Analysing the trajectories of maize-based farming systems using participatory methods in Hawassa area, Ethiopia

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August 2014

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Credits: 36 ECTS

BFS-80436

MSc Thesis Farming System Ecology

January - August 2014

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Preface

This report is the result of my thesis research on which I have been working from January 2014 for the last 6 months. I learned and enjoyed a lot working on the topic. Many people helped me and contributed to this work. Therefore, I would like to acknowledge the following people.

First of all I would like to express my sincere gratitude to my supervisors: Dr. Ir. Felix Bianchi, Ms. Yodit Kebede and Dr. Ir. Sietze Vellema for their inspiration, helpful comments, intensive guidance and professional expertise, which made this work possible. In addition, I am grateful for Ir. Erika Speelman and Ir. Stephanie Alvarez for their very valuable contribution to the completion of my thesis.

I would like to use this opportunity to thank peoples of Wondo Genet, Tula and Hawassa Zuria for their interest, patience and time to share their past and present farming history. Moreover, I am thankful for agricultural extension officers of Hawassa Zuria, Tula and Wondo Genet districts, particularly, to Mr. Amsal Worku agricultural development agent in Hawassa Zuria district for his support by translating the local language and introducing me with the culture of the region. That was an unforgettable time in my life that I enjoyed and shared the culture of Sidama people during my stay with my family in Hawassa.

I owe special thanks to all my family for their constant and tremendous support and encouragement for my success in this program and my life.

Last but not least, I would like to thank my study advisor Dr. Ir. Cor Langeveld for his continuous encouragement in this study program. Furthermore, I would like to thank Farming System Ecology Group at Wageningen University for funding this research and the Netherland Government through Nuffic for awarding me a fellowship program to attend this program.

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Acronyms

ADLI Agricultural Development Led Industrialization

CSA Central Statistical Agency

DA Development Agents

Derg A military Junta that administered Ethiopia between 1974 and 1991

EPRDF Ethiopian People Revolutionary Democratic Front, A Political Party that has ruled Ethiopia since 1991

FGD Focus Group Discussion

FTC Farmers Training Centre

PA Peasant Association (lower level government administrative structure)

PCA Principal Component Analysis

SNNPR Southern Nation Nationalities and Peoples Region

TLU Tropical Livestock Unit

Abstarct

An understanding of the past and the current trajectories of farming systems are the base to design more sustainable agro-ecosystem and better inform sustainable agricultural intensification research. The aim of this study was to identify the trajectories of maize based farming systems by assessing changes to farming system and identifying the drivers that are accountable for these changes in Hawassa area, Ethiopia. Farming system trajectory analysis was conducted using participatory methods in three districts in Hawassa area, characterised by different level of landscape diversity gradients. Farming system changes were defined using sketch maps drawn by key informants and life story interview of individual farmers through informal and focus group discussions and life history interviews for three time periods: (i) prior to 1974, (ii) 1975-1991 and (iii) post 1991. Principal component and cluster analysis of socioeconomic and market access indicator variables was used to identify three-broad groups of farming system trajectories that present in each landscape. The trajectories constitute a group of farms with similar trends of change with regards to resource endowment, production orientation and dominant crop production. The sketches revealed the expansion of arable lands and residential areas, paralleled with eventual disappearance and conversion of natural forest and grazing lands post-1991, resulting drastic decline in the number of livestock in the area. Farm household income source ranges from crop-livestock production to off-farm activities. The production orientation of the area was reduced in the current time, which is attributed to decrease in the universal annual food crop area share and increased perennial cash and food crop based production. Biophysical factors, household socioeconomic conditions and easy market access are the drivers of change at the landscape level, while regime change and market access are driver at the higher level.

Keywords: Farming systems trajectory, Hawassa area, Participatory method, Regime change

Executive summary

This report presents the results of a maize-based farming systems trajectory analysis carried out in 2014 in three districts of Hawassa area, Ethiopia: Wondo Genet, Tula and Hawassa Zuria. The motivation for the study came from the recognition that significant changes have taken place in the Hawassa area farming systems over the past time, which might have resulted from increasing demand for cash crop and perennial food crop source. The general objective of the study was to understand the trajectories of farming systems by assessing changes in crop production and crop diversity, and identifying the factors and drivers that are accountable for these changes in a three sites in Hawassa area, Ethiopia.

Three phases of primary data collection were employed: (i) informal discussion, (ii) focus group discussion, and (iii) life history interviews. The informal discussions were conducted with elderly peoples with the aim to get overview information of the area and determine the starting point of trajectory analysis. The focus group discussion was conducted with key informants in each landscape to understand their perceptions about the biophysical changes, through simple sketching and a timeline of their villages. The life history interviews were conducted on a stratified random sample of 40 households from the three landscapes using semi-structured retrospective questionnaires. The sample was stratified by farm household typologies (four types), defined by the criteria identified during focus group discussions. These are (i) the number of months in which they are self-reliant for food, (ii) their livestock size, (iii) their arable land area and (iv) their home garden crop diversity.

The quantitative data generated via retrospective questionnaires was analysed using principal component and cluster analysis to classify to types of trajectories of farming systems. The mean and standard deviations were calculated to present the results of each trajectory type. The statistical software R version 3.1.0 (R Development core team) was used to run principal component and cluster analysis.

An informal discussion with the elderly people showed three commonly recognized periods. These are times related to regime changes that were common at national level. The prior-1974, the period 1975-1991 and post-1991 are identified to have different characteristic of agricultural systems. Thus, these periods were used for trajectory analysis. The focus group discussion resulted in sketch map of prior-1991 and post-1991, timeline and criteria for farmers' self-categorisation in each landscape. The sketch reveals the expansion of arable

lands and residential areas, paralleled with eventual disappearance and conversion of natural forest and grazing lands post-1991.

Timeline of the area (Table 4.3) reveal historical events: limited access to agricultural lands (prior to 1974), land reform (1975), drought (1985) and access to new forms of extension service (since 1999) that were common at the national level. Historical events such as: flooding and ice in [Hawassa Zuria (1995), Tula (2004) and Wondo Genet (2006)] resulted in losses of crops in the area. Border conflicts between the Sidama and Oromo tribes [Hawassa Zuria (1990), Wondo Genet (2011) also resulted in burning of houses and losses of resources exposing farmers to emergency support. In 2013, maize stalk borer and wind resulted in losses of the maize crop. The relative high intervention of development projects in Hawassa Zuria could be attributed to drought vulnerability of the landscape that could contribute to food insecurity and need for intervention in the district.

Farm households income comes from a range of crop-livestock production to off-farm activities. In 2014, 60, 78 and 50% of household in Wondo Genet, Tula and Hawassa Zuria, respectively have some kind of off-farm activities. The production orientation/ proportion of food crop area to total farmland in the study sites 94, 85 and 56% prior to 1991, shows decline to 89, 70 and 37% in 2014 at Hawassa Zuria, Tula and Wondo Genet, respectively (Figure 4.8). Informal discussions with elderly people and FGD revealed that over the last two to three decades, there has been an increasing demand for food and cash source in the study sites. This resulted in an intense competition between the predominant traditional farming systems and the more lucrative production systems. Currently, maize and enset crop are present in 90% of the farms studied, while the khat and coffee are present at 57.5 and 32.5% of farms, respectively. Haricot bean is ubiquitous, commonly intercropped with maize and other permanent crops. However, the universal staple food crop (maize) area share is reduced post-1991 in the study sites. These could be attributed to the relative increase in the enset area share in each site (Figure 4.4) and khat production in Wondo Genet (Figure 4.7). Increase in khat acreage is explained by the higher financial return from the crop over any other crops. Livestock production was recognized as a long tradition of farming communities in the study sites over the studied period. However, since 1990's, variation in the number of livestock was observed across the study sites (Table 4.6).

Principal component analysis (PCA) identifies three PCs, which explained 59.59% of the total variation of farms diversity. Cluster analysis of the first two PCs, which explained 48.77 % of total variance resulted in three-broard groups of farming system trajectories (Figure 4.10). Thus, Trajectory 1: characterised by a moderate increase in farmland area, decreased maize area, increased enset and khat area and cash oriented production. The group constitutes (n=10, 25%) farms. Farms from Wondo Genet (25%), Tula (33.33%) and Hawassa Zuria (18.75%) belong to trajectory 1 and are characterized by relatively high resource endowment and year round food self-reliance in 2014. The decreasing trends in production orientation, livestock density and intense khat production were observed over the studied period in the trajectory 1. Trajectory 2: characterised by maintaining farm land size (0.57 ha), reduced maize area, minor increase in enset and khat area and self-subsistent food and cash oriented production. The group constitute the greatest number of farms (n=21, 52.5%), and majority of farms from Wondo Genet (75%), Tula (58.33%) and Hawassa Zuria (31.25%). Trajectory 3: characterised by maintaining farm land size (0.85 ha), decreased maize area, introduction of enset, self-subsistent food crop oriented and non-cash crop production. The group constitutes small number of farms (n= 9, 22.5%), and farms from Hawassa Zuria (50%) and Tula (8.34%) belongs to this group.

In this analysis three main farming system trajectories were distinguished constituting a group of farms roughly with similar trends of change. These trajectories present in each landscape regardless of the variation in percentage distribution of the farms in each landscape. The observed changes were not only explained by the landscape itself. There are other factors contributing to the changes and linking the landscapes with the trajectories like easy market access and the political system or regime change are the driver of changes that could be explained at region or national level.

1. Introduction

The demand to feed an increasing African population requires more food production, which can lead to natural resource degradation (Valbuena et al., 2013; Pretty et al., 2011; Abate et al., 2000). In sub-Saharan Africa, agriculture is a dominant source of income for many rural populations (Carswell, 2000). The current agricultural production system is characterized by smallholding, rain-fed subsistence-oriented production systems with low productivity.

Agriculture in Ethiopia contributes to 46% of the national GDP and 85% of the total employment and means of living (World fact book, 2014). Agricultural production in the country is diverse with its subsistence oriented, diverse and the risk-prone nature. However, despite a good agricultural production potential of various Agro-ecosystem and a vast labour pool in the agriculture sector, agricultural productivity remains low. The limited access to agricultural inputs, demographic pressure, natural resource degradation, seasonal variability of rainfall, yield losses from insect-pest and weed infestations are major reasons of low-crop productivity (Taffesse et al., 2011; Abebe et al., 2010).

The struggle of farming communities across the country to feed themselves contributed to the expansion of cropland, changes in land use and farming systems, an increase in the usage of agricultural inputs and plant genetic materials movements. These could lead to the spread and introduction of plant diseases and insect-pest. To improve agricultural productivity, farm household may undergo agricultural intensification or extensification and farm or income diversification (Valbuena et al., 2013; Bishaw et al., 2013; Malmberg and Tegenu, 2007).

Changes in farming systems and livelihood adaptation strategies may be different within and across agro-ecologies, and determined by socioeconomic and institutional factors and agro ecological properties. These suggest that farming system changes and their drivers are heterogeneous and complex, varying between households, locations and time (Carswell, 2000). The aspect has to be taken into account when analysing trajectories of farming systems and identifying the drivers of those changes. Trajectories, as used in this study, are the pathways of agro-ecosystems resulting from ecological, socioeconomic, institutional changes and farmers' livelihood strategies. These trajectories in terms of the diversity of farming systems and livelihood strategies observed can be explained by recording changes in crop selection, land allocation for different crops, change in livestock density, and involvement in off/non-farm activities and the reasons for these changes. This analysis is useful and necessary for understanding changes of the composition of the agricultural

landscapes which will enable to better understand the current challenges and propose informed actions for future agricultural systems.

1.1. Background

Three districts in the Hawassa area, Wondo Genet, Tula and Hawassa Zuria, with contrasting farming systems were selected to analyse historical farm and landscape level changes, which ultimately resulted in the current situation. The need to produce more food crop impulse farming system to become more intensive while better market access could favour cash crop production. The need to increase food crop production and market-oriented cash crop production is responsible for agro-ecosystem changes and the resultant changes in farming practice. In Hawassa area, farmers were seen to replace enset (*enset ventricosum*) and coffee with maize as a staple food crop and khat as a cash crop (Abebe, 2013, Abebe et al., 2010). In a recent year, farmers in Hawassa Zuria were seen reintroducing the perennial food crop (enset) for its drought resistance, use as food and fodder to their livestock and soil erosion control. In the Wondo Genet the cash crop production (e.g. khat, sugar cane and pineapple) increased due to expected higher economic returns and market accessibility (Abebe et al., 2010; Abebe et al., 2006). The expansion of the khat in this district resulted in a 30% decline of natural forest and associated forest fragmentation in major khat producing areas, a decline in food crop production, and soil erosion from steep land cultivation (Dessie and Kinlund, 2008). This problem became worse in the last two decades as compared to the prior to 1991 (Abebe et al., 2010; Dessie and Kinlund, 2008).

