur, Bangladesh. Food and Nutrition Bulletin, Vol. 29, no. 3, 2008, the United Nations University

Hirvonen, K. and Hoddinott, J. (2015). Agricultural Production and Children's Diets: Evidence from Rural Ethiopia. Ethiopia Strategy Support Program (ESSP). International Food Policy Research Institute. Working Paper 69

Hirvonen, K., Taffesse, A.S. and Worku, I. (2015). Seasonality and Household Diets in Ethiopia. Ethiopia Strategy Support Program. Working Paper 74. International Food and Policy Research Institute and Ethiopian Development Research Institute

Hoddinott, J. (2012). Reshaping Agriculture for Nutrition and Health: Agriculture, Health and Nutrition: Toward Conceptualizing the Linkages, Chapter 2. International Food Policy Research Institute. Washington, DC

Hoddinott, J., Headey, D. and Dereje, M. (2015). Cows, Missing Milk Markets, and Nutrition in Rural Ethiopia. The Journal of Development Studies, 51:8, 958-975, DOI: 10.1080/00220388.2015.1018903

Hoddinott, J. and Yohannes, Y. (2002). Dietary Diversity as a Food Security Indicator. Washington DC: International Food Policy Research Institute

Holden, S., Deininger, K. and Ghebru, H. (2011). Tenure Insecurity, Gender, Low Cost Land Certification and Land Rental Market Participation in Ethiopia. Journal of Development Studies 47: 31-47 DOI: 10.1080/00220381003706460

Hurni, H. (1998). Soil Conservation Research Programme, Agro-ecological Belts of Ethiopia: Explanatory notes on three maps at a scale of 1:1,000,000, Ethiopia research report. Centre for Development ad Environment, University of Berne, Switzerland in association with the Ministry of Agriculture. Ethiopia

HWWOARD (Hintalo-Wajerat Woreda Office of Agriculture and Rural Development) (2013). Hintalo-Wajerat Woreda Annual Agriculture Report. Adigudom, Tigray, Ethiopia

IFPRI (International Food Policy Research Institute) (2013). Agricultural Growth in Ethiopia (2004-2013): Evidence and Drivers. ESSP II Working Paper. IFPRI, Washington, DC

IFPRI (International Food Policy Research Institute) (2014). Global Nutrition Report 2014: Actions, Accountability to Accelerate the World's Progress on Nutrition. Washington, DC

IMF (International Monetary Fund) (2014). World Economic Outlook. **URL**: https://www.imf.org/external/pubs/ft/weo/2014/02/pdf/text.pdf

Iram, U. and Butt, M.S. (2004). Determinants of household food security: An empirical analysis for Pakistan. Int J Soc Econ; 31:753–66

Jackman, S. (2000). Models for Ordered Outcomes. Political Science 200C. Stanford URL: httpweb.stanford.educlasspolisci203ordered.pdf [Accessed on January 14, 2014]

Jaleta, M. and Gebremedhin, B. (2009). Price Cointegration Analyses of Food Crop Markets: The Case of Wheat and *Teff* Commodities in Northern Ethiopia. Paper prepared for presentation at the International Association of Agricultural Economists Conference, China, Beijing, August16-22, 2009

Juhar, E. B. (2012). Food Security and Vulnerability Analysis at Household Level: Case Study, Rural Areas of Tigray Region, Ethiopia, Thesis. Mekelle: MU. **URL:** http://opendocs.ids.ac.uk/opendocs/handle/123456789/4512 [Accessed on February 22, 2016]

Kabunga, N., Ghosh, S. and Griffiths, J.K. (2014). Can Smallholder Fruit and Vegetable Production Improve Household Food Security and Nutritional Status of Women? Evidence from Rural Uganda. IFPRI Discussion Paper 01346

Kazianga, H. and Udry, C. (2005). Consumption Smoothing? Livestock, Insurance and Drought in Rural Burkina Faso. Columbia University

Kennedy, E. and Bouis, H.E. (1993) Linkages between Agriculture and Nutrition: Implications for Policy and Research. IFPRI, Washington, D.C

Kennedy, G., Ballard, T. and Dop, M.C. (2013). Guidelines for Measuring Household and Individual Dietary Diversity. Nutrition and Consumer Protection Division, FAO

Kennedy, G., Berardo, A., Papavero, C., Horjus, P., Ballard, T., Dop, M., Delbaere, I. and Brouwer, I.D. (2010). Proxy Measures of Household Food Consumption for Food Security Assessment and Surveillance: Comparison of the Household Dietary Diversity and Food Consumption Scores. Public Health Nutrition, 13, pp 2010-2018

Kollmair, M. and Gamper, J. (2002). The Sustainable Livelihood Approach. Input paper for the Integrated Training Course of NCCR North-South. Development Study Group. University of Zurich

Kumar, N., Harris, J. and Rawat, R. (2015). If they Grow it, will they Eat and Grow? Evidence from Zambia on Agricultural Diversity and Child Undernutrition. The Journal of Development Studies, 51:8, 1060-1077, DOI: 10.1080/00220388.2015.1018901

Levine, S. (2014). How to Study Livelihoods: Bringing a Sustainable Livelihoods Framework to Life. Working Paper 22. Secure Livelihoods Research Consortium. Overseas Development Institute. London

Lewis, C.J. (2014). The Gender Informed Nutrition and Agriculture (GINA) Alliance and the Nutrition Collaborative Research Support Programme (NCRSP). In: Thompson, B. and Amoroso, L (Eds). Improving Diets and Nutrition: Food-based Approaches, Chapter 10. FAO: The Food and Agriculture Organization of the United Nations and CABI.

Lopus, S. (2012).You Eat What You Grow: Positive Links between Crop and Dietary Diversity in a Food-limited Community. University of California, Berkeley

Masset, E., Haddad, L., Cornelius, L. and Isaza-Castro, J. (2011). A Systematic Review of Agricultural Interventions that Aim to Improve Nutritional Status of Children. London: EPPI-centre, Social Science Research Unit, Institute of Education, University of London

Maxwell, D. and Caldwell, R. (2008). The Coping Strategies Index: Field Methods Manual. Second Edition

Maxwell, D., Caldwell, R. and Langworthy, M. (2008). Measuring Food Insecurity: Can an Indicator based on Localized Coping Behaviours be used to compare across contexts. Elsevier, Food Policy 33 (2008): 533-540

Maxwell, D. and Coates, J. (2014). How Do Indicators of Household Food Insecurity Measure Up? An Empirical Comparison from Ethiopia. Food Policy 47: 107-116. DOI: 10.1016/j.foodpol.2014.04.003

