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COORDINATION

This report was coordinated by Dr. Oliver K. Kirui (ZEF) and Dr. Fatunbi Oluwole Abiodun (FARA).

CONTRIBUTORS TO THE COUNTRY DOSSIER ETHIOPIA

Bahir Dar University:	Birhanu Gedif
FARA:	Yemi Akinbamijo, Fatunbi Oluwole Abiodun
ZEF:	Heike Baumüller, Joachim von Braun, Annapia Debarry, Tigabu Degu Getahun, Christine Husmann, Oliver K. Kirui, Ehsan Eyshi Rezaei, Leonie Routil, Sougrynoma Zainatou Sore, Justice Akpene Tambo, Detlef Virchow, Doris Wiesmann
	Layout & Editing: Evelyn Baraké, Sebastian Eckert, Katharina Gallant, Hannah Jaenicke, Yesim Pacal, Katharina Zinn

This report is work in progress and continuously being updated. Any feedback and suggestions for further improvement are welcome and can be sent to pari@uni-bonn.de.

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About this study

In 12 African countries and India Green Innovation Centers (GICs) have been established under the ‘‘One World, No Hunger’’ Initiative (SEWOH) of the German government and other investors. The aim of the GICs is to promote agricultural innovation, improve food and nutrition security and build sustainable value chains in the agri-food sector of these countries. The Program of Accompanying Research for Agricultural Innovation (PARI) has been providing independent research to the SEWOH since 2015. PARI is led by the Center for Development Research (ZEF) at the University of Bonn in close collaboration with the Forum for Agricultural Research in Africa (FARA) and its network of national and regional partners in Africa, the African Growth and Development Policy Modeling Consortium (AGRODEP) facilitated by the International Food Policy Research Institute (IFPRI, Africa Office) and other partners in Germany and India. This country dossier offers a situation analysis of the current state of the agri-food sector, related policies and existing agricultural innovations. It thereby provides basic background knowledge necessary to make fruitful investments in line with the country‘s policies and its potentials, and to find promising partners for development cooperation.

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Acronyms/Abbreviations

ADLI	Agriculture Development Led Industrialization strategy
Africa RISING	Africa Research in Sustainable Intensification for the Next Generation
APRM	African Peer Review Mechanism
ATA	Agricultural Transformation Agency
ATVET	Agricultural Technical and Vocational Education and Training
BMZ	"Bundesministerium für wirtschaftliche Zusammenarbeit und Entwicklung" German Federal Ministry for Economic Cooperation and Development
CAADP	Comprehensive Africa Agriculture Development Programme
CSA	Central Statistical Authority
DA	Development Agents
DHS	Demographic and Health Surveys
EARS	Ethiopian Agricultural Research System
EIAR	Ethiopian Institute of Agricultural Research
FAO	Food and Agriculture Organization
FARA	Forum for Agricultural Research in Africa
FTC	Farmer Training Centre
GDP	Gross Domestic Product
GHI	Global Hunger Index
GIC	Green Innovation Center
GIZ	"Deutsche Gesellschaft für Internationale Zusammenarbeit" German Agency for International Cooperation
GNI	Gross National Income
GTP I & II	Growth and Transformation Plan 1 & 2
IFPRI	International Food Policy Research Institute
ILRI	International Livestock Research Institute
IP	Innovation Platform
IPTA	Innovation Platform for Technology Adoption
LCU	Local Currency unit
MoARD	Ministry of Agriculture and Rural Development
MPCI	Multiple-peril crop insurance
NGO	Non-governmental Organization
NRM	Natural Resource Management
PADETES	Participatory Demonstration and Training Extension System
PARI	Program of Accompanying Research for Agricultural Innovation
PASDEP	Plan for Accelerated and Sustained Development to End Poverty
PID	Participatory Innovation Development
PPP	Purchasing Power Parity
PROFIEET	Promotion of Farmer Innovation and Experimentation in Ethiopia
PROLINNOVA	PROmoting Local INNOVAtion
R&D	Research & Development
RCA	Revealed Comparative Advantage
RUTFs	Ready-to-use therapeutic foods
SEWOH	"One World, No Hunger" Initiative
SNNPR	Southern Nations, Nationalities and Peoples' Region
TFP	Total Factor Productivity
UNICEF	United Nations International Children's Emergency Fund
USAID	United States Agency for International Development
WHO	World Health Organization
ZEF	Zentrum für Entwicklungsforschung/ Center for Development Research

1 General background information on the agricultural and food sector

Ethiopia is a landlocked country in the Horn of Africa, bordering, clockwise from the North, Eritrea, Djibouti, Somalia, Kenya, South Sudan and Sudan. It has the soil and climate required for the production of a variety of food crops. The major food crops grown are cereals, pulses and oil seeds. A broad range of fruit and vegetables and cut flowers are fast-growing export products. Coffee, cotton, tobacco, sugar cane, tea and spices are the main commercial cash crops grown in Ethiopia. According to the World Bank, the total population of Ethiopia amounts to 96,506,031, with 78,169,885 (81%) of the people living in rural areas and earning their livelihoods from agriculture.

The Ethiopian economy is dominated by the agriculture and service sector, accounting for 41% and 46% respectively, leaving only the remaining 13% to manufacturing (Ndukumia, 2010). Developing the manufacturing sector is the government's priority in current policies. Exports are highly concentrated in agriculture, with coffee alone accounting for more than 60% of the total exports. The agricultural sector contributes 90 % of foreign currency earnings, and 85 % of employment. The country's growth rate has been increasing rapidly from 0.5% p.a. in 1981-1992 to 11% in 2004-2014, which makes it the seventh-fastest growing economy of the world. Generally, the overall economic growth of the country has been highly associated with the performance of the agricultural sector, but also other sectors, mainly construction, real estate and hotels have been inducing growth since the 2000s (Robertson, 2016). Coffee is critical to the Ethiopian economy. It earned Ethiopia US$ 841.8 million in exports in 2010/11. Other important export products (2010/11) include gold, oil seeds, chat, flowers, live animals, pulses, leather and leather products, meat and meat products, fruit and vegetables. The government of Ethiopia has exerted maximum efforts to minimize the level of poverty. Different policies, strategies and policy implementation modalities have been designed and implemented. As a result of this, the country is one of the fastest growing both in Africa and globally.

In twelve African countries, including Ethiopia, Green Innovation Centers (GICs) have been established in selected regions under the ''One World, No Hunger'' Initiative (SEWOH) of the German government and other investors. The aim of the GICs is to promote agricultural innovation, improve food and nutrition security and build sustainable value chains in the agri-food sector. The selected value chains in Ethiopia are wheat and Fava beans in Arsi zone.

1.1 Pan-African policies and strategies

1.1.1 The Comprehensive Africa Agriculture Development Programme (CAADP)

The Comprehensive Africa Agriculture Development Programme (CAADP) was officially endorsed by African Heads of State at the Maputo African Union Summit in July 2003. The Programme was rolled out under the auspices of the New Economic Partnership for Africa's Development to serve as a framework for accelerating growth by eliminating poverty and hunger in the continent. Ethiopia officially launched CAADP in September 2008. Ethiopia was among the first four countries that signed a CAADP Compact. The Agricultural Policy and Investment Framework was designed in order to operationalize it (Ministry of Agriculture and Rural Development [MoARD], 2010). Implementation of CAADP was in line with the Plan for Accelerated and Sustained Development to End Poverty (PASDEP). The compact was reviewed at different levels in the presence of the CAADP focal unit. The review process involved consultations with the nine regional/state governments, the private sector, civil society and development partners, and was finalized in July 2009. After the fact, it served as an input for subsequent consultations and exchanges of views and as the basis for the agreement reached by the Compact signatories in the same year. The Compact document states that the CAADP process in Ethiopia is aimed at strengthening and adding value to the Agriculture Development Led Industrialization (ADLI) strategy, PASDEP, and other supportive programs, all of which focus on realizing Ethiopia's rural economic development and food security objectives.

Ethiopia is widely considered a "big success" in CAADP. The key achievements of CAADP in Ethiopia were (i) attracting additional international support to agriculture and (ii) considerably strengthening the coordination in the sector, both among development partners and between development partners and government. This led to effective coordination mechanisms and to a degree of alignment of multilateral and bilateral assistance that many stakeholders suggest should be shared with other African countries as "best practices". Ethiopia is also possibly the best example of the centrality of national leadership and local conditions to the successful implementation of CAADP. Such good progress (including on donor harmonization) is largely due to the choice made by the Ethiopian Government, well before CAADP, to focus and invest in rural development (from 2008 to 2011, almost 20% of government spending was invested into agriculture, and productivity rose each year by almost a quarter, while the CAADP Compact was signed in 2009 and the National Agriculture Investment Plan launched in 2010). According to many national stakeholders, the Prime Minister's direct involvement as a political champion made a difference, while the CAADP Lead Institutions (and the Multi-Donor Trust Fund) did not play a crucial role. Possibly the major bottleneck for CAADP in Ethiopia is the scarce direct involvement of the private sector; one of the key challenges ahead will be to ensure that farmers and companies really own and contribute to the agriculture transformation agenda and to build on the significant experiences of public-private co-operations such as those promoted by the Ethiopian Agricultural Transformation Agency (European Centre for Development, 2014). The Ethiopian government is pushing for stronger involvement of the private sector in its second five-year Growth and Transformation Plan (GTP II). Investments in infrastructure and agro-industrial development will enable an increase in exports of processed agricultural commodities and thereby add significant value to production in the agricultural sector (The Worldfolio, 2016a, b).

1.1.2 The African Peer Review Mechanism (APRM)

Ethiopia formally joined the APRM by signing the Memorandum of Agreement that established the process at a continental level in March 2003. It was among the first countries to join the mechanism, showing, in theory, the commitment of the country to bring about a culture of good participatory political governance, and its willingness to open its gates for public dialogue and peer review. The first steps in implementing the APRM process in Ethiopia were taken around June of 2007. The self-assessment process was completed in 2008, and the country self-assessment report submitted to the APRM Secretariat in Johannesburg in early 2009; the APRM Panel of Eminent Persons led the country review mission to Ethiopia in July 2009. A revised draft of the national program of action was completed in early 2010 in order to address the issues in the APRM review report (Fisseha and Tadesse, 2011). The peer review of Ethiopia was finally held on the 29th of January 2011 at the 14th session of the African Peer Review Forum. In January 2013, the APRM report on Ethiopia was released in Addis Ababa. It was criticized by political analysts on the basis of the Ethiopian government's strong involvement in the process that was furthermore perceived to have left out other stakeholders. Nonetheless, recommendations from the report for Ethiopia's government include stronger "political engagement of key actors" and a "constructive approach to political asymmetries between the regional states and the ensuing regional inequalities". It praises the government's commitment to private sector-led growth and the PASDEP program, but also points out the lack of corporate governance in Ethiopia. The APRM secretariat suggests a yearly report following the review, issued at national level on the progress made, and stresses the responsibilities of all sectors to apply the recommendations made (Lemma, 2013).

1.2 National (and regional) policies and strategies

The agricultural policy of the imperial regime had a feudalist orientation, while the agricultural policy of the Derg regime had a socialist footing. The Ethiopian People Revolutionary Democratic Front regime had a mixed -type agricultural policy. There was progress observed through the regime changes. During the imperial regime, the three Five-Year Plans were formulated in a top-down

approach with the exclusive involvement of the elites and clergy. The Ministry of Agriculture and Rural Development (MoARD), in the Derg regime, developed the Peasant Agricultural Development Extension Programme, which focused on improving extension service and redirecting agricultural resources to the peasant sector.

The current government has adopted and used the ADLI strategy since 1995 as an overall development strategy for the country. Concomitant with the ADLI, a series of Poverty Reduction Strategy Papers were launched, including the Sustainable Development and Poverty Reduction Programme (2001/2002-2004/2005) and PASDEP (2004/2005-2009/2010). The current Growth and Transformation Plan (GTP I) (2009/2010-2014/2015) and GTP II (2015-2020) are also very important steps. In all their programs and policies, poverty reduction is the central theme, and agriculture is given top priority, with particular attention paid to smallholder farmers. After supporting the agricultural sector primarily through the Disaster Risk Management and Food Security program in recent years, as of 2010, the MoARD has been pursuing the Agricultural Sector Policy and Investment Framework in order to operationalize CAADP. The policy will be in place until 2020, with a main focus on reducing degradation, raising rural production and incomes, promoting agricultural commercialization and agro-industrial development, establishing food security, as well as protecting vulnerable households from natural disasters (MoARD, 2010). The ministry also founded the Agricultural Transformation Agency (ATA) on the basis of an extensive diagnostic study on Ethiopia's agricultural sector and international consultations. The ATA is a dedicated institution charged with playing a catalytic role in the agricultural development, tackling systematic bottlenecks and giving strategic support to all stakeholders. The intention is to replicate the agricultural growth observed in some Asian states, such as Taiwan, Korea and Malaysia (ATA, 2016b).

Policies related to agriculture in Ethiopia stated that agricultural development could be achieved by increasing the capacity and extensive use of labor, promoting the proper utilization of agricultural land, linking specialization with diversification, integrating agricultural and rural development, and strengthening the agricultural marketing system. Strengthening the linkages between research, extension services and farmers is essential to the wider use of improved technologies and practices. At the same time, the number of beneficiaries of agricultural extension services was estimated to have increased from 5 million in 2011 to 15 million in 2015 (Stein, 2011).

Other important policies and strategies are:

- Rural Development Policy and Strategy;
- The Plan for Accelerated and Sustained Development to Reduce Poverty;
- Food Security Strategy;
- Climate Change National Adaptation Programme of Action;
- Growth and Transformation Plan (GTP II).

1.3 Data on food and nutrition security

The following section includes information about important socio-economic and agricultural indicators and data on diet quantity, diet quality and nutrition status.

1.3.1 Socio-economic and agricultural data

Significant parts of Ethiopia are characterized by persistent food insecurity. While droughts and other hazards (such as floods) are significant triggers, more important are the factors that create and/or increase vulnerability to these shocks and that have undermined livelihoods. These factors include land degradation, limited household assets, low levels of farm technology, lack of employment

opportunities and population pressure. As a consequence, but also exacerbating the situation, are low levels of education and the prevalence of disease. In 2003, following significant rain shortages, more than 13 million people required assistance and chronic undernutrition stood at approximately 52% (Country Food security program, 2010-2014). Prior to 2005, the typical response to this persistent food insecurity was emergency relief resourced through an unpredictable annual appeals process. Although relief was provided, often at great expense, it was rarely adequate or timely. As a consequence, households were forced to sell assets (further constraining their livelihood options) and to restrict consumption (with immediate impacts on increasing the risk of disease and longer term impacts on chronic malnutrition).

