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A farming system framework for investment planning and priority setting in Ethiopia

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A farming system framework for investment planning and priority setting in Ethiopia

Tilahun Amede, Christopher Auricht, Jean-Marc Boffa, John Dixon, Thilak Mallawaarachchi, Mandi Rukuni and Tilaye Teklewold-Deneke

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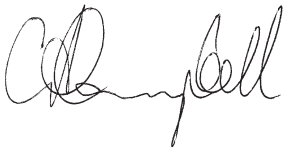
Foreword

The national economies of many Sub-Saharan African countries are growing at an impressive rate—the regional growth rate (excluding South Africa) of 4.2% in 2015 was second only to East Asia. Governments and African regional organizations, such as the Forum for Agricultural Research in Africa (FARA), and development platforms such as the Comprehensive Africa Agriculture Development Programme (CAADP) of the New Partnership for Africa's Development (NEPAD), seek to improve policies and priorities for rural development in a landscape dominated by a diverse population of smallholders with different needs and opportunities, depending on their farming system. Two key challenges are sustainable agricultural intensification and climate proofing of African farming systems to ensure more resilient and commercially oriented agriculture in coming decades.

In Ethiopia, agriculture supports 85% of the population who generate nearly half of gross domestic product and more than three-quarters of exports by value. National policymakers face challenges in formulating national investment plans, as encouraged under CAADP. The diversity of climate, natural resources and rural infrastructure across Ethiopia is enormous—perhaps more than any other country in Africa. This publication demonstrates one approach to supporting agricultural policymakers by systematically characterizing and mapping the farming systems of Ethiopia. The publication reports on a joint effort by the Rural Land Administration and Use Directorate of the Ministry of Agriculture, Ethiopia and the University of Queensland, Australia, supported by the Australian Centre for International Agricultural Research (ACIAR). The analysis and interpretation received valuable contributions from a dedicated group of researchers, managers and policymakers from the Ethiopian Institute of Agricultural Research (EIAR), Ethiopian universities, regional research centres, the Ethiopian Agricultural Transformation Agency (ATA), the United Nations Economic Commission for Africa and CGIAR centres.

This spatial framework that maps and characterizes the farming systems of Ethiopia provides a practical knowledge synthesis tool to support the identification and targeting of policies, institutional innovations and technologies for agricultural and rural transformation. The model reported in this publication could be adapted by other African countries to support agricultural transformation.



Professor Andrew Campbell
Chief Executive Officer, ACIAR

Contents

Acknowledgments

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This SRA was designed as a follow-up to the update of pan-African farming systems that is being developed into a new book. Extension of focus into planning and priority setting required extensive backing from Ethiopian researchers, planners and policy-makers from government, university and international donor agencies. Their assistance in identifying local collaborators, participation in discussions, deliberations at workshops and interpreting results from analysis to add the local context made this project a success. The research team gratefully acknowledges their support. We specifically thank the Director Ato Tigistu Gebremeskel and Senior Land Use Planning Expert Ato Demeke Tefese Kebede of the Rural Land Administration & Use Directorate, Ministry of Agriculture, Government of Ethiopia for their support in coordinating the work across Ethiopian agencies. The Ethiopian Agricultural Transformation Agency (ATA) provided inspiration to this project from its inception and helped attain the project's focus on capacity building for planning and priority setting. We especially thank Selamyihun Kidanu, Techane Adugna, Prof. Tekalign Mamo and Sam Gameda for their support.

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Authors

Tilahun Amede, International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Maputo, Mozambique; T.Amede@cgiar.org

Christopher Auricht, Auricht Projects, P.O. Box 400, Brighton 5048, South Australia, Australia

Jean-Marc Boffa, World Agroforestry Centre, Nairobi, Kenya; J.M.Boffa@cgiar.org

John Dixon, Australian Centre for International Agricultural Research (ACIAR), Canberra, Australia; John.Dixon@aciar.gov.au

Thilak Mallawaarachchi, Risk and Sustainable Management Group, School of Economics, University of Queensland, Brisbane 4067, Australia; T.Mallawaarachchi@uq.edu.au

Mandi Rukuni, Barefoot Education for Afrika Trust (BEAT), 79 Harare Drive, Marlborough, Harare, Zimbabwe; weshambo@gmail.com

Tilaye Teklewold-Deneke, Amhara Regional Agricultural Research Institute (ARARI), Bahir Dar 527, Bahir Dar, Ethiopia; tddeneke@yahoo.com

Preface

This study highlights the diversity of farming systems in Ethiopia and their significance as a basis for planning agriculture-led development interventions in diverse landscapes.

Farming systems are natural groupings of activities on the landscape that draw on natural features of land, highlighting areas of common value as well as differences. These arise due to the nature and extent of human interventions on natural systems to provide for increasing needs of human habitation. Many past interventions were designed and implemented with limited knowledge and resources. Technology-led advances in planning and evaluation that draw on multiple geo-referenced datasets within geographic information systems (GIS) today enhance development effectiveness by helping to target investment to priority needs.

The farming systems framework can assist development professionals in a range of tasks, from conceptualizing development interventions to proposal review and impact assessment, potentially resulting in designs that more closely follow local characteristics and natural systems. Such advances in information management, along with emerging concepts of geodesign, could extend tools that are used in urban landscape planning to agricultural and rural landscapes. Used appropriately with emerging knowledge, stakeholder consultation and more in-depth analysis as needed, these advances in information management and planning will help minimize social externalities and enhance the overall desirability of development interventions.

To make the best use of these information frameworks, the datasets underpinning the analysis and the knowledge gathered from individual experts need to be extended for careful investment in technology and human capital development. As concluded in previous studies of farming systems and associated resource use issues, the correct and diligent application of a range of technology options can enhance crop and animal production and make the use of land, labour and capital linked to these farming systems more efficient. In understanding broader upstream and downstream linkages, and designing policies to address cross-jurisdictional issues that result from broader resource management approaches, system-wide studies as well as more in-depth studies on subsystems will be required (Haileslassie et al. 2008; IAC 2004).

This report should therefore be seen as an initial step towards more systematic processes to support planning and enhance the targeting of development interventions and their local relevance.

Introduction

Agriculture is a predominant sector in African economies (International Monetary Fund 2012). In Ethiopia, agriculture accounts for around 46% of gross domestic product and 80% of exports by value. It supports the livelihoods of 85% of the population. Agriculture is likely to remain a key growth sector, particularly in rural Ethiopia. Hence, agriculture-led growth and economic development are crucial for meeting Ethiopia's needs for food security, income security and wealth creation objectives. In designing strategies for achieving these objectives, the remarkable diversity in Ethiopian pastoral and farming landscapes should receive careful attention. This technical report, developed in a small collaborative research study, provides an update of the spatial distribution of key features of the Ethiopian farming systems and traces some drivers that influence their transition. It aims to offer an improved understanding of the agricultural diversity of Ethiopia, and to provide a template for organizing investments for managing this diversity for long-term sustainable benefits.

Farming systems and the context of change

The snapshot of complex socioenvironmental systems that we identify as farming systems, and present on a map, needs to be viewed with respect to its long-term transition in the broader landscape. The map represents one of many possible ways to organize this diversity. It captures the influence of Ethiopia's geography, as it interacts with the evolving economic and social processes that continue to modify the landscape. In this transition, the changing composition of the landscape reflected in these farming systems provides a living record of farmers' adaptation strategies that allowed them to overcome long-term climatic and associated vegetation change. These have involved different levels of integration of crops, tools and labour with natural cycles of rainfall and soil fertility, as well as with the social vagaries of changing political systems (Gebissa 1996; Schoenbrun 1997).

Ethiopian farming has evolved over millennia, partly facilitated by the time-tested ox-plough technology (McCann 1995). The pattern of change has been a southward movement of farming systems from northern and central highland origins, to annual grain and pulse cropping regimes to supplement perennial livestock systems on the one hand, and highland perennial coffee and enset-based systems on the other. This transformation is still continuing, and the complexity of the underlying system is growing, providing key opportunities in productivity, income diversification and prospects for growth.

The analysis

The analysis in this report attempts to draw together the valuable insights of that rich history in a contemporary context of market-assisted agriculture-led growth. The process of identifying and spatially delineating farming systems, representing broadly similar patterns of resource use on the agricultural landscape, began with the use of existing data that can be linked to a location. Spatial analysis techniques were then used to interrogate datasets, including various data layers from agroecology, market access and population densities. This analysis helped identify similarities and differences amongst a set of agroecological and socioeconomic groupings. Local knowledge, in the form of active participation of a set of national experts from different agencies and regions with alternative perspectives, was then applied to identify each of the farming systems presented here. Although farming systems have some similarities, the key features that differentiate them from others define their separate identity, for the purposes of planning and priority setting.

The analysis demonstrates how factors such as market access, institutional support and population growth alter the features of previously dominant systems such as the pastoral systems, and create new

and emerging farming systems that take advantage of new economic opportunities. The analysis also points to region-specific or broad constraints that prevent changes from taking place. It can help estimate likely benefits when seeking to create new income and intensification opportunities to improve livelihoods. Hence it could assist in planning and priority setting for development activities such as the NEPAD Programme on Agriculture and Climate Change and the African Climate-Smart Agriculture Alliance.

Development planning

National, regional and local planners and policy makers, to whom this report is targeted, understand that policies that control access to natural resources and institutions such as markets have dominated the evolutionary dynamics of farming. Policies and strategies that stimulate markets, set appropriately, can contribute to incomes and the productivity of farmers' natural resources, by bringing tools and technologies to farmers' doorsteps.

Thoughtful development interventions that take note of the evolutionary context and find smarter ways to expand the limits that the current context imposes on farmers will improve the capacity for improving livelihoods. Such interventions—aimed at building skills, developing entrepreneurship and supporting self-reliance—targeted at farming systems level would offer the best hope for improving the productive use of these systems for the greater social good. These interventions support a lasting basis for income and wealth creation opportunities, as has been achieved in other contexts with good success. Following this view, this analysis aims to support development planning by identifying the operating context and prospects for commercialization opportunities for the different farming systems, which need to be further evaluated at a level of subsystems and local organization. Such further analysis will help determine appropriate investment strategies and identify effective policy instruments that will drive efficient utilization of natural resources, including conservation where appropriate.

Farming continues to evolve reflecting new opportunities presented by population growth, urban expansion, changes in natural resources and climate, technology and science—including human and financial capital-led developments such as irrigation, mechanization and market-focused production. Institutions and policies are crucial to build peoples' capacity to overcome the constraints they face. Policies and institutions stimulate markets and trade providing mutually beneficial gains, thus governing the direction and pace of change, and how benefits spread among the population. An improved understanding of the spatial and functional diversity of farming systems, such as summarized in this report, can help guide development priorities by relating investment opportunities and implementation plans in ways that recognize the sources of natural comparative advantage, the potential risks, and ways to mitigate them through effective public policies.

A farming systems approach to investment planning and prioritization

Food producers, both pastoralists and farmers, are an integral part of the broader farming systems in Africa. They support the livelihoods of a majority of the population, both on and off farms; hence they play an important role in the ongoing economic transformation in the region.

Smallholders operating one or more parcels of land, ranging from very small blocks of less than 0.25 ha to 25 ha of land on rare occasions, represent the majority of farmers in Ethiopia (Taffesse et al. 2011). Dixon et al. (2001) classified 72 global farming systems in six developing regions where smallholder production systems dominate livelihood patterns. They define a farm system as the household, its resources, and the resource flows and interactions at the individual farm level.

A farming system is defined here as a group of individual farm configurations that broadly contain a similar resource base, enterprise patterns, household livelihoods and constraints; and hence similar development strategies and interventions would be appropriate to enhance their growth potential (Dixon et al. 2001).

In this report, the classification of farming systems draws on the available natural resource base and the dominant pattern of farm activities and household livelihoods. The agroecology, i.e. the factors that determine the suitability of different crops and pastures, such as rainfall and temperature that influence the length of growing seasons, played a critical role in the classification adopted by Dixon et al. (2001). The current classification introduced here (Figure 1) takes advantage of technological developments since 2001 to better represent agroecology (Figure 2), together with an understanding of the influence of infrastructure and markets in farming systems dynamics. The expertise and field knowledge of researchers and policy practitioners were used to cross-validate analytical insights and draw out factors that separate different systems.

The underlying analysis captures key drivers of agriculture-led economic growth that provides business, employment and income opportunities, as influenced by links to markets, infrastructure and services; and available resource endowments, including the natural resources and climate. Thus it offers a framework for enhancing public policies and institutions and targeting investments in infrastructure and services that will empower smallholders and small and medium enterprises (SMEs) that are linked to agriculture and pastoral livelihoods, and link the rural sector with large enterprises and technologies that collectively underpin the agriculture sector performance (Figure 3). This analysis was achieved through an iterative process (Figure 4) leading to the identification, delineation and characterization of the farming systems presented in this report.