Maxwell, D., Coates, J. and Vaitla, B. (2013). How Do Different Indicators of Household Food Security Compare? Empirical Evidence from Tigray. Feinstein International Centre, Tufts University: Medford, USA

Maxwell, D., Vaitla, B. and Coates, J. (2014). How do Indicators of Household Food Insecurity Measure Up? An Empirical Comparison from Ethiopia. Food Policy 47: 107-116. Elsevier Ltd

Maxwell, D., Vaitla, B., Tesfay, G. and Abadi, N. (2013). Resilience, Food Security Dynamics, and Poverty Traps in Northern Ethiopia: Analysis of a Biannual Panel Dataset, 2011-2013. Feinstein International Centre

Maxwell, S. (1988). National food security planning: first thought from Sudan. Paper presented at a workshop on 'Food security in the Sudan', Brighton, Institute of Development Studies

Maxwell, S. (1991). To Cure all Hunger: Food Policy and Food Security in Sudan. London, Intermediate Technology Publications

Maxwell, S. (2001). Agricultural issues in Food Security. In: Devereux, S. and Maxwell, S. (Eds). Food Security in Sub-Saharan Africa. Bourton Hall, ITDG Publishing. London

Meerman, J. and Aphane, J. (2012). Impact of High Food Prices on Nutrition. Proceedings for FAO's Expert Consultation on Policy Reponses to High and Volatile Food Prices, held in November 2012. FAO Nutrition Division

Meinzen-Dick, R., Behrman, J., Menon, P. and Quisumbing, A. (2011). Gender: A Key Dimension Linking Agricultural Programs to Improved Nutrition and Health. Leveraging Agriculture for Improving Nutrition and Health. 2020 Conference Brief 9. IFPRI

MoARD (Ministry of Agriculture and Rural Development) of Ethiopia (2009). Food Security Programme 2010-2014. August 2009, Ministry of Agriculture and Rural Development, Addis Ababa

MoARD (Ministry of Agriculture and Rural Development) of Ethiopia (2013). Agricultural Growth Program (AGP). **URL**: http://ethioagp.org/agricultural-growth-program-agp/ [Accessed on July 10, 2015]

MoFED (Ministry of Finance and Economic Development) of Ethiopia (2002). Sustainable Development and Poverty Reduction Programme. Federal Democratic Republic of Ethiopia (FDRE), July 2002. Addis Ababa, Ethiopia

MoFED (Ministry of Finance and Economic Development) of Ethiopia (2007). Building on Progress: A Plan for Accelerated and Sustained Development to End Poverty (PASDEP), Annual Progress Report. Addis Ababa, Ethiopia

MoFED (Ministry of Finance and Economic Development) of Ethiopia (2010). Growth and Transformation Plan I: 2010/11-2014/15. Federal Democratic Republic of Ethiopia. Addis Ababa

MoFED (Ministry of Finance and Economic Development) of Ethiopia (2013). Performance Evaluation of the First Five Years Development Plan (2006-2010) and the Growth and Transformation Planning (GTP) for the Next Five Years (2011-2015). Addis Ababa

Muller, C. (2009). Do Agricultural Outputs of Partly Autarkic Peasants Affect their Health and Nutrition? Evidence from Rwanda. Food Policy, 34(2), 166-175. DOI: 10.1016/j.foodpol.200810.010

Njuki, J., J. Poole, N. Johnson, I. Baltenweck, P. Pali, Z. Lokman and S. Mburu. (2011) Gender, livestock and livelihood indicators. International Livestock Research Institute (ILRI)

Pinstrup-Andersen, P. (1981). Nutritional Consequences of Agricultural Projects: Conceptual Relationships and Assessment Approaches. World Bank Staff Working Paper No. 456

Pinstrup-Andersen, P. (2012). Guiding Food System Policies for Better Nutrition. Paper for the State of Food and Agriculture. Rome: Agriculture and Food Organization

Pinstrup-Andersen, P. (2014). Food Systems and Human Nutrition: Relationships and Policy Interventions. In: Thompson, B. and Amoroso, L (Eds). Improving Diets and Nutrition: Food-based Approaches, Chapter 2. FAO: The Food and Agriculture Organization of the United Nations and CABI.

Rajkumar, A.S., Gaukler, C. and Tilahun, J. (2012). Combatting Malnutrition in Ethiopia: An Evidence-Based Approach for Sustained Results. African Human Development Series. The World Bank. Washington, D.C.

Regassa, N. and Stoecker, B.J. (2011). Household Food Insecurity and Hunger among Households in Sidama District, Southern Ethiopia. Public Health Nutrition, 15:7, 1276-1283

Remans, R., Flynn, D.F.B., Declerck, F., Diru, W., Fanzo, J., Gaynor, K., Lambrecht, I., Mudiope, J., Mutuo, P.K., Nkhoma, P., Siriri, D., Sullivan, C. and Palm, C.A. (2011). Assessing Nutritional Diversity of Cropping Systems in African Villages. PLoS ONE 6(6)

Romeo, A., Meerman, J., Demeke, M., Scognamillo, A. and Asfaw, S. (2016). Linking farm diversification to household diet diversification: evidence from a sample of Kenyan ultra-poor farmers. Springer. DOI 10.1007/s12571-016-0617-3. Food Sec. (2016) 8:1069–1085

Ruel, M. (2010). Challenges and Successes in Linking Agriculture and Nutrition. IFPRI. London June 25, 2010

Ruel, M. T. and Alderman, H. (2013). Nutrition-sensitive Interventions and Programmes: How Can They Help to Accelerate Progress in Improving Maternal and Child Nutrition? The Lancet. 382: 536-551. The Maternal and Child Nutrition Study Group. DOI: 10.1016/S0140-6736(13)60843-0

Salami, A., Kamara, A.B. and Brixiova, Z. (2010). Smallholder Agriculture in East Africa: Trends, Constraints and Opportunities. Working Paper series no. 105. African Development Bank. Tunis, Tunisia

Save the Children (2008). The Household Economy Approach: A Guide for Programme Planners and Policy-makers. Save the Children (UK) and FEG Consulting. Biddles Ltd. ISBN 978 1 84187 1196

Savy, M., Martin-Prevel, Y., Traissac, P., Eymard-Duvernay, S. and Delpeuch, F. (2006). Dietary Diversity Scores and Nutritional Status of Women Change during the Seasonal Food Shortage in Rural Burkina Faso. The Journal of Nutrition, 136: 2625-2632

Scoones, I. (2009). Livelihoods perspectives and rural development. Journal of Peasant Studies, Vol. 36, No. 1, pp.171-196