Table 1: Selected national economic and health-related data

Indicator	Value	Year
Population, total	96,506,031	2014
Population growth (annual %)	2.5	2014
Rural population (% of total population)	81	2014
GDP per capita, PPP (constant 2011 international $)	1,432	2014
GNI per capita, PPP (constant 2011 international $)	1,427	2014
Poverty headcount ratio at $2 a day (PPP) (% of population)	72	2010
Poverty headcount ratio at $1.25 a day (PPP) (% of population)	37	2010
Poverty headcount ratio at national poverty lines (% of population)	30	2010
Rural poverty headcount ratio at national poverty lines (% of rural population)	30	2010
Agricultural land (% of land area)	36	2012
Agricultural irrigated land (% of total agricultural land)	0.5	2011
Agriculture value added per worker (constant 2005 US$)	278	2014
Agriculture, value added (% of GDP)	45	2014
Access to electricity, rural (% of rural population)	7.6	2012
Employees, agriculture, female (% of female employment)	75	2005
Employees, agriculture, male (% of male employment)	83	2005
Employment in agriculture (% of total employment)	79	2005
Literacy rate, adult total (% of people ages 15 and above)	39	2007
Ratio of female to male secondary enrolment (%)	63	2006
Mortality rate, under-5 (per 1,000 live births)	64	2013
Maternal mortality ratio (modelled estimate, per 100,000 live births)	680	2011

Source: World Bank, data.worldbank.org/country
Note: GDP refers to Gross Domestic Product; GNI refers to Gross National Income; PPP refers to Purchasing Power Parity

1.3.2 Consumption and nutrition status

Data on diet quantity, diet quality and nutrition status are relevant for assessing food and nutrition security. Overall, dietary energy supply per capita – a measure of diet quantity – is barely adequate in Ethiopia, falling slightly below the average dietary energy requirement of the population (Table 2). Almost one third of the population suffers from chronic undernourishment, as they are unable to meet their minimum dietary energy requirements. Ethiopia managed to cut a staggering undernourishment rate of 75% in 1990-92 by more than half over the past 25 years (Figure 1). The incidence of food-overacquisition has increased during this time, but it is still low: The Food and Agriculture Organization (FAO) estimates that roughly one tenth of the Ethiopian population regularly acquire food in excess of their dietary energy needs (Table 2).

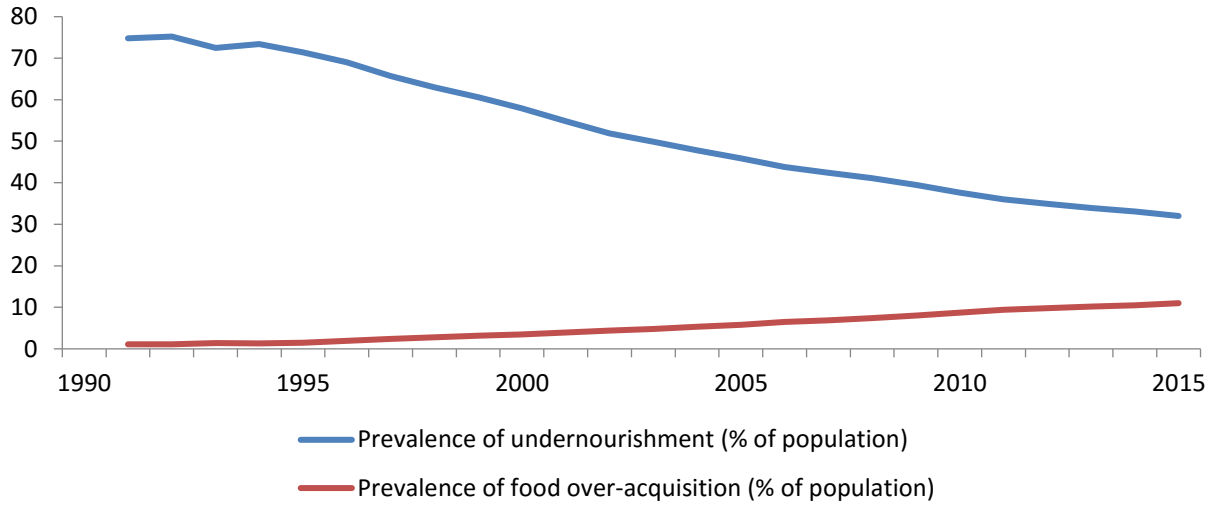
Table 2: Food and nutrition security indicators

Indicator	Value	Year
Diet quantity		
Dietary energy supply (kcal/caput/day)	2192	2014-16
Average dietary energy supply adequacy (% of average requirement)	99	2014-16
Prevalence of undernourishment (% of population)	32	2014-16
Prevalence of food over-acquisition (% of population)	11	2014-16
Diet quality		
Dietary energy supply from cereals, roots and tubers (% of total dietary energy supply)	76	2009-11
Dietary energy supply from carbohydrate (% of total dietary energy supply)	77	2009-11
Dietary energy supply from protein (% of total dietary energy supply)	12	2009-11
Dietary energy supply from fat (% of total dietary energy supply)	11	2009-11
Average protein supply (g/caput/day)	61	2009-11
Average fat supply (g/caput/day)	26	2009-11
Child feeding practices		
Minimum dietary diversity: consumption of 4+ food groups (% of children 6-23 months)	5	2011
Consumption of foods rich in vitamin A (% of children 6-23 months)	26	2011
Consumption of foods rich in iron (% of children 6-23 months)	13	2011
Nutrition status		
Child wasting (% of children under five)	9	2014
Child stunting (% of children under five)	40	2014
Child overweight (% of children under five)	3	2014
Adult overweight and obesity (% of adults 18+ years)	19	2014
Adult obesity (% of adults 18+ years)	4	2014
Vitamin A deficiency (% of children 6-59 months)	50	2013
Anemia in children (% of children 6-59 months)	44	2011
Anemia in women (% of women 15-49 years)	17	2011

Source: Central Statistical Agency and ICF International (2012); FAO (2016), and authors' calculations based on FAO (2016); Stevens et al. (2015), quoted in International Food Policy Research Institute (IFPRI) (2015); World Health Organization (WHO) (2015a); WHO (2016)
Note: See Annex A for definitions of the indicators.

The diet in Ethiopia is heavily based on starchy staples (namely on maize, wheat, sorghum, other cereals, such as teff and barley, and starchy roots) that provide more than three quarters of dietary energy supply (Table 2). The share of the dietary energy supply from carbohydrates exceeds the maximum of 75% recommended by the WHO, while the share of dietary energy supply from fat is below the recommended minimum of 15%, and the share of dietary energy supply from protein lies within the recommended range of 10-15% (WHO, 2003). This means that the diet is not balanced in terms of its macronutrient composition; the share of dietary energy from carbohydrates should be reduced in favor of a higher share of dietary energy from fats. Average protein supply is sufficient to meet protein requirements (Table 2; see Annex A for further explanation).

Figure 1: Prevalence of undernourishment and food over-acquisition (1990-92 to 2014-16)



Source: Authors' presentation based on data from FAO (2016)

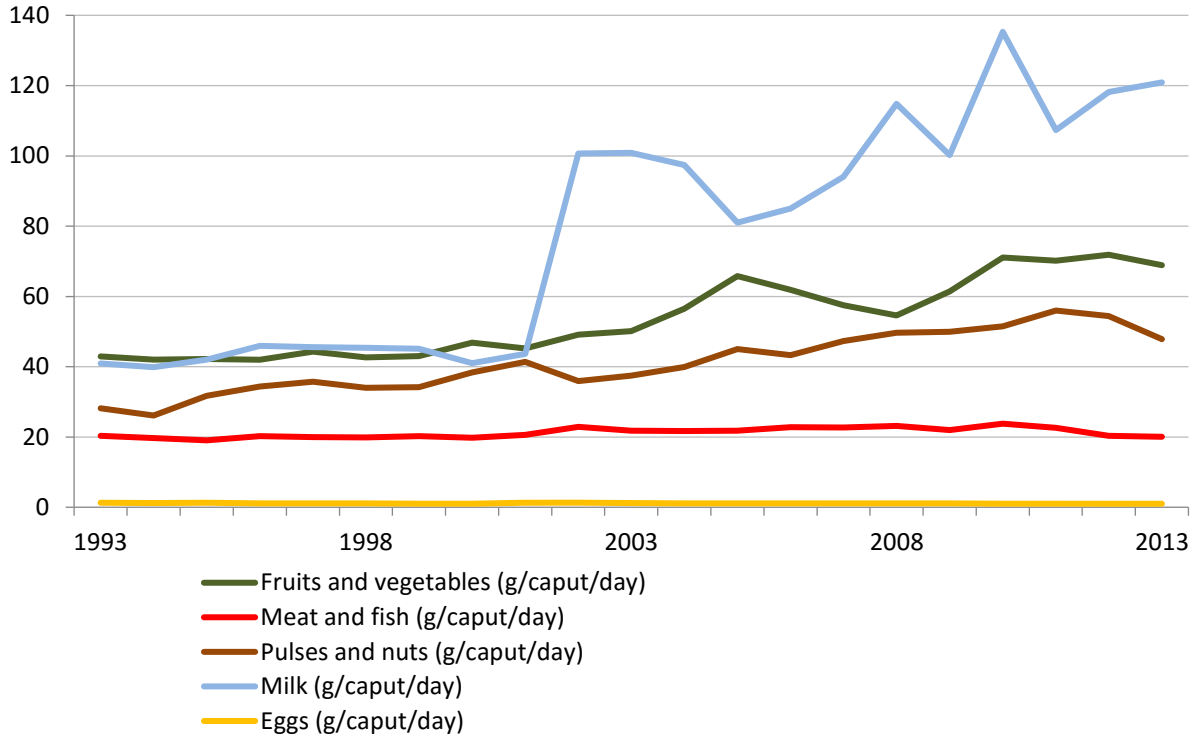
The consumption of sufficient quantities of non-staple foods such as fruits and vegetables and animal-source foods is essential for a diet that provides adequate amounts of micronutrients. Meat supply in Ethiopia is extremely low and stagnant, amounting to only 20 g/caput/day (Figure 2).[1] Milk supply has grown considerably since the early 2000s and has reached a moderate level of about 120 g/caput/day according to the latest data, whereas eggs do not significantly contribute to the Ethiopian diet. The supply of pulses and nuts has increased to roughly 50 g/caput/day, providing 18% of the protein supply in Ethiopia.[2] The supply of fruits and vegetables has risen since the early 1990s, but is still dismally low. Amounting to only about 70 g/caput/day, it falls far below the recommended intake of 400 g of fruits and vegetables per day (WHO, 2003).

Infant and young child feeding practices are crucial for children's nutrition and health status and long-term development. Children 6-23 months should consume at least 4 out of 7 food groups (minimum dietary diversity) and receive iron-rich foods and foods rich in vitamin A daily. In Ethiopia, infants' and young children's diets are sorely falling short of these recommendations; only 5% achieved minimum dietary diversity, about one fourth consumed foods rich in Vitamin A, and 13% consumed foods rich in iron on the previous day (Table 2). Both breastfed and non-breastfed children aged 6-23 months were most frequently fed foods made from grains; other, more micronutrient-rich foods such as meat, fish and eggs, fruits and vegetables, and pulses and nuts, were given much more rarely (Figure 3). Fortified baby foods, which can compensate for a lack of micronutrients in the diet, were consumed by only 4% of breastfed and 6% of non-breastfed children.

Stunting and wasting are indicators of chronic and acute child undernutrition, respectively. In Ethiopia, stunting continues to be a severe public health problem with a prevalence of 40%, whereas wasting has mild public health significance, affecting 9% of children (Table 2). In the early 1990s, more than two thirds of children in Ethiopia were stunted, however, this very high rate has been reduced considerably, by about 27 percentage points (UNICEF/WHO/World Bank, 2016)[3]. Wasting has barely improved over the same period, although it declined again after a transient increase around the turn of the millennium. According to the latest available data, overweight in children is relatively low (Table 2).

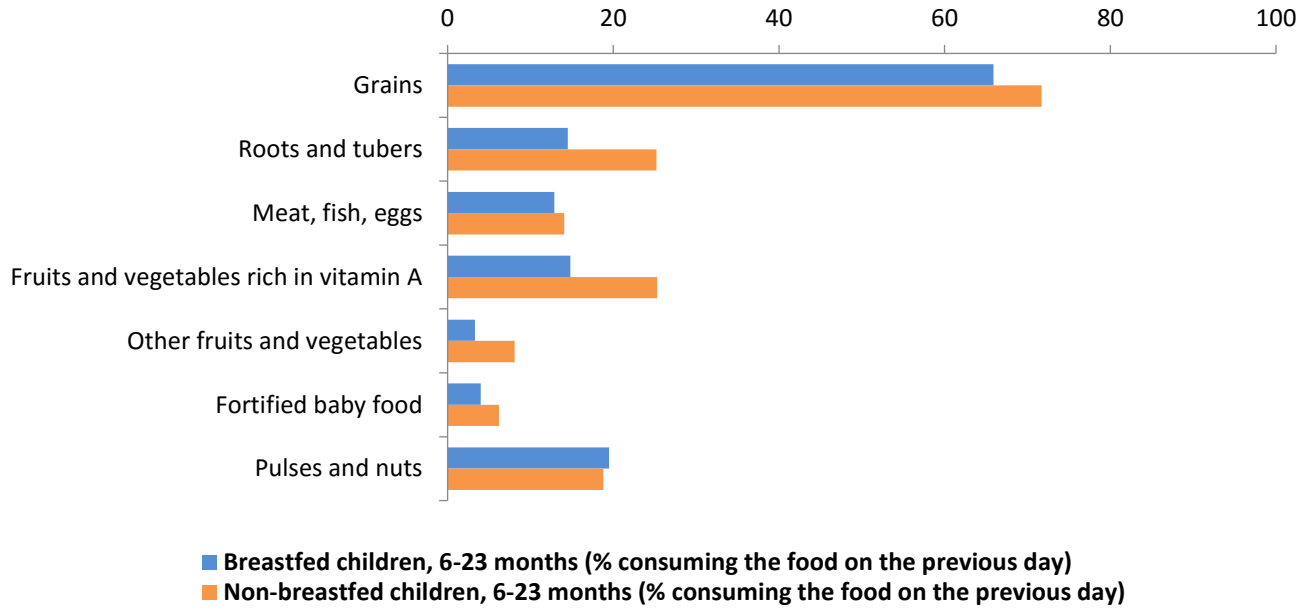
[1] Fish supply in Ethiopia is below 1 g/caput/day and therefore negligible.
[2] Source: Food balance sheet for Ethiopia, 2013, from FAOSTAT, accessed 19 Nov, 2016.
[3] UNICEF = United Nations International Children's Emergency Fund

Figure 2: Supply of non-staple foods (1993-2013)



Source: Authors' presentation based on data from FAOSTAT, accessed 07 Oct 2016
Note: Based on their nutrient profiles, pulses and nuts include groundnuts and soybeans, although these foods are classified by FAO as oilcrops. Coconuts are not included among pulses and nuts because they have low protein content. Data for Ethiopia in its present borders are available from 1993 on, the year when the secession of Eritrea took place.