The contemporary view of farming systems thus embodies four core characteristics:

- it builds on systems thinking;
- it considers various system components at scales relevant for decision-making;
- it embraces close collaboration between social and biophysical sciences; and
- it relies upon analysis of formal datasets and expert judgements to identify new change processes.

Climate variability and change

Many factors influence the variability in production across farming systems. Amongst them, climate variability has a high degree of influence on production in Ethiopian farming systems, particularly in drought-prone areas. Recent studies have revealed that there has not been a significant change in rainfall amount during annual *Kiremt* and *Bleg* seasons over the last 30 years (Suryabhagavan 2017). However, there has been a significant change in rainfall variability over the same period, particularly in the low-lying pastoral and agropastoral farming systems. Figures

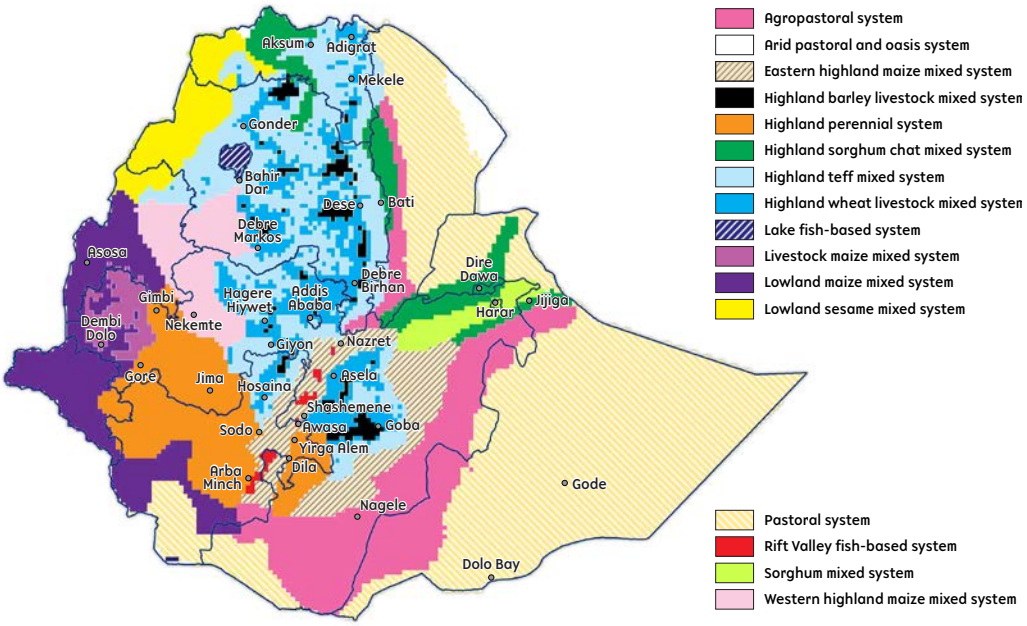

Figure 1. Ethiopian farming systems defined by the current study.

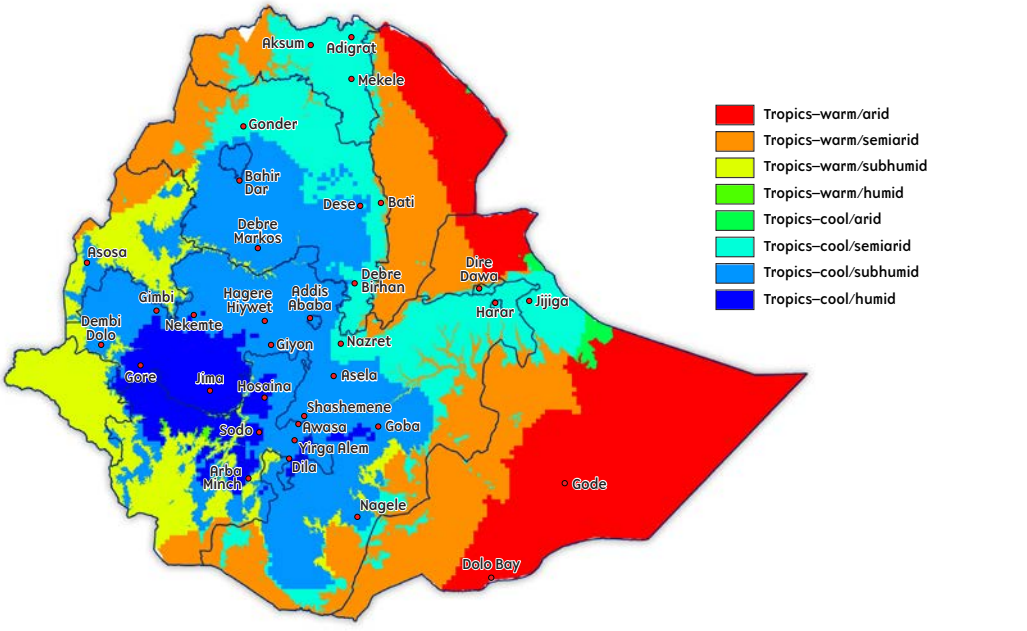

Figure 2. Agroecological zones of Ethiopia, based on Global 16 Class classification system (Sebastian 2009).

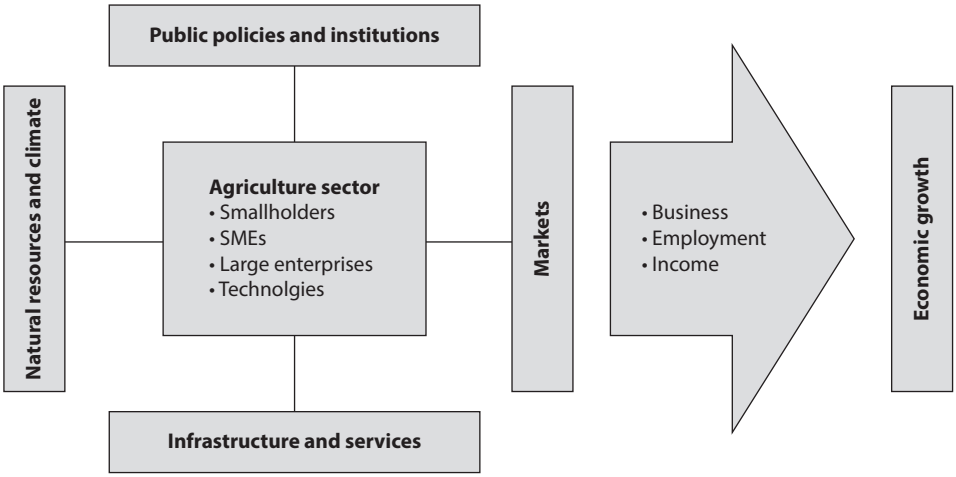

Figure 3. The farming systems and agriculture sector-led economic growth framework.

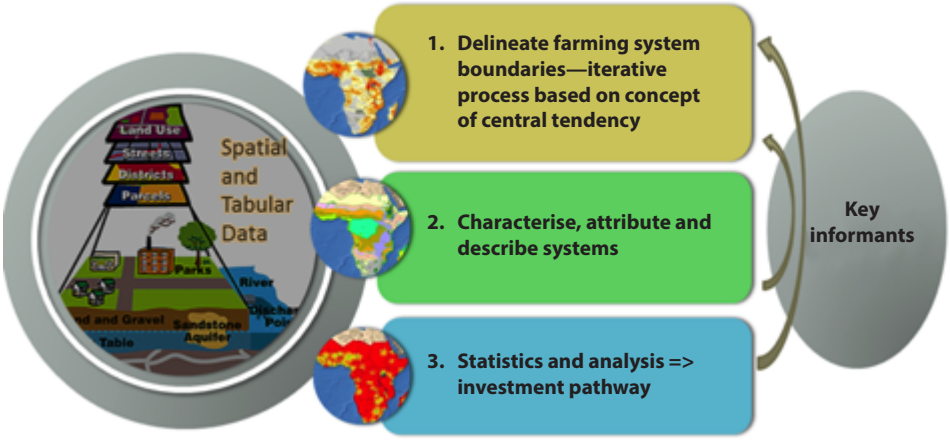

Figure 4. Iterative three-step process for identification, delineation, characterization and analysis of farming systems.

for rainfall received show that, in most of the stations, there has been an increase in frequency and intensity of extreme rainfall events. It has been observed that the number of rainy days with rainfall above 10 mm/day, and rainfall events such as the greatest 10-day total rainfall, are significantly increasing over time across the country. On the other hand, the drought frequency and magnitude vary considerably across Ethiopia. While northern and southern Ethiopia showed higher magnitude and duration of drought events, western Ethiopia has exhibited only two major droughts in the last 30 years (1983–84 and 2002–03), with higher magnitude as well as duration. In general, changes in surface temperatures are more substantial

than changes in rainfall (Figure 5). Together, rainfall and temperature variation influence decisions on crop choice, farming practices, pest and disease incidences and water management strategies.

These variations in natural resources and climate affect farmers to varying degrees, depending on their ability to cope with consequences. In a broader farming systems and agriculture sector-led economic growth framework, the local context, including the characteristics of public institutions, infrastructure and services, and market linkages, will collectively define the external environment that moderates or accentuates the impacts from exposure to changes in the natural environment (Figure 3).

Thus, a farming systems view that captures both the internal and external operating environment of a farm, including farm–non-farm interactions, can better contribute towards sustainable rural development planning, harnessing both interdisciplinary collaborations and local actor engagement.

This approach could provide a more effective basis for organizing information, and identifying knowledge gaps and development opportunities. It could also facilitate the planning and prioritization of changes in resource use and management, to create more opportunities for sustainable growth consistent with social aspirations at a community scale. In determining interventions for improving economic opportunities it is crucial to appreciate the dynamic nature of farming systems and their interaction with the natural environment as also influenced by the institutional context (Darnhofer et al. 2012). Information systems that support these interactions at the region, landscape or farm household scale can stimulate efficient organization of activities across scales and thereby enhance the prospect of sustainability.

In the remainder of this report we identify and describe key farming systems in Ethiopia, drawing on a participatory analysis of the various aspects of the farm operating environment.

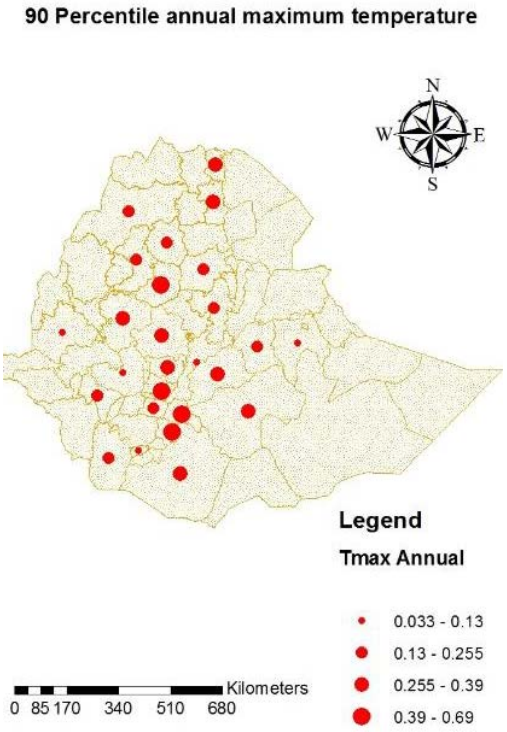

Figure 5. Temporal variability in temperatures in Ethiopia (Suryabhagavan 2017).

Key farming systems in Ethiopia

Agropastoral farming system

Figure 6. The agropastoral farming system area in Ethiopia.

Basic system data	
Total population 2010 (million)	1.96
Agricultural population (million)	1.55
Urban population (million)	0.412
Time to 20K market (h) (range / average)	1–38 / 9
Dominant agroecological zone	Warm/semi-arid
Elevation (m) (range / average)	296–2,094 / 1,102
LGP (days) (range / average)	80–251 / 141
Annual rainfall (mm) (range / average)	265–1,148 / 648
Cultivated area (million ha)	1.046
Cattle (million)	2.04
Goats and sheep (million)	1.74
Number of rural poor (<US$1.25/day)	596,555
Percent of total rural poor in Ethiopia	2.5%

LGP = length of growing period.

General characteristics

The agropastoral farming system extends from Moyale through the southern part of Guji zone to Jijiga zone of the Somale region (Figure 6). It also includes part of the Chefa valley, through Bati to Raya. It extends over 12.67 million ha and features a combination of pastoral and crop production activities at varying levels, interspersed with other land uses, depending on the relative suitability, largely dictated by the availability and reliability of soil moisture for crop production. Cropping activities tend to dominate the mix in terms of income, particularly in favourable seasons, whereas the livestock component acts as a source of income security, draught power, wealth and livelihood diversity (Tolera and Abebe 2007). Two contiguous areas where agropastoral systems are the dominant land use are located in the semi-arid lowlands located east of the Ethiopian Central Highlands and south of the Ahmar mountains (Figure 6). Therefore, the actual area occupied by this system is estimated to be 1.046 million ha.