The need to increase food production can result in changes in land use (e.g. expansion of arable land) and farming practices (e.g. increased use of agricultural inputs) that may aggravate pest problems and induce crop productivity loss (Oerke et al., 1999 cited in Abate et al., 2000). The reduction of crop diversity and increase in maize mono-cropping favoured an increase in maize stem borer infestation, compared to maize crop planted under khat (*Catha edulis*) (Getahun, 2003 cited in CIMMYT, 2012) and with other crops like haricot bean and cowpea (CIMMYT, 2012; and Emana, 2002a cited in CIMMYT, 2012). Analysis of the drivers of these changes may improve understanding in the development of pest pressure in Hawassa area, which is related to the current ongoing Ph.D. research project to design appropriate maize stem borer control methods. The results of the understanding of past trajectories of farming systems will be further combined with experimental results and be used for building scenarios for future development of farming systems in Hawassa area.

The study was designed to better understand the trajectories of farming system, considering the farm diversity at a local level which is responsible for diverse trajectories. The study would also identify and document from the literature study the diversity and drivers of farming systems in Hawassa area. These could be a base to understand the existing farming system changes and better inform sustainable intensification research in the area. The study also aims to identify the extent to what socioeconomic and institutional factors affect trajectories of farming systems.

1.2. Objective

The general objective of the study was to identify the trajectories of farming systems by assessing changes in crop production and crop diversity, and identifying the factors and drivers that are accountable for these changes in three districts in the Hawassa area, Ethiopia.

1.3. Research questions

To address the main objective, the following research questions are asked:

1. What are the diversity of farms and household livelihood strategies observed in the area?
2. What have been the changes in term of crop shifts explaining the current diversity of farming systems of Hawassa area?
3. What are the drivers of the changes and what are the factors influencing the farmer's decision to shift crops?

1.4. Hypotheses

1. The household socioeconomic situation could have affected farming system changes.
2. Farmers with better access to market could have a better chance to shift and diversify their crops.
3. Institutional conditions, as a result, of regime change could have influenced the direction of farming system changes.

2. Review of the literature

2.1. Geographic and historic description of the study area

FAO (2012) defined farming system as "the population of individual farms that share typical agro-ecological conditions, market access, and characterised by similar farm resource bases, family activities and similar development interventions and strategies". Among the 15 farming systems identified by the FAO in Sub-Saharan African countries, the diversified agro-climatic conditions enable Ethiopia to adapt mixed crop-livestock production systems (FAO, 2012). The perennial and horticulture-livestock farming systems are the dominant farming system in the southern part of Ethiopia (FAO, 2012; Getahun, 1978). The traditional enset-coffee home garden Agroforestry farming system is the predominant system in Hawassa area.

Favourable agro-climatic conditions, agriculturally fertile and irrigation based agricultural production coupled with market access enable farmers in Wondo Genet to produce a diverse set of perennial and annual crops (Dessie and Kinlund, 2008). The smallholder perennial crop-based farming system, owning about 0.6 ha arable land holding remains the only means of life for 78% of the entire population (Dessie and Kinlund, 2008; Wondo Gent district office of agriculture, 2013). Tula, once part of Hawassa Zuria district, is characterised by semi-arid to sub-humid agro-climate, average biophysical and socioeconomic conditions enabled the production of both food and cash crops. Being only at 13 km from Hawassa town and easy market access, Tula is an important khat market from where it transit to the capital (Tula district agricultural office, 2013).

Hawassa Zuria, in warm sub-humid lowlands (85%) and sub-humid (15%) agro-climatic condition is characterised by adaptation of maize mono-crop based farming system. In the period 1974-1991, some area of land used to be set of a state-owned farm in the area. In the recent years, post 1991 farmers introduced enset for its drought resistance and use as food and fodder source (Hawassa Zuria district office of agriculture, 2013; SNNP, 2005).

2.2. Access to agricultural resource

Belete et al. (1991) reported that the agricultural systems in Ethiopia prior to 1974 were characterized by a feudal system in which agricultural resource is extracted by individual groups of peoples (the landlords). The feudal system was recognized by exclusion of the

majorities of smallholder farmers from access to agricultural resource, primitive and stagnated agricultural production system. Between 1974 and 1991 the country was governed by a military junta (Derg). This period is characterized by the 1975 land reform (Land to the tiller), which entitled farmers with land use-rights. Officially, all land came under the ownership of the state, but distributed to farmers only on use- right basis (Headey et al., 2014; Belete et al., 1991). During this period, commercial large-scale farmland was distributed to the state farms (Headey et al., 2014; Zerihun, 2009). Following the land reform in 1975, the agricultural production system did not evidence substantial changes due to limited access to appropriate agricultural technologies, inputs and extension service in Ethiopia (Belete et al., 1991). Political instability, drought and government price control policy and free movement of agricultural products also contributed to inadequate performance of agriculture during the Derg regime in Ethiopia (Wubne, 1991).

After the downfall of the Derg regime in 1991 the EPRDF (the current ruling party) gets into power. The post-1991 period was thought to have the effects of changes in agricultural production systems from its agricultural support policy, infrastructural development, and access to agricultural technologies. During this period, the government adopted the agricultural development lead industrialization (ADLI) with the main objectives to enhance the productivity of smallholder's agriculture and improve food security in the country. However, the land still remains state property (Crewett, 2008; Belay and Manig, 2004).

The three mentioned time periods: (i) prior to 1974, (ii) between 1975 and 1991, and (iii) post 1991 were studied to understand the trajectories of farming systems in the area.

2.3. Farm and household diversity

Differences among farms in their resource endowment, access to agricultural technologies, credits and extension services, market access and farming experiences are the main factors for diversity among the farms (Browder et al., 2004). Tittonell (2013) indicated that in developing countries farming systems change with the increasing diversity in the livelihood of families. Thus, in the change farmers adapted to different farming systems as some of the household undergoes contraction of resources like land and herd size. However, within the same locality some group of farmers shows improvement in their farming system through physical or capital intensification and changing their production orientation. Analysis of farm and household diversity to understand the various responses of individuals to the change over the course of time need to be analysed in the context the farm operates (Tittonell, 2014).

3. Methods and materials

3.1. Theoretical framework

The study framed analysis of the "farming system trajectory" succession of chronological steps characterized by structural or organizational change in farming system (Capillon, 1993; Moulin et al., 2008 cited in Rueff and Gibon, 2010). A farming system defined as a population of individual farms sharing typical agro-ecological conditions and market access, and characterized by similar farm resource bases, family activities, and constraints for which similar development strategies and interventions can be appropriate (FAO, 2012). To understand the trajectories of farming systems main socioeconomic, market and institutional factors that are accountable for changes in farming systems were analysed considering three-time period. Therefore, to acquire a better understanding of farm diversity farms were categorized into typologies. Tittonell et al., (2005) demonstrated that categorizing households using functional typologies on the basis of their wealth characteristics, production orientations and their livelihood strategies are more relevant when examining diversity among farm households.

3.2. Description of the study area

The study was conducted in Hawassa area, located in the south central Rift Valley (Figure 3.1). The area lies at $7^0$3'11"N latitude, $38^0$29'43"E longitude, located at 250 km to the south of Addis Ababa, the capital city of Ethiopia. The area is characterized by moist to sub-humid warm subtropical climate with an average temperature of 15 to 20^0C. Annual precipitation ranges from 1000 to 1800 mm in a bimodal distribution pattern, expected in March to April and June to August (Dessie and Kleman, 2007; SNNP livelihood zone report, 2005). The subsistence-oriented smallholder farming system with an average of below one hectare arable land holding characterize the agricultural production of the area (Dessie and Kleman, 2007; Dessie and Kinlund, 2008). Three districts were chosen for this study, showing a gradient of landscape diversity translated in different ratios of perennial/annual crops, field sizes and proportion of non-crop habitat (e.g. Hedgerows). These landscapes also present differences in socioeconomic characteristics. Wondo Genet characterized by a diversity of perennial and annual cash crops based production. Hawassa Zuria chosen for its dominant annual food crop-based production, which mainly consisting of maize, and Tula represents a landscape with intermediate diversity composed of both food and cash crop production (Figure 3.1).

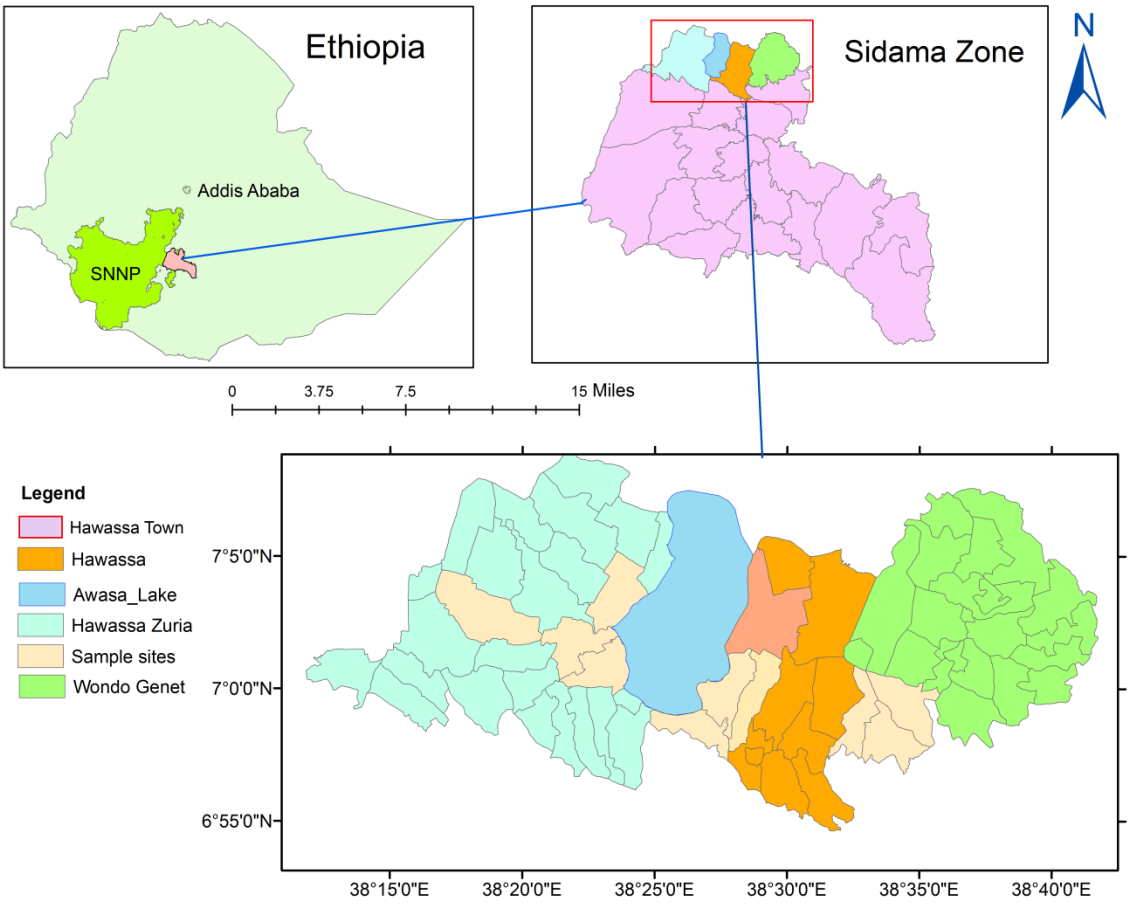


Figure 3.1: Location map of the study area

3.3. Data collection

Qualitative and quantitative data were collected from primary sources. Primary data included (i) informal discussions, (ii) focus group discussions (FGD), and (iii) life history interviews with elderly peoples, key informants and selected individual farm households, respectively.

3.3.1. Informal discussions

Informal discussions were conducted at the initial stage of data collection with 13 elderly farmers: four farmers from Wondo Genet and Tula, and five farmers in Hawassa Zuria district. Informal discussions were used to acquire information on the farming systems, historical changes in access to agricultural resources and to determine the starting points for the trajectory analysis. Farmers were asked to identify crucial periods that affected their farming systems (appendix 4).

3.3.2. Focus group discussions

Focus group discussions (FGD) organized with key informants, those groups of peoples expected to have a better understanding of changes in their local area (Figure 3.2). Accordingly, participants were selected among influential farmers; community representatives who have a better understanding of their local territories, and agricultural development agents (DA) of respective study sites (Table 4.1). Participatory mapping and timeline was employed to get a better understanding and perceptions of farmers in their local areas by simple sketching. The FGD was also aimed to identify criteria for farmer's self-categorization to build a typology of farms (appendix 5).

Figure 3.2: Key informant participating in focus group discussion in Tula district

The objective of the participatory mapping was to acquire an understanding on how participants of the discussion perceive changes in their local areas; this information was acquired by preparation of a timeline and sketch map with the assistance of development agents in each location (Figure 3.3)

Figure 3.3: Key informant participating in the mapping exercise in Hawassa Zuria district

After the sketch, the same group of participants was asked to record a timeline in each location facilitated by the development agents. The timeline mainly focuses on changes in access to resources, technologies, and extreme weather conditions (e.g. flooding and droughts) (Table 4.2). Accordingly, farmers were able to sketch two different sketch maps of their localities, to show biophysical features of their landscapes in the three main periods identified during the informal discussions (Figure 4.2).