Figure 3: Percentage of infants and young children consuming foods from selected food groups (2011)

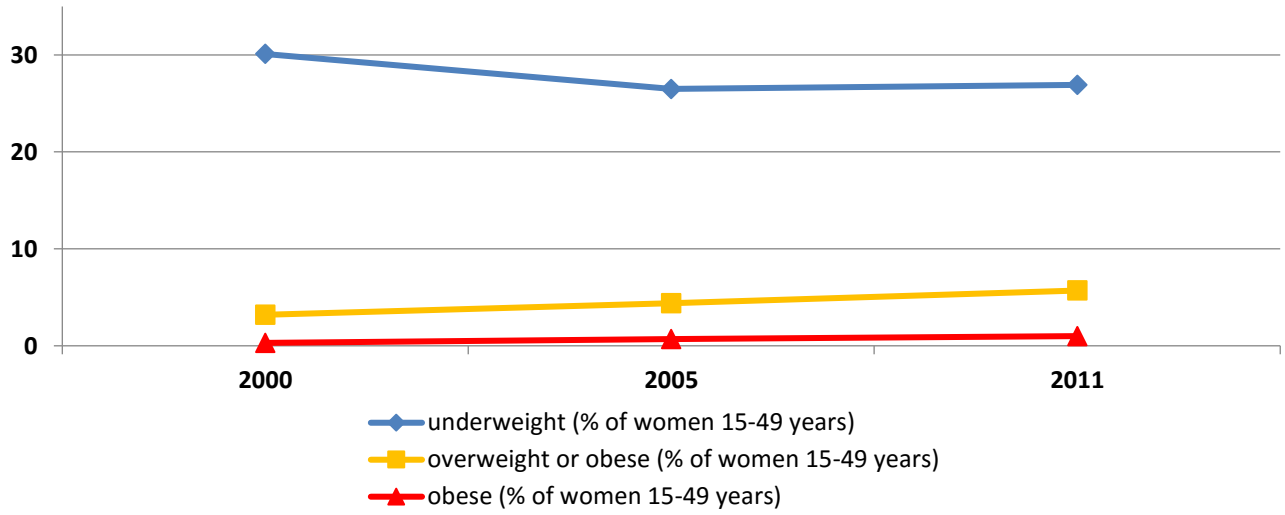


Source: Authors' presentation based on data from Central Statistical Agency and ICF International (2012)

Overweight and obesity are risk factors for chronic diseases such as diabetes (Must and McKeown 2012). About one fifth of adults in Ethiopia are overweight or obese (Table 2). According to data from the Demographic and Health Survey (DHS), the combined prevalence of overweight and obesity has increased in women of reproductive age, yet it was still very low in 2011, amounting to only 6% (Figure 4). In the same year, the prevalence of underweight in women was alarmingly high; 27% of women were underweight, showing only a small improvement compared to the 30% prevalence rate in 2000.[4]

Vitamin A deficiency is a risk factor for blindness and for mortality from measles and diarrhea in children aged 6–59 months (Imdad et al. 2010; Imdad et al. 2011). In Ethiopia, half of all children in this age group are estimated to be vitamin A-deficient (Table 2). Anemia affects 44% of children aged 6-59 months and less than one fifth of women of reproductive age (Table 2). Considering the country's poverty, food insecurity, and very low dietary diversity, anemia rates in Ethiopia are astonishingly low. The high iron content of teff and the low prevalence of severe forms of malaria may contribute to this result (United States Department of Agriculture (USDA), 2016; University of Oxford, 2015).[5] About half of the global burden of anemia can be attributed to iron deficiency, and half to deficiencies of certain vitamins and to acute and chronic infections – including malaria – and other health disorders (WHO, 2015b).

Figure 4: Underweight, overweight and obesity in women of reproductive age (2000-2011)



Source: Authors' presentation based on data from ICF International (2015), The DHS Program STATcompiler, funded by United States Agency for International Development (USAID), accessed 12 Sept 2016

Regionally disaggregated data are available for indicators of nutrition status and child feeding. The diversity of infants' and young children's diets is very low throughout the country. The only regions where more than 10% of children achieved minimum dietary diversity (4+ food groups on the previous day) are the Dire Dawa, Addis Abeba and Gambela regions (Table 3). The proportion of children with minimum dietary diversity amounted to only 2-3% in the Somali and Amhara regions. The Gambela and Dire Dawa regions also do best in terms of the shares of children consuming foods rich in vitamin A, whereas the Affar, Somali and Amhara regions are lagging behind on these indicators (and so does the Southern Nations, Nationalities and Peoples' Region [SNNPR] on the share of children consuming foods rich in iron). Anemia rates in children is lowest in the Addis Abeba and Amhara regions, and highest in the Affar and Somali regions (Table 4). The Affar, Tigray and SNNPRs have stunting rates that

[4] See Annex A for definitions of overweight, obesity, and underweight.

[5] According to data from USDA (2016), the iron content of teff is 2-3 times higher than the iron content of common varieties of maize, wheat, sorghum and millet, and 4-10 times higher than the iron content of unenriched brown or white rice.

amount to 40% or more and are about 2-3 times as high as in the Gambela and Addis Abeba regions. The Somali and Affar regions rank worst on wasting.

Overweight and obesity rates in women are highest in the Addis Abeba, Dire Dawa and Somali regions (Table 5). Underweight rates in women is also high in the Somali region, although they are not as extreme as in the Affar and Tigray regions, where 40% or more of the women are underweight. Anemia incidence among women is most pronounced in the Affar and Somali regions, and lowest in Addis Abeba.

Table 3: Child feeding practices by region, 2011

Share of children 6-23 months consuming:					
4+ food groups		**Foods rich in vitamin A**		**Foods rich in iron**	
Region	**(%)**	**Region**	**(%)**	**Region**	**(%)**
Dire Dawa	15	Gambela	48	Gambela	33
Addis Abeba	12	Dire Dawa	38	Dire Dawa	24
Gambela	12	SNNPR	35	Tigray	20
Harari	8	Addis Abeba	33	Benishangul-Gumuz	18
Oromiya	6	Benishangul-Gumuz	32	Oromiya	17
Tigray	6	Harari	30	Addis Abeba	16
Affar	5	Oromiya	27	Harari	14
Benishangul-Gumuz	5	Tigray	25	Amhara	10
SNNPR	4	Amhara	16	Somali	6
Somali	3	Somali	12	SNNPR	6
Amhara	2	Affar	11	Affar	6

Source: Central Statistical Agency and ICF International (2012)
Notes: GIC regions are highlighted in red. SNNPR = Southern Nations, Nationalities and Peoples' region. See Annex A for definitions of the indicators.

Out of all indicators of children's nutrition status that are available at the regional level, anemia and stunting have the highest prevalence rates (Table 4). Under the assumption that half of all anemia is due to iron deficiency, iron deficiency anemia in children has mild public health significance in the Addis Abeba, Amhara, SNNPR and Tigray regions, and moderate significance in all other regions.[6] Stunting is a severe public health concern in the Affar, Tigray, SNNPR, Amhara and Benishangul-Gumuz regions, a moderate concern in the Oromiya and Somali regions, and a mild concern in the other 4 regions. Wasting levels are severe in the Somali, Affar, and Benishangul-Gumuz regions, moderate in the Gambela, Tigray, and Dire Dawa regions, and mild in the Amhara, Oromiya and SNNPR regions. Overweight in children has moderate public health significance in the Benishangul-Gumuz and Addis Abeba regions, and mild significance in the SNNPR, Harari and Oromiya regions.

Out of all indicators of women's nutrition status that are available at the regional level, underweight has the highest prevalence rates in almost all regions, followed by anemia (Table 5). The Addis Abeba region, where the combined prevalence of overweight and obesity exceeds the prevalence of underweight, and the Somali and Dire Dawa regions, where anemia prevalence surpasses the prevalence of underweight, are exceptions to this rule.

[6] About half of the global burden of anemia is attributable to iron deficiency (WHO, 2015b). Since the prevalence of anemia in children in Ethiopia is in the range of 46.5-74.7% in 7 out of 11 regions, the prevalence of iron deficiency anemia can be estimated to be 23.3-37.4% in these regions, falling within the range of 20-39% that has been defined to classify a moderate public health problem (see Annex A). Anemia is lower in the other 4 regions and the estimated prevalence of iron deficiency anemia suggests that it is a mild public health problem there.

Table 4: Child nutrition status by region, 2011/2014

Prevalence in children under five:						Prevalence in children 6-59 months:	
Stunting		Wasting		Overweight		Anemia	
Region	**(%)**	**Region**	**(%)**	**Region**	**(%)**	**Region**	**(%)**
Gambela	22	Addis Abeba	3	Amhara	0	Addis Abeba	33
Addis Abeba	23	Harari	5	Somali	2	Amhara	35
Dire Dawa	27	SNNPR	7	Gambela	2	SNNPR	37
Harari	28	Oromiya	7	Tigray	2	Tigray	38
Somali	37	Amhara	9	Affar	2	Benishangul-Gumuz	47
Oromiya	38	Dire Dawa	12	Dire Dawa	3	Gambela	51
Benishangul-Gumuz	40	Tigray	14	Oromiya	3	Oromiya	52
Amhara	42	Gambela	15	Harari	3	Harari	56
SNNPR	44	Benishangul-Gumuz	16	SNNPR	4	Dire Dawa	63
Tigray	46	Affar	25	Addis Abeba	5	Somali	69
Affar	46	Somali	28	Benishangul-Gumuz	6	Affar	75

Source: Central Statistical Agency and ICF International (2012); WHO (2016)
Notes: GIC regions are highlighted in red. SNNPR = Southern Nations, Nationalities and Peoples' Region. Data on stunting, wasting and overweight were collected in 2014, and data on anemia in 2011. See Annex A for definitions of the indicators.

Table 5: Women's nutrition status by region, 2011

Prevalence in women of reproductive age (15-49 years):							
Underweight		Overweight + obesity		Obesity		Anemia	
Region	**(%)**	**Region**	**(%)**	**Region**	**(%)**	**Region**	**(%)**
Addis Abeba	14	Benishangul-Gumuz	3	Tigray	0	Addis Abeba	9
SNNPR	20	Tigray	3	Amhara	1	SNNPR	11
Harari	22	Amhara	4	SNNPR	1	Tigray	12
Dire Dawa	25	Affar	4	Benishangul-Gumuz	1	Amhara	17
Oromiya	27	Oromiya	5	Oromiya	1	Benishangul-Gumuz	19
Benishangul-Gumuz	28	SNNPR	6	Affar	1	Oromiya	19
Amhara	30	Gambela	7	Gambela	1	Gambela	19
Gambela	31	Harari	14	Harari	3	Harari	19
Somali	33	Somali	16	Addis Abeba	4	Dire Dawa	29
Tigray	40	Dire Dawa	19	Dire Dawa	5	Affar	35
Affar	44	Addis Abeba	20	Somali	6	Somali	44

Source: Central Statistical Agency and ICF International (2012)
Notes: GIC regions are highlighted in red. SNNPR = Southern Nations, Nationalities and Peoples' Region. See Annex A for definitions of the indicators.

In summary, undernutrition and micronutrient deficiencies are the most pressing nutritional problems in Ethiopia. Dietary energy supply needs to be increased, especially in disadvantaged regions, while trends in overweight and obesity should be monitored. Among starchy staples, teff deserves particular attention because it has a high content of iron and other essential minerals (USDA, 2016). Dietary diversity and the supply of micronutrient-rich foods such as fruits and vegetables, meat and eggs are very low in Ethiopia; there is an urgent need to diversify the diet by developing value chains for vegetables, fruits, and animal-source foods (including milk). The supply of pulses and nuts should be increased further, since they are important sources of dietary energy, protein, and micronutrients. Soybeans and nuts also provide healthy fats, and boosting their production would help to raise the supply of high fat content-food in Ethiopia, which is at present very low. The fortification of staple foods and the production of fortified baby foods could be addressed at the processing stage of the value chain. Promoting biofortified staple foods, such as vitamin A-rich orange-fleshed sweet potatoes and orange maize developed by HarvestPlus, is another option to raise micronutrient intakes.[7]

In addition, reducing the aflatoxin contamination of foods would improve food safety in Ethiopia. Aflatoxins are highly toxic substances that are produced by certain types of fungi and can cause acute poisoning, liver cancer, and stunted growth in children (Bhat and Vasanthi, 2003; Gong et al., 2004). In Ethiopia, aflatoxins and other mycotoxins were detected in sorghum, barley, teff, and wheat; yet, aflatoxins were present in less than 10% of the samples (Ayalew et al., 2006). By contrast, unsafe aflatoxin levels were found in all maize samples collected in the Gedeo zone in Ethiopia (Chauhan et al., 2016). The contamination of animal feed led to the presence of aflatoxins in milk from the Addis Abeba region (Gizachew et al., 2016). Aflatoxin is also a common problem in the groundnut sector. Hilina, an Ethiopian food-processing company, worked with local farmers and enabled them to produce aflatoxin-free groundnuts that could be used as ingredients for ready-to-use therapeutic foods (RUTFs).[8] Farmer incomes from groundnuts quadrupled, and the company was able to avoid expensive imports by procuring locally produced groundnuts at reduced cost (Jones, 2011).

A look at the different regions reveals that nutritional deficiencies are particularly severe in the Affar, Somali and Tigray regions, and, as far as the inadequacy of infants' and young children's diets is concerned, in the SNNPR and Amhara regions as well. This would suggests prioritizing these regions for interventions and agricultural innovations. However, their potential for productivity increases and value chain development may be limited. The Addis Abeba region's undernutrition and anemia rates in children and women are favorable, yet, it also has the highest prevalence of overweight and obesity in women.

Ethiopia is a member of the Scaling Up Nutrition[9] network, a global movement led by 57 countries that aims to end malnutrition in all its forms.

1.4 Data on most relevant crops and value chains

1.4.1 Production

In Ethiopia, grain crops that include cereals, pulses, oilseeds, vegetables, root crops, fruit, fibers, stimulants and sugarcane are grown on 16.5 million hectares of land in different agro-ecological zones of the country. Out of all crops, grain crops are the most important field crops occupying about 86% of the area planted. Private peasant holders grow various crops for their own consumption and/ or economic benefit.

[7] See www.harvestplus.org/what-we-do/crops.

[8] RUTFs are energy-dense, fortified processed foods that were developed for treating severe acute undernutrition.

[9] See scalingupnutrition.org/ for more information.