Sen, A. (1981). Poverty and Famines: An Essay on Entitlement and Deprivation. **URL**: https://www.britannica/topic/Povery-and-Famines-An-Essay-on-Entitlement-and-Deprivation [Accessed on May 29, 2016]

Shannon, C.E. and Weaver, W. (1948). A Mathematical Theory of Communication. The Bell System Technical Journal, 27: 379-423

Sibhatu, K.T., Krishna, V.V. and Qaim, M. (2015). Production diversity and dietary diversity in smallholder farm households. PNAS, Vol. 112, 34: 10657-10662 [www.pnas.org/cgi/doi/10.1073/pnas.1510982112]

Simpson, E.H. (1949). Measurement of Diversity. Nature: 163, 688

Siyoum, A.D. (2012). Broken Promises. Food Security Interventions and Rural Livelihoods in Ethiopia. Thesis, Wageningen University, Wageningen, Netherlands

Slavchevska, V. (2015). Agricultural Production and the Nutritional Status of Family Members in Tanzania. The Journal of Development Studies, 51:8, 1016-1033, DOI: 10.1080/00220388.2015.1018906

Solomon, H. (2005). Socio-economic infrastructure of the Tigray Region, Department of Geography, Mekelle University (Unpublished)

SEZAO (South-eastern zone Administration Office) of Tigray Region (2013). South-eastern zone annual reports, 2010-2013. Mekelle. Ethiopia

Swindale, A. and Bilinsky, P. (2006). Household Dietary Diversity Score (HDDS) for Measurement of Household Food Access: Indicator Guide (Version 2). Washington, D.C.: Food and Nutrition Technical Assistance Project, Academy for Educational Development

TAMPA (Tigray Agricultural Marketing Promotion Agency) (2014). Monthly Average Retail Prices by Market. Mekelle, Tigray

Teshome, A. (2006). Agriculture, Growth and Poverty Reduction in Ethiopia: Policy Processes Around the New PRSP (PASDEP). Future Agriculture. Institute of Development Studies

TBoARD (Tigray Bureau of Agriculture and Rural Development) (2013). Regional Annual Report. Mekelle

TBoFED (Tigray Bureau of Finance and Economic Development) (2013). Regional Annual Reports, 2006-2013. Mekelle

Thompson, B. and Meerman, J. (2014). Towards Long-term Nutrition Security: The Role of Agriculture in Dietary Diversity. In: Thompson, B and Amoroso, L (Eds). Improving Diets and Nutrition: Food-based Approaches, Chapter 19. FAO: The Food and Agriculture Organization of the United Nations and CABI.

U.N. (1975). Report of the World Food Conference. Rome, 5-6 November 1974. New York, United Nations

Vaitla, B., Tesfay, G., Rounseville, M. and Maxwell, D. (2012). Resilience and Livelihood Changes in Tigray, Ethiopia. Feinstein International Center

Van der Veen, A., and Gebrehiwot, T. (2011). Effect of policy interventions on food security in Tigray, Northern Ethiopia. *Ecology and Society* 16(1): 18. [Online] **URL:** http://www.ecologyandsociety.org/vol16/iss1/art18/

Van Dijkhorst, H. (2011). Rural Realities between Crisis and Normality: Livelihood Strategies in Angola, 1975-2008. PhD Thesis, Wageningen University

Webb, P., Coates, J., Frangillo, E.A., Rogers, B. L., Swindale, A. and Bilinsky, P (2006). Measuring Household Food Insecurity: Why is it so Important and yet so Difficult to Do. The Journal of Nutrition 136: 1404S-1408S

Webb, P. and Kennedy, E. (2012). Impacts of Agriculture on Nutrition: Nature of the Evidence and Research Gaps. Nutrition CRSP Research Brief Number: 4

WFP (World Food Programme) (2008). Food Consumption Analysis: Calculation and Use of the Food Consumption Score. Rome: World Food Programme

WFP (World Food Programme) (2009). Comprehensive Food Security and Vulnerability Assessment. Rome: WFP

WFP (World Food Programme) (2012). WFP in Ethiopia 2012 Annual Report URL: https://www.wfp.org/.../WFP%20in%20Ethiopia%202012%20Annual%20Report.pdf [Accessed on January 26. 2014]

Wiesmann, D., Bassett, L., Benson, T. and Hoddinott, J. (2006). Validation of the World Food Programme's Food Consumption Score and Alternative Indicators of Household Food Security. Discussion Paper. IFPRI

Wiesmann, D., Arimond, M. and Loechi, C. (2009). Dietary Diversity as a Measure of the Micronutrient Adequacy of Women's Diets: Results from Rural Mozambique Site. Washington, DC: FANTA at FHI 360

Wiggins, S. and Keats, S. (2013). Smallholder Agriculture's Contribution to Better Nutrition. Overseas Development Institute. London

Woldenhanna, T. (2000). Economic analysis and policy implications of farm and off farm employment: a case study in the Tigray Region of Northern Ethiopia. Ph.D. thesis, Agricultural Economics and Rural Policy Group, Wageningen University, Holland, pp28-30

Woldehanna, T. (2004). The Experiences of Measuring and Monitoring Poverty in Ethiopia for the Inaugural Meeting of the Poverty Analysis and Data Initiative (PADI), held May 6-8, 2004 in Mombassa, Kenya. Addis Ababa Ethiopia

Woldehanna, T. (2014). The Policy Environment for Linking Agriculture and Nutrition in Ethiopia. AgriDiet Working Paper 2

World Bank (2007). From Agriculture to Nutrition: Pathways, Synergies, and Outcomes. Agriculture and Rural Development Department, World Bank. Washington, DC

World Bank (2012). Global Monitoring Report 2012: Food Prices, Nutrition, and the Millennium Development Goals. DOI: 10.1596/978-0-8213-9451-9

World Bank (2017). Agriculture and Rural Development. The World Bank. IBRD-IDA. **URL**: http://www.data.worldbank.org/topic/agriculture-and-rural-development. [Accessed on May 13.2017]

Appendix I: Household survey questionnaire

Household Code:

AGRICULTURE-NUTRITION HOUSEHOLD SURVEY: ETHIOPIA (2013/14)

AgriDiet Round 1

Woreda		
Tabia/Kebele		
Name of Respondent 1		
Name of Respondent 2		
Name of Interviewer		*Signature*
Date of Interview		
Checked by		*Signature*
Comments		

MODULE 1: DEMOGRAPHY AND ASSETS

Q1.1. Members of the Household

Include all household members that live in the household on a permanent basis, using the codes provided below