Focus group discussion participants identified criteria for farmer self-categorization. The periods of food self-sufficiency, livestock size, arable land holding, and farm management practices are identified in the three sites, which relates to suggested criteria for farms in East Africa (Tittonell et al., 2010) (Table 3.1).

Table 3.1: Farmers 'criteria to categories household based on months of food self-sufficiency, resource endowment, farm management practice during FGD in Wondo Genet, Tula and Hawassa Zuria.

Criteria	Description
Selected by farmers in three localities	
Food security	(1) Fully feed family and produced for the market; (2) adequately feed family from own production; (3) partially feed family and work off-farm activity, and (4) can't feed a family, dependent
Livestock size	More than ten cattle, small ruminants with transporting animals; pair of oxen, cows, small ruminants; single or no oxen, cow with /out small ruminants; no livestock
Arable land size	> 1ha; >0.5 ha; <0.5 ha; <0.25 ha or landless
Use of agricultural technologies	Use a fertilizer and improved seeds regularly; using some inputs occasionally for some crops
Selected by farmers in two of the three localities (Wondo Genet and Tula)	
Home garden crop diversity	Produce more diverse food and cash crops; produce different crops, focusing on food crops (maize, enset)
Irrigation	Own water pump or point and produce different crops three times per annum; hire or borrow water pump and produce different crops; use farrow or hand spray; have no access to irrigation water
Educating children	Who can teach his children in private schools; able teach in government schools by fulfilling all needs; able to teach in public schools, but lacks to fulfil their needs; unable to teach his children.
Selected by farmers in one of the three localities (Tula)	
Number of coffee trees	>400-coffee tree; 30-40 coffee trees; 5-7 coffee trees; no coffee tree in his garden.
Maize productivity	60 quintals per ha; 15 quintals per ha; 10 quintals per ha;
Housing type	Quality housing in urban area to rent out or live in;

Source: Own computation from FGD, 2014; Kebede, 2013 (unpublished data).

Household typologies: Farm diversity was stratified by using criteria identified during focus group discussion (Table 3.1). The criteria selected by key informants in the three localities were used to categorise farm households into four typologies, represented by type 1-4. These are (i) the time of the year in which they are self-reliant for food, (ii) their livestock size, (iii) their arable land area, and (iv) their home garden crop diversity. However, home garden crop diversity was not used in household categorisation for Hawassa Zuria. The livestock holding and arable land area are the criteria commonly used in SNNPR for household categorisation based on wealth (USAID, 2005). Socioeconomic data: on period of food self-sufficiency, arable land holdings, livestock size and types of crop were obtained from the baseline survey (Kebede, 2013 unpublished data) to categories farms based on the criteria (appendix 6).

Thus, Type 1. Better off; Type 2: Medium; Type 3: Poor and Type 4: Very poor. The typology also relates to the typologies identified in Sidama maize belt livelihood zone (USAID, 2005).

3.3.3. Life history interview

Life history interview was conducted in April 2014. A stratified random sampling based on criteria identified by key informants was used to select 40 farm households from an existing list of 173 households (Kebede, 2013 unpublished data). The selection of farmers from the unpublished data was also validating by the DAs and community representatives as the raw data generated and the real situation of the same farmer sometimes mismatching. The selected 40 farmers represented four-farm types and invited for an in-depth-life story interview. Twelve-farm households selected from Wondo Genet and Tula, and 16 households from Hawassa Zuria, respectively. Three households per farm type from Wondo Genet and Tula and four households from Hawassa Zuria were selected. Semi-structured retrospective questionnaires were designed to collect information on socioeconomic, institutional and market access indicators, which would enable to understand the decision of individual households towards shifting or diversifying their crops and levels of crop diversification (appendix 7). Socioeconomic factors: age of farm household, source of income, types of crop, livestock density and period of food self-sufficiency area included. Data on market access include the distance to the nearest market and road, and data on institutional factors include access to agricultural resources, access to credit, inputs, and extension service and irrigation water.

3.4. Description of variables to analyse trajectories of farming system changes

To determine the trajectories of farming system a principal component analysis was conducted, which is aimed to reduce the weight of more discriminating variables (Choisis et al., 2012; Ryschawy et al., 2012). Household socioeconomic and market access indicators were analysed using PCA and principal components that explain substantial variation identified. Major Principal Components from the analysis were used to construct a typology of individual farms. Initially, eleven quantitative and six qualitative socioeconomic, market and institutional variables were identified to study the trajectories of farming system changes. However, by looking into the data the six qualitative and one quantitative variable were

excluded from the analysis and considered as supplementary variables. The qualitative variables (access to agricultural extension, inputs and credit service and irrigation water) were removed because they are common to the national level and answer the yes or no questions, which did not show a visible difference between the households. Finally, ten variables were selected to be used in PCA (Table 3.2).

Table 3.2: Description of farm indicators used to analyse farm trajectories

Indicator	Criteria used	Heading	Data type
Farmland size (ha)	Total farm land	land	Quantitative
Herd size (TLU)	Livestock size	lsck	Quantitative
Family size (# of person)	Family member living in the household	fams	Quantitative
Production orientation (%)	Ratio of food crop area of total farmland	prop	Quantitative
Maize production (ha)	Maize crop area/farm area	maize	Quantitative
Cash crop production (ha)	Khat area /farm area	khat	Quantitative
Enset production (ha)	Enset area/farm area	enset	Quantitative
Access to market (km)	Distance to the closest market	markt	Quantitative
Access to road (km)	Distance to the nearest road	road	Quantitative
Food self-sufficiency (# of months)	Month of food self-sufficiency	food	Quantitative
Age	Age of the household	age	Quantitative

Source: Adapted and modified from Choisis et al., 2012; Rueff et al., 2012, Tittonell et al., 2010.

The Bar plot was used to check for correlations between the attributes and select non-correlated variables. Thus, maize area was excluded from the analysis, which showed strong correlation r^2=0. 57 with total farmland size (Figure 3.4). These show that when a farmland size increase, the area of maize increase as well, which is non-discriminating (Pengelly et al., 2001). These are attributed to the dependence of the farm households on maize as a staple food crop source.

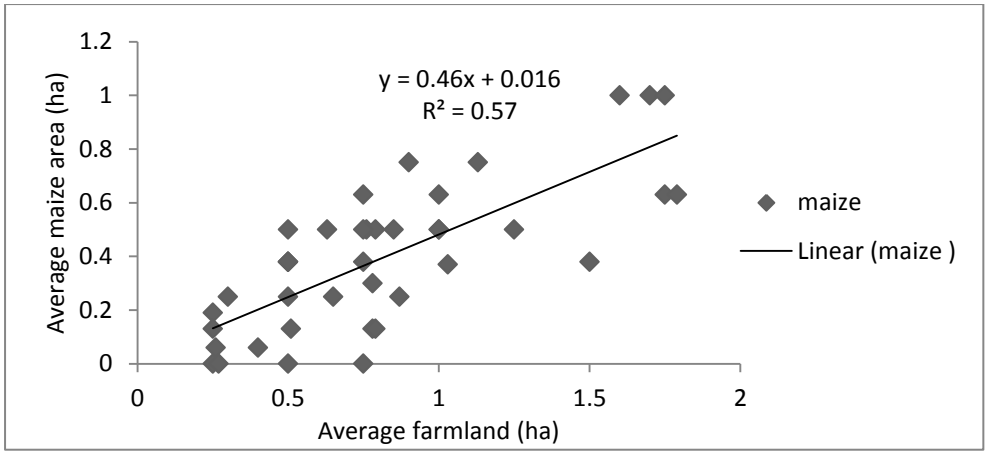


Figure 3.4: Relation between average maize area and average farmland size in the study sites in 2014.

3.5. Data analysis

A two-step method for assessing the diversity of farming system trajectories was used. The selected variables were analysed using principal component and cluster analysis of individual trajectories of farming systems. Cluster analysis was conducted using the hierarchical cluster procedure and ward's aggregation method (Ryschawy et al., 2012; Rueff et al., 2012; Madry et al., 2010; Landais, 1996 and Köbrich et al., 2003). The first two principal components were used to build farming systems trajectory typology. The number of clusters was determined on the "observed 'jumps' in the inertia inter-cluster on the bar plot: a high loss of inertia means that the two associated clusters are far apart" (Choisis et al., 2012).

Principal component and cluster analysis were run using the *dudi.pca* within the routines of *ade4* packages from R 3.0.1 software (R Development team 2013). The mean and standard deviation of the selected variables and the quantitative household socioeconomic data were calculated to analyse changes for each trajectory using SPSS statistical software version 20 and excel sheet.

4. Results

4.1. Informal discussions

The informal discussions conducted with the 13 elderly people reveal three time periods. These are the prior-1974, the period 1975-1991 and post-1991, which are identified to have different characteristic of agricultural systems. These are times related to regime changes that were common at national level. Focus group discussions

4.2. Focus group discussions

Three focus group discussions, one in each landscape, were carried out in Wondo Genet, Tula and Hawassa Zuria. The key informants who are expected to deliver valuable information on changes in their local area selected from different stakeholder groups. In total 46 FGD participants were selected representing farmers, peasant association (PA) representatives and development agents (DA) (Table 4.1).

Table 4.1: Summary of focus group discussion participants in the study sites

Key informants	Wondo Genet		Tula		Hawassa Zuria	
	Male	Female	Male	Female	Male	Female
Farmer	6	3	6	3	4	4
PA representative	3		3		4	
DA	3		2	1	4	
Total	15		15		16	

Source: Own computation from FGD, 2014

During the FGD, which lasted 3-4 hours at each site, the participants were able to draw a sketch map of their local areas and timelines since the 1970's (Figure 4.1-4.3). The result from the mapping exercise in each area illustrates the past and present land use system, crop types, and infrastructure development.

4.2.1 Sketch of the study sites

Forest area was decreased, but the last five years forest restoration projects in a form of water shade development are conducted at the region level and some areas are now under protection to rehabilitate. There is almost no grazing area anymore in the study sites that farmers in

Wondo Genet and Tula bring their livestock to another district (Borecha), out the district during the dry season (April-October) to search feed for their animal.

Hawassa Zuria: The sketch in Hawassa Zuria shows that the majority of farmland was used for maize cultivation with some natural forest covers prior to 1991 (Figure 4.1a). During this period, maize was the dominant crop in the area. However, post-1991 the residential area expanded, infrastructure development and of enset and some vegetable crops around Lake Hawassa were introduced (Figure 4.1b).

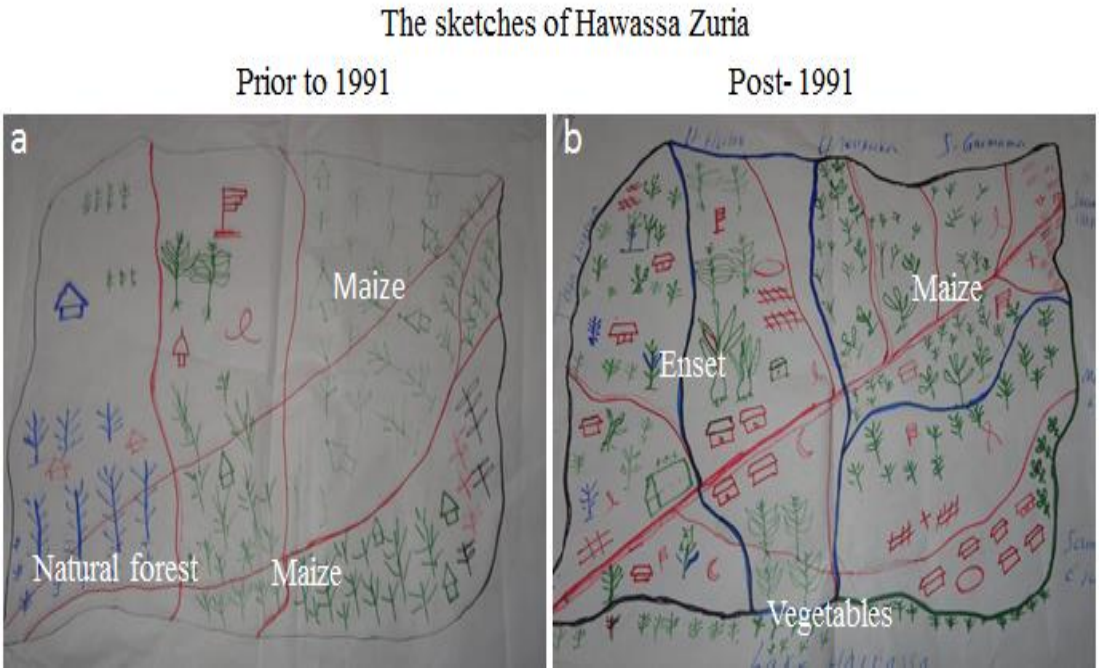


Figure 4.1: Sketch of Hawassa Zuria district pre-1991 (a) and post-1991 (b)

Tula: Sketch of two PAs representing Tula district shows natural forest, grazing land, and enset dominated land use systems with some maize and one state-owned farm prior-1991 (Figure 4.2ac). However, post-1991 there was a rural infrastructure development; expanded residential area and conversion of natural forest and grazing land into khat, coffee, enset, maize, and introduction of vegetable crops along Lake Hawassa side (Figure 4.2bd).