Table 6: Top 10 crops produced by area, volume and value

Area harvested (ha)		Production volume (tons)		Production value*	
Top 10	**Share of Total**	**Top 10**	**Share of Total**	**Top 10**	**Share of Total**
Cereals, nes	19.2	Maize	16.4	Milk, whole fresh cow	18.2
Maize	13.4	Roots and tubers, nes	13.0	Maize	14.3
Sorghum	11.4	Cereals, nes	10.7	Wheat	12.0
Wheat	10.7	Sorghum	9.7	Sorghum	11.8
Barley	6.6	Wheat	9.6	Coffee, green	7.4
Roots and tubers, nes	4.7	Sugar cane	6.5	Barley	5.7
Coffee, green	3.6	Sweet potatoes	4.7	Chillies and peppers, green	4.2
Broad beans, horse beans, dry	3.4	Barley	4.7	Sugar cane	2.4
Millet	2.9	Yams	3.1	Millet	2.2
Beans, dry	2.2	Broad beans, horse beans, dry	2.3	Broad beans, horse beans, dry	1.9

Data: average 2012-2014, FAOSTAT, accessed 17 January, 2017
* Gross Production Value (constant 2004-2006 million US$), data: average 2011-2013, FAOSTAT, accessed 17 January, 2017
Note: GIC value chains marked in red; nes refers to Not elsewhere specified

In Ethiopia, major food crops are grown at subsistence level in different volumes across different agro-ecological zones, since small holders grow cereal crops (*teff*, wheat, maize, sorghum) for their own consumption and economic gain. Pulses and oil seeds are also among the various crops produced in small amounts. Records of cultivated land and production of major crops for the 1994/95 to 2014/15 period are taken from successive editions of the agricultural sample survey statistical bulletin prepared by the Central Statistical Authority (CSA) of Ethiopia. The focus of this paper is on major relevant crops: *teff*, wheat, maize, sorghum, pulses, and oil seeds. All data are for the *Meher* (summer) season of crops that commonly grown by the majority of peasant holders (i.e. large scale commercial farms or co-operatives are not considered). The following quantitative statistical data have been summarized and organized using the information on cropped land area and production of both temporary and permanent crops at the country level.

Table 7: Area, production and yield of major crops for *Meher* season 2014/15

Crop	Number of Holders	Area in Hectares	Area in %	Production In Quintals (qt)*	Yield (qt/ha)
Teff	6,536,605	3,016,063	24.03	47,506,573	15.75
Wheat	4,614,159	1,663,846	13.26	42,315,887	25.43
Maize	8,685,557	2,114,876	16.78	72,349,551	34.31
Sorghum	4,993,368	1,834,651	14.57	43,391,343	23.69
Pulses	7,931,562	1,558,422	12.42	26,718,345	15.5
Oilseeds	2,936,158	855,763	6.82	7,600,993	11.80

Central statistical Agency (CSA) (2014), data archive;
*1qt = 100kg

Out of the 12.6 million hectares land cultivated by smallholder farmers, the production of major crops accounts for 11 million hectares of 87.9% of total coverage. The major crops, teff, wheat, maize and sorghum, are cultivated by the greatest amount of smallholders with production shares of 24%, 13.3%, 16.8% and 14.6%, respectively. The following comparison diagrams give an overview of production

volumes over the last 20 years, which provides information about the rate of change and level of agricultural development. The data allow for a comparison of production trends for different crops. The data is presented in such a way to identify problem areas that should be targeted for corrective measures, in order to boost sustainable agricultural production and industry.

Table 8: Overall agricultural growth (1995-2014)

Year	GDP (current Billion US$)	GDP (current Billion LCU)	GDP growth (annual %)	GDP, Agriculture share (value)	GDP, Agriculture share (%)	GDP, Agriculture share (Billion LCU)
1995	7.66	47.92	6.13	0.53	53	25.40
1996	8.55	54.01	12.43	0.52	52	28.08
1997	8.59	55.82	3.13	0.53	53	29.58
1998	7.82	53.81	- 3.46	0.48	48	25.83
1999	7.70	57.84	5.16	0.45	45	26.03
2000	8.24	67.16	6.07	0.46	46	30.89
2001	8.23	68.55	8.30	0.43	43	29.48
2002	7.85	67.07	1.51	0.39	39	26.16
2003	8.62	74.00	- 2.16	0.38	38	28.12
2004	10.13	87.33	13.57	0.39	39	34.06
2005	12.40	107.29	11.82	0.42	42	45.06
2006	15.28	132.65	10.83	0.43	43	57.04
2007	19.71	173.31	11.46	0.43	43	74.52
2008	27.07	250.21	10.79	0.46	46	115.10
2009	32.44	337.97	8.80	0.47	47	158.84
2010	29.93	385.88	12.55	0.42	42	162.07
2011	31.95	515.08	11.18	0.42	42	216.33
2012	43.31	747.33	8.65	0.45	45	336.30
2013	47.52	864.67	10.49	0.42	42	363.16
2014	54.80	1,047.39	9.94	0.42*	42*	251.80*

Sources: data.worldbank.org/country/ethiopia#cp_surv; * www.tradingeconomics.com/ethiopia/indicators
LCU = Local Currency Unit

Table 9: Total public expenditures and total factor productivity

Expenditure	Total public expenditures	Agricultural expenditures		Total Factor Productivity (TFP)
		Birr	percentage	
2003/04	21479	3454	16.1	0.089
2004/0	28142	5257	18.7	-0.071
2005/06	35098	7316	20.8	0.032
2006/07	41836	7868	18.8	0.062
2007/08	53511	9869	18.4	-0.014
2008/09	67448	11452	17	0.026
2009/10	75509	12830	17	0.02
2010/11	90905	15251	16.8	0.02
2011/2	138294	26854	19.4	.
2012/13	167343	30762	18.4	.
2013/14	194344	31730	16.3	.

Source: Regional Strategic Analysis and Knowledge Support System, 2014. Joint Sector Review Assessment of Ethiopia- East and Central Africa (www.resakss.org)

Table 10: Area, production and yield data for major crops, Meher season

	Area in hectares ('000)							Production in Quintals ('000)						
Year	**Teff**	**Wheat**	**Maize**	**Sorghum**	**Pulses**	**Oilseed**	**Total**	**Teff**	**Wheat**	**Maize**	**Sorghum**	**Pulses**	**Oilseed**	**Total**
1994/95	1841.84	770.77	1101.1	890.89	.	.	4604.6	13013.54	10210.22	16716.75	11211.24	.	.	51151.75
1995/96	2102.1	880.88	1281.28	1251.25	.	.	.	17517.54	10810.81	25425.44	17217.25	.	.	70971.04
1996/97	2172.17	770.77	1321.32	1401.48	.	.	5665.74	20020.83	10010.12	25325.36	20120.16	.	.	75476.47
1997/98	1768.75	790.79	1202.18	954.95	.	.	4716.67	14132.14	11221.14	19728.37	10915.74	.	.	55997.39
1998/99	1751.75	790.79	1101.43	950.95	.	.	4594.92	13113.13	11111.31	19319.35	10710.73	.	.	54254.52
1999/00	2092.09	990.99	1301.38	1041.04	.	.	5425.5	16416.42	11110.43	24224.24	13213.28	.	.	64964.37
2000/01	2122.12	1031.03	1411.41	1001.21	.	.	5565.77	17217.29	12112.15	25325.35	11811.82	.	.	66466.61
2001/02	1818.38	1005	1323.04	1132.5	1016.79	426.13	6721.84	16275.16	14444.34	28002.09	15462.08	10212.15	2081.36	86477.18
2002/03	1931.93	1001	1191.19	1071.07	1054.76	521.45	6771.4	14214.2	10710.7	17917.9	10410.4	10012.45	2890.32	66155.97
2003/04	1989.07	1098.91	1367.12	1283.65	1099.54	570.78	7409.07	16773.48	16144.41	25429.65	17424.54	10373.13	3128.63	89273.84
2004/05	2135.55	1398.22	1392.92	1253.62	1349.12	824.43	8353.86	20255.21	21766.03	23941.62	17159.54	13495.79	5263.96	101882.15
2005/06	2246.02	1459.54	1526.13	1468.07	1292.17	797.34	8789.27	21755.98	22190.75	33367.95	21735.99	12712.47	4866.1	116629.24
2006/07	2404.67	1473.92	1694.52	1464.32	1379.05	741.79	9158.27	24377.5	24630.64	37764.4	23160.41	15786.22	4970.84	130690.01
2007/08	2565.16	1424.72	1767.39	1533.54	1517.66	707.06	9515.53	29929.23	23144.89	37497.49	26591.29	17827.39	5406.85	140397.14
2008/09	2481.33	1453.82	1768.12	1615.3	1585.24	855.15	9758.96	30280.18	25376.4	39325.22	28043.51	19646.3	6557.04	149228.65
2009/10	2588.66	1683.57	1772.25	1618.68	1489.31	780.92	9933.39	31793.74	30756.44	38971.63	29712.66	18980.47	6436.14	156651.08
2010/11	2761.19	1553.24	1963.18	1897.73	1357.52	774.53	10307.39	34834.83	28556.82	49861.25	39598.97	19531.94	6339.99	178723.8
2011/12	2731.11	1437.48	2054.72	1923.72	1616.81	880.87	10644.71	34976.89	29163.34	60694.13	39512.94	23162.01	7308.8	194818.11
2012/13	2730.27	1627.65	2013.04	1711.49	1863.45	818.45	10764.35	37652.41	34347.06	61583.18	36042.62	27510.31	7266.64	204402.22
2013/14	3016.52	4746.23	8809.22	4788.5	1742.6	816.13	23919.2	44186.42	39251.74	64915.4	38288.7	28588.81	7112.59	222343.66
2014/15	3016.06	4614.16	8685.56	4993.37	1558.42	855.75	23723.32	47506.57	42315.89	72349.55	43391.34	26718.34	7600.99	239882.68

Source: CSA (2014); data archive; 1qt = 100kg

Table 11: Estimate of area, production and yield of crops from 1994/95 to 2014/2015, Meher season.

Start Year	End	Area change in %						Production change in %						Yield (Quintal/Hectare) change in %			
		Teff	Wheat	Maize	Sorghum	Pulses	Oilseeds	Teff	Wheat	Maize	Sorghum	Pulses	Oilseeds	Teff	Wheat	Maize	Sorghum
1994/95	1995/96	12.38	12.50	14.06	28.80	.	.	25.71	5.56	34.25	34.88	.	.	13.29	-9.05	23.69	7.80
1995/96	1996/97	3.23	-14.29	3.03	10.72	.	.	12.50	-8.00	-0.40	14.43	.	.	9.16	8.77	-3.22	3.42
1996/97	1997/98	-22.81	2.53	-9.91	-46.76	.	.	-41.67	10.79	-28.37	-84.32	.	.	-22.27	4.81	-9.56	-16.88
1997/98	1998/99	-0.97	0.00	-9.15	-0.42	.	.	-7.77	-0.99	-2.12	-1.91	.	.	3.80	-2.99	-3.72	-2.34
1998/99	1999/00	16.27	20.20	15.36	8.65	.	.	20.12	-0.01	20.25	18.94	.	.	2.83	-21.42	9.60	6.33
1999/00	2000/01	1.42	3.88	7.80	-3.98	.	.	4.65	8.27	4.35	-11.86	.	.	7.52	18.12	-4.34	-6.76
2000/01	2001/02	-16.70	-2.59	-6.68	11.59	.	.	-5.79	16.15	9.56	23.61	.	.	1.90	3.97	15.08	12.17
2001/02	2002/03	5.88	-0.40	-11.07	-5.74	3.60	18.28	-14.50	-34.86	-56.28	-48.53	-1.99	27.99	-20.95	-34.30	-41.07	-40.47
2002/03	2003/04	2.87	8.91	12.87	16.56	4.07	8.64	15.26	33.66	29.54	40.25	3.48	7.62	12.22	27.16	19.35	28.45
2003/04	2004/05	6.86	21.41	1.85	-2.40	18.50	30.77	17.19	25.83	-6.22	-1.54	23.14	40.57	32.34	5.65	-8.20	0.88
2004/05	2005/06	4.92	4.20	8.73	14.61	-4.41	-3.40	6.90	1.91	28.25	21.05	-6.16	-8.18	-28.59	-2.43	21.40	7.56
2005/06	2006/07	6.60	0.98	9.94	-0.26	6.30	-7.49	10.75	9.91	11.64	6.15	19.47	2.11	4.44	9.04	1.88	6.38
2006/07	2007/08	6.26	-3.45	4.12	4.51	9.13	-4.91	18.55	-6.42	-0.71	12.90	11.45	8.06	13.11	-2.83	-5.04	8.77
2007/08	2008/09	-3.38	2.00	0.04	5.06	4.26	17.32	1.16	8.79	4.65	5.18	9.26	17.54	4.34	6.93	4.59	0.12
2008/09	2009/10	4.15	13.65	0.23	0.21	-6.44	-9.51	4.76	17.49	-0.91	5.62	-3.51	-1.88	0.65	4.43	-1.14	5.45
2009/10	2010/11	6.25	-8.39	9.73	14.70	-9.71	-0.83	8.73	-7.70	21.84	24.97	2.82	-1.52	2.69	0.65	13.43	12.03
2010/11	2011/12	-1.10	-8.05	4.46	1.35	16.04	12.07	0.41	2.08	17.85	-0.22	15.67	13.26	1.48	9.36	14.01	-1.61
2011/12	2012/13	-0.03	11.68	-2.07	-12.40	13.24	-7.63	7.11	15.09	1.44	-9.63	15.81	-0.58	7.11	3.84	3.43	2.47
2012/13	2013/14	9.49	65.71	77.15	64.26	-6.94	-0.28	14.79	12.50	5.13	5.87	3.77	-2.17	5.87	13.70	5.99	7.75
2013/14	2014/15	-0.02	-2.86	-1.42	4.10	-11.82	4.63	6.99	7.24	10.28	11.76	-7.00	6.43	6.98	3.85	5.16	3.63

Source: CSA (2014); data archive; 1qt = 100kg

1.4.2 Trade

Coffee and sesame are the main export products of Ethiopia, both in terms of volume and value. The most important import good is wheat, which accounts for more than 60% of the import volume.

Table 12: Top 10 agricultural products exported

Export volume (tonnes)		Export value (USD)	
Top 10	**Share of Total**	**Top 10**	**Share of Total**
Sesame seed	26.6	Coffee, green	41.0
Coffee, green	19.1	Sesame seed	18.3
Beans, dry	11.2	Vegetables, fresh nes	12.3
Chick peas	5.9	Crude materials	10.0
Vegetables, fresh nes	4.6	Beans, dry	3.6
Broad beans, horse beans, dry	4.3	Meat, goat	2.5
Potatoes	4.0	Chick peas	2.0
Oilseeds nes	3.3	Broad beans, horse beans, dry	1.4
Maize	3.3	Oilseeds nes	1.3
Wheat	2.4	Wheat	0.6

Note: GIC value chains marked in red. nes refers to Not elsewhere specified
Data: average 2010-2012, FaoStat, accessed 31 Oct 2015

Table 13: Top 10 agricultural products imported

Import volume (tonnes)		Import value (USD)	
Top 10	**Share of Total**	**Top 10**	**Share of Total**
Wheat	63.1	Wheat	38.5
Oil, palm	9.3	Oil, palm	21.8
Sugar Raw Centrifugal	5.8	Sugar Raw Centrifugal	7.2
Sorghum	5.4	Sorghum	3.9
Rice – total (Rice milled equivalent)	2.9	Rice – total (Rice milled equivalent)	3.3
Sugar refined	2.2	Sugar refined	2.8
Peas, dry	1.9	Peas, dry	2.4
Malt	1.4	Food prep., flour, malt extract	1.9
Food prep., flour, malt extract	1.0	Malt	1.8
Maize	1.0	Food prep nes	1.3

Data: average 2010-2012, FaoStat, accessed 31 Oct 2015
AIC value chains marked in red.