The agropastoral system is a sedentary form of farming. The proportion of farm-based livestock feed is usually used as a basis for its demarcation. In this system around 30% of animal feed originates from crop residues from farmers' fields, and 70% is sourced from communal grazing areas. Depending on the nature of cropping activities, a range of herding practices can be found. Herds are generally small and often, when feed and water resources are scarce, farmers bring their stock together for short distance movement to grazing areas. During the seasonal transhumance, where people move with their livestock between sources of pasture, herders from the agropastoral system interact with herders from the pastoral farming system. This illustrates the fact that sharp boundaries between neighbouring farming systems do not exist, as stressed by Dixon et al. (2001).

In recent years, farm households in this system have increasingly looked for opportunities to supplement their incomes through non-farm activities. As a result, remittances from migrants to the Middle East, informal trade with Somaliland and cattle trade with Kenya are becoming increasingly important as income supplementation in this system.

The major ethnic groups practising agropastoral farming are the Oromo, Afar and Somali people. Being a subsistence-oriented system, and with around 75% of the 2.08 million population linked to agriculture, the level of poverty in the agropastoral farming system is relatively high (38%). This situation presents strong opportunities for development through commercialization opportunities that favour sustainable intensification.

Natural resource context

Vegetation is characteristically dominated by *Acacia* shrub species, which serve as an important source of fodder, firewood and charcoal. In this lowland farming system, the main terrain is flat and soils are generally poor. Luvisols dominate the soil landscape. Rainfall is bimodal in the northern agropastoral region while in the southern area it is unimodal. Water availability is relatively limited but this varies locally; for example, the valley bottoms have more soil water than the hillsides. The decline of the Chefa wetlands, in South Wollo zone in Amhara State, is attributed to overgrazing, irrigated farming and population growth (Aragaw 2014). This area experiences seasonal overexploitation by pastoralists migrating from drier areas during the months of February to June, which is changing the ecosystems of the Chefa wetlands.

Production systems

Agropastoral farming systems are mostly low-intensity, low-input/low-output systems; however the purchase and use of fertilizers is increasing to address soil deficiencies, especially for areas with maize and beans. The average holding size is around 1 ha but this varies depending on soil type.

The main crops grown in the agropastoral system are sorghum, millets and beans, some of which receive fertilizer applications indicating a trend towards intensification. Maize, chat, and to a lesser extent teff and vegetables are grown for home consumption, usually around the household compound and on irrigable farms. This mimics the home garden component of tropical Asian farming systems, but with a low level of diversity. Livestock production includes mostly cattle with some sheep and goats.

Irrigated areas within this system are estimated to cover around 31,000 ha.

Trends and drivers of change

Trends in the farming system include new irrigation schemes, increasing population, and outmigration to the Middle East as well as to urban areas for employment. The area dedicated to sedentary agriculture is increasing to the detriment of grazing areas, partly due to settlement programs of the government. The farming system is now served with increasing extension, water infrastructure and health services which support agricultural development, and intensification, such as increased use of fertilizers. The road network and access to electricity are also improving. The coverage of mobile phone networks has also expanded.

As oxen are the sole providers of draught power for tillage, while cattle and other livestock supply manure for soil fertility maintenance and fuel, there is strong interdependence between the crop and livestock components in this system.

Investment opportunities

- The relative proximity to main sealed roads and urban centres, and the broad mix of crop and livestock activities across a large region, are key to the development potential of this farming system. However, the highly variable climate and the relatively short growing season present limits for sustainable intensification pathways.
- Investment opportunities need to consider crop–livestock subsystem-scale interactions to allow the two subsystems and associated livelihoods to support each other. External flows of capital that enhance productivity and small-scale enterprises are critical development pathways.
- There is an increasing number of irrigation schemes, including on large sugar estates and cotton farms, which are providing options for growing high-value crops and diversifying livelihood options. Creating local capacity in market-oriented farming, including fattening for export markets, could be an entry point to facilitate system change.
- Population growth and low crop productivity can increase land degradation, pushing cultivation into agriculturally marginal lands that were previously used for livestock grazing. Hence the efficient utilization of crop residues as livestock feed has become more important. This could create an incentive for expanding small cereals like teff and barley, which involve more tillage before sowing as they are traditionally believed to require a well-pulverized seedbed.

Arid pastoral and oasis farming system

Figure 7. The arid pastoral and oasis farming system area in Ethiopia.

Basic system data	
Total population 2010 (million)	0.13
Agricultural population 2010 (million)	0.057
Urban population 2010 (million)	0.072
Time to 20K market (h) (range / average)	3–11 / 5
Dominant agroecological zone	Arid
Elevation (m) (range / average)	21–1,736 / 385
LGP (days) (range / average)	22–33 / 27
Annual rainfall (mm) (range / average)	144–273 / 204
Total area (million ha)	1.11
Cultivated area (million ha)	0
Irrigated area (million ha)	–
Cattle (million)	0.011
Goats (million)	0.001
Sheep (million)	0.005
Number of rural poor (<US$1.25/day)	21,381
Per cent of total rural poor in Ethiopia	0.09%

LGP = length of growing period.

General characteristics

This farming system is a part of the continental arid pastoral and oasis system that stretches across west, northeast and southern Africa and extends into a small area in Ethiopia, in the northeastern part of the Afar region (Figure 7). The main part of the system is located within the Elidar woreda bordered by Eritrea to the northeast and Djibouti to the south.

Livelihoods derived from date palms, cattle, small ruminants and off-farm work are typical in this poorly documented but important farming system. Salt mining and sometimes tourism can provide off-farm income.

The average length of the growing period is less than 30 days. In the Ethiopian part of this farming system, scattered irrigated crops along river banks provide some food supply, which is otherwise heavily dependent on livestock.

Local communities survive on rainwater collected in cisterns or dams, as well as steam wells ('bonya' in the local language), a traditional water harvesting technology unique to the Afar that harvests steam ascending from underground streams passing through burning volcanic rocks.

Because of the poor water facilities, water management and sanitation linked with poor health status are key issues in this area. The incidence of rural poverty in this system is high (Medhin 2011).

Natural resource context

The area is hyperarid, the driest and hottest part of the Afar region. Annual rainfall is very limited in time and amount and varies greatly from year to year, resulting in frequent water shortages and severe droughts in some years, lasting from mid-October into July of the following year as reported recently by the Afar Pastoralist Development Association.

The terrain is volcanic and rocky, and allows only scattered human settlements. The soils are characterized by Lithic Leptosols consisting of hard volcanic ashes and sandy soils.

Production systems

Camels, sheep and goats are the most important livestock species. The pastoral lifestyle relies on mobility of livestock, which is the only option to adapt to the prevailing harsh and unstable environmental conditions, and find forage and water. This movement also allows grassland to regenerate during the wet season in normal rainfall years. In times of peace, the pastoral system traditionally relies on grazing areas at far distances in Eritrea and Djibouti.

Women, elders and children lead a more sedentary life in small settlements and take care of smaller ruminants. A permanent water source is crucial for their survival. The better-off pastoralists are able to keep cattle and buy fodder to complement grazing resources. Purchased cereals supplement the pastoralists' food, which is based on livestock products. Chronic water shortages, recurrent drought and livestock diseases are the main challenges in this farming system.

Trends and drivers of change

Drought stresses the nomadic arid pastoral system, and responses include water trucking and the building or rehabilitation of cisterns. When they can, communities move the herds to more favourable grazing. Milk becomes less available as healthy livestock move out of affected areas and local food prices rise well above the national average. Malnutrition of children under five is on the rise. Food security challenges are exacerbated by remoteness and the fact that the people and the region are marginalized from national decision-making processes. These parts of the Afar region are poorly supported by basic services including health and education.

Investment opportunities

- Due to the constant need for water, water interventions are needed based on hydro-geological, cartography and mapping research toward drilling for water.
- Provision of animal feed and veterinary services would improve livestock productivity and health, and address rising levels of malnutrition in children under five.
- Disaster risk reduction approaches could increase the resilience of the nomadic farmers.

Eastern highland maize mixed farming system

Figure 8. The eastern highland maize mixed farming system area in Ethiopia.

Basic system data	
Total population 2010 (millon)	7.61
Agricultural population 2010 (millon)	6.02
Urban population 2010 (millon)	1.13
Time to 20K market (hours), range / average	0–27 / 8
Dominant agro-ecological zone	Cool/subhumid
Elevation (m), range / average	878–2,733 / 1,536
LGP (days), range / average	123–265 / 194
Rainfall (mm), range / average	688–1,425 / 967
Total area (millon ha)	5.83
Cultivated area (millon ha)	1.04
Cattle (millon)	4.19
Goats (millon)	1.82
Sheep (millon)	1.42
Number of rural poor (<US$1.25/day)	2,184,338
Percent of total rural poor in Ethiopia	9%

LGP = length of growing period.

General characteristics

This system is primarily concentrated in the plateaus of the Rift Valley, extending from Derashe to Butajira in the western part and from Guji to Eastern Harerghe in the eastern part (Figure 8). Several national parks are found in the southern part of the farming system, with Awash National Park the main one.

The dominant crops are maize and haricot bean, which are often intercropped. Secondary crops include wheat, teff, potato, sweetpotato, intensive

vegetable production (onion, tomato, irrigated snap beans, rainfed pepper), greenhouse flower production for export, pawpaw, watermelon and strawberry, as well as vineyards. The production of mango, banana and cotton has increased in the southern Rift Valley in recent years. The crops in the eastern and western areas of the system are similar apart from cut flowers which are generally associated with irrigation. Small-scale irrigation is also practised, particularly around Ziway and Koka lakes, producing fruits and vegetables for Addis Ababa markets. Irrigation is practised only in areas where water quality and supply are suitable. The irrigated area is about 0.055 million ha.

A large sugar plantation has become the dominant land use activity in the Wonji and Metehara areas.

In order of importance, the main livestock types are cattle (for milk and beef production, draught and prestige), donkeys (for transportation), goats and chickens. Herds of livestock are sometimes clustered into groups for communal grazing and are grazed on residues from fields. Including all livestock types, the average herd size is 10. There are also a number of intensive commercial livestock fattening feedlots and chicken farms in the farming system, targeting Middle Eastern markets.

Fishing is practised in local Rift Valley lakes, providing livelihoods to thousands of fishermen. For off-farm income, farmers also get involved in commercial flower farms, charcoal production, petty trade, and casual labour both on other farms and outside agriculture. Other enterprises include wine production, tourism and crocodile farming.

Poverty prevalence in this farming system varies widely, reflecting market access and engagement in off-farm activities and production of high-value crops. Poverty rates are lower in southern areas, where productivity is higher.

Ethnic groups working in the eastern highland maize mixed farming system are Oromo, Derashe, Kembata and Hadia.

Natural resource context

Acacia woodlands make up the most common vegetation type. Soils in the farming system include Andosols, Vertisols and Fluvisols. At 700 mm rainfall is not limiting. Fluoride toxicity of groundwater has developed, making water unpotable.

Production systems

The average farm size in the eastern highland maize mixed farming system is about 1–2 ha. In Wollaita zone, the average landholding is less than 0.75 ha per family of seven. The system is characterized by high management intensity, a high level of market linkages and extensive crop commercialization. This farming system has the second largest area under large-scale irrigation.

Trends and drivers of change

This system has undergone significant transformation in recent years. Horticulture has been a focus of investments and vegetable production (onion, tomato) has increased around lakes. There is increasing investment in commercial flower farming, employing thousands of young people all year round. The area of maize cultivation has also recently increased in Awash and Ziway. The system is supplied with a high level of infrastructure and services, for example well-connected road networks and electricity. There is a range of labour opportunities and a high rate of urbanization.

Investment opportunities

- There are significant opportunities for sustainable agriculture-led growth in this system, through greater investment in developing market access, grain storage, efficient irrigation systems and input supply chains (Kindu et al. 2014).
- The priority investment areas would be catalysing the growth of undeveloped industries, such as improving the feed supply for the poultry industry, along with setting policy incentives for increasing productivity and improving market linkages (IFPRI 2010).
- A new train line from the production areas of the central highlands to Djibouti port will reduce transport costs and increase the opportunity for maize to be traded internationally.
- There is also an opportunity to develop the beef sector through improved crop–livestock integration, adapting from the neighbouring sorghum-based Harerghe highlands.

Highland barley–livestock farming system

Figure 9. The highland barley–livestock farming system area in Ethiopia.

Basic system data	
Total population (million)	2.43
Agricultural population (million)	2.00
Urban population (million)	0.27
Time to 20K market (h) (range / average)	2–38 / 11
Dominant agroecological zone	Cool/subhumid or semi-arid
Elevation (m) (range / average)	3,003–4,265 / 3,298
LGP (days) (range / average)	124–278 / 210
Annual rainfall (mm) (range / average)	551–1,565 / 1,146
Total area (million ha)	1.63
Cultivated area (million ha)	0.35
Cattle (million)	1.26
Goats and sheep (million)	0.30
Number of rural poor (<US$1.25/day)	786,430
Per cent of total rural poor in Ethiopia	3%

LGP = length of growing period.