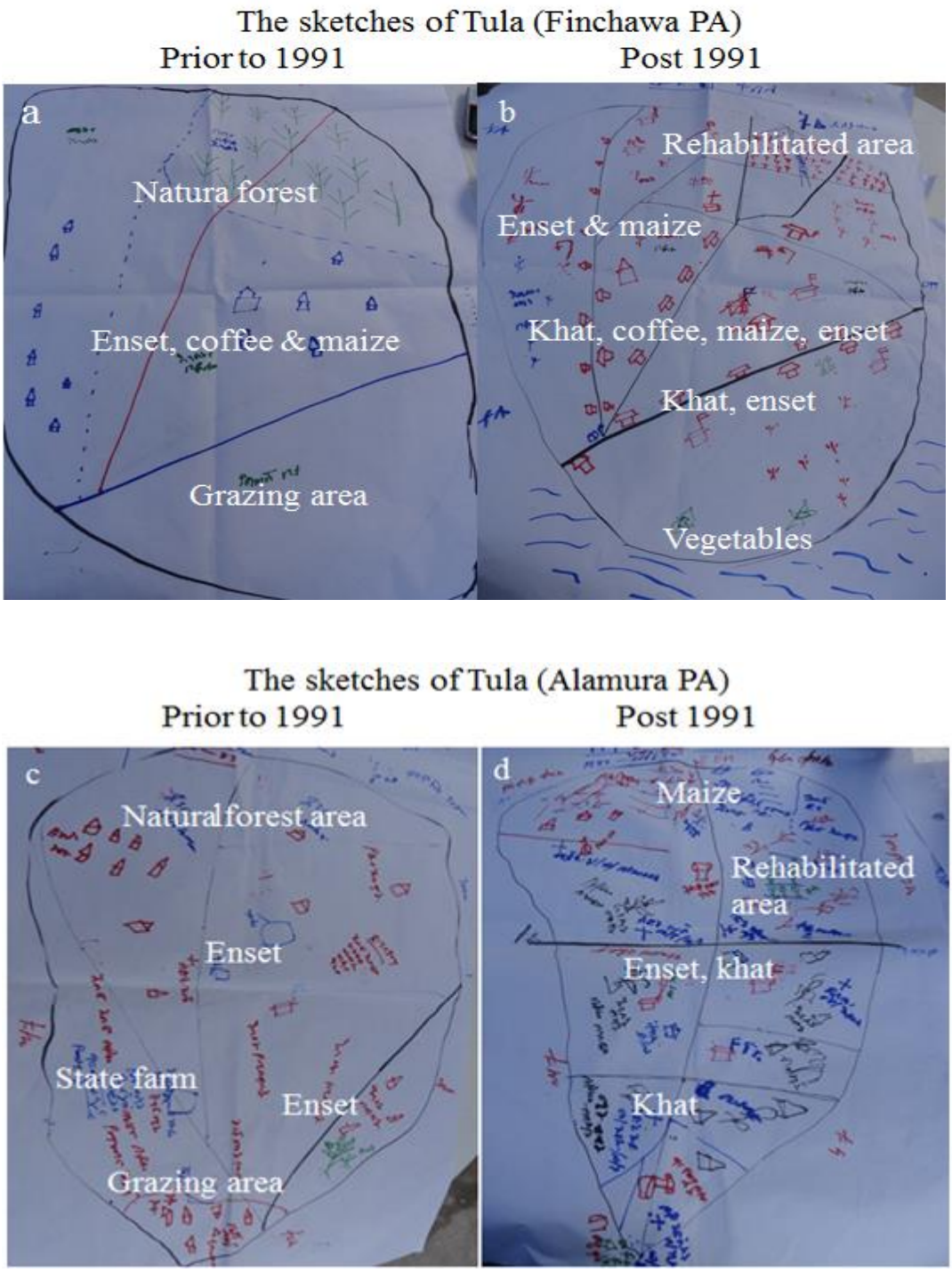
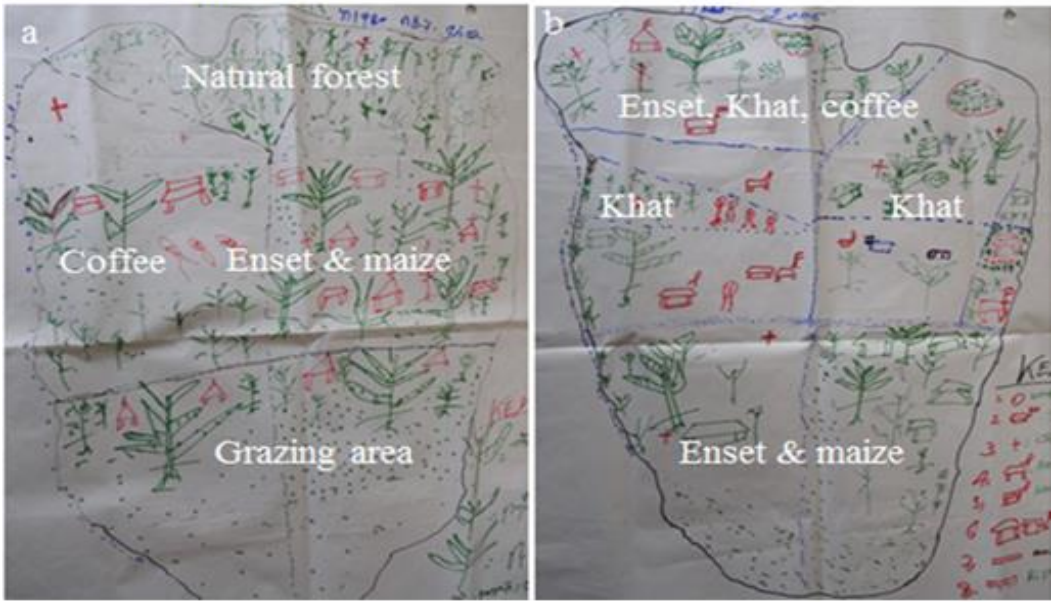


Figure 4.2: Sketch of Tula district prior-1991 (ac) and post-1991 (bd)

Wondo Genet: The sketch of three PAs representing Wondo Genet shows that prior to 1991 the dominant land use systems were natural forest and pasture land, coffee, enset and maize crops (Figure 4.3ace). However, post-1991 there was an expansion of rural roads; expanded residential area and conversion of forest and grazing land into khat, coffee and maize area with some marshy areas (Figure 4.3bdf).

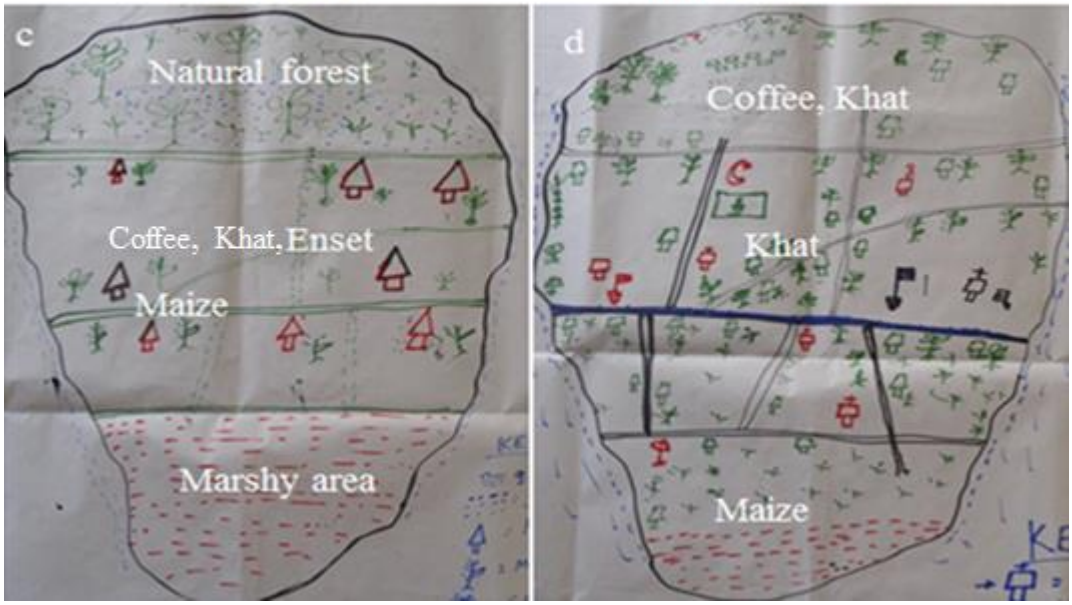
The sketches of Wondo Genet (Aruma PA)

Prior to 1991 Post 1991



The sketches of Wondo Genet (Edo PA)

Prior to 1991 Post 1991



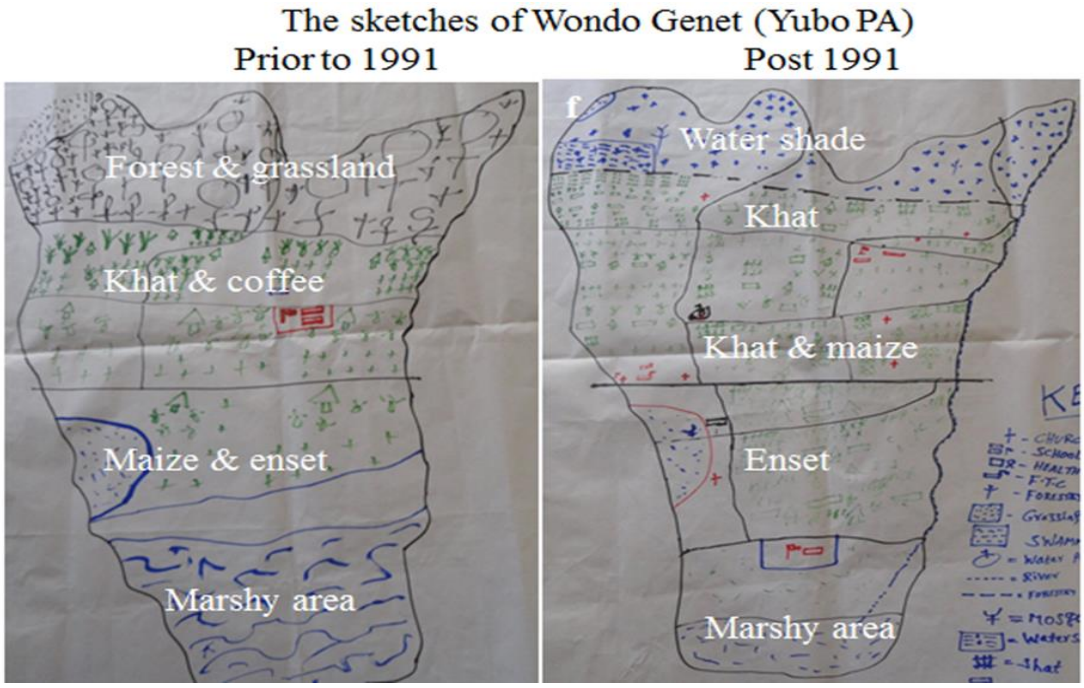


Figure 4.3: Sketch of Wando Genet district prior-1991 (ace) and post-1991 (bdf)

4.2.2. Timeline of the study sites

During the timeline recording participants were asked to recall historical events related to access to resources, adverse weather conditions and access to agricultural technologies (Table 4.2). Timeline of each site (Table 4.2) reveal events that happened at the national level: (i) the prior to 1974 limited access to agricultural lands, (ii) the 1975 land reform, (iii) the 1985 drought, and (iv) access to a new form of extension service, training and agricultural technologies since 1999. FGD participants indicated that they faced problems at the local level from the attack of the maize stalk borer and wind resulting total loss of maize in 2013. Whereas, flooding, Ice and border conflicts between the Sidama and Oromo tribes were resulted burning of houses and losses resource in different time (Table 4.2).

Relativelly high intervention of development projects were observed in Hawassa Zuria, which could be attributed to drought vulnerability of the landscape that could contribute to food insecurity and need for intervention.