1.5 National (and regional) innovation system

1.5.1 Research system and organizations

In Ethiopia, the agricultural sector plays a central role in the economic and social life of the nation and is a cornerstone of the economy. To support the sector, national agricultural research system units such as the MoARD, the ATA, the Ethiopian Institute of Agricultural Research (EIAR) and other public, private and civil society institutions have been established. The contributions of these governmental and non-governmental organizations include the implementation of different projects and programs that are funded both locally and internationally.

1.5.1.1 International

The international (and regional) organizations that have been actively conducting agricultural research and coordinating efforts to support agricultural growth in Ethiopia include:

- The United Nations Food and Agriculture Organization;
- The United Nations Development Program;
- Global Forum on Agricultural Research;
- International Fund for Agricultural Development;
- The Consultative Group on International Agricultural Research:
  - International Livestock Research Institute (ILRI);
  - International Center for Tropical Agriculture;
  - International Maize and Wheat Improvement center;
  - International Food Policy Research Institute;
  - International Rice research Institute;
  - International Water Management Institute;
  - International Potato center;
  - Center for International Forestry Research;
  - International Crops Research Institute for the Semi-Arid-Tropics;
  - Africa Rice;
  - Biodiversity international;
  - World Agroforestry Center;
  - World Fish Center.

Regional organizations:

- Food and Agricultural Research Management-Africa;
- Forum for Agricultural Research in Africa (FARA);
- Africa Research in Sustainable Intensification for the Next Generation (Africa RISING);
- Association for Strengthening Agriculture Research in Eastern and Central Africa;
- African Forum for Agricultural Advisory Services;
- SOS-Sahel;
- Agri Service Ethiopia;
- Alliance for Green Revolution in Africa;
- African Agricultural Technology Foundation.

1.5.1.2 National

The history of agricultural research in Ethiopia dates back no further than the 1950s, when higher education institutions were first established for agriculture. However, the establishment of the Institute of Agricultural Research in 1966 was a formal step to institutionalize agricultural research at the national level. It was renamed the Ethiopian Institute of Agricultural Research (EIAR) on 25th October 2005. EIAR is a federal public institution established by the government of Ethiopia to conduct research and coordinate the Ethiopian Agricultural Research System (EARS). Its headquarters are located in Addis Ababa. The EARS is organized into five sectors: crops, livestock, soil and water, forestry and farm mechanization. Each research process is subdivided into projects conducted by specific teams.

a. Crop Research

- Cereal research case team;
- Pulses, oil crops and fibers research case team;
- Horticulture research case team;
- Coffee, tea and spices research case team;
- Crop protection research case team;
- Aromatic, medicinal and biofuel research case team.

b. Livestock Sub-Sector

The national livestock research strategy is designed as a demand-driven and problem-oriented approach, with considerable resources invested in the assessment of stakeholders' problems. Short- and long-term research objectives are formulated. Research focus is given to smallholder farming systems, the improvement of nutrition and the testing of available technologies. Research in livestock consists of:

- Ruminant research case team;
- Poultry research case team;
- Fishery research case team;
- Apiculture and sericulture research case team.

The Ministry of Agriculture also established 25 agricultural vocational training colleges and 8,780 farmers training centers in the last decade.

1.5.2 Innovation platforms

Innovation platforms (IPs) in Ethiopia are not well developed and are given little attention by the government. Some platforms have been established by a small number of non-governmental organization, and these have benefitted a number of stakeholders, notably smallholder farmers. The responsible agencies of the government (EIAR and Ministry of Agriculture) do not have databases for the innovations, platforms and the value chains. Although it is known that IPs can perform better than conventional approaches in linking farmers to markets, encouraging technology adoption, generating income and reducing poverty, the Agricultural Innovation System of Ethiopia is weak and fragmented (Gedif et. al., 2016).

Below are some of the important IPs in the agricultural sector in Ethiopia.

a. Africa Research in Sustainable Intensification for the Next Generation (Africa RISING)

The Africa RISING program comprises three research-for-development projects supported by the United States Agency for International Development (USAID). The overall purpose of Africa RISING is to provide pathways out of hunger and poverty for small holder families through sustainably intensified farming systems that sufficiently improve food, nutrition, and income security, particularly for women and children, and conserve or enhance the natural resource base. The focus thereby lies on system interventions in the crop-livestock-tree mixed farming system. In Ethiopia, the program works in four highland areas (Amhara, Oromia, Tigray and SNNPR). "In 2014 it established 12 strategic and operational IPs in selected four districts of the four regions. Four strategic IPs are established at District level, whereas eight operational IPs are established at kebele level (the smallest administrative boundary).

The kebele level operational platforms oversee local research activities, foster integration among the farmer research groups, and promote alignment of local on-farm researches with district priorities. Farmer research groups (innovation clusters) are expected to expand to promote scaling of innovation to wider groups of farmers."

The Africa RISING platforms have already succeeded in various ways. Participating farmers' livelihoods have improved. The approach of agricultural intensification through integral crop-livestock-tree farming systems has been successfully introduced, and farmers have started practicing it. Farmers participating directly in the IPs at the operational and strategic level and are able to identify and prioritize their problems themselves and plan for solutions. Improved crop varieties have been selected and distributed. Pest problems have been reduced through the integrated system, which decreased the amount of (women's) labor needed to select and prepare the crops for food. Some farmers have reproduced seeds themselves and even started their own seed store, saving the community money when buying improved varieties (Gedif et. al., 2016).

b. The Ethiopian Apiculture Board

In 2007 the Ethiopian Apiculture Board was established to provide a platform for stakeholders in the beeswax and honey value chains. Beekeeping is an important economic activity in Ethiopia, involving 1.7 million people. Ethiopia ranks tenth and forth in honey and beeswax production, respectively, worldwide. Honey yields in the sector have the potential to increase from their current 54 metric tons per year level to up to 500 metric tons per year. The actors working together to improve the apiculture value chain in the IP are the Ministry of Agriculture and Rural Development, the Ministry of Trade and Industry, the Chamber of Commerce, several financial institutes and banks, the Holeta Research Centre, Bureau of Finance and Economic Development and SNNPR Micro & Small Trade and Industry Bureau, the Quality Standard Authority of Ethiopia, the Consulting Management Business Creation and Development Services, Women associations at national level, Amhara apiculture board, Oromiya apiculture board, and Tigray apiculture board. The IP successfully increased honey prices and honey quality, and introduced improved technologies. Beekeepers benefit more from their as a result.

c. Innovation Platform for Technology Adoption (IPTA)

The IPTA was introduced in Hawella Tulla and Boricha districts in the Sidama zone of SNNPR. The research centers involved in the IP tried to disseminate orange-fleshed sweet potato varieties that were clean of viruses to try to fight widespread malnutrition and vitamin A deficiency in those regions. They encountered challenges such as low acceptance by farmers and consumers, and lack of government-provided extension services. The Hawasa and Areka Research Centers involved in the IP produce clean material trough tissue culture and rapid multiplication in fields. The Woreda office of agriculture extends the technologies to farmers. Farmer representatives included in the IP produce the orange-fleshed sweet potato varieties. Non-governmental organizations (NGOs) are also involved in the IP and have taken up the responsibility of capacity building (e.g. supplying clean planting material). Non-IP members helped disseminate the varieties to non-IPTA regions. A notable success of the IP was increasing consumption of orange-fleshed sweet potatoes throughout the country.

d. PROmoting Local INNOVAtion (PROLINNOVA)

Prolinnova–Ethiopia is a national platform to create space and provide a conducive environment for recognizing and enriching local innovation processes in agriculture and natural resource management (NRM). It aims to scale up and integrate Participatory Innovation Development (PID) approaches into those of governmental and non-governmental organizations that are concerned with agricultural and NRM research, extension, education and training. Its overall objective is to contribute to enhancing food security, safeguarding the environment and improving rural and urban livelihoods based on the sustainable use of natural resources. It is an initiative of several organizations within Ethiopia that had been working in participatory research and development (R&D) in relative isolation and decided to join forces in 2003 under the name PROFIEET (Promotion of Farmer Innovation and Experimentation in Ethiopia). For more information about the background to this initiative, see the Ethiopia National Workshop report from August 2003 (www.prolinnova.net).

After making an initial inventory of organizations and experiences in participatory R&D in Ethiopia and holding a national workshop in August 2004, Prolinnova-Ethiopia drew up an action plan which is jointly revised by member organizations each year. Core activities include:

- Awareness raising and policy dialogue about local innovation and PID;
- Documenting local innovations and innovation processes;
- Joint experimentation by farmers, scientists and development workers;
- Capacity building to identify local innovations and engage in PID;
- Participatory monitoring and evaluation;
- Piloting Local Innovation Support Fund;
- Facilitating Farmer-Led Documentation;
- Studying local climate change adaptation innovations;
- Integrating PID approaches into research, extension and education institutions.

1.5.3 Extension system and organizations

A new agricultural extension system called Participatory Demonstration and Training Extension System (PADETES) was designed primarily to implement the ADLI, strategy, with a particular focus on rural Ethiopia, where 85% of the population resides (Gebre-Selassie, 2010). This program was piloted by the Sasakawa Africa Association and Global 2000 of the Carter initiative. The major component of PADETES was to disseminate modern farm inputs, especially fertilizers and improved seeds, and the accompanying modern farming practices to smallholders. The government has allocated substantial resources to implement the new system with financial assistance from bilateral and multilateral sources. To shape PADETES, the MoARD has developed a document outlining rural development policies, strategies, and instruments.

A core part of the government's investment in agriculture is the public agricultural extension system. As a result of the commitment to improve agriculture, great achievements were made, including increased "modernization" and revitalization of agriculture through improved and new crops, livestock, and NRM technologies (Kristin et al., 2010). The achievements also include the increase in input and improved seed variety use by farmers. The professional capacity of extension has also dramatically increased, with over 60,000 development agents having graduated from the Agricultural Technical and Vocational Education and Training (ATVET) colleges with three-year diplomas (prior to 2000, the existing 15,000 Development Agents (DAs) had received about nine months of training. Furthermore, as of 2014, farmers can now receive extension services via a free hotline established by the ATA. The highly popular service provides farmers with direct access to agronomic advice on best practices and has the potential to revolutionize the extension services (Gedif et. al., 2016).

The existing government continues its efforts to foster production through improved extension systems. It considers the agricultural extension system to be a major element of the agricultural and rural development strategy of the country. As a result it requires that technologies be disseminated through a strong agricultural research and extension system. The lead technologies identified for this purpose are improved seed, fertilizer, artificial insemination and veterinary services. The extension system has federal and regional dimensions. Core institutions are the ATVET centers and the Farmer Training Centres (FTCs).

The following are major weaknesses in the Ethiopian extension system, as identified by different researchers: The top down approach in extension services that focus on technology transfer; limited attention given to subject area specialization (currently, every DAs works both on natural resource management, animal production and technology and plant sciences issues); the high staff turnover and limitations in the quality of field and technical staff; the lack of monitoring and evaluation of the system; the limited information management system; limited partnerships with private sector, universities, research institutes, and NGOs in extension service delivery; and the under-appreciation of the supporting role of indigenous knowledge to the system (Gedif et. al., 2016).

1.5.4 Private research and development activities

Private sector actors have minimal involvement in agricultural research; total private sector spending accounts for less than half of one percent of total agricultural research expenditure. Many private sector actors contract EIAR and other research institutions to conduct research on specific issues on their behalf (Gedif et. al., 2016). The private sector is known to contribute to agricultural production through organized markets and channels for seed, fertilizers, technologies and other farm inputs. The overwhelming presence of the Ethiopian government in all areas of agriculture has been criticized for limiting the expansion of the private sector in previous years[10]. The government states are filling the gap where private sector action falls short, and prioritizes growing and strengthening the private sector involvement in agriculture and private R&D activities in its GTP II (The Worldfolio, 2016a, b).

[10] www.worldwide-extension.org/africa/ethiopia/s-ethiopia. Accessed on September 20, 2015.

1.6 Key challenges, emerging needs and potentials in the agricultural sector

Ethiopia does have tremendous resources: diverse ecology and fertile soil, rainfall, a policy setup that enables extensive research, and the high number of development agents in each kebele of the country. The collaboration of national and international organizations with the government has been of great importance for research, investment and innovation. Consequently the agricultural sector achieved some progress towards food security. Even though the country achieved higher economic growth for a decade, there remain a number of challenges related to the agricultural sector. Since the sector is the main driver of development in the country, these challenges should be first understood and possible solutions should be developed in close collaboration with the relevant actors. The following are major challenges:

- Degradation of land and other natural resources due to intense cultivation and overgrazing;
- Recurrent drought;
- Conflict between clans over resources in some of the regional states;
- Fragmented land holdings, landlessness, and tenure security;
- Fewer employment opportunities for the landless young;
- Neglect and lack of agricultural investment;
- Poor corporate culture to encourage innovators;
- Weak market institution and high transaction costs.

Other challenges contributing to stagnation and to the poor performance of the agricultural sector include:

- Low resource use (e.g., the proportion of cultivated land compared to the total amount of land suitable for agriculture and the amount of water being used for irrigation is low compared to the total potential, resulting in rain-fed agriculture);
- Low-tech farming techniques (e.g., wooden plough pulled by oxen and use of sickles);
- Over-reliance on fertilizers and underutilized techniques for soil and water conservation; Ecological degradation of potential arable lands.

1.7 Potential areas for investment in Ethiopia

Based on the general approach presented in chapter 4 of Husmann *et al.* (2015) and in pursuit of efficiency and effectiveness, investment by Germany into the agricultural and food sector are suggested in African countries that:

- Show actual progress in sustainably increasing agricultural productivity through related innovations, as indicated by comprehensive productivity measurement and innovation actions on the ground;
- Have a track record of political commitment to foster sustainable agricultural growth, as indicated by performance under CAADP; and
- Prioritize actions for hunger and malnutrition reduction and show progress, but where agricultural and rural development and nutrition interventions are likely to make a significant difference, as indicated by public policy and civil society actions.

Results of the assessment for Ethiopia[11]:
Expected agricultural growth performance:

- Ethiopia has had an agricultural growth rate that is higher than the 6% target defined by CAADP for seven between 2005 and 2014 (www.resakss.org);
- Total factor productivity in Ethiopia has improved by 10% between 2001 and 2008 (Fuglie and Rada, 2011), indicating that Ethiopia´s commitment to R&D into the agricultural and food sector is modest.

[11] Details on the data sources and methodology used in the assessment can be found in Husmann et al. (2015)

Government commitment:

- The Ethiopian government has shown a strong willingness to invest in agricultural sector by surpassing the CAADP 10% agricultural expenditure target for eight years between 2005 and 2014 (www.resakss.org).
- Ethiopia has also a track record of political commitment to foster sustainable agricultural growth by being active in the CAADP process and having completed all the eight steps in the CAADP process (www.resakss.org).
- However, Ethiopia spends only 0.3% of its agricultural GDP on agricultural R&D, which is much lower than the Sub-Saharan Africa average (www.asti.cgiar.org) and the African Union target value of 1%. This indicates that Ethiopia´s investment into agricultural innovation is not yet sufficient.