General characteristics

The highland barley–livestock farming system occupies the highest range of the Central Ethiopian Highlands, from Chilalo Highlands to Simien Mountains (Figure 9). Due to the cool, subhumid to semi-arid climate, barley and potato are the two dominant crops followed by oats and pulses including faba bean. In Ethiopia barley is ranked fifth of all cereals, and is mostly grown in this system. Barley yields rarely exceed 1.5 t/ha. It is used mainly as

food, and to make the traditional beer (Tella) for household consumption during festive seasons and for generating cash at other times. Crop residues, including straw, are fed to livestock. Potato is grown either as a relay crop or mixed with the barley. Potato production during the short rains is constrained by a high prevalence of late blight (caused by *Phytophthora infestans*). Very limited fertilizer use occurs, and the majority of farmers do not apply chemical fertilizers. The system also includes some tree crop production, with the emergence of apples, and small homegarden enset patches.

Sheep are the dominant livestock type, with one or two cattle for milk production and equines for transportation of goods across the mountainous terrain. Livestock is kept throughout the year on natural pasture, rangelands and stubble.

For off-farm income, farmers get involved in petty trade and sell their labour for agricultural work at lower altitudes.

Poverty prevalence in the system is high, representing around 3% of the total poor in Ethiopia.

Natural resource context

The system has an altitude range of 3,000 m and above. Vegetation is characterized by juniper and *Hagenia*-based alpine plant formations. The soils vary between locations and include Leptosols, Glyic Cambisols, Vertic Cambisols and Eutric Regosols. Soils tend to be hard and marginal with acidity issues. Annual rainfall is high, between 800 and 1,800 mm. Temperature ranges from below freezing to a maximum of 20°C, with a high probability of frost at night, particularly in October and November.

Production systems

Farm plots are generally small, about 0.25 ha on average, but farming multiple plots the average area operated per household is around 2 ha. This makes communal grazing of rangelands the most important livelihood strategy for these farming communities. Livestock, particularly small ruminants, play a very important role across this system as a source of cash to buy food during bad years, but also for purchasing agricultural inputs (e.g. farm implements and fertilizers), basic household necessities and paying government taxes. Manure serves as a major source of fuel and organic fertilizer.

The highland barley–livestock farming system has a strong subsistence orientation and is characterized by low productivity. Frost, land degradation and erosion are major production challenges.

Trends and drivers of change

This system is one of the most food-insecure systems, aggravated by the challenging terrain, the lack of market opportunities, shortage of capital, poor communication infrastructure, poor institutional and extension support and limited off-farm income opportunities. Crop failure in this system is commonly compensated by food purchase from selling sheep and goats or through food aid. However, this is slowly changing as more farmers are getting access to agricultural inputs. There is also an increasing investment in roads and mobile telephone connectivity, which implies improving access to markets, technologies and information flows.

Investment opportunities

- A lack of incentive mechanisms and targeted extension for barley-based farmers hinders progress.
- Highland sheep is highly preferred by urban consumers for its ‘spicy meat’ which is due to the oregano-based pastures. This meat fetches about a 10% higher price than meat from other areas. Improving sheep breeds, veterinary services and market value chains would significantly intensify the system.
- Increasing demand for malt barley arising from the growing demand for beer provides a useful agriculture-led development prospect, which could also expand opportunities for intensive poultry and small animal production activities in the adjoining lowland areas with better market access.
- Temperate fruits, particularly apple and pear, have already been introduced into the system, and should be scaled out along with value addition, processing and packaging.
- Given the fragility of these systems there is a need to strengthen efforts in watershed management. For example, with site limitations such as moisture deficit or waterlogged conditions, promotion of inputs like fertilizers and improved seeds may not be effective without complementary land and water management technologies (Erkossa et al. 2009).

Highland livestock–maize mixed farming system

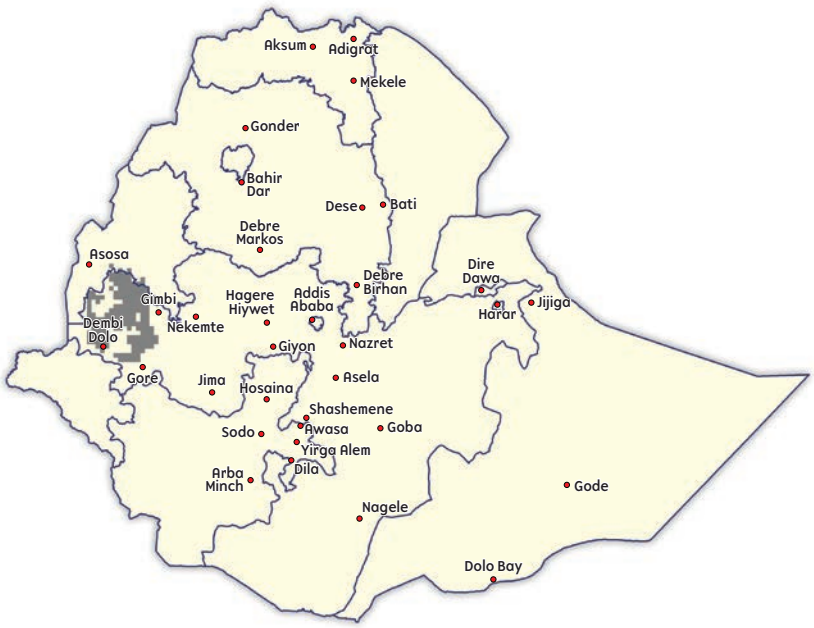

Figure 10. The highland livestock–maize mixed farming system area in Ethiopia.

Basic system data	
Total population 2010 (million)	1.59
Agricultural population 2010 (million)	1.39
Urban population 2010 (million)	0.077
Time to 20K market (h) (range / average)	0–24 / 6
Dominant agroecological zone	Cool/subhumid
Elevation (m) (range / average)	1,502–2,474 / 1,682
LGP (days) (range / average)	210–264 / 236
Annual rainfall (mm) (range / average)	1,304–1,696 / 1,548
Total area (million ha)	1.56
Cultivated area (million ha)	0.027
Cattle (million)	0.81
Goats and sheep (million)	0.88
Number of rural poor (<US$1.25/day)	481,598
Per cent of total rural poor in Ethiopia	1.9%

LGP = length of growing period.

General characteristics

The highland livestock–maize mixed farming system[1] is found in western Ethiopia, particularly in Kelen Welega and Illibabur zones (Figure 10). The dominant commodity of the farming system is livestock, raised for meat, milk and draught power. The main livestock components are cattle and sheep with less emphasis on goats. Production relies on communal grazing. Some crops, such as maize, sesame and sorghum, are raised around household compounds and supplement household consumption needs. Anchote (*Coccinia abyssinica*), an endemic plant grown for its edible tuberous root with high calcium content, is a food, cultural, social and economic crop for farming communities. Excess production is sold in local markets in Gambela. Tree crops include coffee, mango and banana.

Coffee processing and trading activities provide the main source of off-farm income. Informal cattle trade to Sudan and formal trade to the regional capital city as well as traditional gold mining are other income-generating activities in this system. Poverty levels vary reflecting the level of perennial crop integration and off-farm opportunities.

Natural resource context

Agricultural uses dominate the landscape with only small areas of natural vegetation remaining intact. The landscape comprises mid-altitude rolling hills, with soils predominantly characterized as Chromic Vertisols. Annual rainfall is high, and associated with denuded vegetation, this creates potential water erosion problems.

Production systems

The average farm size ranges from 0.5 to 1 ha. Farmers mostly rely on rainfall for crop production but small-scale irrigation is also practised. The system's population density and average farm size are intermediate between the more densely populated highland perennial system and the more extensive lowland maize mixed farming system. The level of system commercialization and market orientation is in the low to mid range, with coffee and maize being the main marketable outputs. Coffee is sold to neighbouring south Sudan and vegetables are sold in the Gambela market.

Trends and drivers of change

Given the high proportion (87%) of the population engaged in agriculture, seasonal rural to urban migration is a characteristic of the farming system. Investment in infrastructure such as irrigation and access to electricity, roads and mobile phone communication networks is ongoing. The Ethiopian Commodity Exchange has promoted commercial activity and absorbed coffee production, the majority of which was previously going to Sudan. There is a severe erosion hazard owing to poor agricultural practices and limited investment in soil and water conservation.

Investment potential

- The relatively favourable rainfall, proximity to markets and the cool subhumid conditions offer good potential for sustainable intensification involving high-value land-preserving farming systems.
- Crops such as anchote offer potential economic opportunities given the fact that it is endemic, its genetic diversity and its adaptation to the range of conditions in this region (Bekele et al. 2014).

[1] In the Ethiopian context this region is considered as mid-highlands. The classification adopted here reflects the broader pan-African context.

Highland perennial farming system

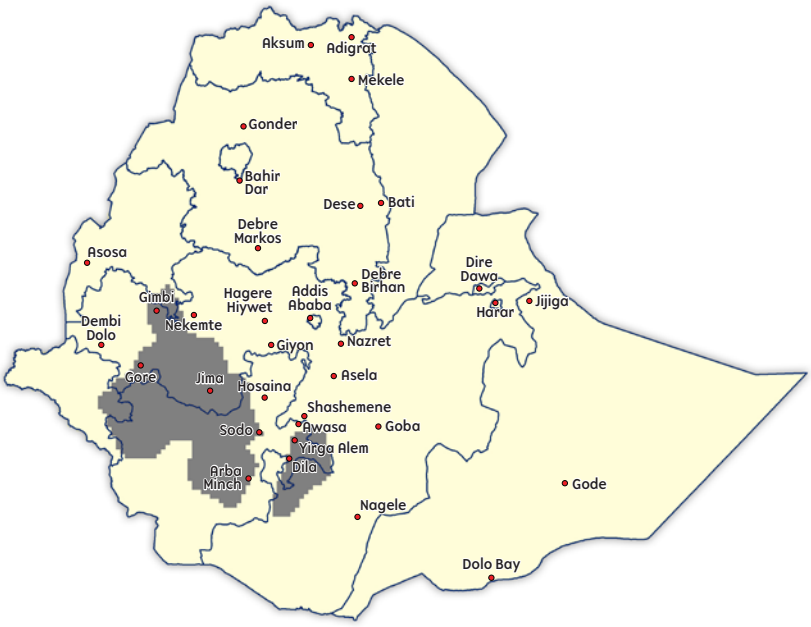

Figure 11. The highland perennial farming system area in Ethiopia.

Basic system data	
Total population 2010 (million)	13.81
Agricultural population 2010 (million)	11.37
Urban population 2010 (million)	1.53
Time to 20K market (h) (range / average)	0–58 / 10
Dominant agroecological zone	Cool/humid
Elevation (m) (range / average)	562–3,323 / 1,743
LGP (days) (range / average)	205–294 / 260
Annual rainfall (mm) (range / average)	915–1,800 / 1,397
Total area (million ha)	9.21
Cultivated area (million ha)	0.44
Irrigated area (million ha)	0.019
Cattle (million)	6.95
Goats (million)	1.25
Sheep (million)	2.64
Number of rural poor (<US$1.25/day)	4,437,729
Per cent of total rural poor in Ethiopia	17%

LGP = length of growing period.

General characteristics

The highland perennial farming system is concentrated in the zones of Sidama on the east part of the Rift Valley, and from Wollaita through Dawro, Arba Minch and Jimma to Illibabur zone in southwestern Ethiopia (Figure 11). The system hosts a diversity of crops. The main tree crops are coffee, enset and chat, with local varieties dominating. In order of importance, food crops include maize, teff, vegetables and root and tuber species (cassava, yam, potato, sweetpotato, taro, and oromo dinich, a local tuber), as well as spices (ginger, coriander, black pepper and cardamom). Tropical and temperate fruit tree crops include banana, avocado, mango, apple and peach. *Cordia* is a common tree in the system and is used for timber and shading the coffee. The system also includes tea plantations and apiculture. Tea and coffee are produced in both smallholder and large-scale farms. This system is also the major source of spices in the country, including for export.

Livestock include cattle, donkeys, sheep, goats and chickens. Cattle are kept for milk, manure, bridal wealth, savings and social security. This is predominantly a cut-and-carry system, where livestock is kept in barns and fed with forage sourced from the vicinity of the farm. Production is not high but livestock is widespread among smallholder farms; this relies on the proximity of household compounds as well as limited communal grazing areas. Large-scale plantation managers do not have livestock.

There are various opportunities for off-farm income including furniture making in rainforest areas, coffee washing, processing by both large plantations and smallholders as well as trading. Tea processing is carried out on large plantations.

Poverty in the system is generally low, but there are pockets of high poverty such as in Wollaita and Gamo.

A high diversity of ethnic groups inhabit the highland perennial farming system area, including the Sidama, Wolaita, Hadiya, Gurage, Gedeo, Oromo, Gamo, Dawuro, Kaficho and Yem.