Table 4.2: Timeline of the study sites since 1970's

Period	Wondo Genet	Tula	Hawassa Zuria
Prior-1974	- Limited access to agricultural resource	- Limited access to agricultural resource	- Limited access to agricultural resource
1975	- Land reform-entitled land ownership	- Land reform-entitled land ownership	- Land reform-entitled land ownership
1985	- Shortage of rain	- Shortage of rain	- Shortage of rain- drought - Famine
1990			- Conflict between Sidama and Oromo tribes resulted in the loss of resources
1995			- Flooding and overflow of Lake Hawassa resulted in the loss of resources
1999-2004	- Access to agricultural technologies, the FTC established, new forms of extension service, training	- Access to agricultural technologies, the FTC established, new forms of extension service, training	- Access to agricultural technologies, the FTC established, new forms of extension service, training
2002			- Safety net programs started - Soil and water conservation - Supplied livestock and equine driven charts
2004	- Flooding and Ice resulted in the loss of crop and resource		- Goal Ethiopia started development intervention - Supplied different vegetables seed and enset seedlings
2006		- Flooding and Ice resulted in the loss of crop and resource	
2011	- Conflict between Sidama and Oromo tribes resulted in the loss of resource and emergency support		- Chili pepper production stopped due to diseases
2013	- Maize crop losses - Stalk borer and wind - Introduction of improved varieties of maize by Pioneer	- Maize crop losses - Stalk borer and wind - Introduction of improved varieties of maize by Pioneer	- Maize crop losses - Stalk borer and wind - Introduction of improved varieties of maize by Pioneer

Source: Owen computation from FGD, 2014

4.3. Characterisation of farming systems of the area

Smallholder subsistence-oriented crop-livestock mixed farming systems are the dominant farming system in the studied sites. Perennial-annual food and cash crops based farming systems characterise agricultural production in Wondo Genet and Tula. Maize and enset crops are a major staple food crop source for almost all farm households in Wondo Genet and Tula over the studied period. Maize remains the only staple food crop source in Hawassa Zuria. However, in the past decade introduction of enset is contributing to the stable food crop source to some of the farm households in Hawassa Zurai.

Perennial crops such as khat, coffee and fruits and vegetables are primarily produced for sale in Wondo Genet and Tula. Perennial cash crop production is not common in Hawassa Zuria, while maize is used as a cash source besides its use as a sole stable food. Crops like haricot bean, sweet potato, potato and chili peppers were also produced as cash crops in Hawassa Zuria. Informal discussions with elderly people and FGD reveal that over the last two to three decades, there has been an increasing demand for food and cash source in the study sites. These result an intense competition between the predominant traditional farming systems and the more lucrative production systems.

4.3.1. Source of farm household income

In all the studied sites, the income of farm households comes from a range of crop-livestock production to off-farm activities (Table 4.4). In 2014, 60, 78 and 50% of household in Wondo Genet, Tula and Hawassa Zuria, respectively have some kind of off-farm activities. Relatively higher involvement in off-farm activities in Tula is attributed to closeness to urban area (Hawassa town) where farmers can have access to market information and temporary employment. Farmers response, 30, 11 and 17% in Wondo Genet, Tula and Hawassa Zuria, respectively shown that children also engaged in some kind of off-farm activities in 2014. Petty trading and casual labour are a primary source of off-farm income in the study sites. Thus, at the beginning of farming activity 50, 80 and 100% of the farmers depend on trade as an additional source of income, respectively in Wondo Genet, Tula and Hawassa Zuria (Table 4.3). However, in 2014, 80, 29 and 82% of the farmers respectively in Wondo Genet, Tula and Hawassa Zuria involve in trading of cereal grain (maize) and cash crop (khat and coffee).

Table 4.3: Farmer's response on the main sources of farm household income and types of off-farm activities in the study sites since 1970's (%).

Source of income	Wondo Genet	Tula	Hawassa Zuria
	Prior-1974		
Crop-livestock production	33	17	19
	During 1974-1991		
Crop-livestock production	50	33	62
Crop-livestock & off-farm	8	25	19
	Post-1991		
Crop-livestock production	17	25	31
Crop-livestock & off-farm	75	42	63
Types of off-farm activity			
	In the current time		
Causal labour		29	18
Trading	80	29	82
	At farming start-up		
Trading	50	80	100

Source: Life history interview, 2014

However, some of the farmers were not getting involved in any form of off-farm activities, which is due to lack of information on off-farm activities across the study sites.

4.3.2. Crop production

Annual and perennial food and cash crops: maize, enset, and khat share the higher proportion of land use of Wondo Genet and Tula over the studied periods. Annual crops: maize, chili peppers and potatoes were the dominant crop prior to 1991 in Hawassa Zuria. Maize and enset crop are present in 90% of the farms studied while khat and coffee present at 57.5 and 32.5% of farms, respectively. Haricot bean is ubiquitous commonly intercropped with maize and other permanent crops. Farmers in Wondo Genet and Tula commonly used to intercrop coffee and different fruit crops with other annual and perennial crops post 1991 that their area share is very negligible. However, the ubiquitous staple food crop (maize) area share is reduced post-1991 in the study sites. The corresponding decrease in the maize area share could be explained by the relative increase in the enset area share in each site (Figure 4.4) and khat production in Wondo Genet (Figure 4.7). The corresponding increase in khat acreage is explained by the increasing demand for khat and higher financial return from the crop over any other crops due to its per annum multiple harvests. Relatively average food and cash crop production is shown in Tula, compared to the two landscapes over the studied period (Figure

4.6). In Hawassa Zuria, enset was introduced over the last one decade with the aim of permanent food and fodder source (Figure 4.5). However, few farmers that currently immigrated into Hawassa Zuria in search of farmland are used to have enset prior to 1991 in Borecha district.

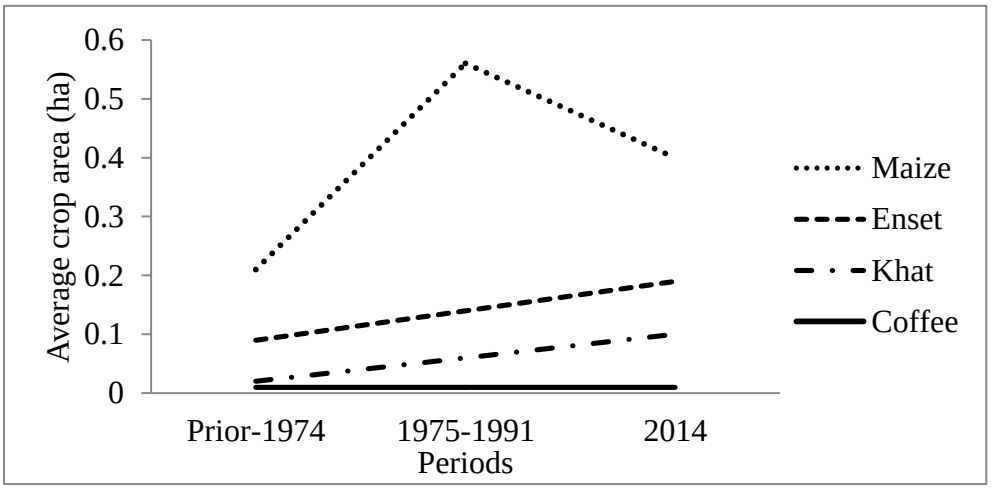


Figure 4.4: Trends in dominant crop production of the study sites since 1970's

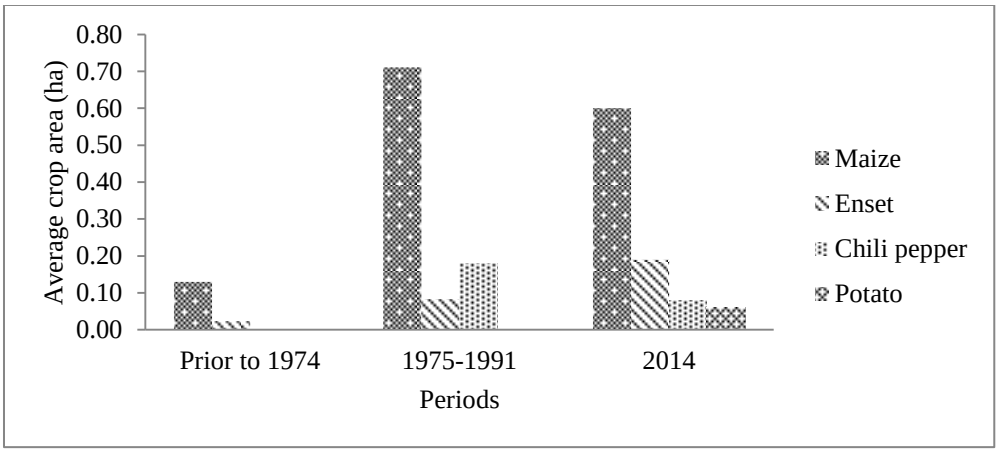


Figure 4.5: Trends in dominant crop production in Hawassa Zuria since 1970's

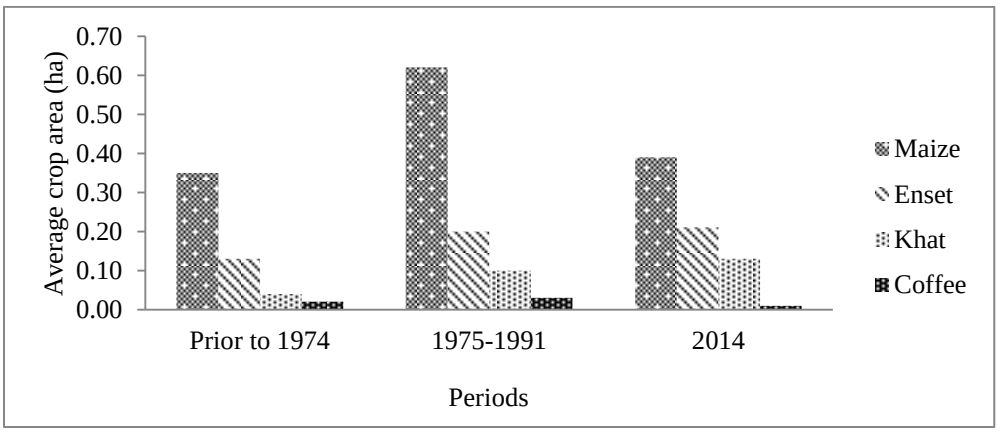


Figure 4.6: Trends in dominant crop production in Tula since 1970's

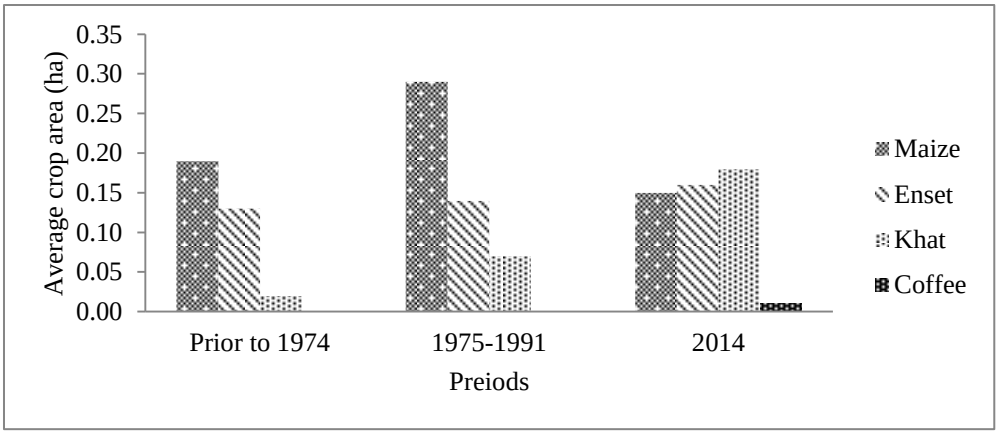


Figure 4.7: Trends in crop production in Wondo Genet since 1970's

Production orientation: Production orientation in the context of this study defined as the proportion of food crop area of the total cropland holdings. Production orientation of the study sites in 1975-1991 shows 94, 85 and 56% in Hawassa Zuria, Tula and Wondo Genet, respectively. However, the relative decline in production orientation to 89, 70 and 37% in Hawassa Zuria, Tula and Wondo Genet respectively observed in 2014 (Figure 4.8). This could be attributed to the increase in cash crop production and off-farm activities like petty trading.

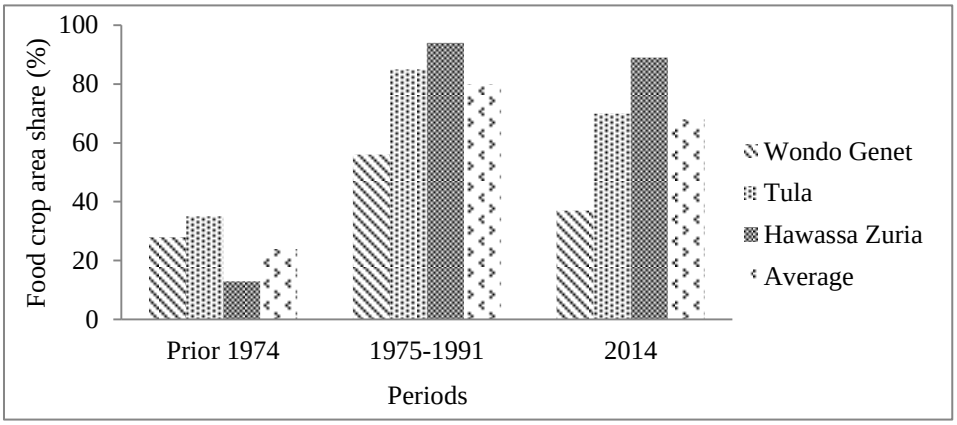


Figure 4.8: Production orientation in the study sites since 1970's

Generic crop diversity: Sidama zone is thought to be home to a diverse home garden to field crop diversity. However, difference among the landscapes and trends in the level of dominant crop diversity gradients were observed in the area. Thus, level of crop diversity in Hawassa Zuria showed a gradual increase from the introduction of enset and vegetables along side of Lake Hawassa in 2014. However, shortage of farmland (81%), lack of irrigation water (69%) and access to agricultural inputs and credit (31%) were identified to limit farmers to diversify their crops in Hawassa Zuria (Table 4.4). Dominant crops (maize, enset, khat, and coffee) diversity in Tula showed stability over the studied periods; these could be attributed to the

potential of the area for both food and cash crop production. Nevertheless, farmers in Tula evidenced the shortage of farmland (67%), irrigation water (58%) and limited access to agricultural extension service (25%) to further diversify crops (Table 4.4). The limited access to agricultural extension service in Tula partly explained by being part of Hawassa district (urban) resulted in less attention was given by agricultural office. Shortage of farmland (75%) which is responsible for the selection of more valuable crops, lack of irrigation water (67%) and limited access to inputs and credits service (33%) were identified as a limiting factor to diversify crops in Wondo Genet (Table 4.4).