Food and nutrition security progress and need:

- Ethiopia is prioritizing for the reduction of hunger and malnutrition, and has shown a 19% improvement in undernourishment between 2001 and 2011, which is above the 10% threshold level (www.resakss.org).
- Nevertheless, Ethiopia has a high Global Hunger Index (GHI) score of 24.4, reflecting an alarming level of hunger (von Grebmer *et al.,* 2014)[12]. This makes investment into the agricultural and food sector in Ethiopia very urgent in order to reduce the high rates of food insecurity.

Table 14: Ethiopia performance indicators

Indicators	Indicator score	Overall score
1. Number of years with more than 6% agricultural growth (2005 to 2014)	7	70
2. Percentage point change in TFP index between 2001 and 2008	10	60
3. Number of years with more than 10% government expenditure (2005 to 2014)	8	80
4. Average share of agricultural GDP spent on R&D (2005 to 2011) in %	0.3	26
5. Steps in CAADP completed	8	100
6. Percentage point improvement in undernourishment between 2001 and 2011	18.8	100
7. Global hunger index (2014)	24.4	100
Total score (weighted)		78

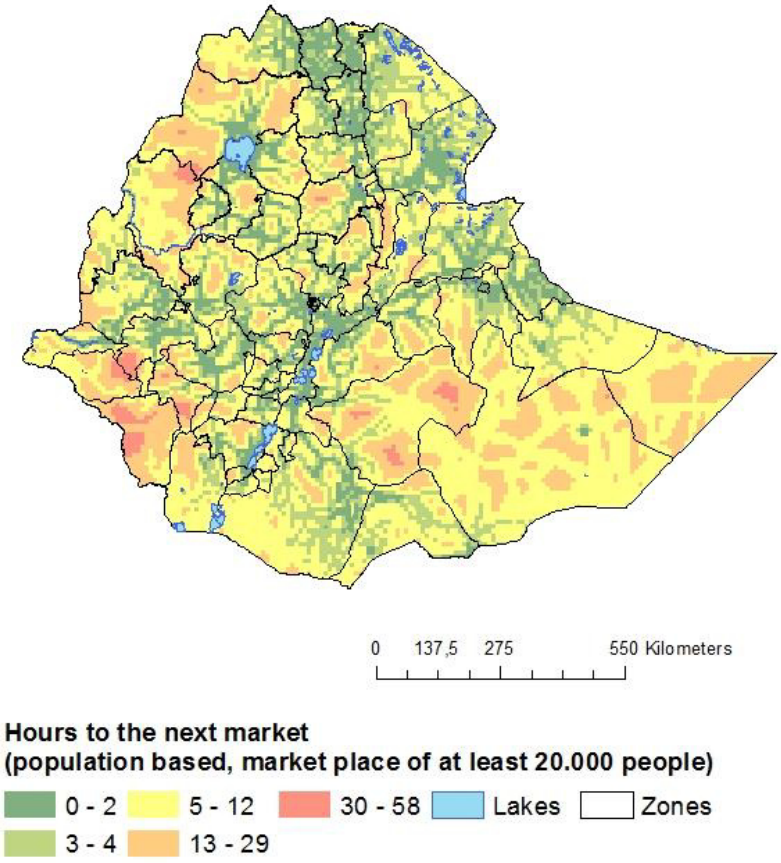
Data source: Husmann *et al.* (2015)
Note: TFP refers to Total Factor Productivity

The economic, political, and social/nutritional framework in Ethiopia strongly suggests the need for increased investment into the agricultural and food sector of the country.

The selection of value chains on which to focus is also determined by market access, i.e. transport intensive products should be promoted in areas that are well connected to markets, whereas remote areas should focus on low volume and livestock value chain segments. Figure 5 presents the average time (number of hours) it takes to reach the nearest marketplace of at least 20,000 people in Ethiopia.

[12] GHI score Values less than 5.0 reflect low hunger, values from 5.0 to 9.9 reflect "moderate" hunger, values from 10.0 to 19.9 indicate a "serious" level of hunger, values from 20.0 to 29.9 are "alarming," and values of 30.0 or greater are "extremely alarming." (von Grebmer *et al.,* 2014)

Figure 5: Distance to markets



Data sources: Hours to next market - HarvestChoice, 2015;
Administrative areas: www.gadm.org/ accessed 209.9.2015
Inland water bodies: www.diva-gis.org/gData (water bodies), accessed 20.9.2015

2 Most relevant value chains in the country

2.1 GIC value chains

2.1.1 Wheat

In 2013/14, 4.7 million farmers produced 39 million quintals of wheat across 1.6 million hectares of land, making it the third most important cereal crop in the country. Between 2007/8 and 2013/14, yield and total production of wheat grew annually by an average of 8.4% and 11.6%, respectively (EATA, 2014). In absolute terms, total national wheat production showed a remarkable 54.7% and 69.6% growth from what it was in 2008/9 and 2007/8, respectively. Despite these gains, demand for wheat continues to outpace supply, and the production growth has been a fraction of what it could be with more focused effort and attention (ibid). Wheat is still the number one import good in the country, making up a share of 35.5% of import value (see Table 12). The comparative disadvantage the country has in wheat production is reflected by a Revealed Comparative advantage (RCA) index of 0.25 (see Table 15). On average, Ethiopian people have a supply of 284 kcal worth of wheat a day, which makes it the one of the most important crops in terms of dietary energy supply (FAOSTAT, 2017). However, the wheat 'supply' does not equal consumption, and "nutrient supply" is much more than dietary energy (calorie) supply.

2.1.2 Fava Bean

Fava bean is one of the twelve pulse species grown in Ethiopia. Among the individual varieties, fava beans (broadly known as horse beans) accounts for the greatest portion of production at 36%, followed by haricot beans (17%) and chickpeas (16%). Other pulses (e.g., lentils, peas, lupines, and mung beans) account for the remaining 32%. Pulses, generally, contribute to smallholder livelihoods in multiple ways. Pulses can indeed play a significant role in improving smallholders' food security, as an affordable source of protein (pulses make up approximately 7% of the average Ethiopian diet and about 18% of protein supply) and other essential nutrients (FAOSTAT, 2013). Moreover, pulses can have an income benefit for smallholders, both in terms of diversification and because they yield a higher gross margin than cereals. Fava beans provide the highest net return among the crops considered, while chickpeas provide higher returns than barley and teff, but comparable returns to wheat. As the third largest crop export product in terms of total volume and the fifth in terms of total value (see Table 13), pulses have a positive impact on the trade balance, and contribute to the country's foreign exchange reserves.

2.2 Other relevant value chains

The other relevant value chains besides those selected for the GICs are discussed in this subsection. The relevance in this case is based on, among other things, the extensive review of available literature on the crop, the importance of the crop in relation to share of area cultivated (harvested), production volume, and trade importance (import and export).

2.2.1 Coffee

Ethiopia is generally regarded as the birthplace of coffee. The word coffee comes from "Kaff," the name of one of Ethiopia's main coffee-producing regions, and more genetically diverse strains of coffee exist in Ethiopia than anywhere else in the world. Coffee remains the most important export crop, making up almost 35% of export value (see Table 13). Over 600,000 ha are used for its cultivation in almost all regional states (EATA, 2014), making up 3.6% of the total area harvested in the country (see Table 6). Ethiopia is the largest coffee producer in Africa and this industry is the largest export earner. It is estimated that coffee forms a main source of livelihood to more than 20 million families (CSA, 2013).

2.2.2 Teff

Teff is currently the dominant cereal crop and is grown on more than 3 million ha of land annually, making up 24% of the total cultivation area of cereal smallholder farmers and covering 6 million smallholder households (see Table 7). Teff constitutes a daily staple food for over 50 million Ethiopians. Nationally, about 47.5 million quintals of teff were produced by peasant holders in 2014/15 during the Meher season. The long-term strategy by different stakeholders is to increase sustainable production and create a well-functioning teff value chain (EATA, 2014).

2.2.3 Maize

Maize is the most produced cereal crop in Ethiopia, accounting for 13.4% of the total area harvested, 16.4% of total crop production volume and 14.3% of production value (see Table 6). It is grown by more than half of all farmers, mostly for subsistence. Maize also forms the cheapest source of calorie intake (19% of per capita daily calorie intake nationally) (CSA, 2014), which makes it a top crop in terms of calorie supply (398 kcal/capita/day). Maize production has achieved high yield growth, with an average annual growth rate of 8% in the period from 2005 to 2012 (FAOSTAT, 2016). The maize development strategy, as envisioned in the Agricultural Transformation Agenda, seeks to see maize production contribute to greater food security and increased incomes for smallholder maize farmers by increasing productivity and improving access to sustainable and efficient markets (EATA, 2014).

2.2.4 Livestock Products

According to the ATA "between 11 and 13 million rural and peri-urban households are engaged in one or more forms of livestock keeping in Ethiopia, involving cattle, sheep, goats, chicken, camels, farmed beekeeping, inland aquaculture and equines." Between 1995 and 2010 the number of livestock doubled from 58 to 107 million. The ATA sees great potential in the livestock production because of "a diverse livestock genetic resource base, the wide range of agro-ecologies in the country, the fast expanding demand for quality livestock products and services and the strategic geopolitical location of the country close to major global livestock markets," but also points out various limiting factors that have to be overcome (see 3.1) (ATA, 2016a).

a. Meat and Live Animals

Ethiopia has the tenth largest livestock inventory in the world, yet the country's current share in the global export market for meat is quite small (IGAD, 2010). Meat production is not only meant for the large domestic market but also directed to the export market. Other related livestock value chains have also emerged over time, including; hides, skins and leather value chains. However, informal trade of live animals across the borders of the neighboring states is believed to significantly reduce the numbers of animals reaching slaughterhouses in Ethiopia (FDRE, undated).

b. Hides, Skins and Leather

The hides, skin and leather sector is a critical strategic sector for the economic and industrial development of Ethiopia (IGAD, 2010). It has an abundant and renewable resource base in Ethiopia's large population of cattle, sheep and goats. It is labor-intensive with the potential to be a major source of employment all along the value chain. The government of Ethiopia has identified the leather and leather products value chain as one of the top four most promising industries in the country due to its strong backward linkages to the rural economy, and potential for poverty reduction. To date, over 10,000 formal jobs have been created, as have thousands of informal handicraft and trading revenue-generating activities (Bellemare and Barrett, 2006; IGAD, 2010). Out of the 17 large shoe factories, 14 are involved in exporting. About 1,000 small and micro-enterprises are also engaged in the production of footwear. Today the sector consists of over 850 legal hides and skins traders, 6,515 workers in tanning, 5,400 workers in foot wear and leather goods factories. The Ethiopian leather industry is one of the leading generators of foreign currency in the country and an important creator of jobs.

c. Dairy

Whole cow milk accounts for 18.2% of the total agricultural production value, which makes it the most valuable agricultural product in Ethiopia (see Table 6) with great potential as the dairy sector continues to grow. With 52 million cattle (including 10.5 million dairy cattle) in 2012, Ethiopia had the largest cattle population in Africa. In 2011/12 the total production of milk amounted to 3.3 billion liters worth 1.2 billion USD, but only 5% off the milk produced is sold in commercial markets (USAID, 2013). Cattle make up the largest share of income from livestock in 70% to 90% of livestock producing households. Since 2013, cattle has accounted for about 78% of the milk produced annually in Ethiopia (Shapiro et al., 2015). At the same time dairy products are imported to Ethiopia, in 2011/12 in the amount of 10.6 million USD, though per capita consumption of milk is very low in Ethiopia (19 liters p.a. compared to the African average of 40 liters) (USAID, 2013). FAO estimated the milk supply in Ethiopia to about 44 kg/capita/year in 2013, close to the African average of 46 kg/capita/year in 2011.

The Ethiopian dairy production and market systems however face severe constraints (see 3.1). I.e. in Borana zone of Oromia regions, where there is a huge livestock resource in the pastoral communities, the average milk production per cow is only 1.5 liters per day, well below international benchmarks (CARE-Ethiopia, 2009). Compared to other African countries Ethiopia's dairy industry is not developed and its milk production remains among the lowest in the world (Sintayehu et al., 2008).

2.3 Promising agricultural products and value chains

In addition to assessing the returns on investments into institutional innovations in Ghana, analyses are also undertaken in order to choose the most promising value chains in the country. This analysis is important because it provides an objective indicator for priority value chains that would have the highest returns on investments into technological and institutional innovations. The trio objectives of PARI (to promote and support the scaling of proven innovations in the agri-food sector; to support and enhance investments in the GICs through research; and to contribute to the development of the agri-food sector in Africa and India through the identification, assessment and up-scaling of innovations) guide the selection of indicators. The indicators should thus focus on improving the food and nutrition security, reducing poverty and improving the market participation of the small holder farmers. Taking into account the availability of data and the purpose of the study, four indicators that focus on poverty and market potential are used to select the five most promising agricultural products from the long list of agricultural products that the country produces and sells. These indicators are:

1. Trade potential (Revealed Comparative Advantage (RCA) index): computed to identify value chains over which the country has revealed, albeit may not necessarily potential, comparative advantage in the export market. The revealed comparative advantage is an index used in international economics for calculating the relative advantage or disadvantage of a certain country in the production and export of a certain class of goods or services as evidenced by trade flows. It is based on the Ricardian comparative advantage concept. We use Balassa's measure of RCA to determine the competitiveness of selected agricultural products in overseas export markets. In the present case, the RCA index compares the share of a given agricultural product in the country's export basket with that of the same product in total world exports
2. Yield gap: used to assess the expected return of the envisaged investment on the given country value chains. The yield gap of a crop grown in a certain location and cropping system is defined as the difference between the yield under optimum management and the average yield achieved by farmers. A standard protocol for assessing yield potential and yield gaps is applied for some crops based on best available data, robust crop simulation models. It is a powerful method to reveal and understand the biophysical opportunities to meet the projected increase in demand for agricultural products.
3. Average yield growth: used to examine the potential of the product for poverty reduction. The most widely used indicator of crop productivity is production per unit of land (also referred to as crop yield). Average yield growth may reduce poverty in the following ways: (1) higher yield implies higher surplus product that could be sold in the market and thereby increase farmers income, (2) higher surplus product mean large quantity of food supplied to urban and rural market at a relatively lower price which in turn reduces urban and rural food poverty, (3) higher agricultural productivity will stimulate growth in the non-agricultural sector through its strong backward and forward linkage. For example, it boosts growth in the industry sector by freeing agricultural labor and reducing urban wage pressure (Lewis, 1962), and (4) agriculture's fundamental role in stimulating and sustaining economic transition, as countries (and poor people's livelihoods) shift away from being primarily agricultural towards a broader base of manufacturing and services (DFID, 2004).
4. Total production of the crop as a share of total supply (production + imports) is also used to assess the relevance of investing on that crop .Because it signals whether the agro-ecological system is suitable for the production of that crop in meeting the global demand for that particular crop. The ratio of production to total supply also illuminates the degree of integration of the producers that particular crop, small holder farmers in most African countries cases, into markets. The extent to which small holder farmers are able to participate in both input and output markets, and the functionality of those markets, are key determinants of their willingness and ability to increase marketable surpluses (Arias, 2013). Across the developing world, smallholders farm in diverse agro-climatic systems which together with their assets and skills, shape their economic lives. Markets and the extent to which they are functioning well, also play a determining role.