Natural resource context

Vegetation patterns vary with climate based on altitude. Rainfall is plentiful in the system, reaching up to 2,000 mm per annum. Soil types vary locally but Nitosols dominate, with acidity and phosphorus fixation issues. The dominance of perennial crops such as banana, plantain, enset and coffee, complemented by cassava, sweetpotato, beans and cereals, means that this is one of the most productive natural resource management systems.

Production systems

The highland perennial farming system is characterized by high population density. Land use is intensive and holdings are very small (the average cultivated area per household is just under 1 ha, but more than 50% of holdings are smaller than 0.5 ha), a trend that is increasing due to population growth. Both smallholder farms and large-scale plantations of coffee and tea are intensively managed with high inputs of labour and chemicals, but this varies by crop and farm size. Linkages to local and global markets are extensive (including for organic tea and coffee). This system is an important source of food products for Ethiopian cities.

The main constraints are diminishing farm size and declining soil fertility, leading to increasing poverty and hunger. People cope by working the land more intensively, but returns to labour are low.

Trends and drivers of change

The system has evolved from a maize–root crop dominated system to a perennial system in the last few decades, particularly due to declining land size and the need for intensification. For instance, the banana-dominated system in Gomu Gofa was a maize-based system until the 1980s. The Ethiopian Government places high priority on this system due to its economic importance. Interventions target infrastructure development, processing and improved quality. The system relies on labour migration for the harvest of crops such as cotton and coffee, and there are also significant migratory patterns to cities and sugar estates. Infrastructure is relatively well developed. Irrigation is being slowly promoted for multiple cropping and three hydropower dams are being built.

Investment opportunities

- The best known coffee brands in the world are produced in this system, including Yirgachefe, Sidama and Jimma. Coffee, tea, spices, tropical fruits and other produce from this system present opportunities for niche marketing. Processing of fruits and spices on the spot would reduce transport costs and increase product value.
- There is a huge potential for honey production given the diverse vegetation, mild temperatures and homestead farming.

Highland teff mixed farming system

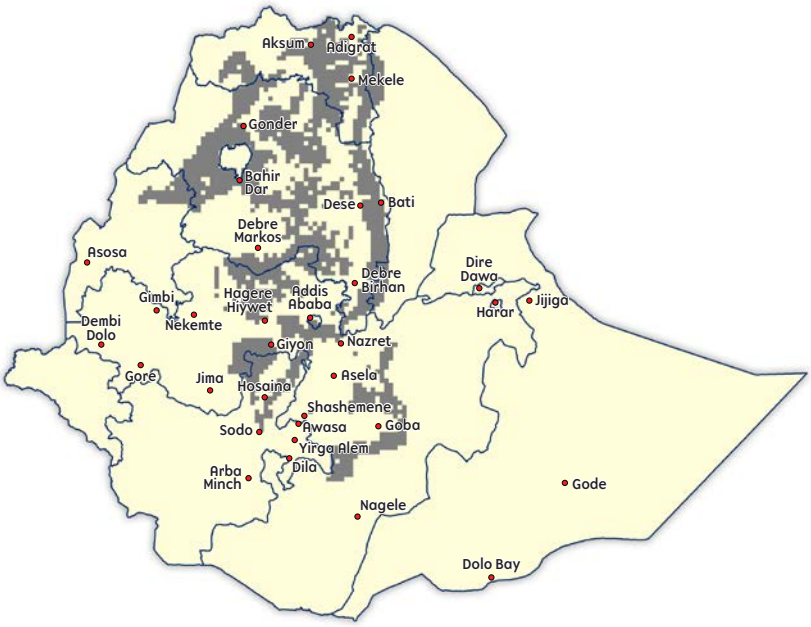

Figure 12. The highland teff mixed farming system area in Ethiopia.

Basic system data	
Total population 2010 (million)	19.22
Agricultural population 2010 (million)	14.89
Urban population 2010 (million)	3.20
Time to 20K market (h) (range / average)	0–43 / 8
Dominant agroecological zone	Cool/subhumid and semi-arid
Elevation (m) (range / average)	522–2,239 / 1,711
LGP (days) (range / average)	86–267 / 174
Annual rainfall (mm) (range / average)	195–1,657 / 1,044
Total area (million ha)	13.83
Cultivated area (million ha)	3.09
Irrigated area (million ha)	0.059
Cattle (million)	10.19
Goats (million)	4.73
Sheep (million)	5.43
Number of rural poor (<US$1.25/day)	6,118,698
Per cent of total rural poor in Ethiopia	24%

LGP = length of growing period.

General characteristics

This system extends from the Central Rift Valley through East and North Shewa, South Wollo, Gojjam to Central Tigray (Figure 12).

This farming system is considered the breadbasket of highland systems because of its high production of agricultural produce, due to good soils and adequate and well-distributed rainfall. It hosts the majority of the population. The mildly warm climate allows relay and intercropping. This is also where small-scale farmers produce most of the vegetables and fruits, including under small-scale irrigation. The major crops produced in this farming system include teff (*Eragrostis abysinica*), maize, wheat, faba beans, chickpeas, beans, grasspea and lentils. Teff is grown by more than 50% of the farming households and accounts for 28% of all cultivated land in Ethiopia (Chamberlin and Schmidt 2012). The system also has a strong livestock component where cattle dominate followed by sheep, goats and equines. Oxen are used for draught. This system is found around urban areas and along major roads, where market opportunity is very high.

As in the highland wheat mixed system, petty trade and migratory seasonal off-farm labour provide off-farm income.

Natural resource context

This farming system is found in areas with altitude ranging from 1,700 to 2,200 m and annual rainfall of 600–1,300 mm, with a growing season of 100–180 days. The soils are fertile. The dominant soils are Vertisols, along with Luvisols, Eutric Leptosols and Eutric Cambisols. *Eucalyptus*, *Croton* and *Cordia* spp. are common tree species in the system.

Production systems

Population density in the highland teff mixed farming system is high. The average family size in a typical household is six, with a landholding of about 1.0 ha. Those with larger farms (2.5 ha) in this system allocate about two-thirds of the cultivated area to cereals, and the remainder to pulses (beans, faba bean) and oil crops (niger seed, flax). Households have additional communal grazing averaging 0.5 ha, producing about 5.0 t dry matter in a normal year. In general, this farming system is complex and characterized by a high diversity of crops, ranging from four to 14. Application of chemical fertilizer to maize and teff is increasing, with diammonium phosphate and urea the most common.

Trends and drivers of change

There are more opportunities to intensify within this crop–livestock system and to respond to market demands than in the barley mixed and the wheat mixed farming systems (Tesema 2006). There is already a strong diversification and intensification trend in favour of market crops, particularly around towns and cities. Investment in soil management, varieties and technologies/extension is increasing. Return for investment is relatively high given high market prices and increasing demand for teff by urban and export markets.

Investment opportunities

- Given the increasing global interest in teff as a health food, strategies are needed to increase productivity and value addition, develop markets, and to brand teff as a unique Ethiopian crop.
- Dairy could be a high potential enterprise in strategic locations close to major urban markets.
- Investments are needed in rural infrastructure and mechanization. Capacity needs to be strengthened to respond to market opportunities.
- An increased understanding of system-wide linkages between crop and livestock components is also needed.

Highland wheat mixed farming system

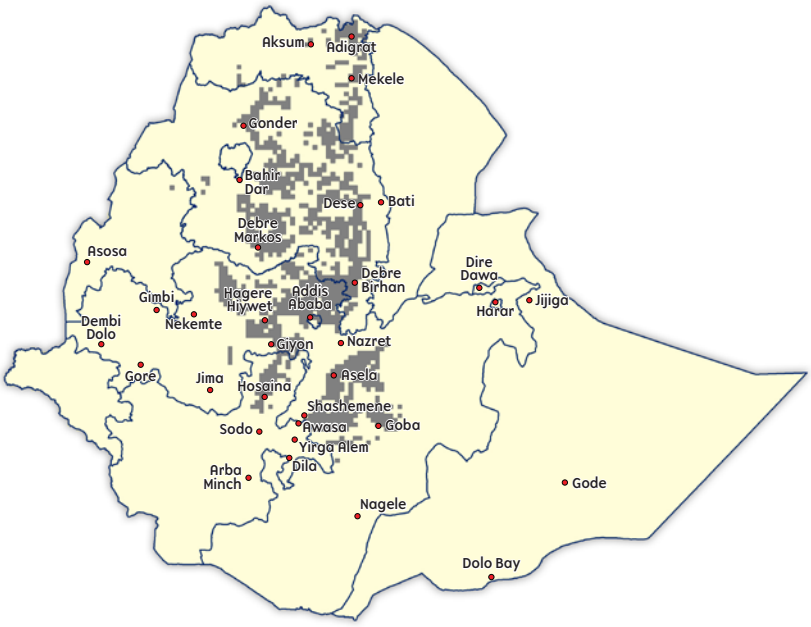

Figure 13. The highland wheat mixed farming system area in Ethiopia.

Basic system data	
Total population 2010 (million)	17.2
Agricultural population 2010 (million)	11.8
Urban population 2010 (million)	4.66
Time to 20K market (h) (range / average)	0–37 / 7
Dominant agroecological zone	Cool/subhumid and semi-arid
Elevation (m) (range / average)	1,939–3,909 / 2,537
LGP (days) (range / average)	93–270 / 196
Annual rainfall (mm) (range / average)	307–1,657 /1,163
Total area (million ha)	8.62
Cultivated area (million ha)	2.08
Irrigated area (million ha)	0.054
Cattle (million)	7.71
Goats (million)	2.03
Sheep (million)	5.61
Number of rural poor (<US$1.25/day)	4,659,623
Per cent of total rural poor in Ethiopia	18%

LGP = length of growing period.

General characteristics

This farming system is predominant in Oromia and Amhara regions, extending from East, West and North Shewa to South Wollo, Gojjam, South Goder and Southern Tigray (Figure 13). It comprises the mid subhumid highlands, where wheat is the major food and cash crop, along with pulses and livestock. Area-wise, wheat is the fourth most important crop countrywide following maize, teff and sorghum. However, the country turned from a net exporting country to a net importing country due to increasing urbanization and food aid, with imports in 2014 being about 900,000 t (Demeke and Di Marcantonio 2013).

Compared to the highland barley–livestock mixed farming system, a larger diversity of crops is found in the highland wheat mixed farming system. In order of importance, crops grown in the system are wheat, maize, barley, faba beans, oats, potato, peas, lentils, niger seed and flax. Cattle are the dominant livestock type. A typical farmer may own two oxen, two cows, a donkey, a horse and about 20 sheep. The system includes areas located around urban areas and major roads, where market opportunity is very high.

Natural resource context

The system is found in areas with altitude 2,200–3,000 m, and rainfall ranging from 800 to 1,600 mm per annum, giving a growing period of 120–180 days. Rainfall is commonly bimodal. Like the teff-based system, the dominant soils are Vertisols along with Luvisols, Eutric Leptosols and Eutric Cambisols. The minimum and maximum temperatures are 6°C and 24°C. *Eucalyptus*, *Croton* and *Cordia* spp. are common wild trees associated with the farming system.

Production systems

Production follows rainfall regimes including bimodal rains (short and long rains). Wheat yield lags behind other cereals, partly due to market disincentives but also recent attacks by wheat rust. The mean yield in the long season usually exceeds that of the short season by about 30%. During the long growing season wheat becomes the principal cereal crop, often covering over 40% of the area allotted to cereals, whereas in the short season other crops (mainly barley) predominate.

Farmers mostly use traditional implements for farm operations. There is an increasing trend in using tractors and combine harvesters in wheat belts, particularly in Arsi and Bale highlands, usually through short-term contractual agreements. Constraints to wider use of farm mechanization include lack of cash to purchase and/or hire farm implements, lack of access to farm implements, land fragmentation, the nature of the terrain and lack of knowledge. Application of chemical fertilizer has a relatively long history in this farming system with some households beginning application in the 1960s. The amount of application is also increasing over time. Crop rotation is rarely practised in the mechanized major wheat production systems of the Arsi and Bale highlands, while farmers using draught power rotate wheat with legumes once every two to three years. Weeds are managed mostly by hand but labour shortage constrains frequent weeding.

An average household size includes seven people, and the average farm size is greater than 1.5 ha, which is larger than in most mixed systems. Farms in this system are intensively managed and they are well connected to markets.

Trends and drivers of change

This farming system experiences the same challenges faced by the barley–livestock mixed system, although enterprises are more diverse, institutional support is relatively stronger, and the diversity of agricultural commodities allows communities to cope better with climatic and market shocks. There is an increasing trend in use of external inputs. There is also increased market-oriented farming through livestock fattening, bee keeping, formation of market cooperatives and improved market linkages.