ID	Name	(1) Sex - *M* - *F*	(2) Age *(months or years)*	(3) Relation with HH Head (Code 3)	(4) Religion *Ortho. Muslim Alternat.*	(5) Marital Status Single Married Widowed Divorced/Separated	(6) Literacy level *(Code 6)*	(7) Major Occupt'n *(Code 7)*	(8) Member moving or migrat'n *(Tick for yes ✓)*	(9) Reason for moving or migrat'n. *(Code 9)*	(10) Vacc-ination. Card. *(Tick for yes ✓)*
01											
02											
03											
04											
05											
06											
07											
08											
09											
10											
11											
12											

Notes/Observations:

Code 3: Relationship with HH head Code Q6: Literacy level Code Q.7: Major occupation	Code Q6: Literacy level	Code Q7: Major occupation	Code Q9: Reason for Moving/Migration
1 Head	1 Illiterate	1 Agriculture/Farming	1 Education (High school/ College)
2 Wife/Husband/Partner	2 Read & Write - Grade: G1, G2,…, G10	2 Handicrafts	2 Search for job
3 Son/Daughter		3 Petty trading/Trading	3 Work
4 Step son/daughter	3 Preparatory	4 Labourer/Skilled-unskilled	4 To stay with relatives
5 Grandchild	4 Tech/Vocational	5 Natural resource extraction (stone, sand…)	5 Others (Specify…)
6 Father/Mother	5 College diploma & above	6 Civil servant	
7 Brother/Sister	6 Too young for school	7 Private sector/NGO	
8 Niece/Nephew		8 Paid Co-op/Kebele official	
9 Father/Mother-in-law		9 Police/Armed forces	
10 Sister/Brother-in-law		10 Pensioner (w. pension)	
11 Others (Specify)		11 Currently unemployed	
		12 Student/Underage	Note on Question 2 – Age For children less than 5 years of age, enter in months (i.e. 0-59m): E.g. 18m. For 5 years and above, enter years only: E.g. 6y
		13 Other activity (Specify)	

Q1.2. Homestead Buildings and Housing condition (Current)

Type of Building	Number of rooms	Quality of Building *1. Traditional (mud wall, thatch roof)* *2. Modern (Block walls, stone, iron roof)* *3. Improved modern (brick/plaster, tile roof)*
Human Dwelling		
Storage / Livestock shed		
Others (Specify) - -		

Q1.3. Agricultural equipment and other assets (2013/14 agriculture year)

Type of Asset	Tick ✓	Remark (Number)
1. Ox-plough (Set)		
2. Animal Cart		
3. Push cart (Wheelbarrow)		
4. Hoe		
5. Axe		
6. Spade / Shovel		
7. Common knife/'gejera'		
8. Water pump (hand, foot)		
9. Motorized water pump		
10. Pond/Hand-dug well		
11. Bicycle / Motorbike (specify)		
12. Truck/Tractor		
13. Improved stove, kerosene stove		
14. Cell phone (per household)		
15.Knapsack Sprayer		
16. Other (specify)		

Q1.4. Land holding during the last cropping/agriculture year (2013/14)

Land category	Land that is owned and used by the household						Only for Land that is rented out or rented in			
	Size / Area (Tsmdi)	Fertility of plot 1=Good, 2=Medium 3=Poor	Area Irrigated (if any in Tsmdi)	Who in the household owns the land? Male Female Both M&F	When did you obtain this land (year)? E.C.	How did you obtain this land? Transfer from parents or spouse Restitution Other	Who do you rent to/from FR = Female Relative MR= Male Relative OF= Other female OM= Other male	When did this land sharing arrangement begin (give year)?	Describe the tenancy arrangement? 1. Simple 50:50 share of harvest 2. 50:50 share of harvest and landowner provides inputs 3. 50:50 share of harvest and tenant provides inputs 4.Cash rental 5. Labour rental (no cash or sharing of harvest) 6. Other (describe)	Is your rental agreement: P = private RK= registered with the Kebele Office
1. Own cultivable land - Plot 1										
- Plot 2										
- Plot 3										
- Plot 4										
-Plot 5										
-Plot 6										
2. Rented-in / Borrowed land*										
3. Rented-out land*										
4. Home garden										

* If you get more than one, separate them by a comma

Q1.5. What documentation do you have regarding your own plots? 1. Blue card ___ 2. Yellow booklet ___ 3. Other (specify) _____ 4. No____

Q1.6. Who makes decisions about land in this household (including dealing with the land registration officials; renting-in and renting-out land, etc.):

Man Only: _____ 2. Woman Only: _____ 3. Man and Woman together: _____

Q1.7. Do you feel fully secure in your landholding: 1. Yes _____ 2. No_____
Say why:

Q1.8. Have you experienced any dispute over land/boundaries in the past five years?
1. With officials: _____2. With neighbours: _____ 3. With land owners or tenants _____4. No_____
Give details:

Q1.9. What land (if any) do you use for grazing /fodder (Tick all that apply and rank in order of importance):

Own grazing land	Own crop land	Communal Grazing	Other (e.g. cut-and-carry from excluded areas etc.)

Q1.10. How do you rate the quality/quantity of grazing in terms of the livestock feed availability? (Tick one) and why?

(1) Good	(2) Satisfactory	(3) Inadequate

Why_____
_____
_____
_____

MODULE 2: HOUSEHOLD ECONOMY

Q2.1. Crop Production and Disposal (2013/14 agriculture year)

Serial number	Crop(s) grown	Area allocated for each crop (Tsmdi)	When planted	When harvested	Intercrop 1=Yes; 0=No	Percent of area each under intercrop (e.g. 50: 50)	Quantity produced (Qt)	Quantity retained home for consumption (Qt)	Quantity Sold (Qt)	Average price/unit (Birr)	Quantity retained for seed (Qt/Kg)	In-kind payments (Qt)****	Gifts given (Qt)	Sale of by-products (Birr)	Remark
I	Cereals: e.g. 1.Teff 2. Wheat 3. Barley 4. Maize 5. Sorghum 6. Millet 7. Hanfets 8. Any other (Specify)														
1															
2															
3															
4															
II	Pulses: 1. Bean 2. Pea 3. Chickpea 4. Lentil 5. Groundnut 6. Vetch 7. Any other (Specify)														
1															
2															
3															
4															
III	Oil Seeds: 1. Linseed 2. Sesame 3. Sunflower 4. Niger seed 5. Any other (Specify). ...														
1															
2															
3															
4															

Q 2.1 (Continued)