Table 4.4: Factors limiting crop diversity in three districts of Hawassa area (% of farmer response)

Limiting factors	Wondo Genet	Tula	Hawassa Zuria
Land shortage	75	67	81
Lack of irrigation water	67	58	69
Limited access to inputs and credits	33		31
Limited access to extension		25	

4.3.3. Livestock production

Livestock production was recognized as a long tradition of farming communities in the study sites. Different species of livestock, such as cattle, goats, equines, chickens, and bee colonies were identified constituting herd composition of the study sites since a long time. The farmers kept local breeds of cattle, characterized by low productivity for milk production, power and cash savings. Since 1990's, variation in the number of livestock was observed across the study sites. A relatively high density of livestock 10.76 and 7.22 TLU kept in Tula and Wondo Genet, respectively, as compared to Hawassa Zuria (3.99 TLU) about 30 years ago (Table 4.5). These could be explained in Wondo Genet and Tula by the availability of natural pasture and forest-based grazing and temporally movement of some farmers with their animals in Hawassa Zuria in search of feed. The lesser density of livestock in Hawassa Zuria could be attributed to limited availability of natural pasture and forest-based grazing; maize crop residue is the only feed source up to now.

Table 4.5: Trends in average livestock holding in the study sites since 1970's (Mean ± standard deviation)

Periods	Wondo Genet	Tula	Hawassa Zuria
Livestock size 30 years ago (TLU)	7.22±13.35	10.76±12.67	3.99±4.35
Livestock size currently (TLU)	1.96±1.95	2.58±2.42	2.41±2.96

Tropical Livestock Units (TLU) is livestock numbers converted to a standard unit. One TLU is equivalent to one cattle with a body weight of 250 kg. Conversion factors are: cattle = 0.7, sheep = 0.1, goats = 0.1, chicken = 0.01 (Harvest Choice, 2011).

However, since the 1990's drastic declines in livestock density was observed in the study sites. 82 % of farmers in the study sites decreased their livestock density in the past 30 years, from sell-off their livestock (39%), feed shortage (39%), livestock disease (16%), and labour shortage (6%). However, 18% of the farmers increased their livestock numbers due to their investing power and use of livestock as cash saving for their family. The trends in livestock holding show relatively higher decline in Tula and Wondo Genet compared to Hawassa Zuria (Table 4.6). The relatively higher decline is attributed to high-feed shortage in Wondo Genet and Tula, compared to Hawassa Zuria.

Table 4.6: Farmer's response to trends in livestock holding and factors accounted for the change in herd size since 1970's (%).

	Wondo Genet	Tula	Hawassa Zuria
Trends in livestock holding			
Decreasing	83	91	73
Increasing	17	9	27
Reasons to decreased livestock size			
Feed shortage	60	50	9
Sell-off livestock	30	30	73
Livestock diseases	10	20	18

Source: Own computation from life history interview, 2014

4.4. Analysis of farming systems trajectories

Principal component analysis (PCA) was conducted on socioeconomic and market access variables for 40 farmers to identify factors that summarize variation among farms. Eigenvalue from the analysis was used to determine the number of components to be included in the farming system's trajectories analysis. Consequently, the first three principal components with eigenvalues above one were selected for the analysis. The three PCs explained 59.59% of the total variation of farms. The first PC, which explained 30.23 % of the total variance, was associated with farmland size (land), periods of food self-sufficiency (food), enset crop area share (enset), herd size (lsck), and family size (fams) with negative loadings. The second PC, which explained 18.45% of the variance was associated with production orientation (pror) and distance to the nearest market (markt) with negative loadings and khat crop area share

(khat) with a positive loading. The third-PC axis, which explained 10.92% of the total variance, was associated with age of farm household with positive loadings.

The correlation circle of quantitative variables is indicated on the first two PCs (Figure 4.9). The first PC (axis 1) sort farms by total farmland area, periods of food self-sufficiency, enset production and herd size. Family size was also linked to the first axis to a lesser extent. These are indicators of farm size and showed strong correlation and greatly contributed to the first axis. Moreover, showed the potential of self-sufficiency from own production. The second PC (axis 2) sort farms by khat area, production orientations and distances to the nearest market.

Khat production and age of the farmers showed a strong correlation, while they contribute to the second axis with distance to the road. These results indicate that older farmers had a relatively more area share for khat crop and living along the roadside. Farmers in Wondo Genet and Tula have better access to the main road which resulted in the dominance of cash crop mainly khat and coffee, compared to Hawassa Zuria. Besides, the potential for cash crop production, Washa town in Wondo Genet and Tula is the main collection centre, market and transit for khat produce. Tula is closest to Hawassa town and on the way to Shashemane and other surrounding towns to transit khat. The production orientation and distance to the nearest market contributed to the second axis, but on the opposite to khat production, age of the farmers and distance to the nearest road. Farmers in Hawassa Zuria, showed relatively higher production orientation, compared to Wondo Genet and Tula. Besides, the use of maize as a sole staple food source famer also uses maize as cash source over the studied period.

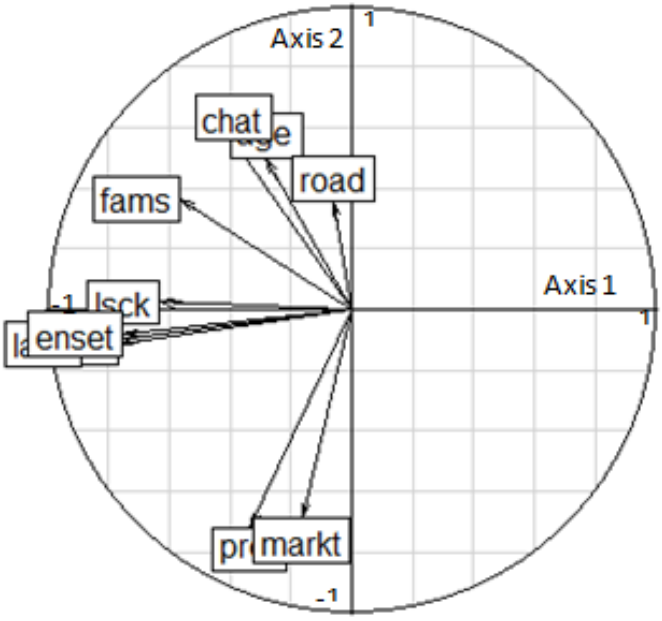


Figure 4.9: Representation of the quantitative variables on the first two principal components of *dudi. pca.*

Land, total farmland owned by the farmer; lsck, herd size; fams, family size; food, months of food self-sufficiency; pror, production orientation; khat, khat area; enset, enset area; markt, distance to the nearby market; road, distance from the road; age, age of farm household.

4.5. Description of farming system trajectory types

The hierarchal cluster analysis of the first two PCs was result three-board groups of farming systems trajectory (Figure 4.10). The three distinguished trajectories were present in all the three landscapes and constitute group of farms roughly with similar trends of change. The number of clusters was determined on the observed 'jumps' in the inertia inter-cluster on the bar plot.

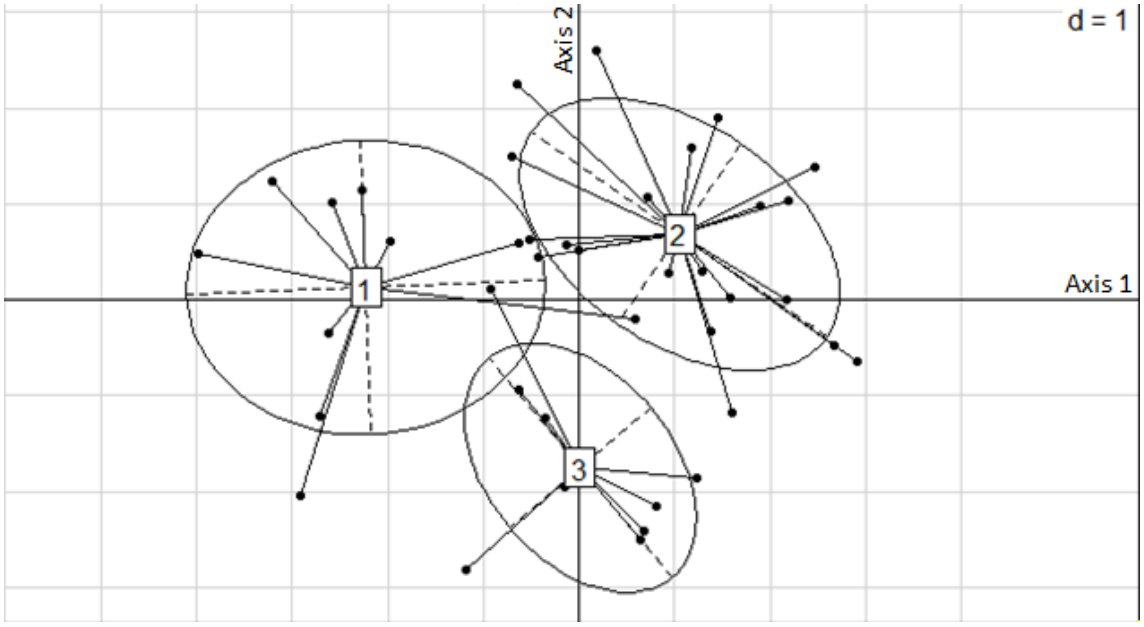


Figure 4.10: Positioning the farms on the first two principal components of the *dudi.pca*.

Almost all farms in each trajectory include off-farm activities as an additional source of family income. About 70, 67 and 100% of farms in trajectory 1-3, respectively include some kind of off-farm activities in 2014. Higher percentage involvement in off-farm activities in trajectory 3 were attributed to lack of other cash sources while farmers in trajectory 1 and 2 could fulfil their cash needs from cash crop production. General descriptions of each trajectory are given in the following paragraph:

Trajectory 1: (Moderate increase in farmland size, reduced annual crop area (maize), and increased perennial crop area (enset and khat), cash oriented production)

The group constitutes (n=10, 25%) farms that experienced moderate increase in farm land size (from 1.16 ha prior to 1991 to 1.33 ha in 2014), thereby increment in perennial crop (enset

and khat) area share and decreased maize area (Table 4.8). Farms from Wondo Genet (25%), Tula (33.33%) and Hawassa Zuria (18.75%) belong to this group. Average family size per household was increased from three at the beginning of farming activity to seven in 2014 and owned by relatively older farmers of about 46.2 years old. Farmers are food self-sufficient from own production for roughly eleven months in 2014. The production orientation of this type decreased from 83% prior 1991 to 76% in 2014. Livestock density declined from 11.86 TLU prior 1991 to 4.86 TLU in 2014. Moreover, farms in this group decreased annual food crop (maize) area share from 0.85 ha prior 1991 to 0.59 ha in 2014, while increasing perennial crop area share (enset) from 0.17 ha prior 1991 to 0.33 ha in 2014. Cash crop area share (mainly khat) was increased from 0.11 ha prior 1991 to 0.21 ha in 2014 (Table 4.7). The increase in perennial crop production in this type could be explained by relatively higher access to irrigation water (40%), compared to the other trajectories.

Trajectory 2: (Maintained farmland size, reduced annual crop area (maize), minor increase in perennial crop area (enset and khat), self-subsistent food and cash oriented)

The trajectory 2 grouped the greatest number of farms (n=21, 52.5%) that experienced stability in farm land size, thereby minor increment in perennial crop (enset and khat) area share (Table 4.8). Majority of farms from Wondo Genet (75%), Tula (58.33%) and Hawassa Zuria (31.25%) belongs to this group. Farms of this type were relatively owned by older farmers with a mean age of about 46.7 years. Average family size per household was increased from three at the beginning of farming activity to seven in 2014. This trajectory corresponds to self-subsistence food and cash crop orientation. Farmers are food self-sufficient for about ten months and characterized by low and decreased production orientation from 73% in 1991 to 54% in 2014. The lower production orientation could be attributed to the relatively smaller mean farmland holdings of 0.57 ha since 1975 and annual food crop area share, compared to trajectory 1 and 3. Moreover, cash crop area share of farms in this trajectory was lower (0.09 ha in 2014), compared to 0.21 ha in trajectory 1 in the same period. However, farms in this trajectory are closest to the road (1.1 km in 2014), compared to the other groups. Livestock density declined from 5.55 TLU prior 1991 to 1.49 TLU in 2014 (Table 4. 7).