Investment opportunities

- There is a need to reconsider policies, including distribution of imported wheat at subsidised prices and export bans that affect farmers' investments and distort markets.
- There is a need to strengthen the link between wheat producers, processers and agroindustry companies.
- Dairy could be a high potential enterprise given the strategic location of the system close to major urban markets.
- Expansion of mechanized agriculture would address agricultural labour and draught power constraints.
- There is potential to expand commercialization opportunities to take advantage of market connectivity.

Lake Tana fish-based farming system

Figure 14. The Lake Tana fish-based mixed farming system area in Ethiopia.

Basic system data	
Total population 2010 (million)	0.22
Agricultural population 2010 (million)	0.024
Urban population 2010 (million)	0.20
Time to 20K market (h) (range / average)	0–7 / 1
Dominant agroecological zone	Cool/subhumid
Elevation (m) (range / average)	436–1,800 / 1,678
LGP (days) (range / average)	99–187 / 170
Annual rainfall (mm) (range / average)	378–1,375 / 1,224
Total area (million ha)	0.32
Cultivated area (million ha)	0.007
Irrigated area (million ha)	–
Cattle (million)	0.015
Goats (million)	0.018
Sheep (million)	0.014
Number of rural poor (<US$1.25/day)	10,034
Per cent of total rural poor in Ethiopia	0%

LGP = length of growing period.

General characteristics

This farming system dominates the West Gojjam and South Gondar zones (Figure 14). There are two major subsystems within the Lake Tana fish-based farming system. The first is a maize-dominated system, an extension of the western highland maize mixed farming system, in combination with teff. This maize system used to be dominant, but livestock has now overtaken it as a major enterprise. The second is a rice-based farming system found on the eastern lakeshore in the wetlands, where pulses (grasspea and chickpea) are produced on residual moisture. Some recession agriculture is practised very close to the lake with teff and chickpea. High-value crops, including onion and tomato, are also widely grown using residual moisture and supplementary irrigation.

Fish species include tilapia (January–July), Nile perch and catfish (June–September) and barbus (June–September).

A threatened cattle breed, called Fogara (with large frame, milk types, trypano tolerant and feed demanding), is found near the lake. In the past, before rice was grown, people depended on the Fogara cattle and feed was readily available. Since the introduction of rice by Koreans in 1980s, most of the grazing land has been converted to rice. Fogara in-situ conservation efforts are being undertaken with farmers. Other livestock include sheep (in the highlands) and goats (in the lowlands), oxen for traction, highland zebu, as well as small numbers of chickens kept by many farm families.

Off-farm income includes proceeds from the sale of fresh fish (and fish filleting by women farmers) to local collectors for town restaurants (in Bahir Dar, Gondar and Woreta), and some export to Sudan through Matema. Land ownership amongst young people is very low, and only older farmers have their own land where the main income is derived from crops. Tourism also generates income for Bahir Dar town people. Young farmers invest time in sand mining from tributary rivers and sell it for construction. Petty trade is another off-farm income source.

Amhara is the main ethnic group in the farming system; others include Woyito and a small tribe of Negede fishers, found mainly near Bahir Dar.

Natural resource context

The Fogera Plain, scattered with wetlands, is the dominant landscape. The annual rainfall of 800–1,000 mm is unimodal and occurs from June to mid/end September, causing extensive flooding of the plain in July and August. Soils are mostly Eutric Leptosols, Luvisols and Vertisols. Papyrus is common on the lakeshores, which are otherwise devoid of trees. Water hyacinth is a problem on the northern and northeastern sides of the lake, impeding fisheries and transport. The lake is used extensively for transportation, serving the needs of monasteries and towns located in and around the lake complex.

Production systems

Farm size is relatively small, around 1–1.2 ha, and can be fragmented in up to five parcels in different areas. The average household size is five to six people. This farming system is one of the most densely populated after the highland perennial, chat–sorghum and sorghum mixed farming systems. System potential is high. Management is intensive with high input use (fertilizer, improved seeds), but it is not mechanized. The system hosts a mix of subsistence farming with a growing trend of cash crops. Farmers actively participate in markets, exchanging their products and selling their excess production. Rice-based farmers are highly commercialized and receive good income from the increasing price of agricultural crops. The cropping system is relatively intensive with up to three crops per year: rice, followed by chickpea or grasspea, followed by onion and tomato using supplementary irrigation.

This traditionally agropastoral system is known for its Fogara breeds, with their high milk potential. However, the livestock sector has been shrinking since the introduction of rice, which is replacing the wetlands that used to be used as grazing areas. A large meat processing plant established in the area has faced supply problems.

Fishing is small-scale and seasonal, between December and April; no fishing takes place during the wet season (May–October) when people are engaged in agriculture. The fisheries are mostly an open-access system that results in overfishing. Gill nets and papyrus boats are used for fishing. More than 50% of the fish catch is for sale.

Households in this farming system generally have good livelihoods compared to sorghum mixed farming areas. This is a good example of a farming system where linkages to markets can strengthen livelihoods and reduce the dependency on crop-based activities.

Trends and drivers of change

Rising population pressure, a high rate of urbanization, high infrastructure development attracting

farmers and fishers to towns as casual labour, and greater access to roads and electricity in towns and small villages have been the key trends over the last 4–5 years. Small-scale irrigation schemes and some larger ones are under construction.

The fish catch and market spread (including to Addis Ababa) have sharply increased in the last 5 years. Because rural unemployment is high, young people without land are engaging in fishing, whereas once only rice farmers close to the lake were fishing. Market linkages for rice-based farmers are increasing. Dry-season onion and tomato production has started recently. Access to improved seeds is increasing, especially for maize farmers.

Investment opportunities

The following are some potential investment opportunities for this farming system.

- Develop policy and build institutional capacity to monitor individuals and cooperatives to minimize overfishing.
- Develop capacity in aquaculture, with fish ponds in rice-based and other systems.
- Invest in value addition and improving shelf life of perishable produce (e.g. tomatoes, onions, garlic).
- Due to urbanization of the system in Bahir Dar, Woreta and Gondar, there is an increasing demand for meat and milk. Beef and dairy could be viable enterprises, along with processing and packaging the produce.
- Strengthen capacity to expand market opportunities.
- Expand commercialization opportunities to take advantage of market connectivity.

Lowland sesame mixed farming system

Figure 15. The lowland sesame mixed farming system area in Ethiopia.

Basic system data	
Total population 2010 (million)	0.69
Agricultural population 2010 (million)	0.56
Urban population 2010 (million)	0.08
Time to 20K market (h) (range / average)	3–36 / 13
Dominant agroecological zone	Warm/semi-arid
Elevation (m) (range / average)	528–2,686 / 890
LGP (days) (range / average)	77–169 / 135
Annual rainfall (mm) (range / average)	528–1,342 / 875
Total area (million ha)	3.78
Cultivated area (million ha)	0.209
Irrigated area (million ha)	–
Cattle (million)	1.16
Goats (million)	0.84
Sheep (million)	0.014
Number of rural poor (<US$1.25/day)	239,793
Per cent of total rural poor in Ethiopia	1.00%

LGP = length of growing period.

General characteristics

The lowland sesame mixed farming system is found over 3.78 million ha in northwest Ethiopia, bordered by Sudan to the west and Eritrea to the north, extending from Humera to Metekel and Assosa (Figure 15). The farming system is characterized by warm semi-arid agroclimatic conditions, low population density (18.25/km^2) and abundant land availability. Only about 6% of the area is under cultivation, but there is an increasing trend of crop production on small farmers' fields, communal lands and commercial farms.

The main crops grown in the farming system include sesame, sorghum, cotton, banana, mungbeans, and rice. An oily gum resin from the Boswellia tree (*Boswellia papyrifera*), traded as frankincense and used locally as traditional medicine and as incense (Alemu et al. 2015), is also an economically important aspect of this farming system. Livestock production includes cattle, goats and sheep, including the regionally unique Gumuz sheep, a breed of lowland sheep carrying the name of the ethnic group that keeps them. Gumuz is the only thin-tailed sheep in Ethiopia, and is confined to the western lowlands bordering Sudan.

The region is sparsely populated and relatively high returns for investment in sesame production create attractive opportunities. The region has thus become an area of resettlement and attracts a large number of seasonal workers. Thus, the level of poverty in this farming system is relatively low.

Important sources of non-farm income for farm households include trading of various items including shoes, clothes, cattle and Boswellia resin with bordering Sudan.

The main ethnic groups present in the farming system include Amhara, Tigray, Benshangul, Kunama and Gumuz.

Natural resource context

The natural vegetation consists of an *Acacia*-based type of savannah with some lowland bamboo forests. The landscape is mostly extensive plains, where fertile cracking clay Vertisols that shrink and swell with changes in moisture content are common. Eutric Cambisols and Chromic Luvisols are also important soil types in this farming system. The region has a distinctly unimodal and relatively high rainfall, received during the *Kiremt* season from June to September. The rest of the year is dry and hot, leading to semi-arid conditions. Water availability for livestock and domestic use can be a serious problem. Water is sourced from privately owned, handpump-operated wells using scarce open-access water sources, in particular in the northeast part of the system. Deep boreholes have been developed for domestic potable water.

Production systems

Two main types of farms coexist in the farming system, almost in equal proportion: smallholder farms ranging in size from 2 to 20 ha, and large commercial landholdings of between 20 and 2,000 ha. Production is mechanized but extensive traditional cultural practices and low levels of input use (broadcast seeding, low reliance on improved sesame varieties, etc.) imply that the system has high development potential. Sesame is grown as a cash crop and hence the system is strongly commercially focused.

Trends and drivers of change

The development of this farming system is recent and only about 6% of the area is under cultivation. The area has emerged as a zone of thriving agricultural development in the past 10 years, focused on sesame production, which is a national development priority. Large urban-based entrepreneurs have invested in land through state leases and run large farms relying on seasonally hired labour for harvesting, leading to the seasonal migration of an estimated 500,000 people from neighbouring highland areas. Introduction of use of Round-up to the area is becoming a driver for expanding labour-intensive crops like teff.

In the past the area also benefited from government resettlement programs for people originating from eastern highland areas that were prone to drought and food shortages. A similar situation exists in the agroecologically identical area located immediately across the border in Sudan. Malaria was a common constraint but is gradually being controlled. As is the case of many areas in Ethiopia, the lowland sesame faming system is supported by government investment in market development. The region is connected by all-weather roads. Sesame, the main agricultural product, is exported both through the central market in Addis Ababa and across the border to Sudan. National development initiatives such as the Ethiopian Commodity Exchange and infrastructure development (including the highway between Ethiopia and Sudan, the airport, expanded mobile network, irrigation and electricity) are all having a positive impact in this region.

Investment opportunities

The following are some potential investment opportunities for this farming system.

- Strengthen capacity and introduce incentive mechanisms to expand market opportunities to address informal cross-border trade.
- Promote the production of tropical fruits, along with water management interventions and market linkages, including postharvest processing.
- Create local research for development capacity, targeting sesame-based systems, including varietal development for reducing losses due to shattering and pests and diseases.
- Consider developing beef as a complementary enterprise.
- Expand commercialization opportunities to take advantage of larger farm sizes and the strong global market opportunities.

Pastoral farming system

Figure 16. The pastoral farming system area in Ethiopia.

Basic system data	
Total population 2010 (million)	5.01
Agricultural population (million)	4.08
Urban population 2010 (million)	0.06
Time to 20K market (h) (range / average)	n/a–30 / 9
Agroecological zone	Warm/arid
Elevation (m) (range / average)	128–2,097 / 627
LGP (days) (range / average)	31–228 / 68
Annual rainfall (mm) (range / average)	126–820 / 373
Total area (million ha)	35.89
Cultivated area (million ha)	0.697
Cattle (million)	1.095
Goats and sheep (million)	2.289
Number of rural poor (<US$1.25/day)	1.8 million
Per cent of total rural poor in Ethiopia	7%

LGP = length of growing period.

General characteristics

This is the most extensive farming system in the country, extending from the south Omo zone through the southern part of Borena, to the wider regions of Afder, Gode to Warder and Degehabur zones of the Somale region to the Afar region (Figure 16). It covers 36 million ha, and provides livelihoods for an estimated population of over 4 million. Those engaged in this farming system, such as the Oromo people, traditionally specialize in mobile pastoralism. They keep livestock including cattle, camels, small animals and equines. The number of animals per household has significantly decreased in the last three decades (from about 80 to 10 animals) due to recurrent drought and limitations to mobility. In the most arid northern areas, livestock consists of mostly goats, with some cattle, camels and sheep; while in the rest of the Afar pastoral region, cattle predominate with some sheep, goats and camels forming the livestock mix.

Pastoralism is regarded as a specialized form of natural resource management, adapted to marginal ecosystems that are characterized by limited, variable and unpredictable resources. Although pastoralism implies the absence of cropping, some agriculture has recently developed in these systems. The cultivated area represents less than 2% of the land under this farming system. As crop failure is common due to erratic rainfall and recurrent droughts, productivity remains low. Because cropping is usually carried out on the best grazing land, these efforts to introduce cropping involve high resource use trade-offs. The pastoral system involves recurrent conflicts between various clans: Afars with Issa in the northeast, Issa with Borena in the southeast, and Gujji with Boren in the southern parts of Ethiopia. Although some of the conflicts are historical power struggles among clans, there has been increasing tension due to decreasing access to grazing land and water for livestock.