Serial number	Crop(s) grown	Area allocated for each crop (Tsmdi)	Quantity produced (Qt)	Quantity consumed / retained at home (Qt)	Quantity Sold (Qt)	Average price/unit (Birr)	Remark
IV Vegetables: 1.Tomato 2. Potato 3. Pepper 4. Cabbage 5. Onion 6. Carrot 7. Lettuce 8. Sweet potato 9. Green Maize 10. Any other (Specify)...							
1							
2							
3							
4							
V Fruits: 1. Mango 2. Avocado 3. Papaya 4. Banana 5. Orange 6. Guava 7. Any other (Specify).....							
1							
2							
3							
4							
VI Non-Food and other crops: 1. Khat 2. Coffee 3. Animal forage 4.Hops 5.Eucalyptus 6. Condiments 7. Any other (Specify)...							
1							
2							
3							
4							

Q2.2. Input use (2013/14 agriculture year)

Serial number	Crop(s) grown	Labour Used			Ploughing		Seed		Fertilizer use		Manure/Compost		Pesticide/Herbicide		Remark: (Labour: land preparation, sowing, weeding and harvesting)
		Family (F) or Other (B)	Hired (H)	Hired Labour In Birr	Oxen Used (See Codes 1)	Cost in Birr	Quantity (Kg)	If purchased, share & price in Birr	Quantity (Kg)	In Birr	Quantity (Kg)	If purchased, share & price in Birr	Quantity (Kg/Lt)	In Birr	
I	Cereals: 1. Teff 2. Wheat 3. Barley 4. Maize 5. Sorghum 6. Millet 7. Hanfets 8. Any other (specify)														
1															
2															
3															
4															
Total for crop category (if preferred)															
II	Pulses: 1. Beans 2. Peas 3. Chickpea 4. Lentil 5. Groundnut 6. Vetch 7. any other (specify)....														
1															
2															
3															
4															
Total for crop category (if preferred)															
III	Oil Seeds: 1. Linseed 2. Sesame 3. Sun flower 4. Niger seed 5, Any other (specify)														
1															
2															
3															
4															
Total for crop category (if preferred)															

Ploughing codes: 1 = own oxen; 2 = shared/borrowed oxen; 3 = oxen swapped for labour; 4 = oxen hired for cash

Q2.2. Input use (continued.)

Serial number	Crop(s) grown	Labour Used			Ploughing		Seed		Fertilizer use		Manure/Compost		Pesticides/Herbicides		Remark: (Labour: land preparation, planting/sowing, irrigating, weeding and harvesting)
		Family (F) or other (B)	Hired Labour	In Birr if hired	Oxen Used (See Codes below)	Cost in Birr	Quantity (Kg)	If purchased, share & price In Birr	Quantity (Kg)	In Birr	Quantity (Kg)	If purchased, share & price In Birr	Quantity (Kg/Lt)	In Birr	
IV	Vegetables: 1. Tomato 2. Potato 3. Pepper 4. Cabbage 5. Onion 6. Carrot 7. Lettuce 8. Sweet potato 9. Any other (specify)														
1															
2															
3															
Total for crop category (if preferred)															
V	Fruits: 1. Mango 2. Avocado 3. Papaya 4. Banana 5. Orange 6. Guava 7. Any other(specify)														
1															
2															
3															
Total for crop category (if preferred)															
VI	Non-food and Other Crops: 1. Khat 2. Coffee 3. Animal forage 4. Hops 5. Eucalyptus 6. Condiments														
1															
2															
3															
Total for crop category (if preferred)															

Ploughing codes: 1 = own oxen; 2 = shared/borrowed oxen; 3 = oxen swapped for labour; 4 = oxen hired for cash

Q2.3. What influences your crop selection?

Q2.4. Who makes decisions for this household around crop production activities?

S. No.	Description/Activities	Particular decision made by:			Remark
		Man only	Woman only	Man & woman together	
1	Choice of crops				
2	Use of inputs				
3	Marketing of crop output				

Q2.5. Within your crop selection, what have you done to promote household nutrition in the last five years? Explain and give an example

Q 2.6: Livestock Production and Disposal (2013/14 agricultural year)

Livestock type	Current Number of Livestock	Number bought (or received as gifts) in past 12 months	No. of animals slaughtered for HHs use in past 12	Number sold in past 12 months (or given as gifts)	Income earned in past 12 months	Average total months milked per animal	Average daily milk yield per animal (litres)	Total Cost of Production (birr) in past 12 months					
								Feed \Fodder	Labour (hired)	Veterinary care	Artificial insemination	Salt	Others
I. Livestock type	1	2	3	4	5	6	7	8	9	10	11	12	13
Milking cows													
Trained oxen for ploughing													
Heifers													
Bulls													
Calves													
Goats													
Sheep													
Chicken													
Camel													
Donkey													
Horse/Mule													
Local Beehives- colony													
Modern Beehives- colony													
Total													
II. Livestock products Sold/exchanged in past 12 months (estimate)													
Eggs													
Honey													
Fresh Milk													
Butter / Cheese/Yoghurt													
Hide/ Skins													
Dung/Manure- wet/dried													
Others (Specify)													

Q2.7. Have your livestock been affected by any diseases in the past 12 months?

Type of Animal	Type of Disease	Source of Veterinary Service	Remarks

Q2.8. What influences your livestock selection (Mention the types)?

Q2.9. Within your livestock selection, could you tell me anything new you have done to promote nutrition in the last five years? Explain and give examples

Q2.10. Who makes decisions around livestock production activities?

S.No.	Description/Activities	Particular decision made by:				Remark
		1.Man only	2. Woman only	3. Man & woman together	4. Separately for different livestock	
1	Choice of livestock					
2	Use of inputs					
3	Marketing of livestock & products					

Give explanation if man and woman decide separately for different livestock, that is, choice 4: such as types of livestock:

_____

Q. 2.11. Credit in the past year

Source	Purpose of loan	Who took the loan (ID)?	Amount (in Birr)	Repayment conditions		
				Amount and Frequency	Duration	Amount Repaid

Q2.12. Give details of any cash savings you have made in the past year

Where was the money saved?	Total amount saved in the last 12 months (in Birr)	Purpose of saving? *(More than one response is possible)*	Whose name is on the account? (put ID)

Q2.13. Extension and animal health services

Issue	Training or information received during the last 12 months (Tick for yes)	Who received the service? - Male only - Female only - Both male and female	Rating of the service 4 = Very good; 3 = Good; 2 = Fair; 1 = Poor
No contact; Say why?			
New variety crops			
Field pest & disease control			
Soil & water conservation			
Soil fertility management (e.g. Crop rotation, Minimum tillage, Leaving crop residue in the field)			
Adaptation to climate change			
Irrigation			
Crop storage			
Markets & prices			
Collective action/ Farmer organization			
Livestock production			
Tree planting / Agroforestry			

Q2.14. What has been then main influence of extension services on your crop and animal production and marketing (in recent memory)?
Crop production:
Livestock production:
Marketing:

Q2.15. What are the major challenges in accessing agricultural services and supplies in your area?