Trajectory 3: (Maintained farmland size, reduced annual crop area (maize), increased and/or introduced enset, self-subsistent food crop oriented production)

Trajectory 3 grouped relatively small number of farms (n= 9, 22.5%) that experienced stability in farm land size, decreased maize area share and introduced enset (Table 4.8). Farms of Hawassa Zuria (50%) and Tula (8.34%) belong to this category. Farms in this group have predominated higher production orientation of 94% prior to 1991 and 89% in 2014. These could be attributed to higher access to agricultural inputs (89%) and credit service (78%), compared to trajectory 1 and 2. Farmers in this trajectory are food self-sufficient for only about six months, which is less as compared to trajectory 1 and 2. These could partly explain the dependency on annual crop (maize) both as food and cash source, compared to the other groups where enset and a khat would contribute to food and cash source, respectively. Moreover, the area share of the annual food crop (maize) area of 0.71 ha prior 1991 which declined to 0.53 ha in 2014. The relative decline in annual food crop could be explained by increased perennial food crop (enset) area share from 0.09 ha prior 1991 to 0.22 ha in 2014. Cash crop production was negligible for this type of farming systems over the studied period. These are assigned to lesser access to agricultural extension service (78%), compared to trajectory 1 and 2, which could contribute to food and cash crop diversification. Relatively younger farmers of about 38.9 years old undertake this type of farming systems. Average family size per household was increased from three at the beginning of farming activity to about six persons in 2014. Farmland holding of this trajectory was 0.85 ha over the studied period, and relatively keep the small number of livestock 3.96 and 1.47 TLU prior 1991 and in 2014, respectively (Table 4. 7).

Table 4.7: Main changes in farm characteristics according to trajectories of changes since 1970.

Variables	Periods	Trajectory 1	Trajectory 2	Trajectory 3	Overall average
Number of farms		10	21	9	
Farms distribution (%)		25	52.5	22.5	
Mean age of farm household		46.20±14.30	46.67±14.43	38.89±4.91	44.8±13.01
Family size (# of family members living with the farmer)	Farm start-up	2.70±1.80	2.76±1.69	3.22±1.98	2.85±1.73
	2014	8.40±3.24	7.19±2.74	6.00±1.18	7.22±2.77
Farm land size (ha)	Prior-1974	0.41±0.81	0.42±0.62	0.0±0.00	0.32±0.62
	1975-1991	1.16±0.64	0.58±0.27	0.85±0.51	0.78±0.50
	2014	1.33±0.49	0.57±0.24	0.85±0.27	0.81±0.45
Livestock size (TLU)	Prior-1991	11.86±13.37	5.55±10.19	3.96±5.31	6.72±10.44
	2014	4.86±2.25	1.49±1.42	1.47±1.16	2.32±2.16
Periods of food self-sufficiency (# of months)	2014	11.2±1.13	10.06±2.51	6.29±2.23	9.03±2.96
Maize area (ha)[a]	Prior-1974	0.32±0.67	0.25±0.39	0.00±0.00	0.21±0.44
	1975-1991	0.85±0.35	0.35±0.41	0.71±0.39	0.56±041
	2014	0.59±0.45	0.26±0.18	0.53±0.22	0.40±0.28
Enset area (ha)	Prior-1974	0.07±0.17	0.13±0.24	0.00±0.00	0.09±0.20
	1975-1991	0.17±0.12	0.14±0.14	0.09±0.10	0.14±0.12
	2014	0.33±0.15	0.11±0.09	0.22±0.12	0.19±0.14
Khat area (ha)	Prior-1974	0.0±0.04	0.03±0.06	0.00±0.00	0.02±0.05
	1975-1991	0.11±0.11	0.06±0.08	0.01±0.04	0.06±0.08
	2014	0.21±0.13	0.09±0.8	0.02±0.04	0.1±0.11
Distance to the nearest market (km)	Prior-1991	13.6±10.84	9.31±+11.69	14.43±10.62	12.17±11.11
	2014	4.6±1.52	3.78±1.32	2.75±2.11	3.62±1.97
Distance to the closest road (km)	Prior-1991	5.2±3.27	7.37±3.46	6.14±7.07	6.4±4.47
	2014	2.4±0.81	1.1±0.76	1.54±0.61	1.57±0.76
Production orientation (% of food crop area to total farm area)	Prior-1991	83	73	94	80
	2014	76	54	89	68
Involvement in off-farm activities (%) [a]	2014	70	67	100	75
Irrigation water (%) [a]	2014	40	29	33	33
Extension service (%)[a]	2014	90	81	78	83
Inputs service (%)[a]	2014	80	62	89	73
Credit service (%)[a]	2014	50	57	78	60

Source: Own computation from life history interview, 2014
Mean ± S.D: are calculated to study relative changes
[a]Supplementary variables not included in principal component analysis

Table 4.8: Trends observed in farming systems trajectories of evolution

Variables	Periods	Trajectory 1	Trajectory 2	Trajectory 3	Overall average
Family size (# of family members living with the farmer)	Change 2	↑	↑	↑	↑
Farm land size (ha)	Change 1	↑	↑	↑	↑
	Change 2	↑	↔	↔	↑
Livestock size (TLU)	Change	↓	↓	↓	↓
Maize area (ha)[a]	Change 1	↑	↑	↑	↑
	Change 2	↓	↓	↓	↓
Enset area (ha)	Change 1	↑	↑	↑	↑
	Change 2	↑	↓	↑	↑
Khat area (ha)	Change 1	↑	↑	↑	↑
	Change 2	↑	↑	↑	↑
Distance to the nearest market (km)	Change 2	↓	↓	↓	↓
Distance to the closest road (km)	Change 2	↓	↓	↓	↓
Production orientation (% of food crop area to total farm area)	Change 2	↓	↓	↓	↓

Change 1: difference of 1975 to 1991from the prior to 1974
Change 2: difference of post to1991 (2014) from the prior to 1991

4.6. Drivers of farming system changes

Increasing family size: The average family size of about 2.85 at the beginning of farming activity was increased to about 7.22 in 2014. These contributed to decreased per capital average farmland holding from 0.27 ha prior 1991 to about 0.11 ha in 2014 from sharing of arable land to family members. The change in farmland size is driving the change in farming system. A decreasing trends in per capital, land holding result a change of farming systems towards selection of valuable crops.

Economic return: The higher economic return from cash crop is driving farmers towards cash crop production mainly khat. Rises in the market price of agricultural produces: cash crops, cereals and vegetables are driving the changes in farming system of the area

Easy market access: Over the last two decade's improvement in access to market have been the main drivers of farming system change in the area (Garrity et al., 2012). A farmer in Wondo Genet and Tula district has more access to the "asphalt road", compared to Hawassa Zuria that cash crop, mainly khat is cash source. However, farmer in the Hawassa Zuria focuses on food crop productions. However, with the improved market access in the area continued subsistence-oriented production characterise farming system of the area.

Institutional change: Change in agricultural policy resulted from regime change enabled farmers to have access to agricultural extension services, agricultural inputs and credits, which could contribute to improved crop productivity.

5. Discussions

The study provides evidence of farming system dynamics between 1974 and 2014 in Hawassa area. The approach used in this study is holistic, combining different quantitative and qualitative data and attempted to describe the changes in farming system, and identify the main drivers of the changes; thereby understand the trajectories of farming system. Our approach differs from those studies which employ quantitative analysis to understand the trajectories of farming systems over a given period (Rueff et al., 2012; Choisis et al., 2012; Rueff and Gibon, 2010). Empirical studies of trajectory analysis based on an interview with farmers could have intrinsic limitations, in which collection of data relies on the farmers memories of past farming characteristics. According to Mottet (2005) and Cialdella et al., (2008) cited in Rueff et al., 2010 "relying only on data from farmers memories could present vagueness that will increase with time and will hamper precision in temporal analysis."

Therefore, our approach has the advantage that it would enable us to triangulate the perception of the communities in their local area, life history of individual farmers and quantitative analysis on the evolution of farming systems. Nevertheless, the approach has inherent limitations because of the difficulties in combining data derived by different methods and data of the different nature.

The participatory mapping based perception analysis shows that changes in the biophysical features of the area were observed since 1991. Arable land and habitat expansions were observed in Hawassa area. However, the increase was paralleled by eventual disappearance and conversion of natural forest and grazing lands. This aspect agrees with quantitative data and life history analysis of individual farmers that show changes in crop production over the studied period. The result also agrees with the work of Negash and Niehof (2004) who reported on the decline in natural forest and grazing lands and conversion to arable land in the area. Reynolds et al., (2010) also reported in Hawassa area on the loss of fertile flatlands with heavy machinery and conversion to maize mono-crop some 30 years ago and clearing of mountain slopes and galley forests from the population growth, which demand for expansion of farmland, fuel woods and construction materials. Dessie and Kinlund (2008) also reported on the expansion of khat crop at the cost of natural forest decline. The expansion of cash crops is driven by higher financial return from a particular crop, market and road networks in Wondo Genet and Tula. The result agrees with other studies that stated demographic

condition, economic and market factors result in the expansion of the khat crop production in Wondo Genet (Abebe, 2013; Dessie and Kinlund 2008).

Socio-political conditions and economic policy change explained at national level influenced land ownership change, access to the resource and economic process, thereby farming system changes at local level. The result in line with the work of Dessie and Kleman (2007) who reported on the pattern of political control and control over resource, and Belete et al., (1991); Zerihun (2009); Headey et al., (2014) who reported on farmers access to farmland as affected by the regime changes.

The quantitative analysis reveals three-farming system trajectories, which present in all the three landscapes. Trajectory 1: Moderate increase in farmland size, decreased maize area, increased enset and khat area, cash oriented production; Trajectory 2: Maintained farm land size, reduced maize area, minor increase in enset and khat, self-subsistent food and cash oriented; and Trajectory 3: Maintained farm land size, decreased maize area, introduced enset, self-subsistent food crop oriented and non-cash crop production. These characteristics, however, present the categorisation of farms built on standard farm household socioeconomic indicators, production orientation and market access.

The three-trajectory groups had clearly defined production orientation, which is characterised by decreasing trends post 1991. Trajectory 3 and 1 has predominantly higher production orientation, compared to trajectory 2. The post-1991, increase in the area share of cash crop (khat) and perennial food crop (enset), is because that cash crop production was more intense in Wondo Genet than Tula and the need for perennial food crop source in Hawassa Zuria. The increase in khat crop production, post-1991 was driven by higher financial return over any other crops per unit area and per annum multiple harvests favoured by improved market access. The result in line with the work of Dessie and Kinlund (2008) who reported on the intense production of the khat crop as favoured by access to road and transport facilities to enable efficient transport of the perishable produce. Abebe et al., (2010) also reported on the economic advantages of khat over coffee and ecological benefits of khat to that of maize post 1991.

The trends in enset production shown to increase over time in each study site for its drought resistance and a multipurpose use as food and fodder source. Focus group discussions and life history analysis shown that enset based food source helped farmers of Wondo Genet and Tula

to withstand the incident of the 1985 famine that happened at national level. The life history analysis and FGD confirm the result that in there saying

"We cannot live without enset as a food source, and enset has been our heritage that we received from our family, and Kocho (food prepared from enset) is our stable and cultural food."

However, enset is virtually never the sole food-source of households and is rarely their chief marketed item. The result contradicts with the work of Abebe et al., (2010) who reported on decreasing trends in perennial food crop (enset) in favour of the annual food crop (maize) in the area. The actions of the farmers were also encouraged by development projects promoting agricultural diversification like Goal Ethiopia (distribute enset seedling and vegetable seeds in Hawassa Zuria since 2004 (Table 4.3). Access to agricultural extension and technologies enabled the farmer to diversify their food crops source since 2004.

6. Conclusions

From the empirical evidence described above, we can derive the following conclusions: The report reflects the expansion of arable land area from the eventual disappearance of natural forest and conversion of grazing lands, per capital decreased farmland holding, decreasing trends in livestock density and change in production orientation. The study also reveals the decreasing trends in maize area share; while trends in perennial crop (enset and Khat) area share is increasing.

The observed change in farming systems were not only explained by the landscape itself. The biophysical factors, micro climatic conditions, household socioeconomic conditions and easy market access are factors drivers explained at the landscape level. The political system or regime change which is accountable to change in agricultural policy, access to resources, access to agricultural technologies and market are the driver of changes that could be explained at higher levels even at region and national level. However, some drivers are relatively specific to a given landscape. For example, development program intervention by different governmental and non-governmental organizations working to improve the livelihood of the farmers suffering from shortages of rainfall.