Note: The share of production of that particular crop over the total crop production is another key indicator considered in this study while assessing the relevance of investing on a particular crop in a country. This indicator is used as an eliminating criteria. If the share of a given crop out of total crop production is less than 0.5 %, we consider it as less relevant and exclude from the list of most promising value chains.

The summary of the five most promising value chains based on the RCA index, average yield growth and relevance of crop is reported in Table 15 below. The production share, RCA index, actual yield growth and relative yield gap for the GIC value chain(s) are also reported at the bottom of the table, when they are not included in the list of the first five most promising value chains.

Table 15: Selection of promising agricultural products /value chains

	Rank by RCA		Rank by yield progress***		Rank by yield gap		Rank by relevance of crop	
Rank	**Name of agricultural Product**	**RCA index (2012)**	**Name of the Crop**	**Average annual Yield growth (2005 to 2012)**	**Name of Stable crop (rainfed)**	**Relative yield gap (%)****	**Name of agricultural Product**	**Production share of supply (2012)***
1	Sesame seed	87	Sweet potatoes	39	Maize	86	Pulses & products	130
2	Meat, goat	67	Yams	37	Sorghum	82	Maize & products	125
3	Vegetables, fresh nes	28	Chick peas	8	Wheat	81	Cereals, Other	123
4	Oilseeds nes	20	Potatoes	8	Millet	77	Peas	122
5	Broad beans, horse beans, dry	19	Maize	8			Beans	120
	Wheat	0.25	Broad/horse beans,	7			Wheat, product	77
			Wheat	5				

Source: * Own computation based on FAO 2015 data, ** from Van Bussel *et al.* (2015).
Note: *** a minimum of 0.5% production (volume) share threshold is used as a screening (crop relevance) criteria.
GIC value chains marked in red.

Results of assessment (Table 15):

- The RCA index is very high for sesame seed, goat meat, vegetable and fruits, oil seeds and one of the GIC-selected value chains, namely broad been (Fava bean, horse bean). This indicates that Ethiopia has a comparative advantage (in the export) of these commodities. The RCA index value for the other GIC-selected crop, wheat, is less than 1, indicating that Ethiopia has a comparative disadvantage in the export of wheat;
- The yield performance which indicates progress suggests that over the CAADP period (2005 to 2012), sweet potatoes, yams, chick peas, potatoes and maize were the five most promising crops. The two GIC selected crops, broad beans and wheat, also grew by an average rate of 7% and 5% respectively;
- Yield gaps indicate potential from another angle, and are observed to be high for rain-fed maize, sorghum, wheat and millet, indicating the high potential return of investing in these value chains;
- In terms of relevance (production share of supply) the leading value chains are pulses, maize, other cereals, peas and one of the GIC-selected crop, beans. The total production of these products

exceeds the total supply. More than three quarters of the total wheat (the other GIC-selected crop) supplied in the market is also domestically produced.

2.4 Summary on selection of agricultural products and value chains

This chapter (chapter 2) has presented different relevant and important value chains in Ethiopia based on different criteria – resulting on the selection of different value chains. In summary, the three top value chains from the three sets – GIC selected value chains, other relevant value chains, and those identified by analysis of promising agricultural products and value chains – are presented in Table 16. The summary table shows that only wheat from the GIC-selected value chains is identified as promising in terms of yield gap by the analysis of promising agricultural products and value chains. However, a number of overlaps in the value chains is shown between the analysis of promising agricultural products and value chains and the literature. These products/value chains are maize, livestock (goat) and teff (cereals).

Table 16: Summary of all value chains

GIC value chains	Other value chains	Promising agricultural products and value chains (top 3)			
		RCA	Yield progress	Yield gap	Relevance of crop
Wheat	Coffee	Sesame seed	Sweet potatoes	Maize	Pulses & products
Fava beans	Teff	Meat, goat	Yams	Sorghum	Maize & products
	Maize	Vegetables, fresh nes	Chick peas, potatoes, maize	Wheat	Cereals, other
	Livestock products				

Source: Authors' compilation

3 Innovations in value chains in the past 20 years

3.1 Main limiting factors

Land degradation due to deforestation, erosion, cultivation on steep slopes, overgrazing and desertification, as well as rainfall variabilities shrinks Ethiopia's cultivation area. The annual loss of more than 1.5 billion tons of topsoil from the highlands, translates to a loss in grain harvest volumes of about 1 to 1.5 million tons. Soil loss and the accompanying loss of nitrogen and soil fertility is especially high on currently unproductive land, with a rate of 70 tons per hectare per year, but it is also striking crop land (40t/ha/year) (Taddese, 2001).

Land tenure insecurity is high in Ethiopia, where all land is state-owned and transfer rights are limited. This restrains – especially in the long run – efficiency, growth and agricultural investment, including soil conservation investments (Ali et al., 2007).

Further restraints to agricultural production include:

- Farm size and land fragmentation (Gebreselassie, 2006)
- Limited access to finance, which keeps rural households in a poverty trap (Geda et al., 2008)
- Limited access to inputs and high input prices

- Bad management practices
- Pests and diseases (Taddese, 2001)
- Weak agricultural research and extension services
- Lack of agricultural marketing
- An inadequate transport network
- Low use of fertilizers, improved seeds and pesticides
- Low level of technology

According to Deressa (2007) the major causes of underproduction are droughts and floods. Relating to the livestock value chain, The Ethiopian ATA sees a lack of contribution from livestock production to household nutrition, revenue generation, gainful employment, and ecosystem services. Land and water resources are often utilized in the extractive sector, raising environmental concerns.
Despite high potential, the improvement of livestock genetics and management is limited by

- Limited access to appropriate technologies
- Weak institutional arrangements
- Lack of a coherent training and extension support system and
- Gaps in the policy environment.

Efficient and competitive commercial livestock production is limited by

- Severe decreases in grassland due to uncontrolled grazing
- High and rising costs of feed
- Limitations in the production, utilization, marketing and regulation of available feed resources
- Lack of feed quality control
- High losses of animals from diseases and parasites
- Difficulties in the adequacy and quality of veterinary inputs
- Limited involvement of the private sector in the delivery of private goods and services
- Badly organized collection, chilling and transportation of milk (ATA, 2016a).

A number of challenges in the structure and functioning of the livestock marketing system are associated with supply shortages of sheep and goats (shoats). These are summarized below (Getachew *et al.,* 2008):

- Initially the supply derived from non-market-oriented livestock production systems involving several highly dispersed smallholder farmers, pastoralists and agro-pastoralists, mainly in remote areas that supply non-homogenous types to local markets;
- There is lack of a well-coordinated livestock supply chain that would link the majority of producers and buyers;
- Problems in the acquisition system of slaughterhouses: in some markets, there are only single purchasers of slaughterhouses or none at all. It may not be justified to establish permanent purchasing points in all supply areas;
- Lack of a monitoring mechanism: slaughterhouses need to establish a mechanism to monitor their purchasing system regularly.

3.2 Important value-chain related and cross-cutting innovations

3.2.1 GIC value chains

Innovations in crop varieties
“Improved seed production is not well organized. The state controls the seed enterprises. But there are some private seed enterprises, who are working on seed multiplication, though under the influence of centralized directives and regional autonomy, as well as the balance between state-directed control and private entrepreneurship (T/Wold A. et al, 2012). A total of 345 crop varieties, 188 Pulse crops, 90 Oil crops, 174 Tubers, Roots and Vegetable crops, 36 Fruit crops, 27 Fiber crops and 36 Stimulant crops are reported as distributed until 2014 (MoARD, 2014). But the performance of the national seed system, which

is expected to ensure access and use of the seeds of improved crop varieties, is still very poor." (Gedif et. al., 2016, p.12)

Wheat Value Chain
A strategy is being developed to help increase the productivity of smallholder wheat production sustainably. The strategy will be updated to align with the GTP II goals.

Innovations in animal production
"The research and innovation system in Ethiopia related to livestock has been in a patronized system which has ignored the ability of farmers to innovate and make them passive partners (ESAP, 2005).'' Farmers/Livestock-keepers have been innovating spontaneously, without the support of formal research and extension services. Since they are ignored, farmers have been blamed for their reluctance to adopt the technologies offered by the conventional research and extension system.

The government of Ethiopia, in collaboration with other stakeholders, has recently paid due attention to the livestock sector in order to improve it. Now farmers are participating in innovations. They work with researchers, extension agents, non-governmental organizations and private companies; though the system does not bring long-lasting solutions to the sector. The livestock market has improved, and farmers get information through the Livestock Market Information System. Improved varieties are being introduced, and veterinary services are relatively available. A cut and feed system has been introduced and animal feed production is promoted in different systems.

Sedentarization of the pastoral community is also a concept which can be effectively used to address lack of enough grazing land for nomadic life. Area closure, which helps rural communities protect their natural resources from degradation, is an important step that is being implemented throughout the country, with some differences between regional states. The efforts made by the different actors brought some changes in the livestock and other animal production sectors, but the contribution of the sector to improve the lives and livelihoods of the sector is almost insignificant when compared to its potential. Innovations are therefore critically important in order to foster the contribution of livestock sector or animal production sectors in general." (Gedif et. al., 2016).

3.2.2 Crosscutting Innovation

Agriculture hotline
In 2014 the ATA successfully launched an agricultural hotline service along with the Ministry of Agriculture, the EIAR and Ethio Telecom. The service provides farmers with advice and delivers timely information about the latest innovations and new husbandry practices tailored to the producers. It is part of the government's bigger initiative to commercialize smallholder subsistence farmers. The hotline is highly popular, with an average of 176,431 new and 879,573 return calls a month. It provides farmers with free information on crop planting, fertilizer use and land preparation.

Crop insurance
The Nyala insurance company, one of the leading private insurance companies in Ethiopia, introduced two types of crop insurance: multiple-peril crop insurance (MPCI) and index-based weather insurance in 2008 and 2009 respectively. It was thereby taking into account the situation of highly rainfall dependent subsistence farmers and their inability to provide collateral. The MPCI insures farmers against a range of shocks including rainfall shortages, excess rainfall, fires and transit risks. The index-based weather insurance is especially targeted at farmers in drought-prone areas.

Innovations in natural resources management
Adopting priority measures to tackle the aforementioned limiting factors and increase fertility and agricultural production is crucial as a basis for successful subsequent innovation. There is a broad range

of husbandry practices (some of which are indigenous, others are developed by farmers through trial and error) that create arable land and help avoid erosion. Research centers and universities are conducting research and introducing area-specific best fit innovations. To ensure that successful techniques are practiced widely, knowledge has to be shared within communities and farmer organizations as well as through vocational training. The ministry of agriculture has been implementing land management activities since the 1970s, involving international and local NGOs in the execution of projects. However, sustainable land management is still practiced on a limited scale across the country.

Many measures that decrease soil loss are linked to an increase in vegetation cover, such as stopping overgrazing and continuous cropping, practicing crop rotation with crops that create higher vegetation cover, such as chickpeas, or afforestation with the possibility of combining agroforestry and agricultural crops. Along with these soil management methods, structural and organic interventions can be used to limit soil erosion, providing barriers to soil erosion and decreasing the slope of the cultivated land. Furthermore, water harvesting and conservation techniques that have historically been used in Ethiopia, such as natural runoff spreading and flood diversion, could be re-employed at low costs. Integrating livestock and crop production would increase soil fertility through animal manure. Soil fertility can also be improved by planting nitrogen-fixing agents such as Acacia trees. To make soil conservation possible, farmers have to be trained in better management and conservation practices. Aside from increasing agricultural productivity, controlling the runoff of fertile soil has the benefit of improving the often poor fresh water quality (Taddese, 2001).

Institutional innovations for farmers

Farmers are organized in cooperatives, working forces, and are being trained at FTCs. The development agents (at least three in each *kebele*) are important resources. The network from the national to grass root level is workable and promising. Ministries have respective offices up to district level.

The investment framework designed by the government is also promising. In addition to this, the interest of farmers in modern technology is a potential area for small businesses and investments. The introduction of improved seed varieties has been successful. Another opportunity is in the research environment in all the regions. The agricultural research centers, the growing number of universities and training centers can be viewed as opportunities, if their capacities are built at optimum level.

Focusing on approaches suitable for small-scale farmers is crucial, since they manage about 95% of the total cultivated area and produce 90% of total agricultural output. They typically use traditional technologies and produce on a low input, low output basis (Deressa, 2007). Due to a multitude of economic reasons and personal characteristics, the rate of adoption of new technologies is low for Ethiopian peasants. Training and promotion will have to be embedded in all approaches.

Kristensen *et al.* (2004) provide a list of approaches suitable for empowering Ethiopian small-scale farmers, especially dairy producers. Therein, vocational training, the promotion of farmer organization and increased cooperation along the value chains play an important role, as do improved infrastructure, access to information and agricultural and veterinary services. The agricultural R&D sector should work with participatory methods and support pro-poor research and advisory services that are smallholder-oriented.

4 Suggestions for collaboration

The German Federal Ministry for Economic Cooperation and Development (BMZ) has set up innovation centers for the agriculture and food sector in Ethiopia. The following themes are potential areas of collaboration:

- Innovations on agricultural technology production. There are a number of limitations in supplying appropriate technologies to the rural farmer. Erratic rainfall is one of the problems in Ethiopia which results in frequent drought. Since the country receives more than 800 mm of average rainfall, water harvesting is believed to reduce the impact of volatility. For this technological inputs are necessary. Water lifting/ pumping technologies, small scale water harvesting structure constructions, etc. are needed;
- Integration and linkage between the innovators (research groups or local) and the platforms are insufficient. Most innovators and researchers are working separately from one another. Working in a fragmented way is ineffective and reduces the chance of actually achieving change. Therefore, integration and linkage need to be established;
- Capacity building for value addition for agricultural outputs is lacking. The livestock sector in the country has particularly high potential. But the sector is not well developed to exploit the resources;
- The research being conducted is plentiful. Yet the problems which are at the core of the research projects and which affect the rural people continue to exist. This is sometimes attributed to the exclusion of farmers as stakeholders during the research process.

The following bodies could be good partners:

- Research centers of universities;
- Cooperatives and cooperative unions;
- EIAR and their branch at the regional level;
- Private seed producers;
- Ministry of Agriculture and its line offices at the district level;
- Research centers like Consultative Group on International Agricultural Research, International Livestock Research Institute, International Maize and Wheat Improvement Center, International Center for Agricultural Research in the Dry Areas, International Crops Research Institute for the Semi-Arid Tropics etc.
- International agencies such as International Fertilizer Development Center, International Fund for Agricultural Development etc. (Gedif et. al., 2016).

The focus of further research to develop innovations should be directed to

- Improved water management practices
- Improved soil conservation practices
- Improved input credit systems with crop insurance
- Improved resilience against climatic shocks (Gedif et. al., 2016)

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Annex A: Background Information on Nutrition

This annex provides background information on diet quantity and quality, child feeding practices and nutrition status (including micronutrient deficiencies) and definitions of the food and nutrition security indicators presented in Chapter 1.4.2.