Q2.16. Are you (i.e. your household) a member of a service cooperatives in your area?
Yes/No
If 'Yes', Specify name, type of organisation(s):
Who is a member: 1. Male only: ____ 2. Female only: ____ 3. Both Male and Female: ____

What services do you access?

Q2.17. Where do you obtain your inputs, and how long does it take in minutes (single trip)?
Place:
Time it takes you in minutes (Single trip):

Q2.18. What is your main market for crops?

Crop type	Location of Market	When sold?	Means of transport (See Code)	Who sells?	Remarks (put * if rare event)
1.					
2.					
3.					

Code: 1. Carried 2. Pack animal 3. Animal cart 4. Motor bike/Bajaj 5. Truck 6. Any other (specify)

Q2.19. What is your main market for livestock and livestock products?

Type	Location of Market	When sold?	Who sells?	Remarks (put * if rare event)
1.				
2.				
3.				
4.				
5.				

Q2.20. Have you or your household members participated in/attended any public meetings or organisations in the past year, and who attended (exclude purely religious or family occasions):

Name/Type of organisation	Purpose of meeting	Who attended? - Male only - Female only - Both male and female	Did you speak or contribute? Yes/No	Do you have a position e.g. on the committee? Describe.

Module 3: Off-farm Employment & Other Sources of Income

Q3.1 EMPLOYMENT: Participation in off/non-farm employment and the income earned during the last 12 months

1. Person who worked (ID)?	2. Type of Employment / name of programme (Code1)	3. Total no. of days worked per month (average)	4. Total no. of months worked in the past year	5. Cash Wage in Birr (specify per day or month)	6. Wage in kind - e.g. kg of grain per day

Code 1*:* 1. *Full-time job;* 2. *Food for work programme (FFW);* 3. *Daily labourer (hire-out labour);* 4.*Cash for work programme (CFW);* 5. *Part-time job;* 6. *Others (specify)*

Q3.2. What influenced your participation in off-farm/non-farm income generating activity? If not, why not?

_____

_____

_____

Q3.3 TRANSFERS: Cash and other benefits transferred to the household from the government or private sources (not as a result of employment)

Category	From Whom:	Why did you get/ receive it	How often did you get it (E.g. twice a year)	Amount (in cash or kind) – month or year
Remittance income				
Food aid				
Gov't transfers (pension, compensation, etc.)				
Assistance from relatives/Neighbours				
Renting out land				
Other (Specify)				

Q3.4: SELF EMPLOYMENT

Category	Who is involved (ID)?	Description of Activity	Amount earned (Birr per month)
Sale of handicraft			
Sale of natural resources			
Hiring out oxen for ploughing			
Sale of beverages			
Khat trading			
Other			

Q3.5: Who controls (makes decisions about) income that comes in to the household from the above sources?
Male only: _____ 2. Female Only: _____ 3. Both Male and Female together: _____ 4. Separately depending on the circumstances _____ Explain: _____

Q3.6. What are the barriers to greater participation in off-farm activities?
_____
_____
_____

Module 4: Household Consumption

Q4.1: Cereals consumed during the last 30 days

Item	Quantity of food consumed in the last 30 days & breakdown of sources					
	Total (Kg)	From own produce (Kg)	Purchased		Gift/ Borrowed (Kg)	Transfers/Aid (Kg)
			Kg	Unit Price (Birr)		
1.Teff						
2. Wheat						
3. Barley						
4. Maize						
5. Sorghum						
6. Millet						
7. Hanfets						
8. Rice						
9. Others (Specify)						
Processed:						
Wheat flour						
Maize flour						
Sorghum flour						
Bread						
Pasta						
Other (specify) -						

Q4.2: Pulses consumed during the last 30 days

Item	Quantity of food consumed in the last 30 days & breakdown of sources					
	Total consumed (Kg)	From own produce (Kg)	Purchased		Gift/ Borrowed (Kg)	Transfers/ Aid (Kg)
			(Kg)	Unit Price (Birr)		
1. Bean						
2. Pea						
3. Chick pea						
4. Lentil						
5. Linseed						
6. Ground nut						
7. Sesame						
8. Sun flower						
9. Vetch						
10. Others						
Processed:						
1. ‘Shiro’						
2. Abish(Pulse)						
3. ‘Berberie’						
Condiment/spices:						
Other (specify - -						

Q4.3: Vegetable/Fruits consumed during the last 30 days (Choose from the list below)

Item (use code1)	Quantity of food consumed in the last 30 days & breakdown of sources					
	Total consumed (Kg)	From own produce (Kg)	Purchased		Gift/ Borrowed (Kg)	Transfers /Aid (Kg)
			Kg	Unit Price (Birr)		

Code1: 1.Tomato 2. Potato 3. Pepper 4.Cabbage 5. Onion 6. Carrot 7.Lettuce 8. Sweet potato 9. Mango 10. Avocado 11.Papaya 12.Banana 13.Orange 14.Guava, 15. Others (Specify)

Q4.4: Livestock and livestock products consumed during the last 30 days

Item	Quantity of food consumed in the last 30 days & breakdown of sources					
	Total consumed (Kg/Lt)	From own produce (Kg/Lt)	Purchased		Gift/ Borrowed (Kg/Lt)	Transfers /Aid (Kg/Lt)
			Kg /Lt	Unit Price (Birr)		
1. Beef						
2. Mutton (kg or head)						
3. Goat (kg or head)						
4. Chicken (Number)						
5. Egg (Number)						
6. Milk						
7. Yoghurt/Cheese						
8. Butter						
9. Others (Specify) -						

Q4.5: Other food items consumed during the last 30 days

Item	Quantity of food consumed in the last 30 days & breakdown of sources					
	Total consumed (Kg/Lt)	From own produce (Kg/Lt)	Purchased		Gift/ Borrowed(Kg/Lt)	Transfers/Aid (Kg/Lt)
			(Kg/Lt)	Unit Price (Birr)		
1. Cooking oil						
2. Soft drink						
3. Sugar						
4. Salt						
5. Others (Specify) -						

Q4.6. Who makes decisions around how food is served and consumed in this household?

S. No.	Description	Decision made by:			
		Male only	Female only	Male & female together	Others (Specify)
1	Types of foods served				
2	Frequency of serving				
3	Quantities served				
4	Allocation of food to individuals				
5	Skipping meals				

Explain: _____
_____

Module 5: Food Frequency, Food Security and Coping Mechanisms

Q5.1 FOOD FREQUENCY: How often have the following foods been served in your household over the past 30 days?