Three farming system trajectories that present in each landscape, constituting a group of farms roughly with similar trends of changes were distinguished. The trajectories were characterised by trends in resource endowment, production orientation and dominant crop production.

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Appendixs

Appendix 1: Average farmland holdings by landscape since 1970's

Districts	Prior to 1974	1975-1991	2014
Wondo Genet	0.35	0.51	0.66
Tula	0.54	0.97	0.87
Hawassa Zuria	0.15	0.85	0.91
Average	0.33	0.78	0.82

Source: Life history interview, 2014

Appendix2: Average dominant crop area by landscape since 1970's

	Maize pre-1974	Maize 1975-1991	Maize post 1991	Enset pre-1974	Enset 1975-1991	Enset post 1991	Khat pre-1974	Khat 1975-1991	Khat post 1991	Coffee pre-1974	Coffee 1975-1991	Coffee post 1991	Chili pepper 1975-1991	Chili pepper post 1991	Potato 1975-1991	Potato post 1991	Sweet potato post 1991
Hawassa Zuria	0.13	0.71	0.60	0.02	0.08	0.19	0.00	0.02	0.02	0.00	0.00	0.00	0.18	0.08	0.25	0.06	0.07
Tula	0.35	0.62	0.39	0.13	0.20	0.21	0.04	0.10	0.13	0.02	0.03	0.01	0.25				0.25
Wondo Genet	0.19	0.29	0.15	0.13	0.14	0.16	0.02	0.07	0.18	0.00	0.00	0.01					
Average	0.21	0.56	0.40	0.09	0.14	0.19	0.02	0.06	0.10	0.01	0.01	0.01	0.20	0.08	0.25	0.06	0.12

Source: Life history interview, 2014

Appendix 3: Principal component analysis summary

	Comp1	Comp2	Comp3	Comp4	Comp5
Eigenvalues	3.02	1.84	1.09	0.99	0.88
Projected inertia (%)	30.23	18.45	10.92	9.9	8.8
Cumulative projected inertia (%)	30.22	48.67	59.59	69.53	78.35
Component loadings	Comp1	Comp2	Comp3	Comp4	Comp5
Age	-0.28	0.50	0.64	0.04	0.29
Fams	-0.56	0.36	0.27	0.45	-0.28
Pror	-0.33	-0.72	0.34	-0.17	-0.18
Food	-0.77	-0.11	-0.15	0.01	0.12
Lsck	-0.63	0.02	-0.35	0.18	-0.55
Land	-0.89	-0.11	-0.01	-0.11	0.09
Enset	-0.75	-0.08	0.15	-0.11	0.22
Khat	-0.39	0.56	-0.53	-0.21	0.33
Markt	-0.16	-0.69	-0.09	-0.11	0.23
Road	-0.06	0.36	0.16	-0.80	-0.39

Appendix 4: Informal discussion checklist

Target group	Tool	Objectives	Checklist
Elderly farmers	Informal discussion	Obtain overview information on farming systems in the area	- How do you explain farming practice in this area - What the environment looks like over a time
		Determine the starting point of trajectory analysis	- Did you observe any changes in farming system - When did change observed - How did you explain regime change - How did you recall regime change and access to resource

Appendix 5: Focus group discussion checklist

Target group	Tool	Objectives	Checklist
Selected key informants	Participatory mapping	Perception on changes	- Land use/ crop type - Forest & grazing area - Degraded area - Main roads - School, health & farmers training centres, religious

			place
	Timeline recording	Timelines of events	- The most historical events - Bad weather - Regime change - Access to resource or technologies
	Self-categorization criteria identification	Farm typology	- Diversity between farm households - Criteria used to categories into groups - Types of farms/farmers

Appendix 6: Creiteria used to categorise farms into typologies.

Farms	Name of respondent	District	Kebele (PA)	Livestock	land	Month of food self sufficency	Crop diversity
1	Samiro Tifa	Tula	Tulo	7	1	12	5
2	Manitu Meligano	Tula	Tulo	4	0.5	10	4
3	Shuramo Holra	Tula	Tulo	2	0.5	10	3
4	Mariame Wageso	Tula	Tula	1	0.38	2	3
1	Hirpho Samago	Tula	Finchawa	2	2.5	12	5
2	Tomas Oyic	Tula	Finchawa	12	1	12	5
3	Tefera lema	Tula	Finchawa	5	0.91	10	5
4	Markose Shibery	Tula	Finchawa	0	0.26	5	3
1	Uburo Mersa	Tula	Alamura	13	1.03	12	4
2	Philipose Daleno	Tula	Alamura	7	1	9	4
3	Erpto Efamo	Tula	Alamura	4	0.88	6	3
4	Betac shotora	Tula	Alamura	0	0.27	1	2
1	Womitu Fulasa	H/Zuria	Kajma	3	1	12	4
2	Alemaz Earimias	H/Zuria	Kajma	3	0.75	11	4
3	Bilbile Biliso	H/Zuria	Kajma	3	0.19	10	3
4	Eyasu Ayula	H/Zuria	Kajma	0	0.64	6	2
1	Adote Agiso	H/Zuria	Dore bafana	3	1.7	12	3
2	Tese Arba	H/Zuria	Dore bafana	1	1	9	1
3	Kajela Kasamo	H/Zuria	Dorie bafana	1	0.43	10	3
4	Yonamsse Aberm	H/Zuria	Dore bafana	2	0.25	4	1
1	Ergamo Etemo	H/Zuria	Gallo argisa	19	2.5	12	3
2	Mermera Letemo	H/Zuria	Gallo argisa	6	1	5	2
3	Barsamo Banata	H/Zuria	Gallo argisa	5	0.7	8	2
4	Walena Hona	H/Zuria	Gallo argisa	2	0.5	6	1
1	Shakure kitessa	H/Zuria	Galalcha	14	1.7	12	3

2	Mengesha	H/Zuria	Galalcha	6	1.75	11	4
3	Esayas huriso	H/Zuria	Galalcha	3	0.63	10	2
4	Yoseph Alemu	H/Zuria	Galalcha	2	0.5	7	2
1	Nasie Safa	W/ Genet	Edo	7	1.31	2	3
2	Mentewad Bezunhe	W/ Genet	Edo	1	0.75	10	3
3	Bekele Shokota	W/ Genet	Edo	2	0.12	0	2
4	Kadir Bute	W/ Genet	Edo	0	0.02	0	2
1	Welaso Sedamo	W/ Genet	Aruma	2	0.8	12	3
2	Eshetu Gobaro	W/ Genet	Aruma	2	0.5	6	3
3	Wako Betiso	W/ Genet	Aruma	1	0.27	1	3
4	Bisru Gobano	W/ Genet	Aruma	2	0.11	0	2
1	Mataye Mersa	W/ Genet	Yubo	12	1	10	4
2	Wako lendamo	W/ Genet	Yubo	5	1	4	4
3	Tariku Ledamo	W/ Genet	Yubo	6	0.5	6	3
4	Samuel Futesa	W/ Genet	Yubo	0	0.19	3	3

Appendix 7: Semi-structured retrospective questionnaires for life history interview

Name of enumerator_____

1. General information

Date (GC):_____ District: _____Kebele: _____ Farm code: _____

1. What is your name? _____
2. What is your date of birth? _____
3. Where were you born _____or when did you settle on this area? _____
4. Educational level: 1. none 2. Elementary 3. Primary 4. Secondary 5. Post-secondary
5. Number of family members when start farming _____and currently _____
6. What are the sources of income to your family over a time?

Sources of income	Before 1974	1974-1991	After 1991	Comment
Crop farming				
Livestock rearing				
Crop-livestock production				
Non-farm income				
Other				

7. Is there any family member working outside the farm at the start of farming and currently 1. Yes 2. No
8. If yes, reason to work outside the farm 1. _____ 2. _____3. _____

10. If no, why? _____
9. Who will involve in non-farm activities? _____
10. What are the non-farm activities?

Activities	At the start of	Currently	Season of work	Use of

	farming		Off season	Active production period	When crop fail	income from it
Casual labour						
Small business (own shop)						
Trading						
Employment (pension)						
Others						

2. Farming system

11. What are the challenges to agricultural production over a time?

Period	Land shortage	Soil fertility	Water shortage	Lack of inputs	Labour shortage	Pests & disease (stem borer)	Feed for livestock	Weather condition change
Pre 1974								
1974-1991								
Post 1991								

12. What were the consequences of those challenges?

_____

_____

_____

13. Measures taken to manage the difficulties

_____

_____

3. Crop production

14. What are the dominant crops on your farm?

Crops	Pre 1974	1974-1991	Post 1991	Increased production? Y/N	How, e.g. area share, input use	Use priority C/F	Remarks
Enset							
Maize							
Haricot bean							
Other cereals							
Potato							
Sweet potato							
Chilly paper							
Coffee							
Khat							
Pin appeal							
Sugarcane							
Other fruits							
Carrots							
Cabbages							
Tobacco							

15. What limited you to diversify crops in different time?

Limiting factors	At the start of farming	Currently	Comment
Market access			
Land shortage			
Access to inputs & credit			
Access to extension service			

Lack of irrigation			
Disease, insect-pest attack			
Policy limitations			

16. What allowed you to diversify your crops?

Enabling factors	At the start of farming	Currently	Comment
Market access			
Extension service			
Inputs & credit			
Access to irrigation			
Land availability			
Policy			

17. How is the productivity of dominant crops over a time?

Types crop	Productivity per ha in pervious time	Crop productivity currently	Comment

18. Looking back over your farming life is there any difficult periods that stand out? 1. Yes 2. No When and what it was? _____
19. How did you manage the difficulties?

_____

_____

4. Livestock production

20. Do you have livestock? 1. Yes 2. No
21. Types & number of livestock

Period		Cow	Oxen	Sheep	Goat	Equines	Chicken
This year	Local						
	Improved						
30 years ago	Local						
	Improved						

22. Trend in number of livestock's? 1. Decreasing 2. Increasing
23. Reason if increasing?

_____

24. Reason if decreasing?

_____

5. Land use

25. Total area of land owed at the start of farming_____ and currently_____
26. What is your land use pattern over a time (in local unit)

Land allotted	Pre 1974	1974-1991	Post 1991	Change	Remarks
Maize					
Haricot bean					
Enset					
Khat					
Coffee					

Sweet potato					
Potato					
Vegetables					
Fruit					
Pasture					
Forest					
Marshy area					

27. Trend in arable land holding/HH 1. Decreasing 2. Increasing
28. Reason if the trend in arable land holding is decreasing: 1st _____
    2nd _____ 3rd _____
29. Which crop is your preference with decreased farm size? _____why?
30. Reason if the trend in land holding is increasing: 1st _____
    2nd _____ 3rd _____
31. Which crop is your preference with increased land size? _____why?
32. Do you have access to irrigation water? 1. Yes 2. No If yes, since when? _____
33. If yes what type of source 1.Motor pump 2. Water point 3. River 4. Catchment
34. Is there any change in type or number of crops you have been cultivating as a result of access to irrigation water?

    _____

    _____

5. Institution

35. How would you describe your access to agricultural resource, use and management in different time?

    _____

36. Do you have access to extension services? 1. Yes 2. No If yes, since when? _____
37. Do you have access to agricultural inputs? 1. Yes 2. No if yes, since when? _____
38. If yes, what are the common inputs you have been using?

    _____

    _____

39. What are the prices of agricultural inputs over time?

Period	Types of input	Amounts of inputs used	Price of input (birr/100kg)	
			Previous	Currently

40. What are the market prices of agricultural produce over time?

Period	Types of produce	Amounts of produce sold	Market price of produce (birr/100kg)	
			Previous	Currently

41. Is there any change in access to agricultural inputs over a time?

    _____

42. Do you have access to credit service? 1. Yes 2. No

43. If yes, are you using this service? 1. Yes 2. No If yes, since when? ___
44. Are there any cooperatives in your area? 1. Yes 2.No If yes, since when? ____
45. Are you a member of any cooperatives? 1. Yes 2.No If yes, since when? ____
46. What are the services provided by the cooperatives?

_____
_____

47. Are you involved in any form of local organization in the community? 1. Yes 2. No
If yes, what are the benefits of this organization to your crop production?

_____
_____

48. Distance to nearby market at the start of farming_____ currently _____km?
49. Distance from high way at the start of farming_____ currently _____km?
50. Transportation access over time_____

General comments

_____
_____

Appendix 8: Some pictures

Mapping exercise in Tula

Mapping exercise in Tula

FGD in Hawassa Zuria

FGD in Wondo Genet

Timeline recording in Tula

Timeline recording in Wondo Genet

Khat expansion in Wondo Genet

Khat expansion in Tula

Enset expansion in Tula

Maize & haricot bean intercropped with enset in Wondo

Maize and potato based annual crop production in Hawassa Zuria

Sugarcane market in Wondo Genet

Khat coffee-enset home garden in Tula

Feed shortage and enset based fodder source in Wondo & Tula