The Somali Regional State is one of the largest and most sparsely populated states in the country. For its inhabitants, pastoralism is not just an economic activity, it is way of life. In the Somali pastoral areas livestock production relies mostly on sheep, goats, camels, and some cattle.

Non-farm income originates from petty trade, livestock brokering, charcoal production, and collection of firewood or construction materials for sale. The level of poverty in the pastoral farming system is high.

Natural resource context

The climate is harsh with daytime temperatures reaching about 40°C during much of the year. Grasslands and shrubs characterize the Somali region vegetation. Thorny *Acacia* and *Prosopis* trees and shrubs dominate huge areas of the drier regions of Africa, including much of the Afar region. *Acacia*-based vegetation dominates in riverine areas. These trees are valuable not only for their ability to thrive under adverse conditions, but also for the range of useful products that they provide, including animal fodder (Fagg and Stewart 1994). However *Prosopis*, an introduced multipurpose leguminous species, presents a dilemma for development planners because of its invasive nature. This could lead to grassland degradation, creating conflict for the grazing and farm areas (Tesfaye 2006).

In both Afar and Somali regions rivers, watering points and boreholes are important sources of drinking water for animals and humans. The region has an annual rainfall of about 300–350 mm. The landscape is generally flat and soil quality varies in relation to location of rivers and streams. Calcisols of various types are predominant in the Somali zones of the farming system, while Lithic Leptosols dominate in the Afar region. The lower Omo landscapes are primarily characterized by Cambisols.

Production systems

Pastoralists lead a nomadic life organized around clan settlements of between about 20 and 300 people located in areas with abundant natural pastures. When feed resources are scarce, a few milking cows are kept at home and the rest are moved in groups by herders as far as 20 km in search of feed, while the rest of the family remains at the settlement. Characteristically, this farming system zone is sparsely populated, but over 80% of the estimated 5.01 million population depends on pastoral livelihoods. Milk as well as live sheep, goats and cattle are brought to local town markets for sale. There are some designated sites for organized milk collection.

Trends and drivers of change

While in the past herders were considered the wealthiest rural people, nowadays the situation has reversed, with groups subsisting on extensive livestock rearing ranking amongst the most vulnerable and insecure (Yimer 2015). This system accounts for around 7% of the rural poor in Ethiopia. Like many pastoral groups of eastern Africa, these communities

live in areas that are arid or semi-arid with low and erratic rainfall. They face a range of problems such as drought and climate change, animal diseases, water shortages, range management and conflict relating to common property resources that are under increasing pressure for development activities, such as the expansion of cultivation areas (Asenso-Okyere et al. 2013). In particular, a recent trend toward privatization of rangelands has led to encroachment of communal grazing areas. Population growth and climate variability are underlying factors.

There has been a concerted effort for development of pastoral areas and communities, since the 1995 Ethiopian Constitution recognized the issues of pastoralists and delegated a federal ministry to coordinate the effort. This has resulted in numerous activities aimed at enhancing the resilience of these fragile but economically and culturally significant land management systems (USAID 2014); these include the USAID Pastoralists' Areas Resilience Improvement through Market Expansion (PRIME), the Agriculture Knowledge, Learning Documentation and Policy (AKLDP) project, and the Resilience in Action initiative.

In recent years, with the spread of farming technology and market linkages, pastoralists have engaged in some forms of cultivated agriculture as a diversification strategy to assure household food consumption needs. For instance, recently developed irrigation schemes around Awash, particularly the Fentale irrigation scheme, have attracted the interest of pastoralists in Afar and Borena to grow food, fodder and horticultural crops.

Development efforts have also led to the establishment of decentralized water points/boreholes, and the expansion of mobile phone networks. The government has also made efforts to settle pastoralists in areas where water is available, for instance in the Afar region along the Awash River, and in the Somali region along the Ganale Shebele River. In these locations, the government encourages production of vegetables (onion, tomato, pepper), maize, rice and groundnut while livestock are kept outside of these areas. This has been done in parallel with the promotion of education through the establishment of elementary schools, road development, and investment in health extension for people as well as veterinary services for livestock. There has also been irrigated sugarcane plantation development for settling pastoralists in outgrower schemes. While these efforts have helped in many ways, they have also escalated tension between traditional inhabitants and the proponents of development, creating a development dilemma (Kamara 2000). There is a risk of destabilizing traditional pastoral livelihood strategies and reconfiguration of relationships due to the rapidly changing socio-ecological settings and development interventions, unless a negotiated development plan is put in place.

Investment opportunities

The following are some potential investment opportunities for this farming system.

- Eradicate *Prosopis juliflora* from grazing lands and valley bottoms and replace with adaptable perennial grass species.
- Practise regulated seasonal flooding for rehabilitating degraded lands and pasture for dry-season grazing.
- Link pastoralists with key market outlets (e.g. processors of camel milk) for increased income and livelihoods.
- Livestock-based intensification through improved water supply, feed technology, veterinary services and road infrastructure.
- Invest in cross-bred livestock supply for the highlanders, including maize-based and sorghum-based systems.
- Strengthen livelihood development activities to provide greater opportunities for diversifying income streams.
- Develop institutional capacity to allow transition of pastoral systems to other activities in ways that protect socio-cultural values.
- Appreciate the social development potential within agropastoral systems as a way of life with wider economic and cultural benefits.

Rift Valley fish-based farming system

Figure 17. The Rift Valley fish-based farming system area in Ethiopia.

Basic system data	
Total population (million)	0.42
Agricultural population (million)	0.20
Urban population (million)	0.22
Time to 20K market (h) (range / average)	0–4 / 2
Dominant agroecological zone	Cool and warm/subhumid
Elevation (m) (range / average)	1,249–1,829 / 1,458
LGP (days) (range / average)	169–254 / 235
Annual rainfall (mm) (range / average)	983–1,411 / 1,103
Total area (million ha)	0.332
Cultivated area (million ha)	0.019
Irrigated area (million ha)	0.0071
Cattle (million)	0.099
Goats (million)	0.019
Sheep (million)	0.032
Number of rural poor (<US$1.25/day)	73,450
Per cent of total rural poor in Ethiopia	0.3%

LGP = length of growing period.

General characteristics

This system covers most of the Rift Valley, extending from Upper Awash through Ziway to Hawassa, Gomu Gofa and Amaro zones (Figure 17). The main lakes in the system are Koka, Ziway, Langano, Abijata, Shala, Hawassa, Abaya and Chamo. Maize and haricot beans are the dominant crops. Vegetables such as onion, tomato and cabbage are also grown for sale. There is also increasing investment in activities such as tourism and recreation, such as bird watching around the lakes.

The main species of fish in the system include Nile tilapia, African catfish and *Labeobarbus* species, with Nile perch as the dominant fish in Chamo and Abaya lakes. Livestock include cattle, goats and donkeys. Oxen are used for ploughing, cows for milk, goats for sale and donkeys for transportation of goods. The use of donkeys is increasing.

Sources of off-farm income are fish marketing, sale of vegetables including onions, tomatoes and cabbages, sale of charcoal and other small trade.

There is a relatively low level of poverty in this farming system.

Ethnic groups include the Oromo in Ziway, Koka, Langano, Abijata and Shala; Sidama in Hawassa; and Gamo and Wolaita in Abaya and Chamo.

Natural resource context

Local vegetation is dominated by *Acacia* species distributed on farm and across wider landscapes. These trees are used mainly for charcoal. The rainfall is unimodal at Ziway, Abjata and Shalla (June–September), and bimodal around the other lakes, where the rainfall may be as low as 550 mm per annum. Soil types vary and include Andosols, Calcisols and Cambisols. High soil pH is one of the agricultural constraints around Abjata and Shalla lakes. There is an increasing siltation of the lakes, notably Ziway, Langano and Abyata lakes, due to agricultural activities upstream. There is also an increasing inflow of affluent to lakes Hawassa and Ziway.

Production systems

An average household size is six to eight people. The system is relatively densely populated; it has a high production potential. It is intensively managed and market oriented with a high income potential. Average household farm size is 0.5–2 ha.

Tends and drivers of change

This farming system is evolving as commercial agriculture. People are investing in vegetable production and unions are being formed for fishing. Developments in irrigation, fish farming and access to market are driving forces for change. People are investing and more people are employed as labourers. Irrigation, electricity, roads and communications are improving. Access to market and technology is also improving. Small irrigation schemes are rapidly being developed in those lakes used for irrigation (Ziway, Koka and Hawassa). Vegetable and fish markets are increasing.

There has been overfishing, particularly in lakes Hawassa and Ziway, which calls for collective action and regulatory policy. Fish diversity is under threat from a big increase in water abstraction, high siltation and changes in the chemical composition of the water. Urbanization, industry, agriculture and deforestation are the major anthropogenic drivers of change affecting water quantity and quality in the Rift Valley lakes.

Investment opportunities

The following are some potential investment opportunities for this farming system.

- Protect the lakes from upland siltation and salinization.
- Invest in efficient irrigation systems and high-value agriculture enterprises.
- Create collective capacity in sustainable fishing methods.
- Invest in developing buffer zones and reducing the risk of poor water quality.
- Given its proximity to market, dairy development would be a viable option.
- Develop institutional capacity to allow efficient access to water resources and avoid future externality costs associated with open access or similar unregulated systems.
- Invest in cold storage and other measures to safeguard quality.

Sorghum–chat mixed farming system

Figure 18. The sorghum–chat mixed farming system area in Ethiopia.

Basic system data	
Total population 2010 (million)	2.28
Agricultural population 2010 (million)	1.95
Urban population 2010 (million)	0.18
Time to 20K market (h) (range / average)	0–19 / 7
Dominant agroecological zone	Cool/semi-arid
Elevation (m) (range / average)	1,156–2,681 / 1,669
LGP (days) (range / average)	93–149 / 125
Annual rainfall (mm) (range / average)	555–950 / 799
Total area (million ha)	1.45
Cultivated area (million ha)	0.27
Irrigated area (million ha)	0.002
Cattle (million)	0.94
Goats and sheep (million)	1.24
Number of rural poor (<US$1.25/day)	708,907
Per cent of total rural poor in Ethiopia	3%

LGP = length of growing period.

General characteristics

This system extends from the northwestern to the eastern Hararghe highlands of Ethiopia (Figure 18). Within the diversity of systems found in these highlands, the sorghum–chat farming system is distinguished by the chat economy. Chat (*Catha edulis*) is a perennial evergreen large shrub, the fresh leaves of which are chewed as a mild stimulant. In Ethiopia, chat is grown primarily in Hararghe and Sidamo, which have good market access to the

surrounding cities and export traders. The market for chat, in addition to Hararghe itself, is Somalia and Djibouti, where chat is an intrinsic part of the culture. Eastern Hararghe is the centre for chat production because of its proximity to the main Somalia markets.

The dominant crops in the system are sorghum and chat, the latter being irrigated in the dry season. Other crops include sweetpotato, beans and maize, as well as a minor production of groundnuts. The system also includes vegetables on limited irrigated areas, for the local markets in Dire Dewa and for export to Djibouti. These include potato, carrot, beetroot, leak, shallot, onion and tomato. The system includes a small range of fruit trees such as peach and *Annona* spp. Livestock includes cattle, predominantly fattening of young bulls, which are highly valued in the Ethiopian beef market and raised in intensive cut and carry feeding systems.

Chat offers opportunities for traders, daily labourers and truck drivers. Many households are involved in packaging chat for sale—which involves the collection and drying of a local grass growing near swamps—and its petty trade. Increased allocation of land for chat reduces the availability of animal feed and food crops, and the availability of manure.

However, due to potential adverse effects of habitual use of chat, there are some concerns about its popularity as a cash crop (Kandari et al. 2014).

While chat is grown quite extensively in other systems, its quality is highest in the sorghum–chat system. Consequently, the level of poverty in the sorghum–chat farming system is low.

Natural resource context

The local vegetation includes highland tree species such as *Juniper* and *Podocarpus*, as well as plantations of *Eucalyptus*. The landscape is hilly and drought-prone, with valley bottoms supporting livestock grazing and small-scale irrigation schemes. The availability of water is good, via household wells. Various forms of Leptosols dominate the soils, which tend to be highly degraded and less fertile.

Production systems

Due to a high population density, landholdings in the sorghum–chat farming system are very small, usually less than 0.5 ha. This agricultural system has responded to emerging market opportunities by shifting from a subsistence grain-based to a market-oriented, cash crop-based (coffee, chat and beef) mixed farming system. The system is extensively linked to markets that generate high profits from chat as well as vegetables, of which the system is the largest producer in the east. This system features a relatively high management intensity involving widespread reliance on inputs and irrigation, and associated high level of service provision. Many families have household wells, and are familiar with irrigation techniques. Chat is a popular crop because it produces young leaves and twigs even during dry seasons with occasional rain showers and with infrequent irrigation. Unlike coffee, it is not affected by disease and is drought resistant. It has been slowly displacing coffee from home gardens and fertile locations in these systems. It is planted on contours in rows and commonly intercropped with sorghum.