	Food type	Examples	Frequency of serving - per month
1	CEREALS	corn/maize, rice, wheat, teff, sorghum, millet or any other grains or foods made from these (e.g. bread, noodles, porridge or other grain products)	
2	WHITE ROOTS AND TUBERS	white potatoes, white yam, or other foods made from roots	
3	VITAMIN A RICH VEGETABLES AND TUBERS	pumpkin, carrot, squash, or sweet potato that are orange inside + other locally available vitamin A rich vegetables (e.g. red sweet pepper)	
4	DARK GREEN LEAFY VEGETABLES	dark green leafy vegetables, including wild forms + locally available vitamin A rich leaves such as spinach	
5	OTHER VEGETABLES	other vegetables (e.g. tomato, onion) + other locally available vegetables	
6	VITAMIN A RICH FRUITS	ripe mango (fresh or dried), ripe papaya and 100% fruit juice made from these + *other locally available vitamin A rich fruits*	
7	OTHER FRUITS	other fruits, including wild fruits and 100% fruit juice made from these	
8	ORGAN MEAT	liver, kidney, heart or other organ meats or blood-based foods	
9	FLESH MEATS	beef, lamb, goat, chicken, other birds	
10	EGGS	eggs from chicken etc.	
11	FISH AND SEAFOOD	fresh or dried fish	
12	LEGUMES, NUTS AND SEEDS	dried beans, dried peas, lentils, nuts, seeds or foods made from these (e.g. peanut butter)	
13	MILK AND MILK PRODUCTS	milk, cheese, yogurt or other milk products	
14	OILS AND FATS	oil, fats or butter added to food or used for cooking	
15	SWEETS	sugar, honey, soft drinks, sweets	
16	SPICES, , BEVERAGES	spices (black pepper, salt), condiments (soy sauce, hot sauce), coffee, tea, alcohol	
17	Other	Specify	

Q5.2. Did your household face food shortages during the last 12 months, and for how many months?
Number of months (1-12): _____ No shortage: _____

Q5.3. If you experienced a food shortage, when was the shortage most serious in the household?

Kiremt (June-August) ____ (2) *Meher* (September-November) ____

Bega (December-February) ____ (4) *Tsedey* (March-May) ____

Q5.4. How was the food situation compared this year to that of previous years?

Better _____ Worse _____ Same _____
Why? (Explain):

Q5.5. Did you experience any major shocks to your livelihood or food availability in the past 5 years? Yes_____ No_____

If Yes, what were the shocks and your major responses?

Description of shock or food shortage:

Your response to the shocks (E.g. sale of assets, migration of a member, credit, etc.):

Q5.6. Household Food Insecurity Access Scale

For each of the following questions, consider whether they have happened in the past 30 days using locally specific terminology.

No.	Question	Never (in last 30 days)	Rarely (once or twice in 30 days)	Some-times (3-10 times)	Often (more than 10 times)
	In the past 30 days, did you worry that your household would not have enough food?				
	In the past 30 days, did it happen that you or any household member were not able to eat the kinds of foods you would have preferred to eat because of lack of resources?				
	In the past 30 days, did it happen that you or any household member had to eat a limited variety of foods because of lack of resources?				
	In the past 30 days did it happen that you or any household member had to eat some foods that you really did not want to eat because of lack of resources?				
	In the past 30 days did it happen that you or any household member had to eat a smaller meal than you felt you needed because there was not enough food?				
	In the past 30 days did it happen that you or any household member had to eat fewer meals in a day because there was not enough food?				
	In the past 30 days did it happen that there was no food to eat of any kind in your house, because of lack of resources to get food?				
	If yes, ask respondent to describe				
	In the past 30 days did it happen that you or any household member went to sleep at night hungry because there was not enough food?				
	If yes, ask respondent to describe				
	"In the past 30 days did it happen that you or any household member went a whole day and night without eating anything at all because there was not enough food?"				
	If yes, ask respondent to describe				

Q5.7. Coping Strategies/Mechanisms and Related

Question *If there have been times in the past 30 days when you did not have enough food or enough money to buy food, has your household had to. .*		Never	Rarely (less than once a week)l	Some-times (1-2 times a week)	Often (3-6 times a week)	Always (every day)
1	Borrow food, or rely on help from a relative?					
2	Purchase food on credit?					
3	Gather wild foods, gather "famine foods," hunt, or harvest immature crops?					
4	Consume seed stock that will be needed for next season?					
5	Send household members to eat elsewhere?					
6	Send household members to beg?					
7	Restrict consumption by adults in order for small children to eat?					

Q5.8. Is there any major changes in diet or feeding practices in the past three years?
Name them:

_____

_____

No change _____

Q.5.9. Self-assessment of current food security status: How do you view your food security over the next 3-6 months?
1. Worrying_____ 2. Uncertain_____3. Safe_____4. Good_____

Why? _____

_____

_____

Module 6: Health Status and Facilities

Q.6.1. Did any member of the household suffer any kind of illness, injury or disability during the last 12 months?

Member ID	What was the illness / disability?	Is the person still suffering *Tick for yes* ✓	Was medical help obtained? *0 – no treatment;* *1 = traditional healer; 2 = clinic;* *3 = hospital*

Q6. 2. What is the main source of drinking-water for members of your household? (Tick ✓)

Piped water into dwelling		Unprotected spring	
Piped water to yard/plot		Rainwater collection	
Public tap/stand pipe		Bottled water	
Tube well/borehole		Cart with small tank/drum	
Protected dug well		Tanker-truck	
Unprotected dug well		Surface water (river, dam, lake, pond, stream, canal, irrigation channels)	
Protected spring		Other (specify)	

Q6.3. What is the main source of water used by your household for other purposes, such as cooking and hand washing? (Tick ✓)

Piped water into dwelling		Tanker-truck	
Piped water to yard/plot		Unprotected spring	
Public tap/standpipe		Rainwater collection	
Tubewell/borehole		Bottled water	
Protected dug well		Surface water (river, dam, lake, pond, stream, canal, irrigation channels)	
Unprotected dug well		Other (specify)	
Protected spring			

Q6.4. How long does it take to go there, get water, and come back?

Water on premises	
No. of minutes (round trip)	
Don’t Know	

Q6.5. Who usually goes to this source to fetch the water for your household?

Adult woman	
Adult man	
Female child (under 15 years)	
Male child (under 15 years)	
Don't Know	

Q6.6. Do you treat your water in any way to make it safer to drink?

Yes	
No	
DK (Do not Know)	

If the answer for question Q6.6 is No proceed to Q6.8

Q6.7. What do you usually do to the water to make it safer to drink?