Background on food and nutrition security

Diet quantity: Dietary energy supply per capita is an indicator of diet quantity that can be gauged against a population's average dietary energy requirement. The data are based on FAO's food balance sheets that estimate the quantity of each food item available for human consumption at the national level. It has to be emphasized that supply does not equal intake: Supply includes food that households feed to domestic animals or pets and food that they waste. Also, a sufficient average supply of dietary energy (or a nutrient such as protein) may leave those parts of the population deprived that have greater-than-average requirements or lower-than-average intakes. Indicators of undernourishment and food over-acquisition seek to consider the distribution of dietary energy consumption in the population and the minimum/maximum requirements of the average individual in a country (Cafiero, 2014).

Diet quality: Assessing diet quality requires a look at the composition of the diet. In the absence of national food consumption surveys for most countries, data from FAO's food balance sheets are used. The percentage of dietary energy supply from starchy staples (cereals, roots and tubers) is a rough indicator of diet quality: generally, the higher this percentage, the lower the micronutrient density of the diet; starchy staples are rich in carbohydrate and good sources of dietary energy, but they are usually not very micronutrient-rich. Non-staple foods are important for micronutrient and protein supply: Foods of animal origin are good sources of high-quality protein and vitamin A as well as highly bioavailable iron and zinc (meat, fish) and calcium (milk, small fish eaten whole with bones). Pulses and nuts are also good sources of protein and micronutrients. Fruits and vegetables provide a range of micronutrients while generally contributing little dietary energy (USDA, 2016).

The shares of dietary energy supply from carbohydrate, protein, and fat roughly indicate whether the diet is balanced in terms of its macronutrient composition. The recommended shares of dietary energy are 55-75% for carbohydrate, 10-15% for protein, and 15-30% for fat (WHO, 2003). It should be noted that these shares do not reveal whether dietary energy supply per capita and average protein supply are insufficient, sufficient, or excessive in absolute terms. A diet that meets the average dietary energy requirement for Africa as a whole (2200 kcal/day according to FAO, 2016) and provides 55-82.5 g protein per day and 36-73 g fat per day contains the recommended shares of 10-15% of dietary energy from protein and 15-30% of dietary energy from fat. For an adult weighing 60 kg, a protein intake of 50 g/day is considered sufficient, and 60 g/day for an adult weighing 75 kg. No safe upper limit of protein intake has been established, but it is unlikely that intakes of twice the recommended level pose any risk (WHO/FAO/UNU, 2007).

Child feeding practices: Feeding practices are determined by local food availability and household access to food, but also by maternal knowledge and care. Breastfed and non-breastfed children aged 6-23 months should eat foods rich in iron (meat, fish, or eggs) and fruits and vegetables rich in vitamin A daily, and consume at least 4 out of 7 food groups every day (PAHO/WHO, 2003; WHO, 2005; WHO, 2010).

Nutrition status: Household food security, the health environment, and mothers' caring capacity influence children's dietary intakes and the risk of infection, and thereby their nutrition and health status (UNICEF, 2013). Wasting, or acute undernutrition, is the result of recent rapid weight loss or the failure to gain weight that is caused by inadequate diets or infection. Stunting is the failure to grow adequately and results from chronic or recurrent undernutrition or infection (UNICEF/WHO/World Bank, 2016). Stunting in early childhood can have irreversible consequences, such as impaired motor and cognitive development, shorter adult height, lower attained schooling, and reduced adult income, whereas wasting carries a higher mortality risk (Victora et al. 2008; Black et al. 2013; Olofin et al. 2013). Overweight in children and overweight and obesity in adults occur when dietary energy intakes exceed dietary energy

requirements. Overweight and obesity increase the risk of noncommunicable diseases (UNICEF/WHO/World Bank, 2016).

Micronutrient deficiencies arise from insufficient intakes or absorption of essential vitamins and minerals. Major causes are poor diets, diseases, and increased requirements during life stages such as early childhood, pregnancy, and lactation. Micronutrient deficiencies are not limited to poor populations with inadequate dietary energy intakes, but may coexist with overweight and obesity in individuals and communities. Measuring micronutrient deficiencies poses challenges: There is often a need to resort to proxy indicators and large data gaps persist. Anemia, for example, is used as a proxy indicator for iron deficiency, although only about half of the global burden of anemia can be attributed to iron deficiency. Iron deficiency anemia impairs cognitive and motor development, causes fatigue and low productivity, and may result in low birth weight and increased maternal and perinatal mortality if pregnant women are affected (WHO 2015b). Whenever survey data on anemia prevalence are not available, modeled estimates from WHO (2015b) are used. Vitamin A deficiency increases the risk of vision problems, infectious diseases, and death among children (Imdad et al., 2010). Without exception, the data on vitamin A deficiency that are presented in this dossier are modeled estimates (Stevens et al., 2015, quoted in IFPRI, 2015).[13]

Table A1: Cutoffs to identify nutrition problems of public health significance in children

Category of public health significance	Stunting	Wasting	Overweight	Iron deficiency anemia
Severe	≥40	≥15	≥10	≥40
Moderate	30-39	10-14	5-9	20-39
Mild	20-29	5-9	3-4	5-19

Source: Adapted from World Bank (2006) and based on data from WHO (1995) and WHO (2000)

Notes: The cutoffs for public health significance were applied to prevalence rates of stunting, wasting, overweight and iron deficiency anemia (estimated from anemia prevalence) that were rounded to the first decimal. In the tables in Chapter 1.4.2, the data have been rounded to integers, which may lead to seeming contradictions: In a region where 29.8% of children under five were stunted (30% if rounded), stunting would be considered a mild public health problem, and in a region where 30.3% of children under five were stunted (also 30% if rounded), stunting would be considered a moderate public health problem.

Indicator definitions

Dietary energy supply: National average energy supply, expressed in kcal/caput/day (FAO, 2016).

Average dietary energy supply adequacy: Dietary energy supply expressed as a percentage of the average dietary energy requirement. Each country's average supply of calories for food consumption is divided by the average dietary energy requirement estimated for its population to provide an index of adequacy of the food supply in terms of calories (FAO, 2016).

Prevalence of undernourishment: Probability that a randomly selected individual from the population consumes an amount of calories that is insufficient to cover her/his energy requirement for an active and healthy life (FAO, 2016). This indicator seeks to estimate of the percentage of individuals in the population who are chronically undernourished because they fail to meet their minimum dietary energy requirements on a consistent basis.

Prevalence of food over-acquisition: Percentage of individuals in a population who tend, on a regular basis, to acquire food in excess of their maximum dietary energy requirements (FAO, 2016).

Dietary energy supply from cereals, roots and tubers: Percentage of dietary energy supply provided by cereals, roots and tubers (FAO, 2016). A higher share of dietary energy supply from cereals, roots and tubers is generally associated with a lower micronutrient density of the diet.

[13] Iodine deficiency disorders are an important public health problem in many countries. They are not discussed here because salt iodization, the main prevention and control strategy, is not related to agricultural value chains.

Dietary energy supply from carbohydrate: Percentage of dietary energy supply provided by carbohydrates, calculated by subtracting dietary energy supply from protein and dietary energy supply from fat from 100%.

Dietary energy supply from protein: Percentage of dietary energy supply provided by protein, calculated as average protein supply times 4 kcal/g divided by total dietary energy supply.

Dietary energy supply from fat: Percentage of dietary energy supply provided by fat, calculated as average fat supply times 9 kcal/g divided by total dietary energy supply.

Average protein/fat supply: National average protein/fat supply, expressed in g/caput/day (FAO, 2016).

Minimum dietary diversity: consumption of 4+ food groups: Percentage of children aged 6-23 months fed four or more food groups in the 24 hours preceding the survey. The food groups are 1) infant formula, milk other than breast milk, cheese or yogurt or other milk products; 2) foods made from grains, roots, and tubers, including porridge and fortified baby food from grains; 3) vitamin A-rich fruits and vegetables (and red palm oil); 4) other fruits and vegetables; 5) eggs; 6) meat, poultry, fish, and shellfish (and organ meats); 7) legumes and nuts (ICF International, 2015, The DHS Program STATcompiler).

Consumption of foods rich in vitamin A: Percentage of children aged 6-23 months who consumed foods rich in vitamin A in the 24 hours preceding the survey. Foods rich in vitamin A include meat (and organ meat), fish, poultry, eggs, pumpkin, red or yellow yams or squash, carrots, red sweet potatoes, dark green leafy vegetables (for example, cassava leaves, pumpkin leaves, kale or spinach), mango, papaya, and other locally grown fruits and vegetables that are rich in vitamin A (ICF International, 2015, The DHS Program STATcompiler).

Consumption of foods rich in iron: Percentage of children aged 6-23 months who consumed foods rich in iron in the 24 hours preceding the survey. Foods rich in iron include meat (and organ meat), fish, poultry, and eggs (ICF International, 2015, The DHS Program STATcompiler).

Child wasting: Percentage of children under five who are wasted, that is, have weight-for-height below minus 2 standard deviations of the median of the WHO Child Growth Standards. This means that they are too thin for their height (UNICEF/WHO/World Bank, 2016).

Child stunting: Percentage of children under five who are stunted, that is, have height-for-age below minus 2 standard deviations of the median of the WHO Child Growth Standards. This means that they are too short for their age (UNICEF/WHO/World Bank, 2016).

Child overweight: Percentage of children under five who are overweight, that is, have weight-for-height above 2 standard deviations of the median of the WHO Child Growth Standards. This means that they are too heavy for their height (UNICEF/WHO/World Bank, 2016).

Adult overweight and obesity/overweight and obesity among women of reproductive age: Percentage of adults aged 18 years or older/percentage of women of reproductive aged 15-49 years whose body mass index (BMI) is equal to or greater than 25 kg/m2 (WHO, 2015a; ICF International, 2015, The DHS Program STATcompiler). BMI is calculated by dividing body weight in kg by squared height in m.

Adult obesity/obesity among women of reproductive age: Percentage of adults aged 18 years or older/percentage of women aged 15-49 years whose body mass index (BMI) is equal to or greater than 30 kg/m^2 (WHO, 2015a; ICF International, 2015, The DHS Program STATcompiler).

Adult underweight/underweight among women of reproductive age: Percentage of adults aged 18 years or older/percentage of women aged 15-49 years whose body mass index (BMI) is below 18.5 kg/m^2 (ICF International, 2015, The DHS Program STATcompiler).

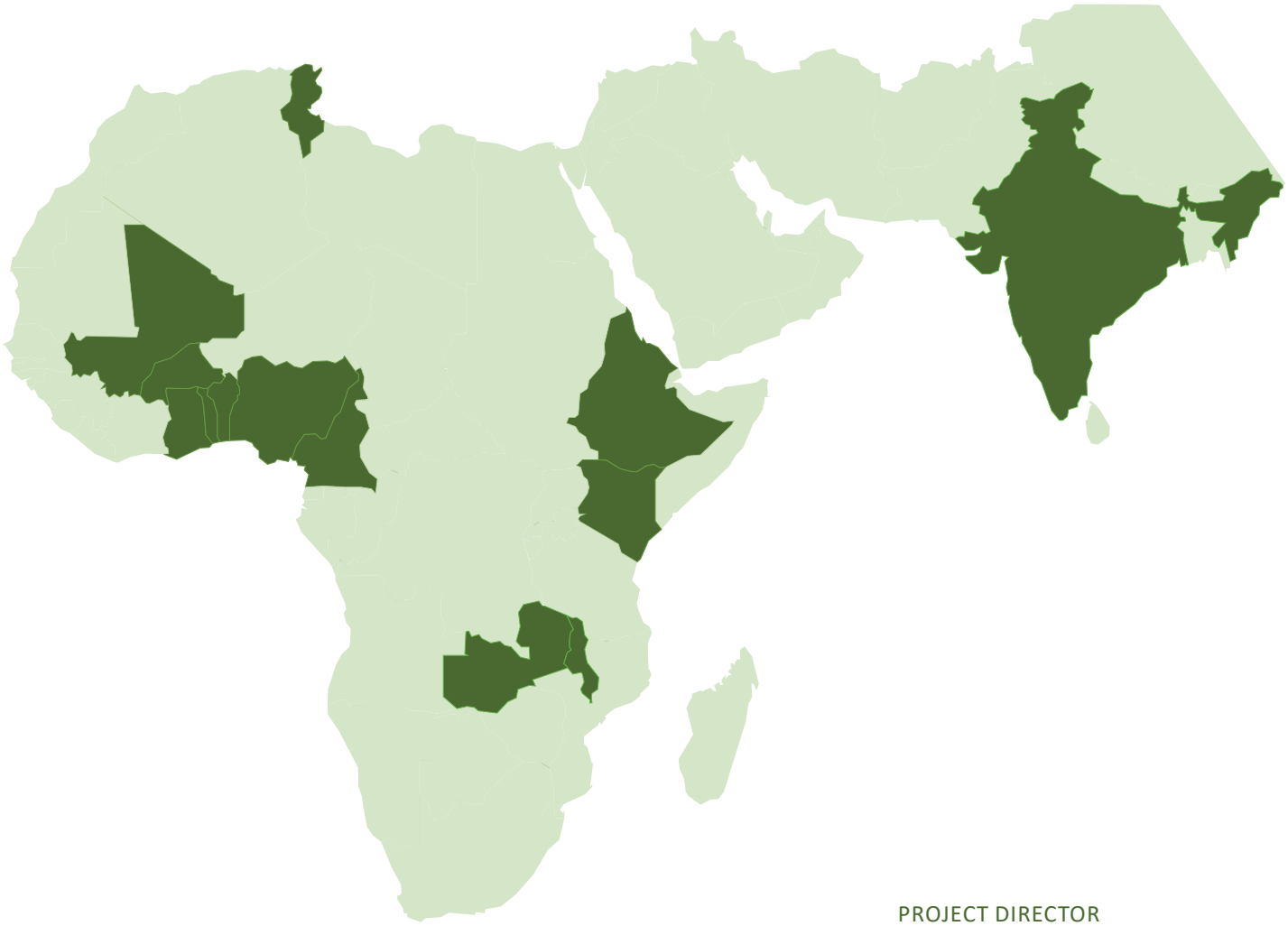
Vitamin A deficiency: Percentage of children aged 6-59 months with a serum retinol concentration below 0.7 µmol/l.

Anemia in children: Percentage of children aged 6-59 months with anemia, namely, a blood hemoglobin concentration below 11.0 g/dl.

Anemia in women: Percentage of women aged 15-49 years with anemia, namely, a blood hemoglobin concentration below 12.0 g/dl for non-pregnant women and below 11.0 g/dl for pregnant women.

ABOUT PARI

The Program of Accompanying Research for Agricultural Innovation (PARI) brings together partners from Africa, India and Germany to contribute to sustainable agricultural growth and food and nutrition security in Africa and India as part of the “One World, No Hunger” Initiative supported by the German government.



PROJECT DIRECTOR
Prof. Dr. Joachim von Braun

Center for Development Research (ZEF)
Genscherallee 3
53113 Bonn, Germany
E-Mail: pari@uni-bonn.de
Phone: +49 - (0)228-73 6740

www.research4agrinnovation.org

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