Trends and drivers of change

Markets are playing a strong role in the development of the system. Harar coffee is a special brand, which fetches some of the highest prices in the global market. However, land suitable for coffee is limited and farmers are looking for other cash crops. The profitability of chat, sold at 1,200 Birr per kilo compared to 500 Birr for 100 kg of sorghum, underscores a strong farmer preference for chat as a cash crop, providing household income and export income to the country. However, chat irrigation has led to overuse of groundwater, and is also linked to drying lakes, for example Haromaya Lake. Investment has been made in various infrastructure including roads, irrigation, electricity, mobile phone and satellite television networks, creating new opportunities for rural people.

Investment opportunities

The following are some potential investment opportunities for this farming system.

- Take advantage of opportunities for formal cross-border trade.
- Support farmers in boosting the productivity and improving the quality and further branding of Harar coffee.
- Capitalize on existing skills of farmers in livestock fattening and invest in commercial fattening, value addition and dairy.
- Promote efficient use of irrigation and water management.
- Soil conservation practices associated with chat are needed, as is investment in research to better understand potential social consequences of chat usage.

Sorghum mixed farming system

Figure 19. The sorghum mixed farming system area in Ethiopia.

Basic system data	
Total population 2010 (million)	4.27
Agricultural population 2010 (million)	3.27
Urban population 2010 (million)	0.75
Time to 20K market (h) (range / average)	0–23 / 5
Dominant agroecological zone	Warm/semi-arid
Elevation (m) (range / average)	528–3,145 / 1,340
LGP (days) (range / average)	39–158 / 110
Rainfall (mm) (range / average)	282–954 / 628
Total area (million ha)	4.75
Cultivated area (million ha)	0.89
Irrigated area (million ha)	5.381
Cattle (million)	1.18
Goats and sheep (million)	1.79
Number of rural poor (<US$1.25/day)	1,391,783
Per cent of total rural poor in Ethiopia	5%

LGP = length of growing period.

General characteristics

The sorghum mixed farming system is found in semi-arid areas of Ethiopia, extending from eastern Hararghe through Shewa Robit, North Wollo to Kobbo, Alamata and Raya valley at low and intermediate elevations (Figure 19). The main crops grown are sorghum, millet, teff, maize and pulses (chickpea)—the same crops as in the agropastoral systems due to similarities in the length of growing season. Sesame is grown in the northern part of the system, and groundnuts in the eastern areas, including Babilie, Gursum, Fafem, Bisidimo and Jijiga. Similar to the sorghum–chat mixed farming system, farmers in the eastern areas often raise one or two oxen for fattening and sale. Fodder is mostly gathered through a cut and carry system as community grazing land is limited. Several species of fruit trees are common, including mango, guava and citrus (orange and limes). *Annona* (local name Gishta) is a common fruit tree crop in the eastern Hararghe area.

The system offers relatively few off-farm activities. Some organizations encourage the processing and marketing of groundnuts. Levels of poverty in the system are high.

The main ethnic groups present include Oromo and Somali in the east, and Amara, Tigray and Kunama in the north.

Natural resource context

The natural vegetation is composed of sparse *Acacia* savanna, with the occurrence of *Prosopis* sp., which is known to be invasive. Congress weed, *Partheneum* spp., is common. *Striga* is a major issue for cereals grown in the system. The environment is dry and water is relatively scarce. Rainfall is low and erratic. The landscape is mixed and undulating. Soil type and quality vary depending on location and landscape. Alluvial soils as well as Cambisols, Fluvisols and Vertisols are found in the northern and eastern zones of the system.

Production systems

Farm size in the sorghum mixed farming system tends to be much smaller than in the agropastoral system. The system is subsistence-oriented with low inputs. Sorghum is the primary staple but yields are low. Livestock is marketed to generate income to buy maize, chat and other goods for the household; thus, linkages to the market are developed. Some fish production occurs in lakes in the northwestern area.

Trends and drivers of change

During the last 30 years, an erratic trend in rainfall and some catastrophic drought periods have meant that this system has been less than self-sufficient in food for about three years out of five, and on three occasions there has been mass famine. One lasting effect is that the poorest third of the population have not been able to renew their lost livestock herds, thus depriving them of assets as security for buying food in times of crop failure. The need to borrow oxen under a labour or crop share payment agreement limits the efficiency of their farming and their command over their harvest even in good years. This in turn increases their propensity to look for casual work on local or distant farms and in towns. Thus, the system has often relied on food relief. Responses have included a number of safety net projects in soil and water conservation, as well as general infrastructure and hydropower development.

Investment opportunities

The following are some potential investment opportunities for this farming system.

- There is a huge opportunity for groundwater development along with tropical fruit production; intensification with exportable fruits and vegetables could be easily developed.
- This system provides the best fit for expansion of export-oriented dryland legumes, particularly groundnuts and mungbeans, in the sorghum systems.
- Facilitate adoption of the beef farming system from the neighbouring systems.
- Invest in drought preparedness measures.
- Encourage adaptation involving non-farm activities.
- Promote efficient small-scale mechanization.

Western highland maize mixed farming system

Figure 20. The western highland maize mixed farming system area in Ethiopia.

Basic system data	
Total population 2010 (million)	3.96
Agricultural population 2010 (million)	3.46
Urban population 2010 (million)	0.21
Time to 20K market (h) (range / average)	1–26 / 9
Dominant agroecological zone	Cool/subhumid
Elevation (m) (range / average)	528–3,145 / 1,340
LGP (days) (range / average)	166–260 / 219
Annual rainfall (mm) (range / average)	1,057–1,657 / 1,458
Total area (million ha)	4.33
Cultivated area (million ha)	0.24
Irrigated area (million ha)	0.014
Cattle (million)	2.26
Goats (million)	0.66
Sheep (million)	1.02
Number of rural poor (<US$1.25/day)	1,276,904
Per cent of total rural poor in Ethiopia	5%

LGP = length of growing period.

General characteristics

This farming system occupies land from East Wollega to East Metekel and Awi zones (Figure 20). The dominant tree crop component distinguishes this system from the eastern highland maize mixed system. Key crops in the western system include maize, teff, finger millet, niger seed (oil crop, *Guizotia abyssinica*), wheat and barley, as well as vegetables (capsicum, potato and tomato), all of which are both home-consumed and marketed. Common tree crops are mango, pawpaw and high-quality coffee south of the Blue Nile. The Awi subsystem, specific to the Awi ethnic group located in the central northern area, is focused on potato, barley and trees (eucalypts, acacias and bamboo). Since the early 2000s, fertilizers are increasingly being used on maize, with maize yield reaching 7 t/ha in farmers' fields, exceeding the national average.

Cattle, sheep, goats, chickens, horses, mules and donkeys are the main livestock. Livestock are fed both on crop residues around the household compound and on communal grazing areas.

Coffee washing, collection and trade as well as honey production are sources of off-farm income. In addition, there are opportunities in the trade of cattle to Sudan and formal trading of agricultural products to Assosa, Bahir Dar and Addis Ababa.

The levels of poverty are low for the system as a whole, but there are geographical pockets with a concentration of poor people.

Ethnic groups practising this system include the Oromo, Gumuz, Amhara and Awi.

Natural resource context

Landscapes where this farming system is found are hilly and undulating. Rainfall is high, exceeding 1,400 mm per annum, and unimodal. Water availability is not limiting for agriculture. Various soil types (Nitisols, Vertisols, Acrisols, Alisols) prevail according to the area. Soil acidity and associated phosphorus deficiency are becoming prevalent. Erosion is common despite some efforts to put soil and conservation structures in place. Major tree species include *Croton* and *Cordia* spp.

Production systems

The western highland maize mixed farming system is one of Ethiopia's high potential productivity cereal-focused systems. Management intensity is high with extensive reliance on improved varieties, fertilizers, compost, herbicides and pesticides. Termite infestation can be a major production constraint, particularly in East Wollega zone. The system is also becoming slowly commercialized.

Malaria is becoming a major challenge within the system, and it is assumed that the expansion of maize to the highlands created conditions conducive for spreading malaria.

Trends and drivers of change

The western highland maize mixed farming system area is endowed with high infrastructural development. Maize was changed from a backyard crop to a field crop through government interventions supported by research and extension programs. The productivity potential of cereals in this system is high. There are medium to large-scale irrigation schemes in the area, such as the 7,000-ha Koga scheme established five years ago. The Dedessa and Fincha hydropower dams are used for irrigation of large sugar plantations as well as smallholder crops.

Investment opportunities

The priority investment areas would be catalysing the growth of enterprises with growing consumer expectations, starting with feed supplies for the poultry industry, along with setting policy incentives for increasing productivity and improving market linkages (IFPRI 2010). Improved transport in the form of the upcoming train system from the production areas, and increased trade relationships between Sudan and Ethiopia, will increase the opportunity for maize to be internationally traded. Other potential investment opportunities include the following:

- There is very high potential for further improvement in agriculture-led growth, particularly intensification towards high-value fruits and vegetables.
- Invest in agriculture-based SMEs to expand farm–non-farm linkages.
- Encourage further diversification of vegetable and crop production within the perennial system, creating multi-enterprise production systems that are more resilient to changes in conditions.
- Promote investment planning over long periods due to the prominence of perennial activities.

Western lowland maize mixed farming system

Figure 21. The western lowland maize mixed farming system area in Ethiopia.

Basic system data	
Total population 2010 (million)	1.97
Agricultural population 2010 (million)	1.56
Urban population 2010 (million)	0.29
Time to 20K market (h) (range / average)	1–54 / 13
Dominant agroecological zone	Warm/subhumid
Elevation (m) (range / average)	382–2,157 / 891
LGP (days) (range / average)	124–263 / 213
Annual rainfall (mm) (range / average)	548–1,755 /1,153
Total area (million ha)	8.29
Cultivated area (million ha)	0.43
Irrigated area (million ha)	0.0015
Cattle (million)	1.12
Goats (million)	0.88
Sheep (million)	0.48
Number of rural poor (<US$1.25/day)	438,902
Per cent of total rural poor in Ethiopia	2%

LGP = length of growing period.

General characteristics

This farming system extends from Benchi Maji through Agnuak to Assosa zones of western Ethiopia (Figure 21). Important crops in this farming system include maize as both a staple and cash crop, sorghum as a staple crop, and other cash crops such as soybean, cotton, sesame and rice. Vegetables include okra, irrigated tomato, capsicum and onions. The farming system is rather extensive and relies on shifting cultivation. The relative absence of perennial enterprises separates this system from the western highland maize mixed system. There are state-owned sugar plantations and several large-scale private investments in rice production. The system also produces the fruit tree crops mango and pawpaw.

Livestock production focuses on cattle for both milk and beef, goats for meat, sheep, donkeys and chickens. The tse-tse fly is a major constraint to livestock production in the lowlands.

Apiculture, traditional gold mining, quarrying for marble, bamboo production and sale and hunting provide off-farm household income.

The farming system is associated with high levels of poverty.

Ethnic groups engaged with this system include several Nilotic ethnic groups in the north—Gambela, Nuer, Agnwak, Mejenger, Shinasha, Mao, Komo, Berta and Gumuz; Omotic ethnic groups in the south; and several small pockets of local indigenous traditional groups.

Natural resource context

Natural vegetation is characterized by scattered *Acacia* and different tropical trees, including bamboo forests, and grassland. Eutric Vertisols and Leptosols are the dominant soil types.

Production systems

The western lowland maize mixed farming system consists of large landholdings, due to more abundant land and low market orientation. The environment is relatively wet and humid and the area was traditionally under agropastoral systems, which are still practised in the southwest. The area is vulnerable to tse-tse fly infestations, which spread trypanosomiasis and cause livestock mortality and morbidity. Large-scale land investments, for instance from India and by the company Saudi Star (for rice and biofuel), are in process.

Trends and drivers of change

Farm households in the system have limited access to services and education. Previously considered a peripheral farming area, the region is now given higher priority by the Ministry of Federal Affairs as an ‘emerging’ region and is receiving greater public investment. Two hydropower stations (Abay and Omo) under construction will augment water supply, allowing irrigation water for state-owned sugar plantations, while a major new road to Sudan will expand markets. These government projects and settlement programs are attracting people to the region.

Investment opportunities

The following are some potential investment opportunities for this farming system.

- Link small-scale farms with the large-scale investments and processing units, as outgrowers of key export commodities.
- Improve the agriculture–energy–water nexus for sustainable management of these fragile systems.
- There is high potential for further improvement in agriculture-led growth, such as through investment in agriculture-based SMEs to expand farm–non-farm linkages, including perennials.
- High potential to develop diversified production systems to take up emerging opportunities.

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