Boil	
Add bleach/chlorine	
Strain it through a cloth	
Use a water filter (ceramic, sand, composite, etc.)	
Solar disinfection	
Let it stand and settle	
Other (specify)	

Q6.8. What kind of toilet facility do members of your household usually use?

Flush/pour flush toilet	
Ventilated improved pit latrine (VIP)	
Pit latrine with slab	
Pit latrine without slab/open pit	
Composting toilet	
Bucket	
Hanging toilet/hanging latrine	
No facilities or bush or field	
Other (specify)	

Q6.9. Do you share this facility with other households?

Yes	
No	

If the answer for question 6.9 is No proceed to Q6.11

Q6. 10. How many households use this toilet facility?

How many other households share this toilet?	
Can any member of the public use this toilet?	
Don't know	

Q6.11. The last time [name of youngest child) passed stools, what was done to dispose of the stools?

Child used toilet/latrine	
Put/rinsed into toilet or latrine	
Put/rinsed into drain or ditch	
Thrown into garbage	
Buried	
Left in the open	
Other (specify)	
Do not Know	

Q6.12. In the past 12 months, have you received training or information from the health extension worker on the following *(tick for yes ✓)*

Safe sources of drinking water	
Safe handling of drinking water in the home	
Use of Latrines/Sanitation	
Hand washing	
Disease control / prevention	
Food storage	
Food preparation	
Household Waste Disposal	
Advice on nutrition / food choices	

Q6.13. How many visits were there from health extension officers in the past 12 months?
Never: _____
Number: _____

Q.6.14. What is the main source of fuel for cooking? _____

Q.6.15. Where is fuel sourced/gathered?_____

Q6.16. By whom is fuel gathered?_____

Q6.17. Time spent gathering fuel (specify frequency)?_____

Q6.18.Where is cooking done: - Main dwelling house_____
- In a separate room _____
- Outdoors _____
Q6.19. Do you keep livestock in the living house? Yes/No_____

Q6.20. Does your family participate in any feeding or supplement programmes – e.g. School meals, Vit-A, Iodine, Iron- in the last 12 months? Give details:-

THANK YOU FOR YOUR COOPERATION!!!

Appendix II: Focus Group Discussion (FGD) questions: Households

A. Agriculture-nutrition linkage and Decision making:
1. The key agriculture decisions and challenges
2. Agriculture's effect on nutrition and barriers to nutrition as perceived by households
3. Food consumption and food taboos in the area
4. Differences in decisions on food production, purchase and consumption made by FHH and MHH
5. Role of women in production, consumption, income control and decision
6. Shocks faced and their effects on food consumption
7. Food consumption pattern between a pre-harvest season and immediately after harvest
8. On land ownership, use right and fertility improvement

B. Off/Non-farm Related issues
1. Contribution of off/non-farm activities, including PSNP, to food security and maintaining/improving livelihoods and factors influencing participation

C. Consumption/nutrition and copping strategies
1. Feeding practices and priorities in the area (for infants, young children, lactating mothers, men and women)
2. Foods commonly consumed in the area and reasons
3. Coping strategies of the community during food shortage
4. Community understanding of nutrition

Appendix III: Key Informant Interview (KII) questions: Agriculture and health DAs and village officials
1. The understanding of good nutrition in the area and this in terms of children, men and women and the change over time
2. What are your views about how much agriculture is doing at the moment for nutrition and should do for nutrition in the future?
3. Opinions to making agriculture more pro-nutrition
4. Performance of the local market on food availability and prices and changes during the year
5. Problems farmers face in terms of production, consumption and marketing
6. Issues of land security and use right
7. Nutrition interventions in the last five years

Appendix IV: Selected photos that describe respondent households and part of the study villages

Photo 1: Part of Andi Woyane village

Photo 2: Soil and Water Conservation activities

Photo 3: A living house in the study area

Photo 4: Respondent household

Photo 5: Livestock owned by households

Photo 6: A female head of HH in her garden

Appendix V: Approval letters for data collection

(1) Letter from Mekelle University to district offices

መቐለ ዩኒቨርሲቲ
Mekelle University

ቁጥር
Ref. CDANR/1270/2005
ቀን
Date: 21/12/2005

College of Dryland Agriculture and Natural Resources

Dean Office

CDANR

ህፀተ ዝናብ ግብርናና ተፈጥሮ ሃብት ኮሌጅ

ዲን ጽ/ቤት

ለሕንጣሎ ዋጃራት ወረዳ አስተዳደር ፅ/ቤት
ለሕንጣሎ ዋጃራት ወረዳ ግብርነና ፅ/ቤት
ዓዲጉዶም

ጉዳዩ፡ መረጃ መጠየቅን ይመለከታል ፡፡

በመቐለ ዩኒቨርስቲ የህፀተ ዝናብ ግብርናና ተፈጥሮ ሃብት ኮሌጅ ባልደረባ የሆኑት አቶ ዘነበ አብርሃ በግብርናና ኑትረሽን ዙሪያ በእንደርታና ሕንጣሎ ወጃራት ወረዳዎች የተመረጡ ሳይቶች ጥናት ሰለሚያካሂዱ ለዚህ ጥናት የሚሆን መረጃ በመስጠት የተለመደ ትብብራችሁ እንድታደረጉላቸው እየጠየቅን ለሚደረግላቸው ሁሉ በቅድሚያ እናመሰግናለን፡፡

ከሰላምታ ጋር

አትንኩት መዝገቡ (ዶክ.)
ዲን
Atinkut Mezgebu (PhD
Dean

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(2) Letter from district offices to sector offices

ኣብ ብሄራዊ ክልላዊ መንግስቲ ትግራይ ቤት ፅሕፈት ምምሕዳር ወረዳ እንደርታ
The Governmet of The national State of Tigray
Enderta Wereda Administration Office

ቁፅሪ(Reff.No)እወም/02/ቅ702 / 8-1
ዕለት(Date21/12/05

ናብ ቤት ፅሕፈት ጥዕና ወረዳ እንደርታ

ከሪሓ

ዋኒኑ፡- መፅናዕቲ ዘካይዱ ምትሕብባር ይምልከት

መቐለ ዩኒቨርሲቲ ኣብ ወረዳና ዝተመረፃ ጣቢያታት መፅናዕቲ ኣብ ሕርሻን ስነ መዓዛን ከካይዱ ስለዝደለዩ ነቲ መፅናዕቲ ዘካይዱኣካላት ካብ ቤት ፅሕፈትኩም ዝደልዩዎ መረዳእታ ብምሃብ ኣድላዪ ምትሕብባር ክትገብሩሎም ነተሓሳስብ።

ምስ ሰላምታ

ተፈሪ ወዳጅ

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